

Morris, T., Dorling, D. Davies, N. and Davey Smith, G. (2019) School enjoyment at age 6 predicts later educational achievement as strongly as socioeconomic background and gender, SocArXivPaper, August 10th, <https://osf.io/preprints/socarxiv/e6c37/>

School enjoyment at age 6 predicts later educational achievement as strongly as socioeconomic background and gender.

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Keywords: Education; achievement; emotion; GCSE; cognition; intelligence; ALSPAC.

Abstract

Education is influenced by a broad range of factors including socioeconomic background, cognitive ability, and the school environment. However, there has been limited research into the role that school enjoyment, particularly at the start of schooling, plays in the development of pupil's education and their final attainment. In this study we used data from a UK cohort, the Avon Longitudinal Study of Parents and Children to answer three related research questions. Is school enjoyment patterned by gender, socioeconomic background or cognitive ability? How well does school enjoyment explain later educational attainment? Does early school enjoyment at age 6 explain social or gender differences in later educational attainment at age 16? Our results show that school enjoyment measured at age 6 associates with gender and cognitive ability, but not with family socioeconomic background. For example, girls were over two and half times more likely to report enjoying school than boys (OR: 2.62; 95% Confidence Interval: 2.11, 3.24). School enjoyment and later attainment were also associated, whereby pupils who reported enjoying school at both ages scored on average 29.9 (20.2, 39.6) more points, equivalent to a 5-grade increase across all GCSE's, and were 72% more likely to obtain 5+ A*-C GCSE's including Maths and English (OR: 1.69; 95% CI: 1.38, 2.08) than those who did not enjoy school. Differences in school enjoyment helped to statistically explain the gender attainment gap, with boys' GCSE attainment more strongly linked to school enjoyment than girls. These results highlight the importance of school enjoyment for educational attainment. As a potentially more modifiable factor than socioeconomic background, cognitive ability or gender, school enjoyment may represent a promising intervention target for reducing educational inequalities and future experimental designs are required to test causation.

Introduction

Educational attainment is influenced by a vast array of factors including cognitive ability (Deary et al., 2007); teacher ability (Chetty et al., 2014a, 2014b); school quality (Rasbash et al., 2010; Slater et al., 2012); parental academic support (Phillips et al., 1998); family socioeconomic background (Bynner and Joshi, 2002; Morris et al., 2016); and peers (Wentzel and Caldwell, 1997). One area on which there is relatively little evidence is school enjoyment, despite its 'common sense' link to attainment (Smith et al., 2016). It has been acknowledged that enjoyment of learning is a key aim for educators and policymakers to improve pupils' educational experience and outcomes (Gorard and See, 2011), and school enjoyment is, at least intuitively, far more easily modifiable than other factors such as family socioeconomic position (Smith et al., 2016). School enjoyment may therefore offer a promising target for interventions to increase educational attainment.

Prior research has demonstrated that children who enjoy school are much more likely to outperform those who dislike school (Larson et al., 1985; Lüftenegger et al., 2016; Tze et al., 2016). In a study of 90 Chicago high school students' performance in a research project, enjoyment of the project was the second strongest predictor of final grade (behind high school grade point average) and accounted for almost half a grade difference (Larson et al., 1985). In a study of 388 psychology university students in Austria, exam enjoyment was associated with a one-sixth increase in final grade where grades were scaled from one to five (Lüftenegger et al., 2016). A meta-analysis of academic boredom and academic outcomes (motivation, learning strategies and achievement) revealed an overall correlation of -0.24 (Tze et al., 2016). Studies have also observed an association between enjoyment of specific school subjects such as Maths and reading and higher subject performance (Chiu and McBride-Chang, 2006; Prendergast and O'Donoghue, 2014; Smith et al., 2012). The inconsistent measurement of enjoyment makes these results somewhat incomparable, but the overall trend of findings from these studies suggests that enjoyment of the learning environment is positively associated with attainment.

School enjoyment has been hypothesised to result in higher academic inspiration and motivation to learn (Smith et al., 2016), which in turn leads to higher educational attainment (Vecchione et al., 2014). However, this is somewhat circular as children who perceive themselves as having low ability are less likely to enjoy school or education activities (Miserandino, 1996; Pekrun et al., 2009). School enjoyment could therefore arise from a reaction to external reward factors that high ability pupils experience rather than reflecting intrinsic motivations (Ryan and Deci, 2000). From the awarding of awards, through to being allocated to high ability sets, there are numerous ways in which the behaviour of children who act in certain ways is rewarded at schools in a manner that might lead some to feel greater satisfaction. Conversely, the awarding of punishments such as detention for some behaviours through to subtle but public chastisement of a child by a teacher in a classroom are examples of how children who do worse at school can be made to feel worse too. Previous research has, for example, found that school support is positively associated with school enjoyment while mental health-related needs are negatively associated (Smith et al., 2016).

Many previous studies have used school enjoyment as an input to constructs of positive emotions (c.f. Lüftenegger et al., 2016; Pekrun et al., 2009), but few have appropriately controlled for parental or family factors as potential confounders. This reflects a general lack of understanding of the family level drivers of school enjoyment. Friendship groups, relationships with teachers, classroom activities, teachers attitude to lessons and school facilities are also important determinants of school enjoyment (Ainley and Ainley, 2011; Gorard and See, 2011), and each of these are linked in complex ways to family background characteristics through the social structures surrounding UK education.

On average, girls have been estimated to have higher levels of school enjoyment than boys (Siann et al., 1996). However, this may not hold true across all aspects of schooling and there will be considerable variability between individual children. For example, one study found evidence that boys were more likely to enjoy maths lessons than girls (Prendergast and O'Donoghue, 2014). There is also some evidence that school enjoyment may mediate gender differences in attainment (Chiu and McBride-Chang, 2006), raising the possibility that enjoyment plays a role in the formation of gender inequalities in education. As with other drivers of educational attainment, difficulties arise in isolating the contribution that school enjoyment makes independent of other factors. The substantial socioeconomic inequalities that pervade education in the UK could confound associations (Feinstein, 2003; Jerrim and Vignoles, 2013; Morris et al., 2016; Strand, 2011).

Whether the association of school enjoyment and achievement is causal and/or confounded by factors such as family socioeconomic position has important implications for teachers and policy makers. For example, a child's enjoyment of school may partly reflect parental involvement or interest in their education, which is itself highly socially patterned (Flouri, 2006). Previous studies have focussed on enjoyment at the time of examination (Larson et al., 1985; Lüftenegger et al., 2016; Tze et al., 2016), but enjoyment may vary considerably throughout a child's schooling, from initial enrolment through to final examinations. Strong longitudinal associations between school enjoyment in early childhood and later attainment may offer promise for early intervention possibilities before educational inequalities can widen with age (Feinstein, 2003; Jerrim and Vignoles, 2013; Morris et al., 2016).

In this paper, we use data from a UK cohort study, the Avon Longitudinal Study of Parents and Children (ALSPAC), to investigate the association between school enjoyment at age six and educational attainment in nationally standardized tests at age 16. We first assess the socioeconomic patterning of self-reported school enjoyment during early childhood to determine if this could confound enjoyment-attainment associations. We then test the association between early school enjoyment and educational attainment at age 16 controlling for a range of potential confounding factors including parental education, socioeconomic position and cognitive ability to investigate if these explain associations between school enjoyment and attainment. Finally, we test whether gender differences in enjoyment help to explain the gender gap in educational attainment.

Methods

Study sample

Participants were children from ALSPAC. Pregnant women resident in Avon, UK with expected dates of delivery 1st April 1991 to 31st December 1992 were invited to take part in the study. The initial number of pregnancies enrolled was 14,541. When the oldest children were approximately 7 years of age, the study was expanded to include eligible cases who had failed to join the study originally. This additional recruitment gave a total sample of 15,247 pregnancies and resulted in 14,899 children who were alive at one year of age. For full details of the cohort profile and study design see Boyd et al (2013) and Fraser et al (2013). The study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool at <http://www.bristol.ac.uk/alspac/researchers/our-data/>. The ALSPAC cohort is largely representative of the UK population when compared with 1991 Census data; there is under representation of some ethnic minorities, single parent families, and those living in rented accommodation (Boyd et al., 2013). Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. From the core sample of 14,899 children alive at one year, 3,372 had full data. See Figure S1 in the supplementary material for a STROBE diagram detailing the causes of attrition.

Educational attainment

Our measure of educational attainment was fine graded point scores from age 16 examinations. The age 16 examinations represented the end of compulsory schooling at the time the ALSPAC cohort were in school. Fine graded point scores were used to obtain the richest measure of a child's formal attainment currently available; there is greater variability than in level bandings or binary classifications such as achieving 5 A*-C GCSE's (the required standard for many further educational and occupational opportunities). Scores were obtained through data linkage to the UK National Pupil Database, which represents the most accurate record of individual educational attainment available in the UK. The database still does not cover all children in the UK: some private schools do not submit data to the NPD, and children who have been exclusively home schooled will also not have records.

School enjoyment

At age 6 years (mean age 6.2 years, interquartile range 6.1 to 6.2) the ALSPAC participants were asked if they like school, with the response options of *yes* and *no*. Some children responded both *yes* and *no*, and these were set to missing. At age 6.5 years (mean 6.5 years, IQR 6.5 to 6.6) they were asked how much they liked going to school, with the response options *I like it a lot*, *I like it a bit*, and *I don't like it*. Responses *I like it a lot* and *I like it a bit* were coded together to maintain consistency with the binary response at age 6 years. Our final school enjoyment variable was a three-category combination of these two responses, denoting (i) children who did not enjoy school at both occasions, (ii) children who enjoyed school at only one occasion, and (iii) children who enjoyed school at both occasions. In the complete case analyses children with a missing value on either school enjoyment measure were excluded.

Covariates

Our analysis adjusted for a range of covariates including sex; month of birth; ethnicity; cohort school year; age at enjoyment questionnaire completion; cognitive ability at age 8; highest maternal education and parental social class. The ALSPAC cohort is split over three school years, so we use a three-category variable to indicate year and account for any temporal differences between the school year cohorts. Ethnicity was derived from mother reports and coded as white or non-white, to reflect the ethnic homogeneity of the cohort. Highest maternal education was recorded at pregnancy as certificate of secondary education (CSE); vocational; O-level; A-level; or Degree. CSE and vocational were combined due to low numbers. Parental socioeconomic position was measured using Social Class based on Occupation, consisting of the following categories: I (professional occupations); II (managerial and technical occupations); III-Non-Manual (non-manual skilled occupations); III-Manual (manual skilled occupations); IV (Partly skilled occupations); and V (Unskilled occupations). To avoid low numbers, categories I and II were combined, and categories IV and V were combined to give a four-category variable. Armed forces personnel were set to missing due to the inability to distinguish seniority. Cognitive ability was measured at age 8 using the Wechsler Intelligence Scale for Children (WISC) (Wechsler, 1992). The WISC was administered by members of the ALSPAC psychology team and overseen by an expert in psychometric testing, and at the time of the clinic was the most widely used individual ability test worldwide. A short form of the measure was used whereby alternate items were used for all subsets, except for the coding subtest which was administered in its full form. Raw scores were recalculated to be comparable to those that would have been obtained had the full test been administered then age-scaled to give total scores for the performance and verbal scales, and a total overall score. Short form tests have high reliability and are widely used (Crawford et al., 2010). We return to the potential implications of using cognitive ability measured after school enjoyment in the discussion.

Multiple imputation

Given the amount of attrition in the complete case sample we conducted Multiple Imputation by Chained Equations (MICE) (Royston and White, 2011). We imputed data on all variables except for sex, month of birth and ethnicity, resulting in an imputed sample size of 12,135. While the proportion of missing data are large for some variables, previous work has been demonstrated that this will not bias imputation results (Madley-Dowd et al., 2019). 100 datasets were imputed for the analyses. The supplementary material contains further details on patterns of missingness and the imputation process.

Statistical analysis

We estimated the odds of mixed enjoyment or enjoying school compared to not enjoying school using multinomial logistic regression. We estimated the association of school enjoyment and educational attainment using linear regression for fine graded GCSE point scores and logistic regression for obtaining 5+ A*-C GCSE's. Three sets of models are used for each modelling approach; the first is an unadjusted analysis controlling only for sex of child, month of birth, ethnicity, cohort school year and age at enjoyment questionnaire completion; the second additionally controls for parental occupational social class and mother's highest education; the third additionally controls for the child's cognitive ability. We present results here for the multiple imputed datasets; results from the complete case analyses are presented in the supplementary material.

Results

Descriptive statistics

Table 1 displays the descriptive statistics of the analytical sample before and after multiple imputation. Compared to the sample of 3,372 participants with full data, the descriptive statistics of the imputed sample were highly similar. 78.2% of the imputed sample enjoyed school at both occasions, 16% enjoyed school at one occasion, and 5.7% did not enjoy school at both occasions. Compared to the multiple imputed dataset, the complete case dataset resulted in underrepresentation of non-white participants, families with parents in more routine and manual occupations, families with less educated mothers, and children who scored lower on cognitive ability tests from the wider ALSPAC cohort.

Table 1: Descriptive statistics from complete case and multiple imputation samples. Percentages may not sum to 100 due to rounding.

	Complete case (n=3,372)		Missingness N (%)	Post-imputation (n=12,135)	
	N (mean)	% (SD)		N (mean)	% (SD)
GCSE points	(353.7)	(72.6)	2,213 (18.2%)	(326.16)	(89.44)
5+ A*-C GCSE grades					
Yes	5,365	53.6	2,126 (17.5%)	6,629	54.6
No	4,644	46.4		5,506	45.4
Enjoys school			4,527 (37.3%)		
No enjoyment	189	5.6		756	6.23
Mixed enjoyment	482	14.3		1,934	15.9
Enjoyed school	2,701	80.1		9,445	77.8
Sex			0 (0%)		
Male	1,603	47.5		6,254	51.5

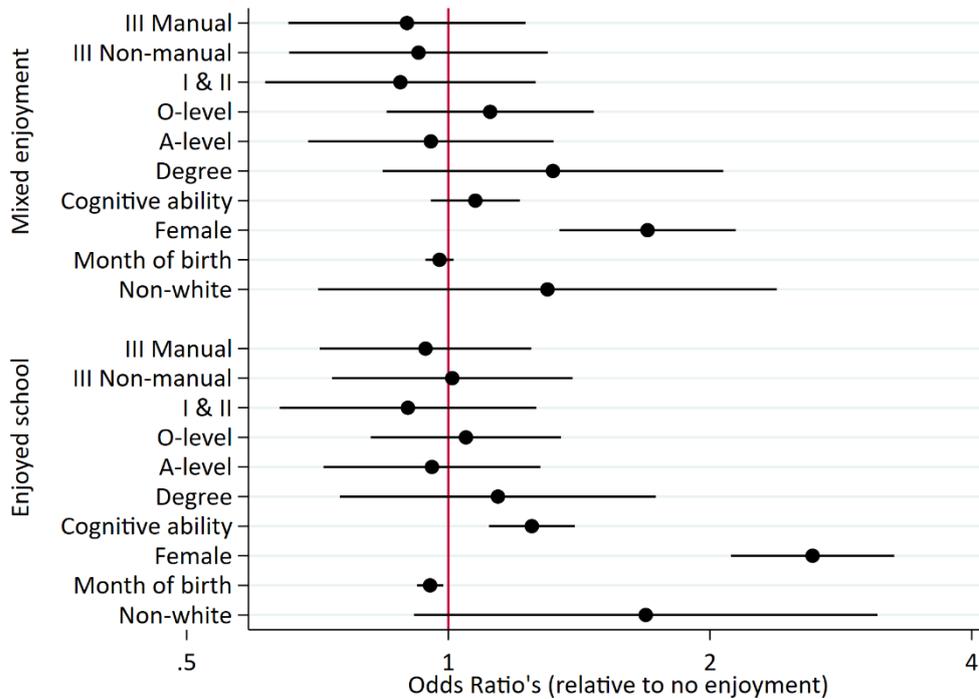
Female	1,769	52.5		5,881	48.5
Month of birth			0 (0%)		
Sep	326	9.7		1,190	9.8
Oct	347	10.3		1,173	9.7
Nov	299	8.9		1,114	9.2
Dec	304	9.0		993	8.2
Jan	197	5.8		681	5.6
Feb	159	4.7		568	4.7
Mar	186	5.5		709	5.8
Apr	281	8.3		962	7.9
May	331	9.8		1,099	9.1
Jun	312	9.3		1,165	9.6
Jul	314	9.3		1,288	10.6
Aug	316	9.4		1,192	9.8
Ethnicity			0 (0%)		
White	3,265	96.83		11,525	95.0
Non-white	107	3.17		612	5.0
Social class			815 (6.7%)		
IV & V	565	16.8		2,484	20.5
III Manual	862	25.6		3,571	29.4
III Non-manual	946	28.1		3,002	24.7
I & II	999	29.6		3,079	25.4
Maternal education			67 (0.55%)		
CSE/vocational	659	19.5		3,525	29.1
O-level	1,194	35.4		4,246	35.0
A-level	978	29.0		2,774	22.9
Degree	541	16.0		1,591	13.11
Cognitive ability	(0.12)	(0.96)	5,453 (44.9%)	(-0.12)	(1.02)
School year			2,216 (17.5%)		
2006/2007	704	20.9		2,567	21.2
2007/2008	2,063	61.2		7,410	61.1
2008/2009	605	17.9		2,159	17.8

Is school enjoyment socially or demographically patterned?

There was no clear social patterning of school enjoyment by either measure of family socioeconomic position (Figure 1 & Supplementary Table S3). Children with parents in more skilled occupations were as likely to report not enjoying school as those with parents in less skilled and routine occupations. Children with higher educated mothers were generally as likely to report not enjoying school as those with less educated mothers, though children with degree-educated mothers were more likely to report enjoying school at both occasions (Odds ratio: 1.44; 95% CI: 1, 2.08). Children with a one standard deviation higher measured cognitive ability were also more likely to say they enjoyed school than did not enjoy school (OR: 1.25; 95% CI: 1.12, 1.38). These associations persisted after controlling for family socioeconomic position. There was little evidence of two-way interactions between each of social class, maternal education and cognitive ability. Girls were two and a half times more likely to say they enjoyed school than boys (OR: 2.62; 95% CI: 2.11, 3.25). Non-white children were more likely to enjoy school than white children, but these associations were imprecise (OR: 1.65; 95% CI: 0.90,

3.03). Children born later in the school year were less likely to enjoy school, with each additional month of age associated with a 5% reduction in the odds of enjoying school (OR: 0.95; 95 %CI: 0.95, 0.99). Results were consistent across imputed and complete case datasets (Supplementary Tables S3 & S4).

Figure 1: Odds Ratio's for being in the “mixed enjoyment” and “enjoyed school” response categories relative to the “no enjoyment” category. Models adjust for sex, ethnicity, month of birth, age at questionnaire response, and cohort year group. See Supplementary Table S3 for estimates.

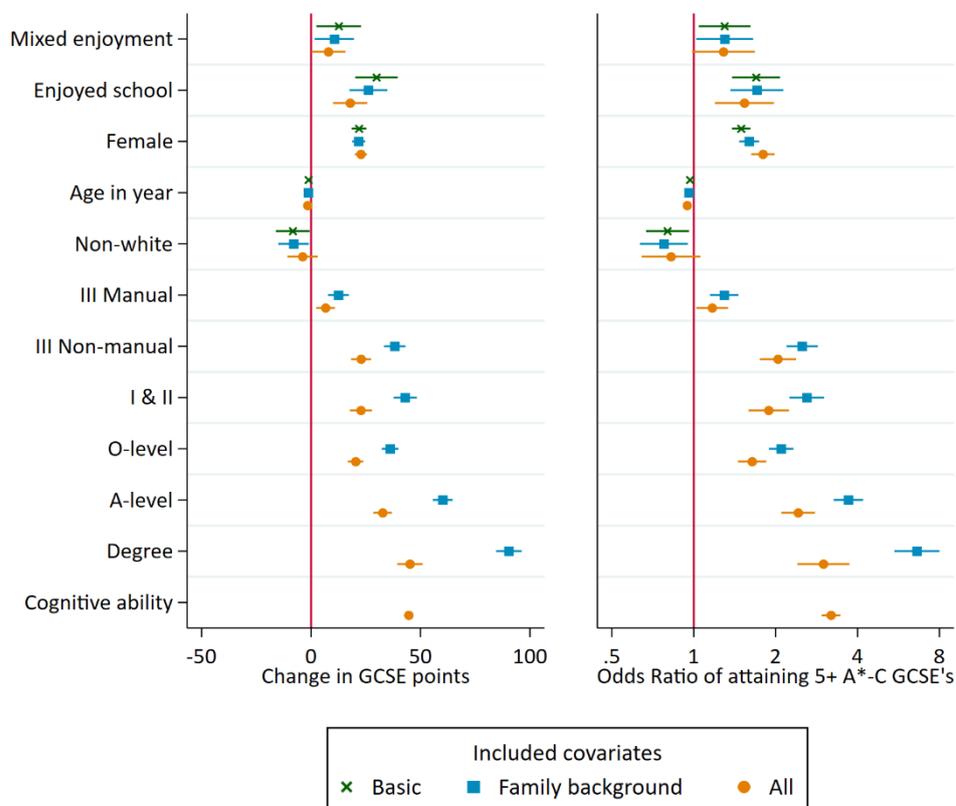


School enjoyment and educational attainment

Figure 2 displays the association of school enjoyment and (later) GCSE attainment (see Supplementary Table S5 for estimates). Children who enjoyed school scored on average 29.9 (95% CI: 20.2, 39.6) more points at GCSE and those had mixed enjoyment scored on average 12.7 (2.45, 22.9) more points compared to children who did not enjoy school. Based on the calculation of 6 points per GCSE grade, these differences are equivalent to five and two grade differences in GCSE's respectively. Controlling for family socioeconomic position slightly attenuated the associations to 26.2 (17.6, 34.9) and 10.6 (1.65, 19.6) respectively. Furthermore, controlling for performance on cognitive ability tests attenuated associations to 17.9 (10.0, 25.7) and 7.9 (0.148, 15.7) point differences; broadly equivalent to differences of three and one grades. In the fully adjusted model, the association between enjoying school at age 6 and educational attainment at age 16 was almost as large as that for sex (β : 22.8; 95% CI: 20, 25.6) and social class (β : 22.8; 95% CI: 17.7, 27.8). Maternal education had a much greater effect size on GCSE point scores than other variables, whereby children with degree educated mothers scored on average 45.2 (39.4, 51.0) points above children whose mothers had no qualifications, CSE or a vocational qualification. Measured cognitive ability was also strongly associated with GCSE score (β : 44.6; 95% CI: 42.8, 46.4), though care must be taken when interpreting this parameter as it was measured after school enjoyment. The results were generally consistent across the imputed and the complete case datasets (Supplementary Tables S5 & S6), though the complete case analyses underestimated the association between cognitive ability and attainment relative to the estimates from the imputed analysis.

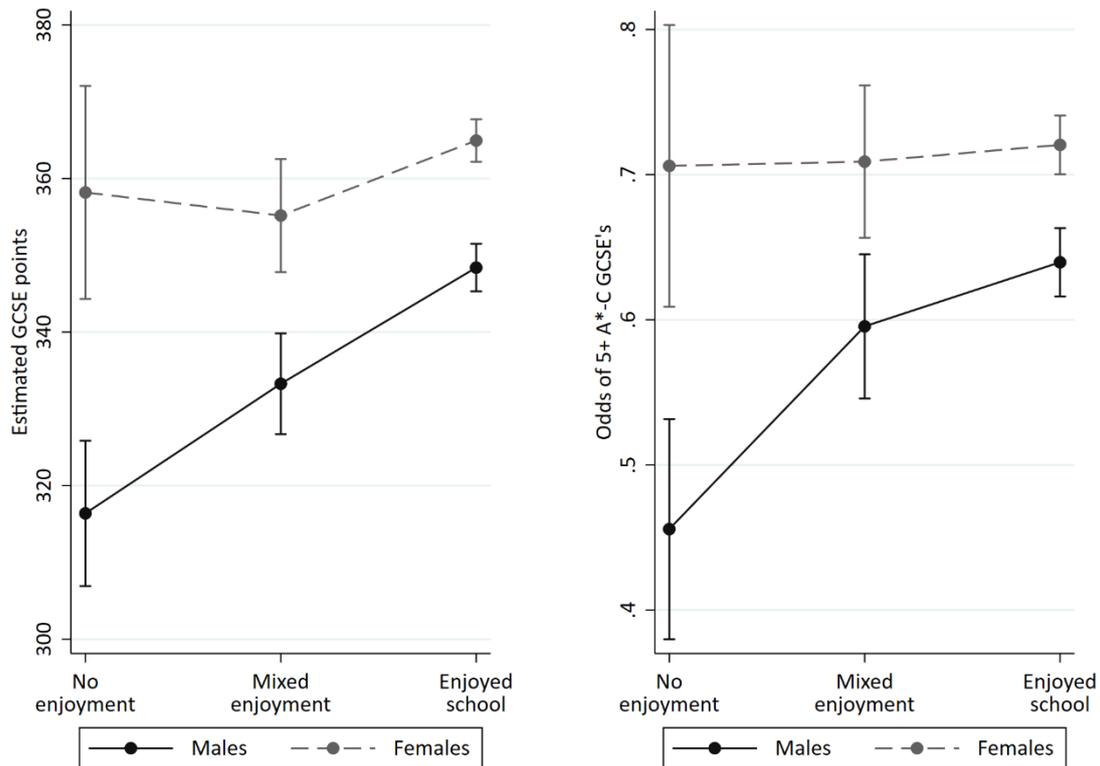
Results were similar in logistic regression analyses of obtaining 5+ A*-C GCSE's including English and Maths (Figure 2 & Supplementary Table S7). Children who enjoyed school were 69% more likely to obtain 5+ A*-Cs than children who did not enjoy school (OR: 1.69; 95% CI: 1.38, 2.08). Children with mixed enjoyment were also more likely to obtain 5+ A*-C GCSE's than children who did not enjoy school, but the association was weaker (OR: 1.30; 95% CI: 1.04, 1.62). These associations were greater than sex differences in the odds of obtaining 5+ A*-C GCSE's (OR: 1.49; 95% CI: 1.38, 1.61). The associations with levels of school enjoyment were similar after adjustment for socioeconomic position (β : 1.71; 95% CI: 1.36, 2.13 and β : 1.30; 95% CI: 1.021, 1.65 respectively). The association of enjoyment and attainment were smaller than associations of occupational social class and maternal education differences with attainment. Further controlling for child cognitive ability attenuated the association for children who enjoyed school (OR: 1.54; 95% CI: 1.20 to 1.97) and those who had mixed enjoyment (OR: 1.29; 95% CI: 0.986 to 1.68). Performance in the cognitive ability test was the strongest predictor of attainment; a one standard deviation increase in cognitive ability was associated with over three times higher odds of obtaining 5+ A*-C GCSE's (OR: 3.2; 95% CI: 2.95 to 3.46). The complete case analyses overestimated the association between school enjoyment and attainment but was otherwise consistent with the imputed dataset (Supplementary Tables S7 & S8).

Figure 2: Associations with GCSE point scores (left) and Odds Ratios of attaining 5+ A*-C GCSE grades including Maths and English (right). Model 1 represents adjusts for sex, ethnicity, month of birth, age at questionnaire response, and cohort year group. Model 2 additionally adjusts for parental socioeconomic background. Model 3 additionally adjusts for measured cognitive ability. See Supplementary Tables S5 & S7 for estimates.



There was little strong evidence of interactions in either the linear or logistic complete case analyses between school enjoyment and each of social class (interaction p values=0.302 and 0.553 respectively), maternal education ($p=0.402$; $p=0.814$), and cognitive ability ($p=0.121$; $p=0.749$) on GCSE attainment. There was however evidence of an interaction between school enjoyment and the pupil's sex ($p=0.018$; $p=0.050$) (Figure 3).

Figure 3: Interaction between school enjoyment and sex on GCSE attainment. Left: Linear regression of GCSE point scores. Right: Odds Ratios of attaining 5+ A*-C GCSE grades including Maths and English.



Discussion

Our results highlight the importance of school enjoyment for educational attainment. Children in our sample who enjoyed school at age 6 scored on average 32.42 more GCSE points at age 16 and were 72% more likely to attain 5 or more A*-C grades than children who did not enjoy school. Because the point measure we use is a capped fine graded point score for GCSE's at the time the cohort were in school, this represents a total difference of around 5 grades across the best eight GCSE's. Given the importance of having 5+ A*-C GCSE grades to progress into further education and enter skilled jobs in the labour market (Payne, 2003), school enjoyment may provide an early indicator of pupils in need of more and better educational support, or different school environments. Our results corroborate those from previous studies on school enjoyment contemporaneously measured with attainment (Larson et al., 1985; Lüftenegger et al., 2016; Tze et al., 2016) and extend this to exams set 10 years after enjoyment was measured.

That enjoying school is positively associated with attainment may be intuitive (Smith et al., 2016), but it is remarkable that school enjoyment as early as age six predicts GCSE outcomes a decade later so well. The differences in attainment by enjoyment were similar to differences by parental occupational social class and sex, which have been widely acknowledged to be intervention worthy inequalities (Strand, 2011). The underlying binary indicators of school enjoyment that we used likely provided only a crude measure of the underlying variation in school enjoyment. Better measurement of school enjoyment in future studies will help better understand the role that school enjoyment plays in educational attainment.

Associations of school enjoyment and attainment were not explained by other factors that are strongly related to education including socioeconomic position and cognitive ability (Bynner and Joshi, 2002; Deary et al., 2007; Morris et al., 2016). This suggests that enjoyment of the learning environment reflects more than a propensity for innate cognitive ability or curiosity to learn (Alberti and Witryol, 1994; Henderson and Wilson, 1991) and may capture something unique to educational outcomes. There is, of course, very high overlap between what cognitive ability tests seek to measure and what most GCSEs are designed to measure. Furthermore, the general lack of social patterning in enjoyment that we observed is surprising and suggests that children's enjoyment does not just reflect social norms or parental behaviours that are patterned by socioeconomic position (Flouri, 2006). Because school enjoyment is more modifiable than socioeconomic factors (Smith et al., 2016) it potentially represents a promising intervention target for reducing educational inequalities. For the purposes of identifying children who may need greater educational support, our results suggest that a simple measure of school enjoyment at an early age may have long term predictive value to educators. However, these results highlight that some children appear to gain little enjoyment from schooling. More detailed observational evidence is required to test why some children do not enjoy school before interventions can be developed to improve enjoyment and evaluated to see if improving enjoyment translates to better educational outcomes.

Strong gender differences existed whereby boys were more likely to dislike school than girls, conforming to previous research (Siann et al., 1996). Interaction terms revealed that the association of school enjoyment and GCSE scores were larger for boys than girls, with boys' attainment more dependent on their level of enjoyment. School enjoyment may therefore play a more important role in boys' than girls' education and help to explain why gender disparities exist in education. Gender differences in education may reflect gender specific motivational differences (Freudenthaler et al., 2008) or teacher biases (Campbell, 2015) which could lead to differential performance. Further work on larger samples is required to examine if these gender differences persist across other datasets, to investigate the reasons that underlie gender differences in school enjoyment, and to determine how they could be reduced. In short, why do so many more boys dislike school and what can be done about this? Children who were younger in each school cohort were less likely to enjoy school and more likely to have lower achievement than those who were older, consistent with prior research into age and achievement (Mayer and Knutson, 1999; Tymms et al., 2000). There is continued debate about the impact of inflexible school starting ages used in some countries such as the UK (Sharp, 2002), and our results highlight that children born later in the school year may not only perform less well in school but also derive less enjoyment from schooling. Future work on samples from countries which have flexible school starting ages is required to see if these associations persist. From a statistical point of view, age in year may provide a valid instrument for instrumental variables analysis into the impacts of education.

This study has several limitations. First, the ALSPAC cohort does not provide a representative sample of the UK school population, meaning that our results may not be generalisable to the wider

population of UK school children. Future research conducted on population representative samples is required for generalisability of these findings. That said, the associations that we investigated can be expected to hold in the wider population provided that participation in ALSPAC was not heavily stratified by school enjoyment and educational attainment (Munafò et al., 2017). Second, the associations here are estimated from observational data and therefore may arise due to further confounding factors between school enjoyment and educational attainment that we did not control for. Our results were robust to adjustment for some of the strongest drivers of educational attainment in the UK (family socioeconomic position, sex, ethnicity, age) (Strand, 2011) so it is unlikely that unobserved confounding will induce sufficiently large bias to explain our results. Third, because we condition our analysis on a measure of cognitive ability that was collected after the school enjoyment data, it is possible that this induced collider bias into our results (Elwert and Winship, 2014). Confounder variables should exert a downstream influence on exposure and outcome variables, and therefore adjusting for post-exposure variables can introduce bias. Ability as measured by cognitive tests is highly stable over time (Deary et al., 2000), meaning that our use of a cognitive ability measure obtained two years after school enjoyment is unlikely to induce sufficient collider bias to invalidate our results. There is no earlier measure of cognitive ability in ALSPAC with a large enough sample size to explore the potential impact of collider bias, but future research using datasets that have cognitive ability and enjoyment measured contemporaneously could explore this. Finally, while multiple imputation improved the sample size of our study and permitted inclusion of more participants than the complete case analysis, numerous assumptions are built into the data generating process that we used for the imputations. If important information were not included in the imputation process, then the imputation and subsequent results will be biased. Future research on datasets with a greater number of complete cases is required to demonstrate the replicability of these results.

In conclusion, our results suggest that differences in attainment by school enjoyment are almost as large as socioeconomic and gender differences, that they are independent of these factors, and that they may partly explain gender disparities in educational attainment. Approaches to increase children's enjoyment of schooling could offer substantial beneficial returns to educational and subsequent health and labour market outcomes if these findings hold in the wider UK school population.

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Acknowledgements

We are extremely grateful to all the families who took part in this study, the midwives for their help in recruiting them, and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. The UK Medical Research Council and the Wellcome Trust (Grant ref: 102215/2/13/2) and the University of Bristol provide core support for ALSPAC. TTM is funded by an Economics and Social Research Council (ESRC) Postdoctoral Fellowship [ES/S011021/1]. The Medical Research Council (MRC) and the University of Bristol fund the MRC Integrative Epidemiology Unit [MC_UU_12013/1, MC_UU_12013/9, MC_UU_00011/1]. The ESRC support NMD

via a Future Research Leaders grant [ES/N000757/1]. This work is part of a project entitled ‘social and economic consequences of health: causal inference methods and longitudinal, intergenerational data’, which is part of the Health Foundation’s Efficiency Research Programme. The Health Foundation is an independent charity committed to bringing about better health and health care for people in the UK. The funders had no role in the conceptualization, design, data collection, analysis, decision to publish, or preparation of the manuscript.

Author contributions

GDS conceptualised the study. TTM analysed the data and drafted the original manuscript. All authors interpreted the data and contributed to the final manuscript.