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What role do enjoyment and students' perception of ability play in social disparities in subject choices at university?

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Abstract

Previous research has identified social disparities in the subjects that students choose to study at university, particularly that students from less educated families are both less likely to study STEM (Science, Technology, Engineering and Maths) and Arts and Humanities. Students are driven to choose subjects that they like and think they are good at, and these attitudes are unevenly distributed within the population by levels of advantage. This study used a large, representative sample of university students studying in England to explore the relationship between student attitudes and socio-economic disparities in subject choices. Although attitudes differed by students' parents' education level and were associated with subject choices, disparities in choices remained when accounting for these differences. Students whose parents had lower education levels were less likely to choose arts and humanities subjects, and more likely to study Social sciences, Law and Business (SLB) subjects over STEM subjects, even when their enjoyment and perception of ability in STEM were similar. This suggests interventions aimed at reducing the social gradients in subject choices would not be successful if they focus solely on individual attitudes. Further, students whose parents had higher levels of education were more likely to choose STEM subjects over arts and humanities as their enjoyment of STEM subjects increased, compared with students whose parents had low levels of education. This suggests that there are different underlying processes driving students of different background in their choices.

Introduction

There is a vast body of literature outlining educational inequalities in the UK, and the mechanisms through which more advantaged families help their children to achieve higher levels of education (e.g. Blanden & Gregg, 2004; Blanden, Gregg, & Machin, 2005; Bukodi, Goldthorpe, Waller, & Kuha, 2015; Goldthorpe & Mills, 2008). This research has typically focused on vertical stratifications in education; of quantity of education and attainment differentials by students' background. With increasing overall access to university, relative *quality* of education, and the horizontal stratification within levels of education is an increasing important way social position is passed on from parents to their children (Gerber & Cheung, 2008). The paper focuses students' choices of field of study at university, shown to be highly associated with levels of advantage in the UK (Codiroli Mcmaster, 2017; Van de Werfhorst, Sullivan, and Cheung, 2003). Aside from subject choices effecting personal outcomes, for example access to professional or higher paying occupations, there are also considerations for an equitable society, which is compromised if students are stratified according to levels of advantage.

There remains limited research into reasons for social background disparities in subject choices. In contrast, mechanisms explaining gender segregation is a highly researched area, focussing primarily on ways different traits predict choices, and how these traits are unevenly distributed. A wide variety of traits have been identified to predict choices, particularly how much students enjoy subjects and their perceived ability in their chosen field (e.g. Sheldrake, Mujtaba, and Reiss, 2014; Eccles, 1983). This study aims to extend the literature on the extent of disparities in choices by students' social background by analysing relationships between students' attitudes including their perception of ability, enjoyment of subjects, and degree subject choices.

Firstly, I consider the extent of social background differences in choices, and associations between student attitudes and subject choices. Given the fact that student academic ability is strongly associated both with attitudes towards subjects and social background, I test whether the link between social background and attitudes is explained by prior attainment. Next, I consider whether student attitudes can explain socio-economic gaps in subject choices; this will have important implications for interventions aimed at reducing disparities. The study goes further by examining whether students' attitudes are differentially associated with choices, given students' family background. This could signal different drivers of choice for students from different social backgrounds. For example, whether students are less likely to choose subjects they enjoy or think they are good at, depending on family circumstances.

Literature review

Although research into educational inequalities has primarily focused on vertical inequalities, including attainment and access to higher levels of education, there has been a shift towards studying differences in horizontal inequalities, including fields of study. Prior research has primarily considered a binary definition of subject choices, focusing on Science, Technology, Engineering and Maths (STEM) subjects, with high gender disparities in uptake and a key policy agenda in increasing participation overall (e.g. Department for Business, Innovation and Skills, 2015). The Higher Education Statistics Authority (HESA) outlines key demographic characteristics associated with subject studied at university, showing that socio-economic disparities appear particularly large in Science, Engineering and Technology (CaSE, 2012). These statistics do not, however, take into account attainment differences by students' background (e.g. The Royal Society, 2008), and the fact that higher attaining pupils are more likely to study STEM subjects.

The literature above did not consider whether differences in attainment drove differences in choices, or whether disparities were present for students with similar attainment levels. Van de Werfhorst, Sullivan, and Cheung (2003) analysed data from the 1958 National Childhood Development Study (NCDS), showing that social class predicts participation in 'prestigious' subjects at university, i.e. medicine and Law, even when attainment was taken into account. Dilnot (2016) considered participation in subjects chosen at age 16 that were most likely to facilitate entry to elite universities, finding that strong socio-economic trends in participation were largely explained by attainment and earlier choices. Henderson, Sullivan, Anders & Moulton (2016) found a similar social gradient in highly academically selective subjects and STEM subjects at age 14, which were again largely explained attainment differences. Focusing on science participation, Gorard, See, and Smith (2009) exploited data from the Pupil-level Annual Schools Census (PLASC) and the National Pupil Database (NPD), exposing a strong association between SES and participation in all levels of post-compulsory science, and point out that no suitable explanation has been put forward to fully account for this disparity. A key issue in identifying disparities by students' background lies in the measures used. Variously studies focused either on social class, financial dis/advantage, parent level of education, or some mixture of the three. Recent research suggests that compared with other background characteristics, parents' education plays the largest role in disparities in subject choice. Students whose parents are more highly educated are most likely to study arts and humanities, and least likely to study social sciences, law and business (Codiroli Mcmaster, 2017).

There is growing international evidence that the social gradient in subject choices appears to be gendered (Codiroli Mcmaster, 2017; Leppel, Williams & Waldauer, 2001; Ma, 2009; Van de Werfhorst, 2017; Trusty, Plata, & Ng, 2000). Studies of students in the UK, US and Netherlands have consistently shown that social background differences appear larger for women than men, often explained by the fact that high SES women are more likely to study subjects typically chosen by men, which also lead to greater occupational and financial gain upon graduation. Van de Werfhorst (2017) suggests this is because family background is associated with the

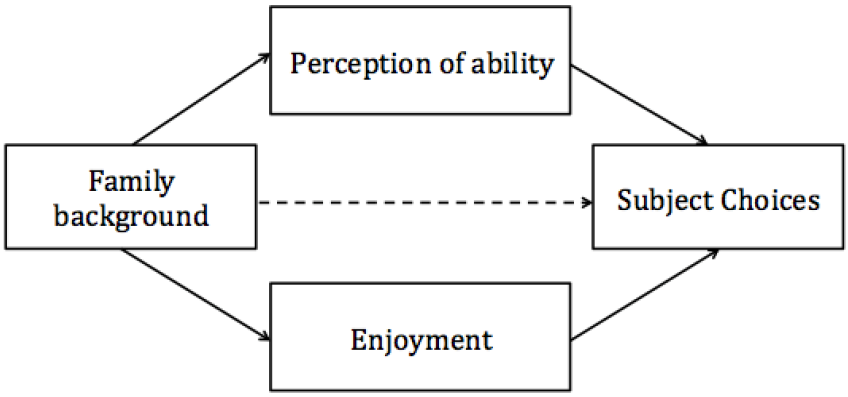
extent that social norms are both adhered to and encouraged. Mothers' education, in particular, is associated with the extent that they adhere to gender norms (Crompton & Lyonette, 2005). This helps us understand both why parents education may be the key driver of differences in students choices, and gives more understanding of the nuanced nature of the relationships. This effect has also been identified in qualitative studies; through extensive interviews with young women who choose to study Physics at A-level, Archer and colleagues (2017) found that they tended to be from relatively advantaged backgrounds and to come from families with strong links to science knowledge and careers.

There has been limited research into why these disparities in choices by social background occur. It is possible differences in students' enjoyment of science and maths, or their perception of ability could drive the gap. Whilst Gorard, See and Davies (2012) point to a need for more robust evidence in the question of how student attitudes and beliefs drive post-compulsory participation, there is a rich evidence base suggesting attitudes could be key in explaining students' subject choices generally. This hypothesised mechanism is illustrated in figure 1. This research has typically focused on choice of STEM subjects and gender disparities in choices, and has not considered either social background disparities or a broader range of possible choices. STEM subjects are perceived to be particularly difficult, and students perceive science and maths study to only be suitable for naturally 'brainy' students (DeWitt, Archer, & Osborne, 2013). Qualitative research suggests they are most likely to rate sciences as 'difficult' and 'boring' (e.g, Lyons, 2007). Whilst there is indeed evidence science and maths are more difficult at A level when comparing relative difficulty of achieving high grades (Coe, Searle, Barmby, Jones, & Higgins, 2008), this additional barrier to study may put off many students who could otherwise enjoy STEM but do not view themselves as particularly smart.

The relationship between perception of ability and STEM study has been explored in some depth; defined as the extent to which students rate their own ability positively either overall or in specific tasks. Whilst perception of ability is strongly related to actual attainment, they also independently predict choices and aspirations. Results from the Programme for International Student Assessment (PISA) show that across OECD countries students' self-efficacy beliefs in mathematical problem solving at 15 is strongly associated with science career aspirations (Schulz, 2005). Most recently, Sheldrake, Mujtaba, and Reiss (2014) show in a large longitudinal study of English students, as part of the Understanding Participation rates in Mathematics and Physics (UMAP) project, that students' ratings of their ability in mathematics predicted both GCSE (age 16) attainment and aspirations for future study. Students' self-beliefs can also go some way to explaining gender disparities in subject choices. Girls' relatively negative self-beliefs in their abilities, compared with boys, can go a large way to explaining the underrepresentation of young women in STEM (e.g. Lyons and Quinn 2010). This was particularly pronounced in 'harder' physical sciences, with largest gender disparities in participation. As yet it is unclear whether perception of ability can explain other disparities in choices, which this paper aims to address by looking directly at disparities by social background.
Along with perception of ability, Sheldrake et al. (2014) also found intrinsic motivation to be key in aspirations for future mathematics study. Intrinsic motivation, or students' inclination to study subjects based on personal reward and enjoyment, is an important factor in academic decisions, with literature again situated in gender

disparities. Whilst it seems overall students do enjoy studying mathematics at the start of secondary school, there is considerable variation in preferences, and enjoyment appeared to be declining in line with future study aspirations from 2003-2007 (National Audit Office, 2010). Where this relates to students' family background is less clear. The study of intrinsic motivations has strong roots in psychological literature. Eccles aimed to explain gender differences in uptake of science and mathematics by modelling psychological characteristics of students, and their subsequent choices (Eccles, 1983). There has been extensive research into associations between subjective task-value and subject choice, finding consistently that task-value can go some way to explaining gender gaps (e.g. Eccles, 2011; Eccles & Wigfield, 2002). In contrast, as part of another longitudinal study into student aspirations with a focus on STEM, ASPIRES, DeWitt, Osborne, et al. (2013) show enjoyment of science and mathematics do not necessarily predict participation. However little work focuses on SES, and research was generally undertaken with students from advantaged backgrounds.

Figure 1: Representation of the hypothesis that student's intrinsic motivations will explain differences in subject choices.



It is also possible that attitudes are differentially related to choices, depending on students' family circumstances. This possible moderation effect is illustrated in figure 2. Cultural reproduction theory (Bourdieu, 1984) and the theory of relative risk aversion (Breen & Goldthorpe, 1997), could offer some insight into differing processes underlying choice depending on students' background. Cultural reproduction theories focus on cultural capital held by families; traits often held by higher classes over and above financial assets, including education, cultural knowledge and participation, and manner of speech and presentation. It appears parents' education specifically drives disparities, as opposed to financial resources or social class (Codiroli Mcmaster, 2017). Parents who have been to university may have more knowledge of the range of options available for students within university, and the career opportunities those options may lead to. They may also be more likely to encourage students in their interests through involvement in their education

(Sacker, Schoon, & Bartley, 2002; Sui-Chu & Willms, 1996), and through promoting after school activities that match their preferences (Lareau, 2000).

Researchers working on the ASPIRES project suggest that students' science capital (the extent to which their families have knowledge of STEM, work in STEM careers themselves and encourage STEM participation) may account for participation disparities. As well as being associated with students' gender and ethnicity, science capital is strongly associated with other forms of capital, and students' relative level of advantage (Archer et al., 2012). Students with more science capital are also more likely to be knowledgeable about the range career options after studying STEM, and to realise that skills learned from STEM degrees can be transferable to many different sectors and roles. This echoes Akerlof (1997), who argued parents pass on knowledge of university systems. In respect to subject choices, parents appear to pass on knowledge of the value of studying particular subjects, and relative advantages this may confer.

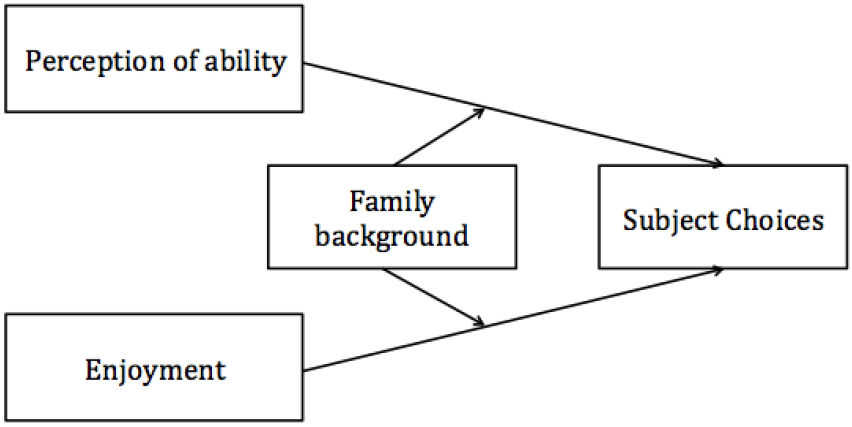
The theory builds upon Boudon's work on primary and secondary effects of social background. Primary effects generally refer to attainment in school, that may influence subjects students *can* study, whilst secondary effects refer to choices made by students based on values and preferences passed down by parents by associated with social position (Boudon, 1974; Girard and Bastide, 1963). For example, the strong social and science capital may explain why students from more advantaged backgrounds are more likely to study STEM and Arts and Humanities, but not Business, Social Science and Law.

According to the model of Relative Risk Aversion, people aspire to achieve social standing that is at least as good as their parents (Breen & Yaish, 2006), leading to lower educational aspirations if parents aren't well educated themselves. Assuming students want to avoid downward social mobility, this may lead students from more advantaged backgrounds to aspire to more prestigious subjects, and to be more concerned with economic return to study, over subjects they enjoy. Recent UK research suggests students from higher income families are more concerned with economic returns of university choices (Davies, Mangan, Hughes, & Slack, 2013). That this would translate to more advantaged students choosing higher return subjects, and rests on the assumption that students have accurate understandings of returns to education (Botelho & Pinto, 2004; Manski, 1993).

In contrast, considering additional barriers students from less advantaged background face in the labour market (Crawford & Greaves, 2015), more advantaged students may see university as a chance to study something they're interested in 'for learning's sake,' and to be more concerned with intrinsic rewards university study will bring, rather than extrinsic rewards. Whilst it is likely the majority of students are somewhat concerned about job security and salaries upon graduation, this may be a more salient concern for students from less educated families, who have less of a 'safety net' provided by parents. They may not have access to professional networks, knowledge and/or financial capital to help enter less stable professions (particularly arts and humanities focused jobs). Less advantaged students may therefore be *less* concerned about choosing subjects they enjoy. This echoes some previous studies suggesting students from higher SES backgrounds are more concerned with

intrinsic, rather than extrinsic, rewards of higher education (Kohn & Schooler, 1983; Mortimer, Lorence, & Kumka, 1986).

Figure 2: Representation of the hypothesis that student's intrinsic motivations have different relationships with subject choices depending on their backgrounds (Moderation effect)



In summary, previous literature tells us that student background is indeed associated with subject choices, with students from more privileged backgrounds appearing to choose subjects that confer higher economic rewards and potentially entrenching their privilege. Another strand of research suggests student' attitudes and preferences strongly predict choices, and can go a large way to explaining choice disparities by gender. This paper brings together these distinct literatures to further understand reasons for disparities in subject choices by family background. I test the hypothesis that differences in students' choices are driven by differences in students' personal attributes, specifically ratings of their own abilities and enjoyment in studying these subjects. I do this by looking at students' choices of three groups of subjects: STEM; Social sciences, Law and Business (SLB); and arts and humanities. SLB subjects are distinguished from arts and humanities subjects because they offer very different occupational returns upon graduation and very different students choose these groups of subjects (Walker & Zhu, 2013; Codiroli Mcmaster, 2017). The research also aims to explore whether the focus of prior research into the role of attitudes and student choices on relatively advantaged student samples masks important differences in drivers of choice depending on students' background.

Method

Participants

The study uses data from Next Steps, formerly the Longitudinal Study of Young People in England (LSYPE). This is a large longitudinal panel study following over 15,000 students, starting in 2004 when students were 13-14 years old. The final wave of data used in this study was collected in 2010 when students were 18-19 years old. The longitudinal nature of the data allowed me to compare students' characteristics and attitudes measured at 13 - 14 (in the first wave of data collection), with choices at 18-19, eliminating the possibility subject studied would influence reporting of characteristics or attitudes. For example, students who were studying STEM, or were in the process of applying to study STEM at university, may report enjoying science and maths because they were more actively engaged with the subjects. The data has been linked with the National Pupil Database (NPD), giving detailed information on students' academic attainment across school years. Of the 8,682 participants in wave 7, 3,894 were studying for a degree at university, and of these 3,884 gave valid responses for subject studied, and 3,378 also gave valid responses for ethnicity and gender. Thus, the final analytical sample was 3,878.

As far as possible Next Steps aimed to be representative of the population at the time; this was achieved through sampling underrepresented groups and those less likely to participate, through including 'boost samples' of student groups with higher levels of attrition, and through including sampling weights to better reflect the population. A full specification of sampling design, methods used and student characteristics included in weights can be found in the LSYPE user guide (Department for Education, 2011). Combined longitudinal and cross-sectional weights were used throughout analysis (unless indicated otherwise).

Multiple Imputation methods were recommended by Mostafa & Wiggins (2015) as an appropriate method to reduce bias caused by attrition and non-response in longitudinal surveys. Missing data were imputed through chained equations with 20 datasets created. Fewer than 10% of values were missing on each variable, however because this was not confined to 10% of individuals, using complete case analysis would have reduced the sample whilst disposing of other useful information. The method assumes data are Missing At Random (MAR); that is the missingness can be accounted for by other observable variables in the model. It makes fewer assumptions than complete case analysis, which assumes data are Missing Completely At Random (MCAR), and better maintains representativeness of the data. The method also gives advantages above other imputation methods (e.g. mean imputation) by not underestimating expected variation in responses, and giving more realistic standard error estimates (Little and Rubin, 1987).

Analytical strategy

This paper aims to address the following four research questions:

- What are the differences in subject choices by parents' education level, and to what extent do these relationships persist over and above attainment differences?
- What is the relationship between student enjoyment and perception of ability subjects at age 13-14, and choices at university?
- Do students' enjoyment and perception of ability explain observed disparities in subject choice by student's background?
- Do these associations differ by students' parents' education level?

I first present descriptive statistics outlining the extent of differences in subject choices and in attitudes towards STEM and English by students' parents' education level, and students' relative attitudes by subject choices. This is an important first step in ascertaining what the raw relationships are between attitudes, family background and subject choices. I go on to present a series of tables that outline the proportions of students studying each subject group at different levels of perception of ability and enjoyment in STEM and English, split by parents' education level. This will go some way to answering my final research question; whether the associations between student's attitudes and subject choices differ depending on their social background.

Whilst raw comparisons of proportions of students studying each subject, like those published by HESA (Equality challenge unit, 2016) can give us some indication of disparities in participation, this does not give the full picture since student characteristics are highly related. For example, student ethnicity and social background are both highly correlated, and associated with choices in different ways. In consideration of this, and to more fully address my research questions, I use multinomial logistic regression methods. This is the most appropriate approach because the dependent variable has three levels; students either choose to study STEM, arts and humanities or SLB.

This study predicts student choices, and the model relies on the assumption of Independence of Irrelevant Alternatives (IIA); that is, the odds of choosing one subject group over another would not be confounded by the presence of an 'irrelevant' alternative. Because the subject groupings were chosen due to their distinctness (for example, the choice of STEM over SLB wouldn't be an 'irrelevant' choice), it is unlikely the propensity for students to choose one group of subjects over another is significantly affected by the third subject group, and therefore reasonable to assume the assumption holds for this study.

The multinomial regression models are built up in four stages. The first model predicts students' propensity to study each group of subjects based on their sex, ethnicity and family background, showing the extent of SES disparities in choices. Students' perception of ability and enjoyment of subjects are strongly intertwined with their attainment. I therefore exploit the longitudinal nature of the data to try and tease

apart this relationship by including attainment *before* students are asked how much they like and are good at subjects in the second model (KS2 attainment measure when participants were 11 years old) and additionally include attainment *after* attitudes were measured in the third model (GCSE attainment at 16 years old). The addition of prior attainment in the second model allows me to quantify the association between student attitudes and choice over and above the effect mediated through prior attainment. The second and third regression models help me to answer my third research question; whether differences in students' perception of ability and enjoyment of subjects explain observed social disparities in subject choices. If the coefficients on parents' education are reduced or no longer significant when I include students' attitudes into the model this will suggest disparities are driven by differences in student attitudes. If there is no change, this suggests there are other drivers to disparities in choice.

The final model includes interaction terms between students' parents' education and their attitudes in predicting subject choices. This will help answer my final research question and test whether associations between attitudes and choices differ by students' background, signalling different processes underlying university degree choice.

Measures and descriptive statistics

Subject choice

In the English education system, students begin choosing subjects at around 14 (when studying for GCSE examinations), however at this stage they will be required to study maths, science (although they can opt to study more, or less, science) and English. At this stage social background disparities in subject choices are already beginning to emerge (see Henderson, et al., 2016). At 16, when students aspiring to attend university choose subjects for Advanced level qualifications (A levels), or equivalent, choices are further refined and there is no requirement for students to study any particular subjects, and the majority of students study between three and four subjects. On application to university, students typically choose one subject to focus on in depth. At these two stages disparities in subject choices are well established (see Codiroli Mcmaster, 2017).

Subject choices were split into three groups, reflecting differences in future outcomes including job prospects and average salaries upon graduation (see Walker & Zhu, 2013). The subject groups include arts and humanities, STEM, and Social sciences, Law and Business (SLB). The most recent data collect from the Destination of Leavers from HE (DLHE) show that 83% STEM graduates were in professional occupations six months after graduation, compared with 70% SLB graduates and 64% arts and humanities graduates in 2015/16[1]. The table below shows subjects included in each level of the dependent variable, and proportions of students choosing each group of subjects in the current sample.

[1] Data sourced from the Destination of Leavers from HE: https://www.hesa.ac.uk/data-and-analysis/students/destinations

Table 1: Subject included in groupings, and proportions of students studying each group of subjects

Subject Choice	Subjects include	Proportion of students	Un-weighted N[2]
Arts and humanities	Architecture Building and planning Linguistics European language Eastern Literature History and philosophy Creative arts Education	33%	1,252
STEM	Medicine and dentistry Subjects allied to medicine Biological sciences Veterinary sciences Agriculture and related Physical sciences Mathematical and computer sciences Engineering and technologies	39%	1,482
SLB	Social sciences Law Business & administration studies	28%	1,144

There is some disagreement about whether medicine and allied subjects should be included in the STEM grouping in the current literature. This paper follows recent work (e.g. Botcherby & Buckner, 2012; Equality Challenge Unit, 2016) in including subjects under STEM for three reasons. Firstly, social class disparities in uptake of medicine are large (Equality Challenge Unit, 2016; Van de Werfhorst et al., 2003) and the focus of this paper is family background disparities. Secondly, the subjects clearly have a strong science component and require some specialisation in science before entry. Finally, the paper aims to speak to policy concerns regarding lower uptake of key subjects, and it is of clear policy relevance to also focus on uptake of medical sciences. Social sciences, law and business are also considered separately, as compared to arts and humanities, as they offer higher returns upon graduation (Walker & Zhu, 2013).

[2] Because proportions are weighted and numbers are not, they do not match.

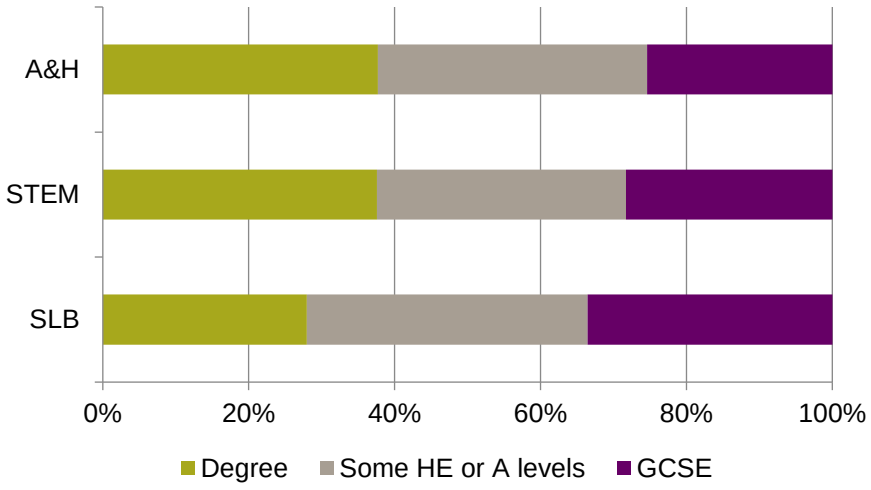
Explanatory Variables

Student characteristics

The key measure of family background in this study is parents' (or legal guardians') highest qualification; following prior research showing that parents' education has the strongest association with subject choices, when compared with parent's social class and financial resources (Codiroli Mcmaster, 2017). The qualification of the parent with the highest education level (or only parent) was used in analysis, and students were split into three groups, those whose parents had a degree or higher qualification (29%), those whose parents had A levels, some higher education or equivalent (34%), and those whose parents were educated to GCSE level or below (37%). This was taken from wave 1 interviews with parents, at the same time as students' reports of enjoyment and perception of ability in key subjects Students' ethnicity (white, mixed ethnicity, Indian, Pakistani, Bangladeshi, black African, black Caribbean or other ethnicity) and gender were also included in all analysis.

Figure 3 shows the raw relationship between students' parent's education level and subject choices; students whose parents are better educated are most likely to choose either STEM or A&H subjects, and least likely to choose SLB subjects.

Figure 3: Parents' highest qualification by subject chosen



Enjoyment and perception of ability

Enjoyment of STEM was defined by combining two variables; 'How much do you like or dislike this subject: maths,' 'How much do you like or dislike this subject: science.'

For enjoyment of English, students were asked ‘How much do you like or dislike this subject: English.’ These ratings were on a 1-4 likert scale, with 1 indicating ‘like a lot’ and 4 indicating ‘don’t like at all.’ This score was reversed, so a high score indicates high enjoyment of STEM. Attitudes towards maths and science were combined to account for the fact that choice of studying maths and science were combined in the outcome measure. Perception of ability in STEM was defined by combining scores for questions ‘How much good or bad at this subject: maths?’ and ‘How much good or bad at this subject: science?’ For English, students were asked ‘How much good or bad at this subject: English?’ These ratings were also on a 1-4 likert scale, with 1 indicating ‘very good’, and 4 indicating ‘very bad’. For the final variable, high scores indicated high perception of ability. Scores for all indicators were standardised to mean 0 and standard deviation 1. These traits were measured in the first waves of data collection, when students were 13 - 14 years old, so they do not reflect any changes in these traits that may have been influenced by university attendance or by subject choice.

Figures 4 & 5 shows how students’ enjoyment of, and perception of ability in STEM and English differ by parents’ education level and by the subjects they study at university. Student average standardised scores for each parental education group are shown. Students whose parents are highly educated are most likely to say they are good at STEM and English, and (to a lesser extent) to say they enjoy science and maths and English. Students who chose to study STEM subjects at university were most likely to say they were good, and enjoyed, science and maths, whilst those who chose Arts and Humanities were most likely to say they were good at and enjoyed English at school.

Figure 4: Student standardised enjoyment and perception of ability in STEM and English at age 13-14 by parent education level

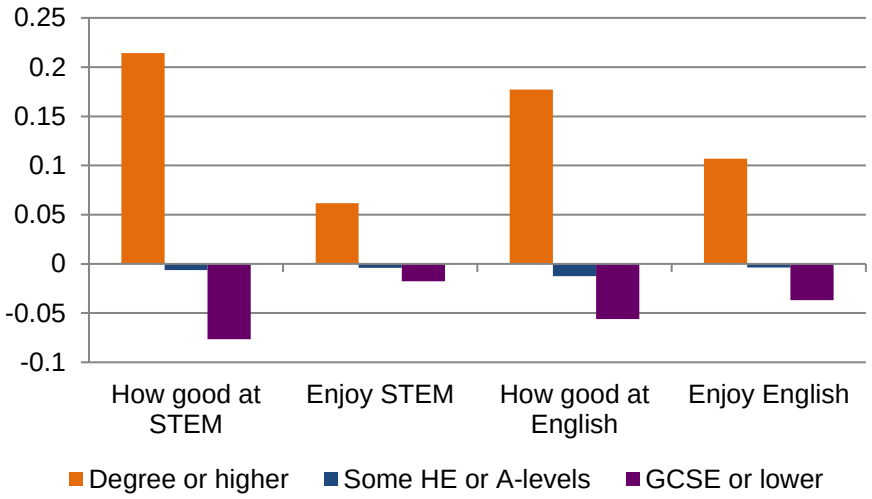
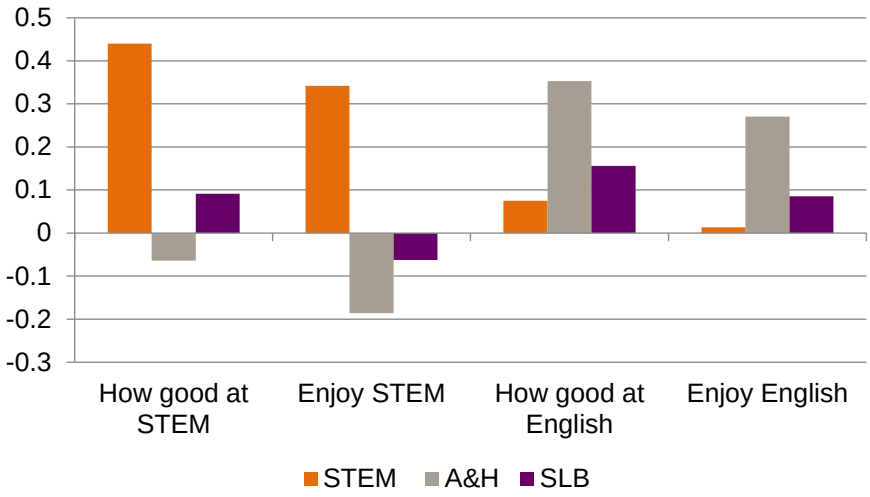


Figure 5: Student standardised enjoyment and perception of ability in STEM and English at age 13-14 by subject studied in university



Prior attainment

Students' prior attainment measured at KS2 and KS4 (GCSEs) are included as controls in the last two models of analysis. KS2 point scores in maths, science and English are included separately to acknowledge expected differing associations between achievement and choice across the three subjects. Due to data restrictions, GCSE scores could not be included as separate subjects; so capped overall scores are included. All measures were standardised with a mean of 0 and standard deviation of 1.

Interactions between social background and attitudes: unconditional results

Figures 6-9 illustrate how associations between attitudes and subject choices differ by parental education level, with each line representing students whose parents have a different level of education. Students are split into three equal sized groups (low, medium or high) according to their perception of ability or enjoyment in STEM and English in relation to their peers. The vertical axis represents the difference in proportions of students studying the select subject groups. Where lines diverge differences in subject choices by social background are observed, and where lines are not parallel interactions between social background and attitudes are observed. Overall interactions suggest students whose parents have a degree are more likely to be driven by how good they think they are and how much they enjoy STEM or English in making subject choices, compared to students whose parents have lower levels of education.

Figures 6 and 7 compares proportions of students studying each subject group by their perception of ability and enjoyment of STEM. For choice of arts and humanities subjects, students of different social backgrounds who think they are good at, or enjoy STEM are more alike in their choices (in this case with lower proportions choosing arts and humanities), and differences in choices appear larger for students who do not think they are good at, or like STEM. For choice of STEM subjects a similar interaction is observed in the opposite direction. As students perception of ability and enjoyment of STEM increases the social gradient in choices increases. There does not appear to be a consistent interaction concerning SLB subjects and perception of ability, however as enjoyment of STEM subjects increases, students whose parents have a degree or higher are increasingly less likely to study SLB compared to students whose parents have lower levels of education.

Figures 8 and 9 show that similar interactions are also observed for perception of ability and enjoyment of English. Overall, the associations between attitudes and choice of arts and humanities or STEM subjects appear stronger for students whose parents have higher levels of education. These patterns are again not observed for choice of SLB subjects.

In the introduction I discussed possible directions of interaction suggested by the theory of relative risk aversion. The data suggests students whose parents are more educated are most likely to choose subjects for intrinsic reasons. Whilst there is more chance of occupational success upon graduation for students who study STEM or SLB, more advantaged students may also expect a level of success from studying arts and humanities, and their less advantaged peers may face more barriers upon graduation in these particular subjects. For example, they will have more access to well-educated networks that can offer advice and guidance in applications and work experience. Their parents will also be more able to support them financially through periods of worklessness or unpaid internships. Further, their increased cultural capital may help them indirectly, and be particularly useful when applying for and attending interviews for jobs in arts and humanities. This could thus explain why students from more advantaged backgrounds are more inclined to study subjects for ‘enjoyments sake,’ and worry less about employability upon graduation.

This is contrary to what would be expected if the theory of Relative Risk Aversion was applicable to subject choices. According to the theory students from more advantaged backgrounds would be more likely to choose subjects that had higher occupational returns in the aim to avoid downward mobility, and less likely to choose subjects based on intrinsic motivations. In contrast, students from less advantaged backgrounds are already achieving upwards mobility simply by attending university. As the main driver of disparities is parents’ education level specifically, rather than social class or family income, it is likely parents’ education more directly affects the strength of associations. The literature suggests more educated parents are better able to foster students’ interests and perceived strengths, and push them in the direction of subjects that suit their individual preferences (Sacker, Schoon, & Bartley, 2002; Sui-Chu & Willms, 1996; Lareau, 2000).

Figure 6: Proportion of students studying each group of subjects by perception of ability in STEM, split by parents' education

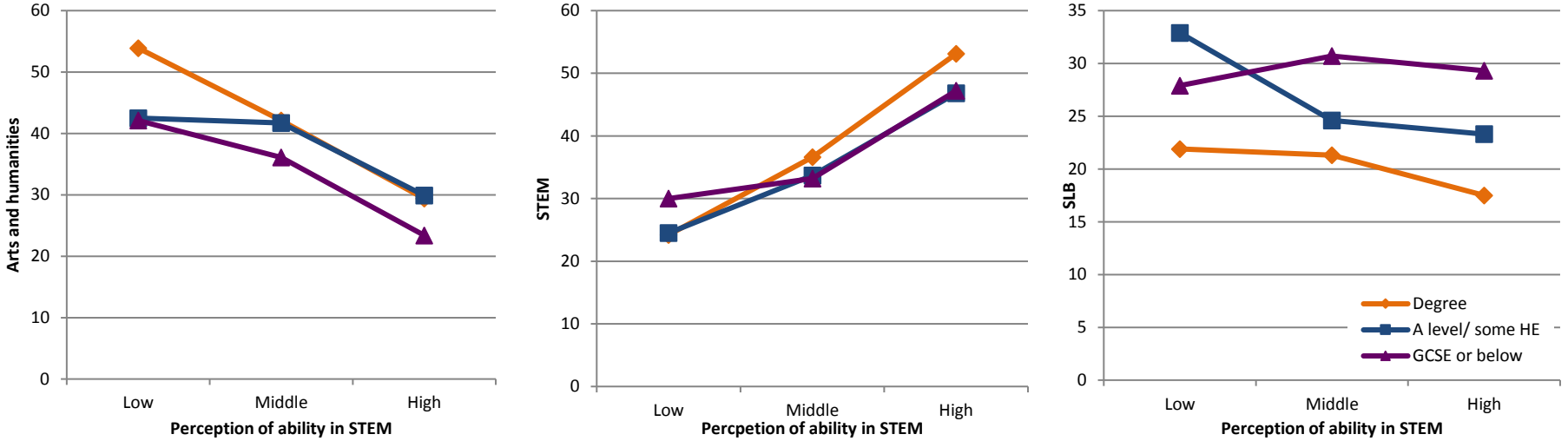


Figure 7: Proportion of students studying each group of subjects by enjoyment of STEM, split by parents' education

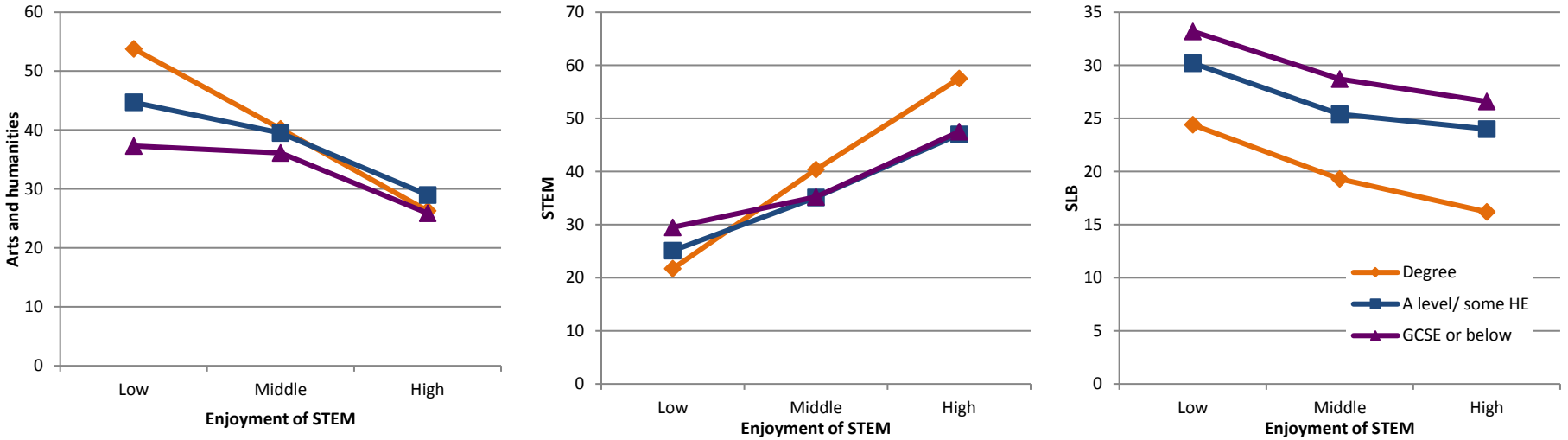


Figure 8: Proportion of students studying each group of subjects by perception of ability in English, split by parents' education

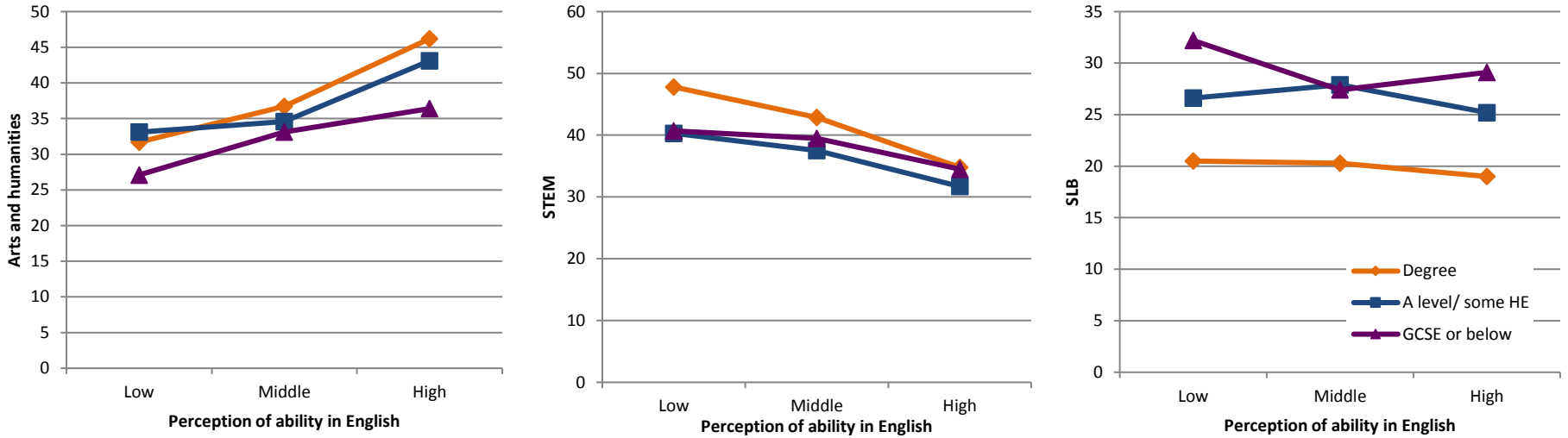
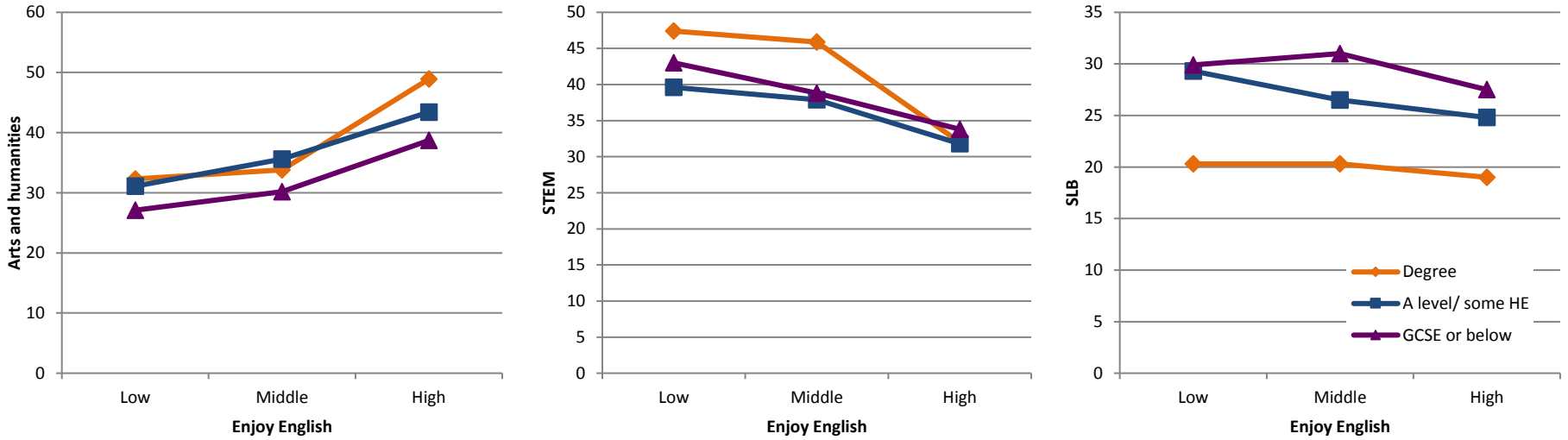


Figure 9: Proportion of students studying each group of subjects by enjoyment of English, split by parents' education



These tables show a consistent picture of differences in associations between students' attitudes and choices by their background. In the next stage of analysis I go on to test whether relationships remain when controlling for other factors.

Regression results

The first multinomial logistic regression model aimed to show the 'raw' association between parents' education level and subject choices, with ethnicity, gender and other family background characteristics controlled. Consistent with prior research, relative risk ratios from Table 2 illustrate that students whose parents have higher levels of education are more likely to choose STEM over SLB subjects at university. Students whose parents have lower education levels were around 40% more likely to choose SLB subjects than STEM subjects, compared with students whose parents had a Degree level or higher qualification.

The second and third models also controls for academic attainment and attitudes, which changes associations substantially. For students with similar academic attainment, enjoyment and perception of ability, only students whose parents have intermediate levels of education remain more likely to choose SLB over STEM by around 30%, compared with students whose parents have high levels of education. The difference in choices between STEM and SLB subjects for students with the lowest and highest levels of education is no longer statistically significant. The relationship between social background and choice of Arts and Humanities over STEM subjects, however, becomes statistically significant when controlling for GCSE scores. This suggests that academic attainment, particularly attainment at 16, is acting as a stronger push factor to studying STEM subjects instead of Arts and Humanities for less advantaged students.

The second and third models also introduce students' enjoyment of, and perception of ability, in STEM and English; both to quantify the extent of association between attitudes and subject choices for the whole cohort of students, and to test whether attitudes explained observed disparities in subject choices. Students' perception of ability and enjoyment of subjects did indeed predict university choices over and above their relationship with prior attainment. Attitudes are standardised so relative risk ratios represent change in propensity to study STEM, over arts and humanities or SLB, with 1 standard deviation increase in the corresponding indicator. Students studying arts and humanities subjects rated themselves as less able in maths and science subjects, and more able in English, than their peers who choose STEM subjects. They also said that they enjoyed maths and science less, and whilst they enjoyed English more this relationship was only significant at the 10% level. Students who choose SLB subjects also thought they were less able in maths and science than students who choose to study STEM, but they enjoyed these subjects more and enjoyed studying English less.

Table 2[3]: Multinomial logistic regressions showing students odds of studying arts and humanities, or SLB, over STEM subjects at university. Relative risk ratios are shown with standard errors in parenthesis.

Subject choice (reference: STEM)	Arts and humanities				SLB			
	Raw	Attitudes and ks2 attainment	Attitudes, ks2 and ks4 attainment	Interactions	Raw	Attitudes and ks2 attainment	Attitudes, ks2 and ks4 attainment	Interactions
Parents Education Reference: Degree								
HE or A levels	0.033	-0.042	-0.087	-0.090	0.413***	0.364***	0.310**	0.266*
	(0.106)	(0.112)	(0.114)	(0.126)	(0.124)	(0.126)	(0.129)	(0.139)
GCSE or lower	-0.036	-0.196	-0.262**	-0.287**	0.379***	0.270*	0.191	0.112
	(0.118)	(0.125)	(0.128)	(0.141)	(0.132)	(0.139)	(0.141)	(0.154)
Attitudes towards subjects								
How good at STEM		-0.334***	-0.318***	-0.377***		-0.170**	-0.151**	-0.122
		(0.064)	(0.064)	(0.112)		(0.069)	(0.069)	(0.126)
Enjoy STEM		-0.301***	-0.288***	-0.447***		-0.366***	-0.350***	-0.489***
		(0.058)	(0.060)	(0.104)		(0.064)	(0.064)	(0.121)
How good at English		0.335***	0.347***	0.404***		0.123*	0.138**	0.142
		(0.062)	(0.063)	(0.110)		(0.064)	(0.064)	(0.121)
Enjoy English		0.110*	0.114*	0.158		0.014	0.017	0.069
		(0.059)	(0.060)	(0.113)		(0.058)	(0.059)	(0.113)
Parents education x STEM attitudes Degree x Good at STEM								
HE or A levels x Good at STEM				0.196				-0.213
				(0.151)				(0.180)
GCSE or lower x Good at STEM				-0.048				0.166
				(0.168)				(0.167)

[3] Notes: other family background characteristics were included in initial analysis to ensure that parents' education was the main driver of choices, and that coefficients did not change substantially if they were added as controls. These included NS-SEC occupational social class (highest of both parents), housing tenure, and how well the family reported managing on finances. None were independently associated with subject choices, nor did they substantively impact results. Thus, the more parsimonious regression models are presented in this paper.

Degree x Enjoy STEM				0.141				0.285*
				(0.142)				(0.167)
HE or A levels x Enjoy STEM				0.403***				0.134
				(0.152)				(0.162)
Parents education x English attitudes								
Degree x Good at English								
				-0.098				0.110
				(0.151)				(0.167)
HE or A levels x Good at English				-0.079				-0.152
				(0.160)				(0.167)
GCSE or lower x Good at English								
				-0.097				0.110
				(0.148)				(0.167)
Degree x Enjoy English				-0.037				-0.152
				(0.157)				(0.167)
HE or A levels x Enjoy English								
GCSE or lower x Enjoy English								
Controls								
Female	0.460***	0.079	0.128	0.126	0.179*	-0.076	-0.013	-0.005
	(0.088)	(0.095)	(0.097)	(0.098)	(0.096)	(0.105)	(0.108)	(0.108)
Ethnicity Reference: White								
Mixed	0.0144	0.081	0.072	0.094	0.264	0.296	0.282	0.279
	(0.244)	(0.259)	(0.266)	(0.267)	(0.273)	(0.282)	(0.285)	(0.287)
Indian	-0.825***	-0.773***	-0.751***	-0.755***	0.429***	0.466***	0.494***	0.513***
	(0.173)	(0.190)	(0.191)	(0.193)	(0.143)	(0.153)	(0.155)	(0.155)
Pakistani	-1.409***	-1.398***	-1.387***	-1.442***	0.376*	0.435**	0.447**	0.446**
	(0.252)	(0.242)	(0.240)	(0.240)	(0.194)	(0.192)	(0.191)	(0.191)
Bangladeshi	-0.710***	-0.723***	-0.706***	-0.738***	0.526***	0.565***	0.585***	0.570***
	(0.246)	(0.248)	(0.249)	(0.243)	(0.194)	(0.212)	(0.213)	(0.206)
Black Caribbean	-0.166	-0.444	-0.478	-0.473	0.292	0.182	0.141	0.186
	(0.358)	(0.436)	(0.445)	(0.442)	(0.354)	(0.379)	(0.383)	(0.375)

Black African	-0.256	-0.409	-0.424	-0.459*	0.766***	0.750***	0.730***	0.696***
	(0.254)	(0.264)	(0.273)	(0.271)	(0.226)	(0.241)	(0.251)	(0.252)
Other	-0.961***	-0.904***	-0.835**	-0.861***	-0.169	-0.064	0.019	0.012
	(0.306)	(0.324)	(0.324)	(0.334)	(0.267)	(0.273)	(0.274)	(0.277)
Independent school	-0.109	-0.399**	-0.357**	-0.344**	0.056	-0.095	-0.043	-0.049
	(0.155)	(0.166)	(0.168)	(0.173)	(0.181)	(0.188)	(0.191)	(0.192)
Academic attainment GCSE (overall capped score)			-0.389***	-0.392***			-0.474***	-0.477***
			(0.138)	(0.138)			(0.143)	(0.143)
KS2 Maths score		-0.308***	-0.234**	-0.239**		-0.010	0.0807	0.086
		(0.093)	(0.095)	(0.096)		(0.101)	(0.106)	(0.106)
KS2 Science score		-0.055	-0.030	-0.031		-0.226**	-0.196*	-0.205*
		(0.106)	(0.107)	(0.108)		(0.111)	(0.112)	(0.112)
KS2 English score		0.026	0.125	0.146		0.030	0.150	0.151
		(0.104)	(0.107)	(0.107)		(0.106)	(0.114)	(0.113)
Constant	-0.174*	0.305***	0.452***	0.457***	-0.872***	-0.503***	-0.328**	-0.296**
	(0.0899)	(0.112)	(0.125)	(0.133)	(0.107)	(0.125)	(0.137)	(0.144)

* p < 0.10, ** p < 0.05, *** p < 0.01The profile of students studying Arts and Humanities over STEM subjects indicated by the model is not surprising, including those who, relative to their peers, think they are good at English, and both less able at STEM as well as not enjoying the subjects as much. In contrast, the profile of students studying SLB subjects over STEM offers some interesting insights into student choices. Compared to their peers, they seem to enjoy maths and science, but do not see themselves as good at the subjects, and come from families with intermediate levels of education. It is perhaps the case that these students are put off by the perception that maths and sciences are particularly difficult subjects, thus choose subjects that may have some STEM content but are seen as more accessible regardless of ability. The fact that these relationships are observed for students with similar academic ability indicated that students' perception of their ability, over and above that informed by their actual test scores, is driving their choices.

Interactions between social background and attitudes: full model

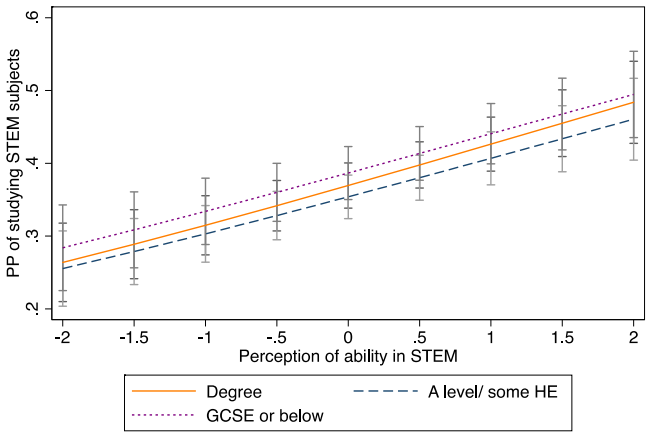
In the final model of the regression, interaction terms between students' parents' level of education, and attitudes towards subjects were included. When controlling for other associated characteristics, only interactions between parents' education and enjoyment of STEM subjects were statistically significant. Students whose parents

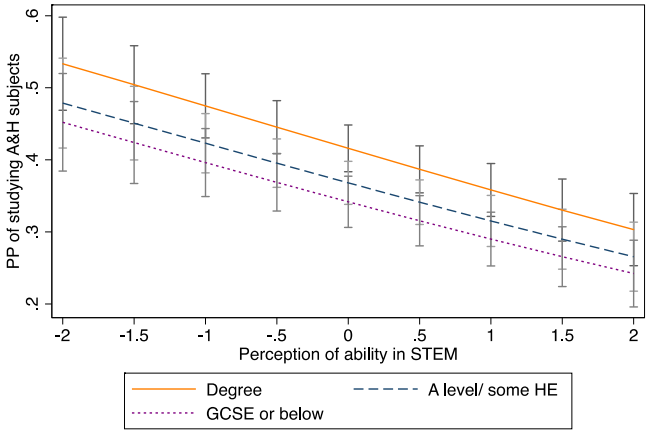
had higher levels of education were more likely to choose STEM subjects over arts and humanities as their enjoyment of STEM subjects increased, than students whose parents had low levels of education. The interaction between parents' education and enjoyment of STEM subjects is also significant, however only at the 10% level.

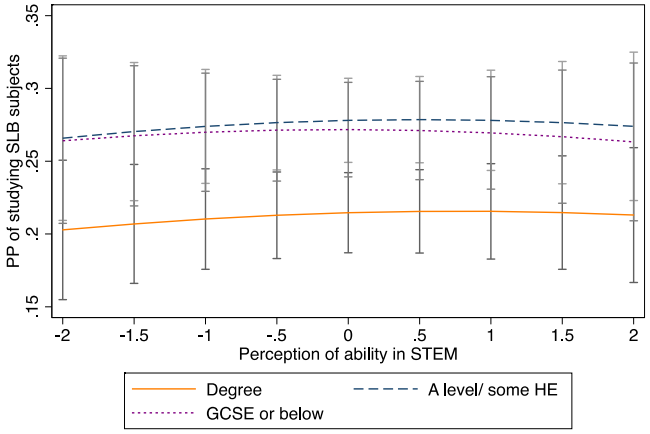
The disparity in choice of STEM over SLB subjects increased with students' enjoyment of STEM, such that students whose parents had a degree were increasingly more likely to study STEM compared with students whose parents had A levels or some higher education as their enjoyment of STEM increased. This suggests that there is a difference in the gradient of the slope in the relationship between students' enjoyment of STEM and subject choice, with a larger difference in choices by social background for students who enjoy STEM, and a smaller social difference for students who do not enjoy STEM. Thus in line with descriptive analysis, students whose parents are more educated appear to be more likely to choose subjects based on intrinsic motivations, particularly on what they enjoy studying

Figures 10 & 11 illustrate the predicted probabilities of students choosing STEM, arts and humanities, or SLB subjects by students' relative level of perception of ability and enjoyment of STEM subjects (measured as standards deviation differences from the mean). They give an alternative view to the relative risk ratios discussed above, as they predict probability of studying each group of subjects individually, rather than in comparison with one another. Relationships are estimated at each level of parental education to assess the differences in slopes of the lines. If slopes diverge, differences in the social gradient in subject choice by students' enjoyment of STEM are observed.

Figure 10: Predicted probability of studying each group of subjects by perception of ability in STEM and parents' education level



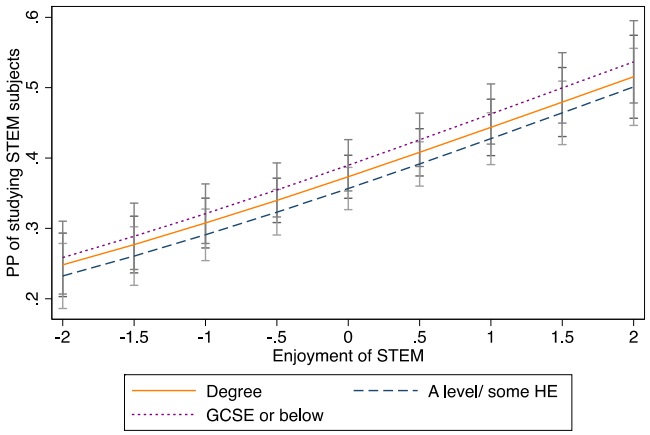


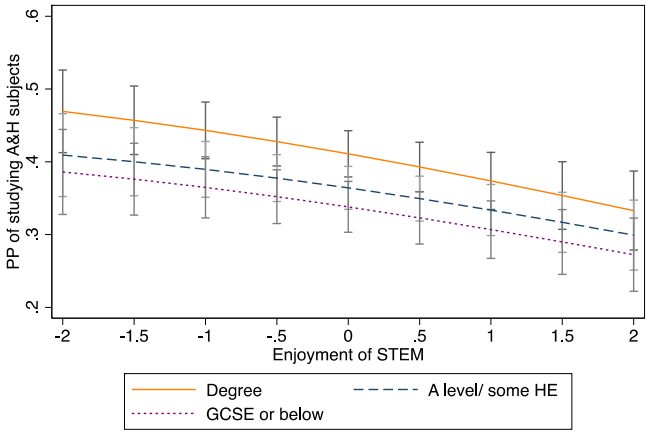


The relationships between students' social background and subject choices by perception of ability in STEM are shown in figure 11. Whilst there is little difference in propensity to study STEM subjects by parent's education, students whose parents have a degree are more likely to study arts and humanities and less likely to study SLB subjects than students whose parents have lower qualifications. Students who

think they are good at STEM subjects in school are more likely to choose STEM and less likely to choose arts and humanities. There is little association between choice of SLB subjects and perception of ability; students appear equally likely to study SLB whether they think they are good at STEM or not.

Figure 11: Predicted probability of studying each group of subjects by enjoyment of STEM and parents' education level





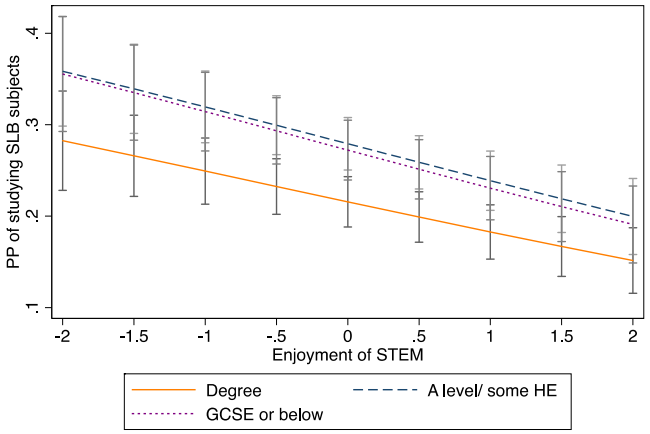


Figure 11 shows that students whose parents have a degree are most likely to be studying STEM subjects, and students whose parents have intermediate levels of education least likely. A similar relationship is also seen for arts and humanities subjects, and students with a degree are least likely to study SLB subjects. Whilst the gradient of the three lines appears similar for all students studying STEM subjects regardless of parent's education level, they differ for propensity to study arts and humanities or SLB subjects. For arts and humanities subjects the gradient is steeper, suggesting that enjoyment of STEM subjects has a stronger negative association with choices for students whose parents have a degree, than for students whose parents have lower levels of education. Whilst advantaged students remain more likely to study arts and humanities at university, for those who enjoy STEM the confidence intervals overlap, suggesting differences are no longer significant. For choice of SLB subjects, the social disparities are highest for students who do not enjoy STEM, suggesting that for students who don't like STEM, students whose parents have higher levels of education are particularly less likely to study SLB than students whose parents have lower levels of education. This is perhaps reflected in the fact that studying arts and humanities is negatively associated with social background, and students who dislike maths and science but do not have highly educated parents are more likely to choose SLB subjects instead.

Discussion

This study explored the mechanisms of horizontal stratification in the English education system of students into different subject areas. Historically academics have focused on vertical stratifications in education by social background, or gender differences in subject specialisations, more recent research has shed light on differences in subjects studied by social background (Codiroli Mcmaster, 2017; Dilnot, 2016; Van de Werfhorst et al, 2003). Whilst it is a widely held position that students should not be constrained by their level of education depending on family circumstances, it is also important that they are equally able to study subjects that they enjoy and think they are good at.

Alongside work considering how student characteristics influence subject choices a distinct area of research has also identified a selection of personal attitudes that predict choices. Students' subjective task-value, the extent to which students *want* to study a subject, and beliefs about their own ability were identified as important drivers of choice. Subjective task value can be split into four sub-components, with 'intrinsic value,' or the extent that they enjoy a subject, being a key factor (Eccles, 1983). These studies were typically based on relatively advantaged students responses to questionnaires, and the extent to which these attitudes and associations differ based on students' characteristics, with exception of gender, was not yet comprehensively explored.

This paper adds to the literature on the psychological mechanisms informing choices by using a large, representative cohort of university students across England from a range of social backgrounds. I examined the relationship between students' personal and background characteristics in determining subject choices at university, and whether students make subject choices for the same reasons regardless of

background. The study replicated prior work by showing key differences in the subjects that students choose to study according to their parents' education level. Students whose parents had higher levels of education were both more likely to choose arts and humanities subjects, and less likely to choose social sciences, law or business, compared to students whose parents had lower levels of education. The study also confirmed findings from the psychological literature, showing that students from a range of social backgrounds were most likely to choose subjects they thought they were good at and enjoyed.

A unique contribution of this research is that it shows ratings of enjoyment and perception of ability influenced university choices over and above actual attainment and a range of other student characteristics. The uneven distribution of students' enjoyment of, and confidence in subjects by background was considered a potential driver of disparities in subject choices. Descriptive statistics suggested students whose parents had lower levels of education were less likely to enjoy science and maths and to rate themselves as 'good' at these subjects. However, disparities in uptake remained when conditioning on attitudes, suggesting that even when students enjoyed STEM, and thought themselves equally capable, students whose parents had higher education levels remained more likely to study arts and humanities over STEM, and to study STEM over SLB subjects at university. In contrast, when accounting for differences attitudes, young women were just as likely to study STEM subject as young men. More research is required to understand fully why the processes driving gender and social background disparities in choices differ so widely.

Whilst initial results confirmed positive associations between attitudes and subject choices, further analysis set to understand whether all students regardless of background were equally likely to make choices based on their personal preferences and beliefs about their abilities. The current research uncovers a difference in processes influencing choice by students' background, but cannot go as far as to identify specific influences over and above attitudes. To further understand this, it is important to explore the specific ways in which students' family background may influence their rationale and motivations in making choices. There is evidence students' socio-economic position could influence their choices directly, for example through the importance they place on intrinsic versus extrinsic benefits of study. For example whether they want to choose a subject they personally enjoy and think they are good at, or whether they are more likely to consider labour market returns and outcomes upon graduation (Breen & Goldthorpe, 1997; Breen & Yaish, 2006). However, the theory of relative risk aversion suggests students whose parents are better educated would be more inclined to choose subjects based on extrinsic motivations to avoid downward mobility. The study presented offers evidence to the contrary; students whose parents are more educated are more likely to choose subjects based on intrinsic motivations. This could be due to the fact they are likely to have a 'safety-net' on graduation, and compared to less advantaged students are more likely to succeed in whichever field they choose.

Findings indicate that mechanisms affecting disparities in uptake differ depending on the student characteristic concerned. For example, interventions aimed at engaging students in STEM and increasing their confidence may attract more young women, but would be unlikely to close social class gaps. Recent research into the efficacy of these interventions suggests that for all students attitudes are difficult to manipulate, and it is more effective for practitioners to foster students' knowledge of positive

outcomes associated with studying STEM (Archer, DeWitt, & Dillon, 2014). This study presents support for the argument that for many students, attitudes to science and maths are not the key issue.

Whilst this study is clearer on what would *not* work in interventions to attract students towards particular subjects, other studies have uncovered areas both associated with subject choice and family background. In the introduction I outlined literature suggesting family circumstances may be associated with the extent to which parents are able to inform their children about career options after study, and to guide them in how best to pursue their interests. This would suggest that these students are most in need of quality advice at school, however currently students from working class backgrounds are most likely to report receiving no careers advice at all (Archer and Moote, 2016). Future research could explore the link between careers advice and subject choices at university, further, and test whether closing this gap could help foster aspirations for students who already have positive attitudes towards STEM.

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