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# Is the relationship between socioeconomic status (SES) and student achievement causal? Considering student and parent abilities

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**ABSTRACT**

Most studies on the relationship between students' socioeconomic status (SES) and student achievement assume that its effects are sizable and causal. A large variety of theoretical explanations have been proposed. However, the SES–achievement association may reflect, to some extent, the inter-relationships of parents' abilities, SES, children's abilities, and student achievement. The purpose of this study is to quantify the role of SES vis-à-vis child and parents' abilities, and prior achievement. Analyses of a covariance matrix that includes supplementary correlations for fathers and mothers' abilities derived from the literature indicate that more than half of the SES–achievement association can be accounted for by parents' abilities. SES coefficients decline further with the addition of child's abilities. With the addition of prior achievement, the SES coefficients are trivial implying that SES has little or no contemporaneous effects. These findings are not compatible with standard theoretical explanations for SES inequalities in achievement.

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## Introduction

Parents' socioeconomic status (SES) is considered the major influence on a range of students' educational outcomes including student achievement. The general assumption is that aspects of SES, such as parents' education and occupation, and family income, have strong and policy-relevant causal relationships with student achievement. A large variety of theoretical explanations have been proposed to account for the SES–achievement relationship often citing economic, cultural, and school factors.

Economic theories emphasise the ability of affluent parents to buy educational success for their children, by sending them to expensive private schools or living in neighbourhoods serviced by high-quality public schools (Heckman, 2000; Orr, 2003). They can employ tutors or purchase other types

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of shadow education (Byun et al., 2018). At the other end of the economic continuum, families cannot afford basic educational resources and their schools are poorly resourced (Parcel & Dufur, 2001). Yeung and Conley (2008) suggest that the wealth–achievement relationship can be accounted for, at least in part, by higher quality home environments and better parenting behaviours. Mayer (1997, pp. 45–54) distinguishes "investment" and "good parent" explanations for why family income may be important. High-income households can invest in their children's education whereas low-income parents are unable to do so. Furthermore, low income causes stress which inhibits good parenting.

There are a variety of cultural explanations for SES inequalities in student achievement. These include: codes of speech (Bernstein, 1971); attitudes to the value of education (Hyman, 1966); parenting style (Baumrind, 1966, 1989); educational plans and expectations (Berthelsen & Walker, 2010; Brookover et al., 1967); home literacy environments (Park, 2008); scholarly culture (Evans et al., 2014); the frequency of reading to children (Kalb & van Ours, 2014); student engagement (Tomaszewski et al., 2020); involvement with children's schoolwork (Berthelsen & Walker, 2010); and class cultures (Lareau, 1989). Brown and Iyengar (2008, p. 24) account for the parental education–achievement relationship to increased opportunities, parental beliefs and attitudes concerning the value and utility of education, and, notably, the transmission of cognitive competencies.

School tracking and streaming (or setting) are prominent explanations for the SES–achievement relationship. The general argument is that high-SES students colonise the most academic or prestigious tracks in which the curriculum is more demanding, boosting academic performance. In contrast, lower SES and minority students are relegated to the lower tracks (Ansalone, 2003; Domina et al., 2017; Oakes & Lipton, 1990; van de Werfhorst & Mijs, 2010). Other aspects of schools postulated as important to SES inequalities in achievement include: school quality (Rouse & Barrow, 2006); teacher quality (Chiu, 2015); school effectiveness (Hobbs, 2016); school climate (Berkowitz et al., 2017); school differences in opportunities to learn (Yang Hansen & Strietholt, 2018); and school resources (Greenwald et al., 1996).

The most prominent explanation for the SES–achievement relationship is cultural capital theory, which argues that high-SES students are advantaged by their familiarity with elite culture, which is also the dominant culture of education systems and schools, so high-SES students are naturally rewarded by teachers and other educational gatekeepers (Kingston, 2001; Lareau & Weininger, 2003).

Despite the large theoretical, empirical, and policy-focused literatures on SES, the SES–achievement relationship is not strong. White's (1982) meta-analysis of over 200 mainly US studies of student achievement calculated a mean correlation between SES, measured in various ways, and academic achievement (at the student level) of only 0.22. A later study by Sirin (2005, p. 437) with better measures of SES calculated average correlations around 0.30. The SES–achievement correlations increase with the number of SES components in composite measures, from below 0.20 for single indicator measures of SES to around 0.40 for some composite measures (White, 1982, pp. 468, 470). Harwell et al.'s (2017) meta-analysis of the SES–achievement relationship calculated an average SES–achievement correlation of 0.22, which the authors describe as surprisingly modest.

The influence of SES on student performance is very small when considering prior achievement. For the US, Benner et al. (2016, p. 1059) report a standardised coefficient of 0.09 for family SES on students' grade point average, net of prior achievement. For Germany, Baumert et al. (2010, pp. 159–160) report no statistically significant estimates for the International Socio-Economic Index (ISEI), a measure of occupational status, on mathematics achievement score, and one statistically significant (but very small) estimate for parental education, net of prior achievement in mathematics and cognitive ability. Armor et al. (2018, p. 624), analysing system-wide population data from North Carolina, reported standardised coefficients of 0.06, 0.01, and 0.72 for SES (the measure included parents' education), school SES, and prior achievement on mathematics achievement score and standardised coefficients of 0.07, 0.02, and 0.69 for reading.

Although it is well known that prior achievement has very strong relationships with student achievement, it is not well appreciated. For example, the Organisation for Economic Co-operation and Development's reports based on the Programme for International Student Assessment (PISA) do not discuss prior achievement, nor consider that their conclusions on the importance of SES for student achievement and school differences are unlikely to be supported if their analyses included prior achievement. If prior achievement is at all considered, it is frequently regarded as just another influence, ignoring its much stronger impact than any other predictor. Furthermore, it is often falsely assumed that prior achievement is mostly a function of SES, so is disregarded theoretically and in policy discussions.

## *An alternative explanation*

An alternative explanation for the SES–achievement relationship involves parents' and their children's cognitive abilities, and genetic transmission from parents to children. In Western, educated, industrialised, rich, and democratic (WEIRD) countries, the observed relationships of family income, parents' occupation, and education, or composite SES measures, with achievement may be largely due to their associations with parent and student abilities. Parents' socioeconomic characteristics are correlated with parental ability; there is genetic transmission of ability from parents to their children (i.e., transmission of cognitive competencies); student ability is a strong correlate of student achievement;

and both cognitive ability and student achievement have sizable genetic components. Therefore, much of the theorising and policy discussions on the SES–achievement relationship may be irrelevant.

Parents' ability is correlated with SES and commonly used SES components. According to "best" studies in Strenze's (2007, p. 411) meta-analysis, the average correlations of cognitive ability, measured between ages 3 and 23, was 0.56 with educational attainment, 0.45 with occupational status, and 0.23 with income among adults. Torres (2013, p. 166) reported a correlation of 0.53 between mother's Armed Forces Qualification Test (AFQT) score, a commonly used measure of ability, measured during adolescence or early adulthood, and family SES measured decades later.

The average correlation between the parental cognitive ability (mostly mothers) and their biological child, based on 8,000 pairs, is 0.42 (Plomin et al., 2013, p. 195). The father–child ability correlation is also between 0.4 and 0.5 (Anger, 2012; Black et al., 2009; Grönqvist et al., 2017; Scarr & Weinberg, 1978). The correlation between parents and their children's intelligence increases with children's age (Plomin et al., 2013, p. 201).

Achievement and cognitive ability are strongly correlated. For the US, Walberg (1984, p. 23) computed an average correlation of 0.71 between various IQ measures and academic achievement. Duckworth et al. (2012, p. 443) reported correlations between 0.7 and 0.8 for IQ measured in Grade 4, and Grade 5 and 9 achievement tests. For Germany, Baumert et al. (2012, Table S1) reported correlations around 0.5 for IQ with both reading and mathematics. Kriegbaum et al. (2015) reported a correlation of 0.55 between a measure of fluid intelligence and PISA 2003 score in mathematics. Rindermann (2018, p. 53) cites a German study that calculated an average correlation of 0.65 between cognitive ability and student performance in PISA. For the Netherlands, Bartels et al. (2002) reported a correlation of 0.63 between IQ and performance in the CITO tests at 12 years of age. Kriegbaum et al.'s (2018, p. 135) meta-analysis estimated a correlation of 0.44 between intelligence and achievement. With corrections for range restriction and attenuation, the correlations were between 0.6 and 0.7.

Parents' abilities have stronger relationships with achievement than SES. Analysing data from children of mothers of the National Longitudinal Survey of Youth 1979 (NLSY79-C), Currie and Thomas (1999, p. 302) reported standardised coefficients of between 0.6 and 0.7 for mother's Armed Forces Qualification Test (AFQT) score, a commonly used measure of ability, on child's Peabody Picture Vocabulary Test (PPVT) score compared to a standardised coefficient around 0.2 for SES. Similarly, Carlson and Corcoran (2001, p. 789) reported large standardised coefficients for mothers' AFQT scores on their 7- to 10-year-old children's reading and math scores, with much smaller coefficients for family income. In the UK's Millennium Cohort Study (MCS), the addition of mother's and her partner's language abilities reduced the coefficients for social class on child's language skills to statistical insignificance and substantially reduced the coefficient for parental education by about one half (Sullivan et al., 2021).

### Genetics

Cognitive ability has a substantial genetic component which increases with age. The key concept is heritability; the proportion of variance in a trait attributed to genetics. Haworth et al.'s (2010) meta-analysis of six large twin studies from Australia, the Netherlands, the UK, and the US found that the heritability of cognitive ability increased from 0.41 at age 9, to 0.55 at age 12, and 0.66 at age 17. Bouchard's (2009, 2013) meta-analysis including a variety of designs (twins, twins and siblings, parents and offspring) also concluded that the heritability of IQ increases with age from less than 0.25 at 5 years of age, to almost 0.80 at 18 to 20 years old.

Student achievement also has sizable genetic components. For student achievement, grades, and performance in system-wide examinations in a range of countries, the heritabilities are generally between 0.5 and 0.8, averaging about 0.7, with much lower estimates for the contribution of the common family environment (Jensen, 1998, p. 182; Plomin et al., 2013, pp. 222–228; Pokropek & Sikora, 2015). Recent meta-analyses of twin studies reported heritability estimates for student achievement ranging from 0.4 to 0.7; the contribution of the shared environment, which includes SES, was substantially smaller with estimates mostly less than 0.2 (de Zeeuw et al., 2015; Little et al., 2017).

## The current study

Conventional analyses of socioeconomic inequalities in student achievement rarely consider parents' and their children's abilities. Studies on the SES–achievement relationship without considering student ability implicitly assume children's abilities are irrelevant. In studies that find SES has statistically significant impacts on student achievement, net of student ability, most do not consider that SES effects may, at least in part, largely be proxies for parents' abilities. Parents' socioeconomic characteristics and parental behaviours may mediate the relationships between parents' abilities and achievement rather than reflect inequalities in economic or cultural resources.

The central research question of this study is to what extent is the SES–achievement association spurious, that is accounted for by confounding variables? How important is SES when considering early childhood cognitive ability, prior achievement, and parents' abilities? This study is not about establishing the causal influences on student achievement, but whether theoretical explanations for the SES–achievement relationship are plausible given that parents and children's abilities are likely to be confounders.

This study analyses both disaggregated and aggregated SES measures because both approaches are used in educational research. Disaggregated measures inform on which aspects of SES are the most or least pertinent. Composite SES measures provide single parameter estimates which are easier to interpret and facilitate comparisons across models and achievement domains.

## Materials and methods

### *Data*

The data analysed for the analysis of student achievement are from the kindergarten cohort of the Longitudinal Study of Australian Children (LSAC). The sample frame comprised government health records of in-scope children born between March 1999 and February 2000. The sample was selected through multi-stage cluster sampling (Soloff et al., 2005). The first wave of data collection occurred when the children were aged 4 or 5 in 2004. Data collection for subsequent waves occurred every 2 years. Details on the study instruments and response rates are available (Australian Institute of Family Studies [AIFS], 2018, 2019).

The LSAC data for Waves 1 to 6 were merged with student achievement data from the Australian National Assessment Program–Literacy and Numeracy (NAPLAN). Data from the Year 7 NAPLAN test were collected in May 2012 or May 2013, and Year 9 NAPLAN data were collected 2 years later (Daraganova & Edwards, 2013).

### *Measures*

#### *Student achievement*

In the LSAC data, measures of student achievement are based on their test scores in the NAPLAN assessments in Years 3, 5, 7, and 9. Student scores in each of the five domains across the 4-year levels are standardised to a mean of 500 and a standard deviation of 100 and range from 0 to 1,000. The dependent variables are students' Year 9 NAPLAN scores in numeracy and reading when they were aged 14 or 15. The prior achievement measures are their Year 7 scores in the respective domain.

#### *SES components*

There are five SES components: family income, and father's and mother's education and occupational status. Data for these measures were obtained from interviews with parents. All SES measures were constructed anew for each wave of LSAC data.

Family income was derived directly from the weekly incomes from both parents from all sources. This approach ensured that income was measured as accurately as possible (Baker et al., 2017; Mullan & Redmond, 2011). For these analyses, family income was first adjusted to 2014 dollars through the annual Consumer Price Index (CPI), then logged, and all non-missing values were averaged across waves.

Fathers and mothers' educational attainments are measured by the number of years of formal education from two variables: highest level of schooling completed and post-school qualifications. Vocational qualifications were not included since they reduce the explanatory power of the parental education measures. Fathers and mothers' education were based on the highest level of education recorded across the six waves of data.

Fathers and mothers' occupations were coded to the Australian and New Zealand Standard Classifications of Occupations (Australian Bureau of Statistics, 2006). Four-digit occupational codes were used to create measures of occupational status, the Australian Socioeconomic Index 2006, AUSEI06 (McMillan et al., 2009). AUSEI06 scores are estimated iteratively maximising the relationship between occupation and income, net of education. So that the metric estimates (unstandardised coefficients) do not appear overly small, the original zero to one-hundred-point AUSEI06 measures were divided by 10, so range between zero and 10.

### *Composite SES measure*

The composite SES measure constructed is comprehensive, reliable, and strong. It comprises the five SES components with imputed data to account for missing data and is based on multiple waves of data. For each LSAC wave, the SES components were factor analysed and the first unrotated principal components were extracted and standardised. The first factor accounted for around 40% of the variance with no trend across waves. The final measure was the mean of the SES measures from Waves 2 to 6, standardised to a mean of zero and a standard deviation of one. Its correlations with achievement ($r \approx 0.4$) are much larger than that reported in the meta-studies cited earlier.

### *Childhood ability (LSAC)*

The LSAC data include three early childhood cognitive ability measures: *Who Am I?*, the PPVT, and a *Matrix Reasoning* test. Tests were conducted by trained administrators in the children's homes.

The *Who Am I* (WAI) test assesses "the general cognitive abilities needed for beginning school" (AIFS, 2018, p. 7). WAI consisted of 11 pages on which children were to write their names, copy shapes, and write words and numbers. Each response was assessed on a 4-point scale relating to the skill required for the task (Rothman, 2005). WAI measures the cognitive processes that underlie the learning of early literacy and numeracy skills (de Lemos & Doig, 1999).

The *PPVT* assesses receptive vocabulary. The test comprises a book with 40 plates of display pictures. For each plate, children point to (or say the number of) the picture that best represents the meaning of the word read out by the interviewer. It is used as a measure of verbal ability (Dunn & Dunn, 1997). Verbal ability is a component of many standard intelligence tests.

The *Matrix Reasoning* test measures non-verbal abstract problem solving, inductive reasoning, and spatial reasoning ability. Children are shown coloured matrices or visual patterns with something missing. The child is asked to select the missing piece from a range of options. It is a component of the Wechsler (2003) Intelligence Scale for Children (WISC–IV).

The WAI test was administered only in Wave 1. The *PPVT* was administered in Waves 1, 2, and 3, and the matrix reasoning test in Waves 2 to 4. Rothman (2005) details the scaling of the *Who Am I* and *PPVT* measures for LSAC.

Data from these tests were used to construct the measure of early childhood cognitive ability. Factor analysis of the early childhood cognitive measures (WAI, PPVT, and Matrix Reasoning) was performed on data from Waves 1 to 3. The factor scores for the first unrotated factors were combined to create the measure of childhood ability.

Table 1 presents descriptive statistics for the variables used in the analyses. Table 1 shows that the major source of missing data is from the four achievement measures and, to a lesser extent, father's education and occupation. Table 2 presents the correlations.

### *Regression analyses of student achievement with observed data*

Sequential regression models were employed for the first set of analyses of Year 9 student achievement. The first model comprised only the five SES components; Model 2 adds childhood ability, and Model 3 adds same-domain Year 7 achievement score. Standardised coefficients are presented in the result tables to enable comparisons of the magnitudes of the coefficients. The metric and standardised estimates are presented in Table 3.

**Table 1.** Descriptive statistics of study variables before imputation for missing values.

| | Number of Cases | Number of Missing Cases | *M* | *SD* | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Socioeconomic status | 4,865 | 118 | −0.0 | 1.0 | −2.3 | 3.2 |
| Family Income (log) | 4,875 | 108 | 7.5 | 0.6 | 5.1 | 10.0 |
| Father's Education | 4,510 | 473 | 12.7 | 2.8 | 6.0 | 18.0 |
| Mother's Education | 4,961 | 22 | 12.9 | 2.7 | 6.0 | 18.0 |
| Father's Occupation | 4,550 | 433 | 4.9 | 2.2 | 0.5 | 10.0 |
| Mother's Occupation | 4,807 | 176 | 4.9 | 2.1 | 0.3 | 10.0 |
| Childhood Ability | 4,871 | 112 | −0.0 | 1.0 | −5.7 | 4.0 |
| Year 7 Numeracy | 3,791 | 1,192 | 555.5 | 74.0 | 343.0 | 922.8 |
| Year 7 Reading | 3,808 | 1,175 | 558.0 | 70.8 | 140.0 | 785.3 |
| Year 9 Numeracy | 3,364 | 1,619 | 603.7 | 73.4 | 268.9 | 920.0 |
| Year 9 Reading | 3,389 | 1,594 | 597.7 | 69.5 | 195.6 | 890.6 |

The second set of analyses repeats the first, replacing the five SES components with the composite SES measure generating single parameter estimates for SES (Table 4).

For these analyses, missing data were handled by multiple imputation (MI), which involves a three-step process. The first step involves multiple data sets in which missing values are replaced by values randomly drawn from the distribution of predicted values from regression analysis of the observed variables (Allison, 2012; Baraldi & Enders, 2010). Only the independent variables were used in the imputations since including the dependent variable can add error to the estimates (von Hippel, 2007). Step 2 involves estimating the parameters from the regression model for each of the 25 generated data sets with imputed data. In Step 3, the parameter estimates and standard errors from the imputed data sets were combined generating valid statistical inferences. The standardised coefficients and R square measure reported are the averages across the multiple data sets. Point estimates can be simply averaged over imputations (SAS, 2011, p. 4683).

### *Incorporating fathers and mothers' abilities*

The third and fourth sets of analyses include fathers and mothers' abilities. Although parents' abilities are not observed, their correlations with observed variables are included based on the literature.

The logic is as follows. The literature indicates that ability measured during childhood or adolescence is correlated, say, at 0.5 with educational attainment, 0.4 with occupational status, and 0.2 with income. These correlations are different for men and women. Spouses' abilities correlate at 0.4. So, these correlations are added to the observed correlation (or more correctly, the covariance) matrix, which is read by statistical software to produce regression coefficients for father's and mother's abilities and for the other predictor variables. This analytical strategy was employed during the 1960s and early 1970s in several prominent stratification and education publications to analyse properly specified theoretical models utilising different data sources (Duncan, 1966; Duncan et al., 1972; Jencks et al., 1972, pp. 320–350).

### *Supplementary correlations and their justification*

Although Strenze (2007, p. 411) did not publish separate correlations for ability and socioeconomic outcomes by gender, these were obtained from Tarmo Strenze, who kindly reran his meta-analyses. The correlations between ability, measured during childhood or adolescence, and adult education, occupational status, and family income were 0.49, 0.39, and 0.24 for men and 0.45, 0.35, and 0.12 for women. For these analyses, the correlations for parents' education and occupation were set at 0.50 and 0.40 for fathers, and 0.45 and 0.35 for mothers. Preliminary analyses indicated that the income correlations were too low producing unrealistic and "bouncing" coefficients between models. The correlations with family income were set at 0.35 for father's ability and 0.25 for mother's ability. The cross-spouse correlations for education and occupation were set at 0.25.

The correlation between one parent's ability and early childhood cognitive ability was set at 0.45. The correlations for fathers and mothers' abilities and student achievement in numeracy and literacy in Years 7 and 9 were set at 0.40. Deary et al. (2005, p. 449) report correlations of between 0.41 and 0.45 between mother's AFQT score and their children's age-adjusted achievement scores in mathematics and reading.

The correlation between spouses' cognitive abilities was set at 0.4. Plomin and Deary's (2015) review article offers a spouse correlation for ability of around 0.4. Guided by Torres's (2013, p. 166) reported correlation of 0.53 between SES and mother's ability, the correlations of the composite SES measure with fathers and mothers' abilities were set at 0.55 and 0.50, respectively.

### *The analysed covariance matrix*

As for the previous set of analyses, 25 data sets were generated that include imputed values for missing data. These data sets were then averaged, and covariances were calculated for each pair of variables. Using matrix algebra, the covariance/correlation matrix was supplemented with the correlations for father's and mother's abilities, detailed above. The number of cases was set at 3,380, based on the estimated degrees of freedom in the previous set of analyses. Table 2 presents the analysed correlation matrix, the variable means, and standard deviations, which is the basis of the regression analyses reported in Tables 5 and 6. The means and standard deviations for fathers and mothers' cognitive abilities were set at zero and one.

## Results

### *Regression analyses*

Table 3 presents the estimates from regression analyses of student achievement in numeracy and reading in Year 9 on the SES components, early childhood cognitive ability, and prior achievement. Model 1 shows that the five SES components account for 16% and 17% of the variance in Year 9 numeracy and reading. Of the SES components, family income has the weakest relationship indicated by the standardised coefficients.

Model 2 shows that childhood ability has much stronger relationships with student achievement than any of the SES components. The standardised coefficients for childhood ability are just below 0.50, and its addition more than doubles the variance explained to 36% and 38%. This is impressive since

**Table 2.** Means, standard deviations, and correlations for analyses of student achievement in secondary schools.

| | Socioeconomic status (SES) | Family Income | Father's Education | Mother's education | Father's Occ. St. | Mother's Occ. St. | Childhood Ability | Year 7 Numeracy | Year 7 Reading | Year 9 Numeracy | Year 9 Reading | Father's Ability | Mother's Ability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *M* | −0.02 | 7.48 | 12.63 | 12.89 | 4.86 | 4.88 | −0.01 | 549.48 | 552.25 | 594.36 | 589.48 | *0.00* | *0.00* |
| *SD* | 1.00 | 0.57 | 2.69 | 2.66 | 2.15 | 2.06 | 1.00 | 75.59 | 72.64 | 75.29 | 71.25 | *1.00* | *1.00* |
| SES (Composite) | 1.00 | 0.65 | 0.78 | 0.76 | 0.78 | 0.73 | 0.37 | 0.40 | 0.41 | 0.39 | 0.40 | *0.55* | *0.50* |
| Family Income (log) | | 1.00 | 0.39 | 0.38 | 0.51 | 0.48 | 0.27 | 0.26 | 0.28 | 0.24 | 0.23 | *0.35* | *0.25* |
| Father's Education | | | 1.00 | 0.46 | 0.65 | 0.40 | 0.27 | 0.32 | 0.32 | 0.33 | 0.33 | *0.50* | *0.25* |
| Mother's Education | | | | 1.00 | 0.42 | 0.66 | 0.31 | 0.32 | 0.32 | 0.29 | 0.31 | *0.25* | *0.45* |
| Father's Occupation | | | | | 1.00 | 0.43 | 0.30 | 0.31 | 0.33 | 0.31 | 0.33 | *0.40* | *0.25* |
| Mother's Occupation | | | | | | 1.00 | 0.30 | 0.30 | 0.34 | 0.29 | 0.31 | *0.25* | *0.35* |
| Childhood Ability | | | | | | | 1.00 | 0.60 | 0.62 | 0.52 | 0.54 | *0.45* | *0.45* |
| Year 7 Numeracy | | | | | | | | 1.00 | 0.69 | 0.83 | 0.64 | *0.40* | *0.40* |
| Year 7 Reading | | | | | | | | | 1.00 | 0.61 | 0.77 | *0.40* | *0.40* |
| Year 9 Numeracy | | | | | | | | | | 1.00 | 0.67 | *0.40* | *0.40* |
| Year 9 Reading | | | | | | | | | | | 1.00 | *0.40* | *0.40* |
| Father's Ability | | | | | | | | | | | | *1.00* | *0.40* |
| Mother's Ability | | | | | | | | | | | | | *1.00* |

Note: Data from the Longitudinal Survey of Australian Children (LSAC). Entries in roman font are from observed data. Italicised entries are supplementary correlations.

**Table 3.** Parameter estimates for socioeconomic-status components, early childhood ability, and prior achievement on students' Year 9 numeracy and reading performance.

| | Numeracy | | | | | | Reading | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 1 | | Model 2 | | Model 3 | |
| | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. |
| Intercept | 408.8*** | . | 468.2*** | . | 108.8*** | . | 448.4*** | . | 501.0*** | . | 177.1*** | . |
| Family Income (log) | 8.7** | 0.06 | 7.1** | 0.05 | 5.1*** | 0.04 | 3.3 | 0.03 | 2.5 | 0.02 | 2.4 | 0.02 |
| Father's Education | 4.5*** | 0.17 | 3.8*** | 0.14 | 1.5*** | 0.06 | 3.3*** | 0.13 | 2.7*** | 0.11 | 1.2** | 0.05 |
| Mother's Education | 2.9*** | 0.10 | 1.1* | 0.04 | 0.3 | 0.01 | 2.7*** | 0.10 | 1.0† | 0.04 | 0.8* | 0.03 |
| Father's Occupation | 3.2*** | 0.10 | 1.0 | 0.03 | 0.1 | 0.00 | 4.4*** | 0.14 | 2.2*** | 0.07 | 1.0* | 0.03 |
| Mother's Occupation | 3.2*** | 0.09 | 1.4* | 0.04 | 0.3 | 0.01 | 4.5*** | 0.13 | 2.8*** | 0.08 | 0.3 | 0.01 |
| Childhood Ability | . | . | 37.0*** | 0.47 | 5.8*** | 0.07 | . | . | 35.8*** | 0.48 | 10.0*** | 0.14 |
| Prior Achievement (Yr. 7) | . | . | . | . | 0.8*** | 0.77 | . | . | . | . | 0.7*** | 0.67 |
| Adjusted R Square | 0.16 | | 0.36 | | 0.73 | | 0.17 | | 0.38 | | 0.64 | |
| Degrees of Freedom | 3358 | | 3357 | | 3356 | | 3383 | | 3382 | | 3381 | |

Note: Metric = unstandardised; Std. = standardised. Multiple imputation of missing values by IM algorithm.
*0.05 < $p$ < 0.01. **0.01 > $p$ > 0.001. ***$p$ < 0.001.

childhood ability is based on tests administered when the children were aged 4 to 8 and Year 9 achievement was measured when they were 14 or 15. Controlling for childhood ability, the only SES component showing moderately sized standardised coefficients for numeracy is father's education ($\beta = 0.14$). For reading, father's and mother's education and occupation exhibit similarly sized standardised coefficients.

The stronger explanatory power of Model 2 compared to the initial SES models means that the influence of childhood ability is largely independent of SES. The SES components do not account for the impact of childhood ability. The correlations between childhood ability and achievement in Table 2 can be compared to the bivariate standardised coefficient for childhood ability on achievement. The standardised coefficients for child's ability are only reduced by around 10% after controlling for the five SES components, from 0.52 to 0.47 for numeracy and from 0.54 to 0.48 for reading. If the influence of childhood ability is accounted for by SES, then childhood ability would have only small, or statistically insignificant, standardised coefficients in Model 2.

Prior achievement has even stronger impacts on student achievement than childhood ability (Model 3). Its standardised coefficients are very large: 0.77 for numeracy and 0.67 for reading. Its addition substantially increases the variance explained to 73% for numeracy and 64% for reading. The coefficients for the SES components become trivial and are often not statistically significant. This model indicates that the contemporaneous relationships between the SES components and achievement are very small ($\beta \leq 0.06$). The addition of same-domain prior achievement also substantially reduced the standardised coefficients for childhood ability to 0.07 for numeracy and 0.14 for reading. This implies that prior achievement largely incorporates early ability.

Table 4 presents the estimates substituting the SES components with the composite SES measure. The estimates for childhood ability and prior achievement are almost identical to the estimates in the corresponding models in Table 3. Similarly, the R square values are the same or only marginally smaller for each corresponding model. After the addition of childhood ability (Model 2), the SES coefficient is reduced by about 40%[1], and its standardised coefficients are more than twice that of SES.

Consistent with the analyses reported in Table 3, the composite SES measure does not account for the correlations of childhood ability with achievement. Compared to the raw correlations in Table 2, the addition of the SES composite reduces the association between child's ability and achievement only marginally, from 0.52 to 0.48 for numeracy and from 0.54 to 0.49 for reading.

The addition of same-domain prior achievement (Model 3) reduces the standardised coefficients of SES substantially to 0.08 for numeracy and to 0.11 for reading. Again, the contemporaneous effects of SES on the achievement measures are small ($\beta \approx 0.10$).

**Table 4.** Parameter estimates for socioeconomic status (SES), early childhood ability, and prior achievement on students' Year 9 numeracy and reading performance.

| | Numeracy | | | | | | Reading | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 1 | | Model 2 | | Model 3 | |
| | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. |
| Intercept | 600.4*** | . | 596.7*** | . | 171.4*** | . | 594.6*** | . | 591.1*** | . | 225.9*** | . |
| SES | 28.8*** | 0.39 | 17.0*** | 0.23 | 6.2*** | 0.08 | 28.1*** | 0.40 | 16.7*** | 0.24 | 7.5*** | 0.11 |
| Childhood Ability | . | . | 37.1*** | 0.48 | 5.8*** | 0.07 | . | . | 36.0*** | 0.49 | 10.0*** | 0.14 |
| Prior Achievement (Year 7) | . | . | . | . | 0.8*** | 0.78 | . | . | . | . | 0.7*** | 0.67 |
| Adjusted R Square | 0.15 | | 0.35 | | 0.73 | | 0.16 | | 0.37 | | 0.64 | |
| Degrees of Freedom | 3362 | | 3361 | | 3360 | | 3387 | | 3386 | | 3385 | |

Note: Metric = unstandardised; Std. = standardised. Multiple imputation of missing values by IM algorithm.
*0.05 < $p$ < 0.01. **0.01 > $p$ > 0.001. ***$p$ < 0.001.

### *Incorporating father's and mother's abilities*

Table 5 presents the estimates from analyses of the variance-covariance matrix incorporating fathers and mothers' abilities. Models 1 and 2 are included to compare the two approaches: the standard approach analysing variables in a data set and analysing the appropriate variance-covariance matrix. The metric coefficients from the two approaches for the SES components in Model 1 are very similar (compare Model 1 in Tables 3 and 5); the standardised coefficients are often identical. The estimates for childhood ability in Model 2 (Table 5) are slightly lower in the variance-covariance matrix approach compared to the standard variable approach (Model 2 in Table 3). In Model 2, the small coefficients for the SES components tend to be slightly higher with the covariance matrix approach, except for family income, which is lower. Therefore, the estimates are robust to the analytical approach employed.

Model 3 shows that the addition of father's and mother's abilities reduces the coefficients for father's and mother's education compared to Model 1. Compared to Model 1, the metric coefficients for father's education on numeracy declines from 4.7 to 2.3 and for reading from 3.6 to 1.3. The initially smaller coefficients for mother's education also decline substantially. The coefficients for father's and mother's occupational status increase slightly. In Model 3, the standardised coefficients for the five SES components are small: around 0.10 or lower, and a few are not statistically significant. The standardised coefficients for father's and mother's abilities are moderate between 0.20 and 0.25.

Childhood ability is added in Model 4. The coefficients for the SES components tend to decline further, and the coefficients for father's and mother's abilities are substantially lower, indicating that much of the impact of parents' abilities are mediated by child's ability. With the addition of prior achievement in Model 5, the standardised coefficients for the SES components and childhood ability are only very small.

For the analyses reported in Table 6, the SES components are replaced by the SES composite measure providing single parameter estimates for SES. The coefficients for the composite SES measure in Models 1 and 2 are identical with the two analytical approaches (compare Models 1 and 2 in Tables 4 and 6). The variance-covariance approach produces slightly weaker coefficients for childhood ability in Model 2, which reduces the explanatory power of the model. Comparing the estimates in Models 1 and 3, about 60%[2] of the relationship between SES and student achievement can be accounted for by fathers and mothers' abilities. The coefficients for fathers and mothers' abilities are almost identical (Model 3, Table 6) to the corresponding coefficients in the SES component analyses reported in Table 5, further evidence of the robustness of the approach. Model 4 shows that the associations between SES and achievement, net of parents' and their children's abilities are small ($\beta = 0.13$, $0.15$). The residual coefficients for parents' abilities most likely represent parental

**Table 5.** Parameter estimates for socioeconomic-status components, early childhood ability, parents' abilities, and prior achievement on students' Year 9 numeracy and reading performance.

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. |
| **Numeracy** | | | | | | | | | | |
| Intercept | 431.7*** | 0.00 | 515.5*** | 0.00 | 546.1*** | 0.00 | 561.4*** | 0.00 | 189.2*** | 0.00 |
| Family Income (log) | 6.3 | 0.05 | 1.4 | 0.01 | −0.1 | −0.00 | −1.0 | −0.01 | −2.1 | −0.02 |
| Father's Education | 4.7*** | 0.17 | 4.0*** | 0.15 | 2.3*** | 0.09 | 3.0*** | 0.11 | 1.2** | 0.04 |
| Mother's Education | 2.7*** | 0.10 | 0.8 | 0.03 | 0.3 | 0.01 | −0.3 | −0.01 | −0.7 | −0.03 |
| Father's Occupation | 3.3*** | 0.10 | 1.6* | 0.05 | 2.6*** | 0.08 | 1.5* | 0.04 | 0.6 | 0.02 |
| Mother's Occupation | 3.1*** | 0.09 | 1.9** | 0.05 | 2.6*** | 0.07 | 1.8* | 0.05 | 0.6 | 0.02 |
| Father's Ability | . | . | . | . | 15.3*** | 0.21 | 7.4*** | 0.10 | 3.2*** | 0.04 |
| Mother's Ability | . | . | . | . | 18.1*** | 0.25 | 11.1*** | 0.15 | 5.1*** | 0.07 |
| Childhood Ability | . | . | 32.2*** | 0.44 | . | . | 26.0*** | 0.35 | −0.8 | −0.01 |
| Year 7 Numeracy | . | . | . | . | . | . | . | . | 0.8*** | 0.78 |
| Adjusted R Square | 0.15 | | 0.32 | | 0.26 | | 0.34 | | 0.70 | |
| **Reading** | | | | | | | | | | |
| Intercept | 469.3*** | 0.00 | 550.8*** | 0.00 | 577.6*** | 0.00 | 592.8*** | 0.00 | 268.9*** | 0.00 |
| Family Income (log) | 0.9 | 0.01 | −3.8 | −0.03 | −5.2* | −0.04 | −6.1** | −0.05 | −6.5*** | −0.05 |
| Father's Education | 3.6*** | 0.14 | 3.0*** | 0.11 | 1.3* | 0.05 | 1.9*** | 0.08 | 0.9* | 0.03 |
| Mother's Education | 2.5*** | 0.10 | 0.7 | 0.03 | 0.4 | 0.01 | −0.2 | −0.01 | −0.0 | −0.00 |
| Father's Occupation | 4.5*** | 0.14 | 2.8*** | 0.09 | 3.8*** | 0.12 | 2.7*** | 0.08 | 1.4** | 0.04 |
| Mother's Occupation | 4.4*** | 0.13 | 3.2*** | 0.09 | 4.0*** | 0.12 | 3.2*** | 0.09 | 1.0 | 0.03 |
| Father's Ability | . | . | . | . | 15.0*** | 0.22 | 7.2*** | 0.10 | 4.3*** | 0.06 |
| Mother's Ability | . | . | . | . | 16.3*** | 0.23 | 9.4*** | 0.14 | 5.0*** | 0.07 |
| Childhood Ability | . | . | 31.3*** | 0.45 | . | . | 25.7*** | 0.37 | 3.1** | 0.04 |
| Year 7 Reading | . | . | . | . | . | . | . | . | 0.6*** | 0.67 |
| Adjusted R Square | 0.16 | | 0.34 | | 0.27 | | 0.36 | | 0.61 | |

Note: Metric = unstandardised; Std. = standardised. Regressions based on analyses of a covariance matrix. Sample size set at 3,380. Models 3 to 5 include supplementary correlations.
*$0.05 < p < 0.01$. **$0.01 > p > 0.001$. ***$p < 0.001$.

**Table 6.** Parameter estimates for socioeconomic status (SES), early childhood ability, parents' abilities, and prior achievement on students' Year 9 numeracy and reading performance.

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. | Metric | Std. |
| **Numeracy** | | | | | | | | | | |
| Intercept | 604.2*** | 0.00 | 604.2*** | 0.00 | 603.9*** | 0.00 | 604.1*** | 0.00 | 183.6*** | 0.00 |
| SES | 28.5*** | 0.39 | 16.8*** | 0.23 | 10.9*** | 0.15 | 9.5*** | 0.13 | 1.9* | 0.03 |
| Father's Ability | . | . | . | . | 16.4*** | 0.22 | 8.4*** | 0.11 | 4.0*** | 0.05 |
| Mother's Ability | . | . | . | . | 17.3*** | 0.24 | 9.2*** | 0.13 | 4.2*** | 0.06 |
| Childhood Ability | . | . | 31.9*** | 0.44 | . | . | 26.7*** | 0.36 | −0.9 | −0.01 |
| Year 7 Numeracy | . | . | . | . | . | . | . | . | 0.8*** | 0.78 |
| Adjusted R Square | . | 0.15 | . | 0.32 | . | 0.24 | . | 0.33 | . | 0.70 |
| **Reading** | | | | | | | | | | |
| Intercept | 598.2*** | 0.00 | 598.2*** | 0.00 | 597.9*** | 0.00 | 598.1*** | 0.00 | 240.3*** | 0.00 |
| SES | 27.9*** | 0.40 | 16.4*** | 0.24 | 11.7*** | 0.17 | 10.3*** | 0.15 | 3.3*** | 0.05 |
| Father's Ability | . | . | . | . | 14.9*** | 0.22 | 6.9*** | 0.10 | 4.1*** | 0.06 |
| Mother's Ability | . | . | . | . | 15.9*** | 0.23 | 7.8*** | 0.11 | 4.4*** | 0.06 |
| Childhood Ability | . | . | 31.1*** | 0.45 | . | . | 26.7*** | 0.39 | 3.2** | 0.05 |
| Year 7 Reading | . | . | . | . | . | . | . | . | 0.6*** | 0.67 |
| Adjusted R Square | . | 0.16 | . | 0.33 | . | 0.25 | . | 0.35 | . | 0.61 |

Note: Metric = unstandardised; Std. = standardised. Regressions based on analyses of a covariance matrix. Sample size set at 3,380. Models 3 to 5 include supplementary correlations.
*0.05 < $p$ < 0.01. **0.01 > $p$ > 0.001. ***$p$ < 0.001.

behaviours to their children, associated with parental abilities but independent of SES. With the addition of prior achievement in Model 5, the coefficients for SES are very small, indicating that SES has only a very weak contemporaneous influence on student achievement.

## Discussion and conclusions

There are several limitations to this study. First, the child ability measure was obtained when the children were very young and is likely to include substantial amounts of measurement error. The coefficients for child's ability would be stronger if obtained when the children were older. A second limitation is that there are many missing data, which may have affected the estimates, although the imputation strategy used is appropriate. A third limitation is that it is not possible to incorporate genetics into the analyses, since the study did not include twins, siblings, and stepsiblings, which have different biological relationships. The most obvious limitation of the study is that it did not analyse actual measures of father's and mother's abilities. The estimates are ultimately based on correlations from the literature which may be too high or too low for this context. If the parental ability correlations are lower, the SES coefficients estimated net of parental abilities are likely to be higher. However, the analyses without parental abilities indicate that the contemporaneous impact of SES is much weaker than assumed in theoretical explanations. Of course, it would be preferable to analyse actual measures of mother's and father's abilities rather than the variance/covariance matrix, but few studies on student achievement and educational attainment collect data on parental abilities. It should be kept in mind that most analyses of student achievement assume that parents' abilities are irrelevant, that is, an implicit correlation of zero which is neither theoretically nor empirically defensible.

The common response to the strong relationship between childhood ability and achievement, and the even stronger prior-achievement–achievement relationship, is that SES has strong causal effects on both childhood ability and prior achievement. In other words, they are simply proxies for the most important influence, SES. If that were the case, the coefficients for childhood ability and prior achievement would be small in the presence of SES. This was not the case. The sizable relationship between childhood ability and achievement ($\beta \approx 0.5$) and the even stronger prior achievement–achievement relationship ($\beta \approx 0.7, 0.8$) cannot be accounted for by the weaker SES–achievement relationship ($\beta \approx 0.4$).

A second response is that stronger measures of SES would affirm the primacy of SES. In these analyses, the composite SES measure is more comprehensive, reliable, and powerful than most SES measures. It comprises five SES indictors, combined over the six waves of the study. Much care was taken to ensure that the measures were as accurate as possible. The data were obtained directly from parents, not by proxy reports from their children. Furthermore, the SES–achievement relationship is much stronger than that reported in meta-studies.

Since few studies have data on father's and mother's abilities, their relevance is seldom discussed. This study confirms the importance of parents' abilities demonstrated by analyses of the NLSY79-C and the MCS. In this study, more than one half of the SES–student achievement relationship is accounted for by fathers and mothers' abilities. Fathers and mothers' abilities are rarely considered in theoretical explanations of SES. This study also implies that the focus on SES by policymakers in most educational jurisdictions is likely to be fruitless.

Omitting or ignoring relevant important influences is known as "model misspecification" in sociology, "unobserved heterogeneity" in economics, and "the omitted variable problem" in psychology and education. It is a far more serious issue for knowledge accumulation than replicability, measurement error, or statistical technique (Schmidt, 2017; see Wai et al., 2018). Researchers should be aware that their estimates are likely to be spurious if they have not considered influences that the literature indicates are important to their variables of interest.

The point of this paper is that the common assumption that SES and its components have strong causal effects on student achievement is not tenable. Furthermore, theoretical explanations that assume strong causal effects for SES should be discarded or substantially modified. On the basis of this study and relevant academic literature, we contend that in WEIRD countries, over half of the SES–achievement relationship is accounted for by parental abilities; student ability makes an additional contribution, and the contemporaneous effects of SES are very small. Therefore, the relationships between aspects of SES (e.g., parents' education and occupation, family income and wealth) and achievement cannot be assumed to be causal, but to a considerable extent reflect their associations with parental abilities. The parental abilities–achievement relationships are likely to be mediated with factors associated with SES, for example parenting, home literacy environment, and parental beliefs and attitudes to education. This is the best explanation given the available evidence. That is not to say that all aspects of SES do not have causal effects, but in WEIRD countries their magnitudes are likely to be much smaller than commonly believed.

## Notes

1. Calculations for percentage reduction: (28.8 − 17.0)/28.8 = 0.41 and (28.1 − 16.7)/28.1 = 0.41.
2. Calculations for percentage reduction: (28.5 − 10.9)/28.5 = 0.62 and (27.9 − 11.7)/27.9 = 0.58.

## Disclosure statement

No potential conflict of interest was reported by the author.

## Notes on contributor

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