

UNDERSTANDING AND INFLUENCING PUPILS' CHOICES AS THEY PREPARE TO LEAVE SCHOOL

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Background

Why We Did This Study

For young people in England, Wales and Northern Ireland Year 11 represents a potentially vulnerable stage of development. At a time when they are no longer children, yet are not quite adults, 16 year olds come under pressure to perform well in high-stakes examinations (General Certificate of Secondary Education – GCSEs) and to make important choices about the best educational path for them to adult life and employment. In short, Year 11 is a transition point during which young people’s decisions can have important and lasting consequences. While some young people sail through the transition, this is certainly not the case for all.

The aim of our study was to use twin data to gain new insights into aspects of experience that can either support young people in doing their best or knock them off track. We hoped to identify the environmental influences that make a difference (from the point of view of young people and their parents) and to evaluate these hypothetical influences as potential correlates of GCSE achievement, pupil wellbeing and capacity to plan for the future. We hoped to be able to use the evidence gathered as a basis for discussion about whether there is more that can be done to support pupils as they go through Year 11.

Twin studies have found that approximately half of the differences between young people in how they perform at GCSE can be explained by differences in their genes (Shakeshaft et al., 2013; Krapohl, Rimfeld et al., 2014). Environment and measurement error explain the remaining differences between individuals.

In the twin study literature there is compelling evidence that the strongest environmental influences on behaviour

“Year 11 is a transition point during which young people’s decisions can have important and lasting consequences.”

are those that have different effects on siblings growing up in the same family (non-shared environment; NSE).

Such influences could include experiences such as having different friends, teachers or hobbies, or could represent shared experiences which affect individuals differently, such as exam pressure or parental divorce. The sharpest tool we have for identifying NSE influences involves looking at differences between identical (monozygotic) twins. Because monozygotic (MZ) twins share 100% of their genes, as well as their home environment in this study, any discordance between them must be caused by non-shared environment (NSE). Because siblings other than MZ twins differ genetically as well as environmentally, only MZ twin differences can unambiguously pin down NSE. We therefore used an MZ twin differences design, followed by a full twin design, to address the following research questions:

Our Research Questions

1. Which experiences in school and elsewhere influence young people as they reach the end of their compulsory education?
2. Do these environmental factors differ between groups based on socio-economic status (SES), gender or general cognitive ability?
3. Could these environments be used for the benefit of more young people as they prepare to make the transition out of compulsory education?

Phase 1: A Qualitative Hypothesis-generating MZ Twin Differences Study

We conducted a qualitative hypothesis-generating study in which MZ pairs and their parents were asked to tell us about any differences they had observed between the twins in their GCSE achievement or other educationally-relevant traits, including wellbeing and plans for the future. They were asked to identify when they first became aware of a difference between the twins and what they perceived as the causes of it. The aim was to identify families' own explanations for why one identical twin behaved differently to the other with a view to using these explanations as testable hypotheses about NSE effects.

Method

Participants

Participants for all phases of this project were drawn from the Twins' Early Development Study (TEDS), a longitudinal study of twins born in the UK between 1994 and 1996 (TEDS: Haworth, Davis & Plomin, 2013). Questionnaire data were gathered from 497 TEDS families with identical twins (61% female; average age = 17.3). The sample was a convenience sample in that we invited families who were not engaged in other TEDS studies at the time of data collection. Families reported retrospectively on twins' experiences during Year 11. Telephone interviews were conducted with 97 families in which pairs were either at least two grades apart in at least one GCSE subject (56 of the 97 pairs) or were strikingly discordant in another relevant way e.g. health, wellbeing or future plans. Twins and their parents were very open with researchers during the telephone interviews.

Measures

A screening questionnaire was used to identify potential sources of MZ twin discordance, and families' explanations of how, why and when the twins began to differ. Telephone interviews were conducted with the most discordant pairs by two experienced interviewers (both twins in each pair were interviewed by the same person). All interviews were recorded and transcribed with the full consent of participants.

Findings: GCSE Achievement

In responding to our questionnaire, 65 of 497 families reported differences of at least two grades in one or more core GCSE subjects. Thirty sets of MZ twins showed a two-grade difference in English, 23 in Maths, and 31 in Science. Between them, these 65 families reported 101 possible explanations for differences in attainment in the three core GCSE subjects. Explanations reported by at least three families in any one subject are summarised in Table 1.

EXPLANATION	SUB-CATEGORY	ENGLISH	MATHS	SCIENCE	TOTAL
Teachers	One had a 'better' teacher	3	2	-	5
	Different teachers / teaching styles in same subject	5	3	2	10
Ability grouping	Different sets	1	5	2	8
Personality	One more focused/determined/motivated	4	1	2	7
	Different people/individuals	2	3	1	6
	One finds it harder to concentrate	3	5	4	12
Ability	One understands more/better comprehension/finds subject easier	8	15	8	31
	One more academic/scientific/creative	-	-	3	3
Effort	One worked harder/put in more effort during GCSE period	6	7	7	20
	One revised more/harder for assessments	7	5	10	22
Interest	One more interested	8	5	9	22

Table 1: Explanations found in questionnaire data for two-grade discordance within MZ pairs in GCSE English, Maths and Science

It was surprising, and disappointing in a hunt for environmental influences, that student behavioural factors such as discordant effort, ability and interest were the most frequently mentioned explanations for discordant achievement. We had hoped our approach would generate hypotheses about environmental 'hotspots' that could form the basis for targeted environmental interventions but the traits and aspects of

behaviour offered as explanations by these families cannot sensibly be described as 'environments'. A question remains though: Why would one young person work harder or be perceived as less able than their genetically identical co-twin? The fact that they do suggests that the link between effort and achievement is not solely genetic. Identifying environmental explanations for MZ discordance in effort, ability and interest therefore became an important aim of the interviews undertaken in the second wave of qualitative data collection.

Fifty-six of the 61 families in which twins were discordant by at least two grades were interviewed. Interviews covered explanations offered in the questionnaires which spanned the entire period from the mother's pregnancy through birth and neonatal experiences, preschool years, experiences of primary school, transition to secondary school and GCSEs. All of these data were taken into account in considering potential influences on MZ-d discordance in GCSE achievement. Two key themes were identified in the analysis of interview transcripts: *School environment* and *Individual traits/behaviour*.

School environment

Of the 56 families interviewed, 75 percent perceived ability grouping, quality of teaching, or the teacher-pupil relationship as part of the explanation for one twin doing better than the other at GCSE.

The general consensus among twins and parents was that students in higher sets tended to receive a better quality of teaching. This was variously described as the teacher explaining issues or concepts better, engaging more with students, having more passion for the subject, pushing students to reach their potential, or being better able to control the class. In all cases families perceived discordance in these experiences as explanations for why one twin got a grade that was at least two higher or lower than that achieved by their co-twin. It cannot be assumed that any effect was in fact causal, but this is how families described it.

Parents and twins also offered explanations for GCSE discordance relating to their perceptions of teacher quality. They talked in terms of discordance in exposure to inspirational teachers, absent/supply teachers, innovative teaching methods, and good behaviour management skills. For example one twin, who had previously been taught by a Maths teacher whom he and his mother perceived as struggling with behaviour management, was predicted to achieve a Grade E before being moved into a new teacher's class:

[The new maths teacher] had a very stern approach to things. A firm hand. He was strict but fair. You would always do your homework; you would always work hard in the class ... [The previous teacher] was notoriously bad... He didn't have any control, didn't have any control over anybody ... And everybody used to talk and he didn't seem to mind everybody talking which was bizarre because he was a teacher and should have been teaching us.

It was noteworthy in this case that, although this pupil's performance was said to improve to a grade B due to the efforts of the new teacher, his genetically identical co-twin (who had not experienced a 'low quality' teacher) achieved an A*. Poor teacher quality was perceived by this family as the cause of this achievement discordance. Several families offered similar explanations for discordance.

Participants also talked about the importance of teacher-pupil relationships, albeit sometimes in contradictory ways. Some students reported feeling demotivated by a poor relationship with their teacher, while others wanted to prove them wrong:

Well, I know that I didn't really get on with my teacher much, and she told me things like I would be lucky if I got a C... We just didn't gel. She was kind of a bit like that with everyone really, apart from the ones she really liked... I worked quite hard... I wanted to prove her wrong. That was the only motivation I had.

This pupil succeeded and achieved a Grade B. However, as in the case of the Maths teacher described above, her co-twin (who had not experienced a problematic teacher-pupil relationship) achieved an A*.

Finally, some families referred to teachers having 'favourite' students. For instance:

I hated him ... the teacher must definitely be part of it. You would stick your hand up and he wouldn't even come to you. He would just choose favourites, it was ridiculous. The person [co-twin] sat next to was one of his favourites so he was always on that table, which obviously helped.

The chance event of one twin sitting next to one of the teacher's 'favourite' students, and thus indirectly receiving more support, was seen as the main cause of the twin quoted above achieving a Grade D in Maths while his 'luckier' co-twin achieved a B. It also exemplifies the idea that chance is likely to play an important part in NSE influences on behaviour and outcomes.

Non-shared effects of discordant traits or behaviour

Although some participants attributed their achievement discordance to the school environment – and in smaller numbers to environmental factors such as bullying, social media and romantic relationships – they also put discordant achievement down to the effects of discordant effort, ability and interest.

Effort

Effort was the most commonly cited explanation for discordant GCSE results.

Parents and twins alike reported that the twin who worked harder or revised more for assessments performed better. While this is not surprising, and has been found in non-genetic research, it is novel to suggest that discordant effort may have effects that can explain the NSE component of variance in academic achievement.

Interviewers probed for explanations for within-pair discordance in effort and families spoke of the influence of the twin relationship, peer relationships and plans for the future, all potential NSE influences on effort.

The dynamic of the MZ twin relationship is an important factor to consider and, where possible, to control for. Although it has been shown that findings from twin studies can be generalised to non-twin populations it remains feasible that MZ twins react to each other in a different manner to other siblings, and this was suggested by some families. Issues with peers were also mentioned by families in relation to discordant motivation – some twins reported working better in a class with friends while for others this was said to have the opposite effect. It was also of interest that some young people reported not putting as much effort into subjects they expected would not be of use to them in their future careers.

Interest

Parents and twins in several families explained discordance in GCSE results on the grounds that the twins had different levels of interest. However, other than reports of inspirational teachers triggering interest, few environmental explanations were offered for this discordance.

Ability

In spite of the identical DNA of MZ twins, several families believed one twin had more 'natural' ability than the other and that this explained their discordance in achievement. Environmental explanations were rarely offered for perceived ability differences which were usually said to emerge early (possibly indicating pre-natal NSE influences).

Personality

Some families described characteristics such as self-confidence or perfectionism as reasons for one twin performing better than the other. Again, environmental explanations were not generally offered for personality discordance.

Phase 1 findings related to GCSE achievement are detailed in full in:

Asbury, K., Moran, N. & Plomin, R. (2016). Non-Shared Environmental Influences on Academic Achievement at Age 16: A Qualitative Hypothesis-Generating Monozygotic Twin Differences Study. AERA Open, 2 (4) 2332858416673596.

Discordance in Other Areas

Families told us about a wide range of within-twin-pair discordance, including discordant self-confidence, plans for the future, personality, preferences and mental health. One of the most commonly mentioned areas of discordance was in peer relationships. We therefore analysed discordant peer relationships as a non-shared experience and explored hypothetical causes and consequences, as cited by the twins in our sample, and their parents.

Findings: Discordant Peer Relationships

In questionnaires and interviews 112 of 497 families (22.5%) spontaneously mentioned discordant peer relationships. We coded this qualitative data and generated a typology of peer relationship discordance. We found that families reported MZ twins as differing in six areas detailed in Table 2.

Discordance Category	Number of families described
Discordant peer victimisation	15
Discordant peer rejection	7
Fewer friends	39
Different friends	23
Different attitudes to friendship	23
Dependence on co-twin	5
N	112

Table 2: A Proposed Typology of Friendship Discordance in MZ twins

Discordant peer victimisation

Twins were categorised as being discordant for peer victimisation when they reported one twin being affected by the *actions* of others who deliberately and actively set out to hurt them. It can be differentiated from discordant peer rejection which was the code applied when one twin was affected by the *attitudes* of others, who may have ignored or disliked them. Fifteen twin pairs (13% of pairs who described peer discordance and 3% of the total sample) were categorised as discordant for peer victimisation. Evidence of discordant peer victimisation in this sample included name calling, cyberbullying and physical bullying which, in some cases, was persistent and very severe. One example of name-calling involved a twin who had been badly scarred by meningitis:

He's had to cope with the ... nickname 'Scar Boy'.

In the most severe case of bullying the bullied twin said:

...the police got involved because it became so bad. They'd jump me as I got off the bus, there'd be about twenty of them waiting for me.

These fifteen families reported causes or sources of discordant bullying that included discordance in sexuality (2 pairs), behavioural disorders (e.g. ADHD, ASD) (3 pairs), appearance (e.g. weight, skin problems) (5 pairs), other relationships (e.g. being liked by a bully's girlfriend) (2 pairs), or chance (e.g. being placed in a class with bullies) (6 pairs). In summary, MZ twins reported discordant experiences of peer victimisation that they perceived as being based on chance occurrences or enhanced vulnerability (standing out in a way that others perceived as negative or threatening).

Participants reported the consequences of discordant peer victimisation as discordance in confidence (6 pairs), mental health (including eating disorders, self-harm, anxiety, suicide attempts, social phobia) (6 pairs), future plans (4 pairs) and social isolation (3 pairs). In all cases the victimised twin reported worse outcomes. Perceived consequences of victimisation were very pronounced. In one case where the bullied twin had ADHD a mother said:

He used to have marks on his arms and stuff from where he used to bite himself ... He didn't like himself very much.

Another mother of a daughter who cut herself and had attempted an over-dose said:

Twin 2 is dissatisfied with herself and would like to reinvent herself somewhere else where her life would be more 'beautiful'.

These data suggest that peer victimisation may have NSE effects on mental health, self-confidence, social isolation and future plans. New hypotheses can be developed in these areas.

Discordant peer rejection

Twins were coded as discordant for peer rejection when one twin experienced feeling left out, ignored or disliked by their peer group and this was evident in seven families. All presented theories for discordant acceptance of the twins and suggested causes included discordant character judgement, sexuality, mental health problems (associated with school absence), protecting a vulnerable co-twin and chance.

In terms of perceived consequences, outcomes tended to be more negative for the rejected twin. Suggested outcomes included changed future plans, social isolation and reduced confidence:

[she] lost some of her sparkle

I think due to the discrimination I have faced since coming out in public and mainly school, I have become much more vulnerable and scared.

As with victimisation the hypothetical causes of discordant peer rejection appear to be related to chance and enhanced vulnerability, and the consequences were generally negative and serious for the rejected twin. It may therefore be reasonable to combine hypotheses related to peer victimisation and peer rejection. The difference between them may be down to chance in the sense that chance is likely to play a part in whether they are exposed to, and disliked by, bullying or rejecting individuals.

Fewer friends

Thirty-five percent of the families who described peer discordance (8% of the total sample) reported one twin having fewer friends than the other. In a minority of cases (7/39) this was considered to be a positive situation in which each twin had a friendship group of a size and closeness that suited their personality and preferences. In all of these cases participants cited personality and preference as the cause of discordance in peer group size. However, in all other cases (32/39) having

fewer friends was perceived as a negative experience. One girl, who had missed a lot of school because of mental health problems, said:

I'm probably going to end up with no friends because of the panic disorder. That's something I haven't said before. No friends and a crap job makes for a grim future, doesn't it?

When offering explanations for why one twin had fewer friends most participants cited pre-existing behavioural or psychological discordance. For example, 22 families cited reasons related to discordant personality, confidence and self-esteem.

Even as a baby, Twin 1 was always much quieter and less secure – he never wandered off at playgroups. Twin 2 is more easy-going.

Seven families cited discordant health as the reason one twin had fewer friends. A smaller number of families cited discordant interests (1 pair) or appearance (2 pairs).

The environmental hypotheses for discordant size of friendship group included chance events (e.g. having a best friend leave) (5 pairs), falling out with peers (1 pair) and having a boyfriend (5 pairs). It was notable that in the five cases where a boyfriend was cited as the reason for one twin ending up with fewer friends, participants said the twin with the boyfriend ended up being more socially isolated.

As with peer victimisation and peer rejection, having fewer friends than a co-twin was generally viewed as a negative non-shared experience that was triggered by behavioural discordance. It is important to note, however, that behavioural discordance in MZ twins must also have NSE roots. Perceived consequences of having fewer friends included reduced confidence (5 pairs), discordant future plans (8 pairs) and social isolation (10 pairs).

I am ready to leave home and become more independent, something that uni life will offer me. My twin is happy to be in the comfort of home and a local college.

These data suggest the hypothesis that having fewer friends than you would like (feeling unpopular) may have NSE effects on outcomes including social isolation, confidence and future plans. However, it is also important to note that some people prefer small, close friendship groups and the current data do not suggest any negative outcomes of this. On the contrary, these young people were more likely to

be described as confident, independent, more likely to value friends and to be less subject to peer pressure. The key question, it seems, is whether young people wish they had more friends or whether they are happy with their lot.

Different friends

In 23 families (20% of the peer discordant group and 5% of the total sample), participants stated that the twins had different friends, without adding that one had fewer friends or that one was rejected or victimised by peers. In 17 of these cases they said that the reason for the twins having different friendship groups was that, at some point in their education, they had been split up and were therefore exposed to different peer groups. In seven of these cases they were split up *by choice* because they actively wanted the opportunity to be treated as individuals. For example, in one family one twin:

was keen to gain a little more independence and possibly to make a wider circle of friends not shared with her sister.

In eight cases they were split up *by chance*, in that they were allocated to different classes or educational settings. In the remaining two cases in which twins were said to have different friends as a result of being split up, the reason for the split was unspecified. In addition, two families mentioned discordant personality and confidence as a reason for having different friendship groups, one mentioned discordant interests and a final family cited parental encouragement.

In terms of consequences the most common discordance reported by participants as a result of having different friends was discordance in personality and confidence (13 families). In general, the twin who had been more successful in making friends who were a good fit for them, and with whom they could be themselves, were reported to be more confident and/or outgoing than their co-twin. In a family in which one twin had missed a lot of school as a result of surgery, her co-twin said:

Her health problems cause a lot of her stress, especially around friends as she missed a year of school due to it, whereas I continued going to school and gained greater independence and confidence socially.

In four cases families perceived discordant interests to be an outcome of different peer groups and, in a further five, discordance in future plans. Finally, in three families in which one twin had made friends who were seen as a better fit for them discordance in friendship quality and social life was reported as a perceived outcome of having different friends.

In summary, different friendship groups were primarily seen as the natural outcome of being split up and exposed to different peers. Non-shared peer groups were hypothesised to explain discordance in personality, confidence, interests and social life. It seems reasonable, therefore, to hypothesise that friends can explain NSE variance in these aspects of adolescent behaviour, although the relationship between perceived causes and consequences would benefit from further untangling.

Different attitudes to friendship

In 23 families (20% of the peer discordant group and 5% of the total sample), participants described MZ discordance in attitudes to friendship. In some cases the twins shared a friendship group and in others they did not. These families' responses were characterised by a specific focus on each twin's attitude to having and being a friend. Five different explanations for discordant attitudes to friendship were suggested. In 11 cases participants said that one twin was more willing to make an effort to socialise than the other:

My twin likes to go out more than me. We both have the same friend group but sometimes if an opportunity to go out turns up then I might say no and my twin would normally say yes.

In eight cases families said that one twin was motivated by a greater need for peer approval. For example:

Twin 1 wants to be accepted and in with the cool crowd. Twin 2 [is] more inwardly confident, not so worried what people think of him.

Five families said that discordant attitudes to friendship were driven by discordant confidence (caused by earlier discordance in, for example, OCD and anorexia) and four by discordant personality. Finally, two families said that discordant attitudes to friendship were triggered by the twin relationship and, in particular, within-pair comparisons.

Discordant outcomes of these different attitudes were suggested by 16 of the 23 families and included discordance in social life (6 pairs), future plans (3 pairs), study habits (3 pairs), a preference for fewer, closer friends (3 pairs), personality (1 pair) and stability of friendships (1 pair). It was interesting to note that in 18 of the 23 cases discordance in outcome was either not specified (5 pairs) or was neutral in content (13 pairs). That is, neither twin was seen as having gained an advantage over the other by their attitude to friendship. In the remaining five cases worse outcomes were described for one twin and were seen as the result of their attitude to

friendship, or of the situation or behaviour that was seen as underpinning their attitude to friendship. For example:

I think when I developed anorexia at 13 my confidence and social skills and health suffered, and this has led us to be different types of people. My twin is how I believe I would have been if I hadn't got anorexia.

Families reported behavioural discordance as underpinning different attitudes to friendship and in most cases participants were relaxed about what they saw as the ensuing discordance which they tended to see as reflecting individual preferences.

Dependence on co-twin

Five families described discordance in experience of peer relations in the sense that one twin was dependent on the other, that is, one twin made friends and the other just 'tagged along'. In four cases this was seen as the result of discordance in personality (factors such as extraversion) and in one the result of chance. In the pair where chance was cited the twins had previously attended separate schools and when they came together one knew more people than the other. When the twin who was new to the school tried to 'tag along' with her sister this caused friction. Other than this, all five families described the outcome of this discordance within the twin relationship as a concern about how the dependent twin would cope in Further or Higher Education when they would be split from their co-twin. Hypotheses from this aspect of discordant peer relationships are not applicable beyond twins. These findings are detailed and discussed in full in:

Asbury, K., Moran, N. & Plomin, R. (submitted). Do MZ twins have discordant experiences of friendship? A Qualitative Hypothesis-generating MZ twin differences study.

In Conclusion

Phase 1 of this project was used to identify hypothetical NSE influences on a range of outcomes for 16 year olds in the UK. In terms of GCSE achievement the hypotheses generated related to perceptions of self and teachers in academic subjects, effort, family influences on future plans, self-confidence about future plans, the influence of work experience and of social media use. Peer relationships were also identified as an NSE influence on development and socialisation.

In Phase 2 we designed a quantitative measure of NSE influence based on the qualitative information gathered here. We focused particularly, although not exclusively, on environmental predictors of achievement discordance.

Phase 2: Developing SENSES: Student Experiences of Non-Shared Environment Scales

We developed the Student Experiences of Non-Shared Environment Scales: SENSES. A detailed account of the development of this measure can be seen in:

Asbury, K., Yerdelen, S., Durksen, T.D., Rimfeld, K. & Plomin, R. (currently in revision)
Non-Shared Environmental Influences on exam performance and life satisfaction in adolescence: A twin study.

Method

Participants

Twins from 2165 TEDS families were invited to participate in this wave of data collection. Opposite-sex twins were excluded from the target sample, as were twins participating in concurrently running studies. Twins of unknown zygosity and those with severe medical problems were also excluded. After exclusions we received SENSES and life-satisfaction data from $n=926$ of these pairs (53% MZ; 61.9% female). In 908 cases we received data from both twins and in 18 cases, only from one. Data were gathered, therefore, from 1834 individuals (Mean age=18.4). Of these, 1672 also provided us with Year 11 achievement data. The sample was not fully representative of the UK population, or of the original TEDS sample. The relatively increased proportion of girls (from close to 50% at first contact) is broadly representative of TEDS data at age 16, but not of the UK population. This discrepancy may be the result of a greater willingness to engage with data collection among girls than boys at this age. Furthermore, standardized socio-economic status (SES) was higher in this sample than in the population ($M=0.31$), and, more surprisingly, standardized g scores (measured at age 12) were slightly lower ($M=-0.12$). These discrepancies may be due to sample selection effects.

Measures

Student Experiences of Non-Shared Environment Scales (SENSES)

We developed SENSES, a 49-item, 10-factor measure of students' NSE experiences in late adolescence, on the basis of Phase 1 qualitative data. SENSES was administered as a paper-based self-report questionnaire. We found it to be reliable and valid in the TEDS sample (See Appendix 1).

We explored SENSES' external validity via correlations with GCSE performance, self-reported life satisfaction and three aspects of future orientation (planning ahead, time perspective and consideration of future consequences). Experiences in English classes correlated significantly with English GCSE achievement ($r=.39$), and the same was true for Maths and Science (average $r=.39$). Correlations with self-reported life satisfaction were mainly significant but weak (average $r=.13$). However, there was a moderate correlation of $r=.48$ between pupils' self-confidence about their ability to achieve their future plans (SENSES) and life satisfaction. In terms of future orientation SENSES factors correlated at levels ranging from .01 through to .23 (average $r = .10$). The strongest correlations were between effort and the three measures of future orientation (average $r = .21$). The fact that SENSES factors correlate significantly with these outcomes suggests that the decision to explore them as having potential NSE effects was a valid one.

General Certificate of Secondary Education (GCSE)

GCSE grades were collected by post shortly after the official release of UK school examination results in August 2010, 2011 and 2012.

Self-Reported Life Satisfaction

Data were gathered on self-reported life satisfaction using a well-validated five-item measure of global life satisfaction (Diener et al., 1985). These items were included with the paper-based SENSES questionnaire.

Planning the Future

Future Orientation was measured using Steinberg et al.'s (2009) Future Orientation scale. This 15-item measure assesses planning ahead, time perspective and consideration of future consequences and was adapted for the current study. This measure was also included with the paper-based SENSES questionnaire.

Analysis

Data were analysed using exploratory factor analysis and confirmatory factor analysis for the purpose of measure development. We then used descriptive statistics, correlations, univariate genetic analysis and bivariate Cholesky decomposition analysis. Finally, group differences were analysed using t-tests and ANOVA.

Findings

We asked how much of the variance in each of the study measures could be explained by genes (A), shared or common environmental effects (C) and NSE effects (E) (See Table 3).

It can be seen in Table 3 that all ten SENSES factors were moderately to strongly influenced by NSE effects with estimates ranging from 45% for effort to 65% for perceptions of Math teachers and work experience. This substantial NSE component indicates that, we are to some extent getting at non-shared environment with this measure of student experience. In order for a measured environment to be considered as a candidate NSE influence it needs to demonstrate a high proportion of NSE variance (Turkheimer & Waldron, 2000).

Nonetheless, SENSES is not purely an environmental measure: Genetic factors explained 20% to 48% of the variance in the SENSES factors ($M = 36\%$) while shared or common environmental effects explained 0% to 15% of the variance ($M = 8\%$).

We also conducted univariate analyses of our measures of GCSE achievement, life satisfaction and future orientation. Genes explained 49% - 55% of the variance in GCSE subjects; shared environmental effects explained 28% - 35%; and NSE effects explained 17-19% of the variance. This is in line with recent reports of GCSE data using the TEDS sample (Kraphol, Rimfeld et al., 2014; Shakeshaft et al., 2013).

Life Satisfaction was substantially influenced by NSE effects (46%) and also by genetic effects (35%). Shared environmental effects influenced life satisfaction too, albeit to a lesser extent (19%). In summary, there is more NSE variance to be explained in Life Satisfaction than in GCSE achievement at this age and in this sample, as predicted by extant research (e.g. Bartels, 2015). This was even more noticeably the case for our measures of future orientation, each of which was mainly explained by NSE influences (75% for Planning Ahead; 69% for Time Perspective; and 81% for Consideration of Future Consequences).

Having calculated the correlation between SENSES and our outcome measures, and decomposed variance in these measures into genetic and environmental components, we went on to use a bivariate Cholesky decomposition analysis to explore how much of the relationship between SENSES factors and achievement/life satisfaction could be explained by genetic, shared and NSE factors shared between both experience (SENSES) and outcome (GCSE, life satisfaction and future orientation) (Figures 1a to 1g).

FACTOR	A	C	E
ENGLISH: Perceptions of Self and Teacher	0.47	0	0.53
	(0.35 – 0.53)	(0.00 – 0.09)	(0.47 – 0.60)
EFFORT: English, Maths and Science	0.42	0.13	0.45
	(0.22 – 0.60)	(0.00 – 0.30)	(0.39 – 0.51)
SCIENCE 1: Perceptions of Self	0.47	0.02	0.51
	(0.26 – 0.56)	(0.00 – 0.20)	(0.44 – 0.58)
MATHS 2: Perceptions of Teacher	0.2	0.15	0.65
	(0.00 – 0.42)	(0.00 – 0.33)	(0.57 – 0.74)
MATHS 1: Perceptions of Self	0.48	0	0.52
	(0.38 – 0.54)	(0.00 – 0.07)	(0.46 – 0.59)
SCIENCE 2: Perceptions of Teacher	0.28	0.14	0.58
	(0.06 – 0.48)	(0.00 – 0.32)	(0.51 – 0.66)
PLANS 1: Family influence	0.25	0.12	0.63
	(0.01 – 0.44)	(0.00 – 0.31)	(0.56 – 0.71)
PLANS 2: Self-confidence	0.33	0.06	0.61
	(0.09 – 0.46)	(0.00 – 0.25)	(0.54 – 0.69)
SOCIAL MEDIA CONNECTIONS	0.33	0.15	0.52
	(0.12 – 0.53)	(0.00 – 0.32)	(0.45 – 0.59)
PLANS 3: Work experience	0.35	0	0.65
	(0.26 – 0.43)	(0.00 – 0.06)	(0.57 – 0.72)
Outcome Measures			
GCSE English	0.55	0.28	0.17
	(0.42 – 0.69)	(0.14 – 0.40)	(0.14 – 0.20)
GCSE Maths	0.49	0.35	0.17
	(0.37 – 0.62)	(0.21 – 0.46)	(0.14 – 0.20)
GCSE Science	0.49	0.31	0.19
	(0.36 – 0.64)	(0.17 – 0.44)	(0.16 – 0.22)
Life Satisfaction	0.35	0.19	0.46
	(0.15 – 0.55)	(0.01 – 0.36)	(0.40 – 0.53)
Planning Ahead	0.25	0	0.75
	(0.15 – 0.33)	(0.00 – 0.06)	(0.67 – 0.84)
Time Perspective	0.31	0	0.69
	(0.15 – 0.39)	(0.00 – 0.13)	(0.61 – 0.77)
Consideration of Future Consequences	0.19	0	0.81
	(0.00 – 0.27)	(0.00 – 0.17)	(0.73 – 0.91)

Table 3: Univariate Twin Analyses of SENSES factors, GCSE performance and Life Satisfaction

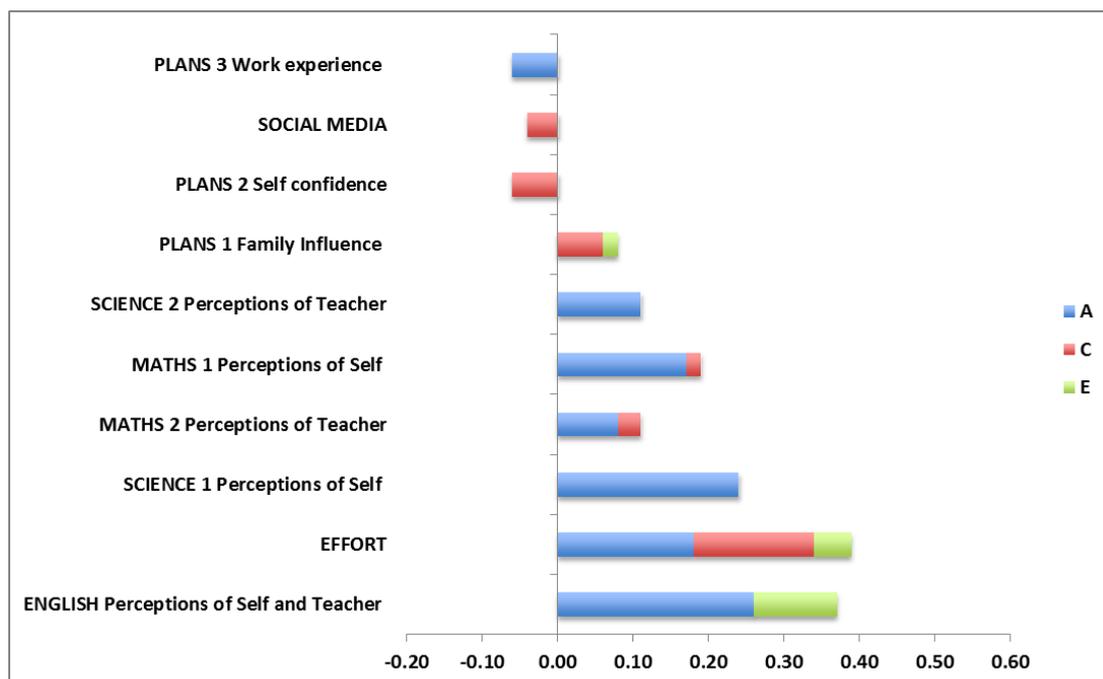


Figure 1a: Bivariate Analysis of relationship between SENSES factors and achievement in GCSE English

The strongest correlations for English were with SENSES' self-reported effort ($r=.39$) and perceptions of self and teacher in English ($r=.37$). In both cases genetic factors were the strongest mediator of the relationship. They explained 75% of the relationship between GCSE grade and perceptions of self and English teacher, and 46% of the relationship between effort and achievement. Shared environment did not explain any of the correlation between the English factor and achievement but it was interesting to note that shared environmental factors explained 41% of the correlation with effort, almost as much as genetics.

We found that NSE factors explained 30% of the correlation between the English (perceptions of self and teacher) factor and GCSE English achievement ($r=.37$) and 13% of the relationship between effort and achievement ($r=.39$). For the other SENSES factors NSE did not significantly mediate relationships with GCSE English and, in most cases, relationships were primarily explained by shared genetic factors.

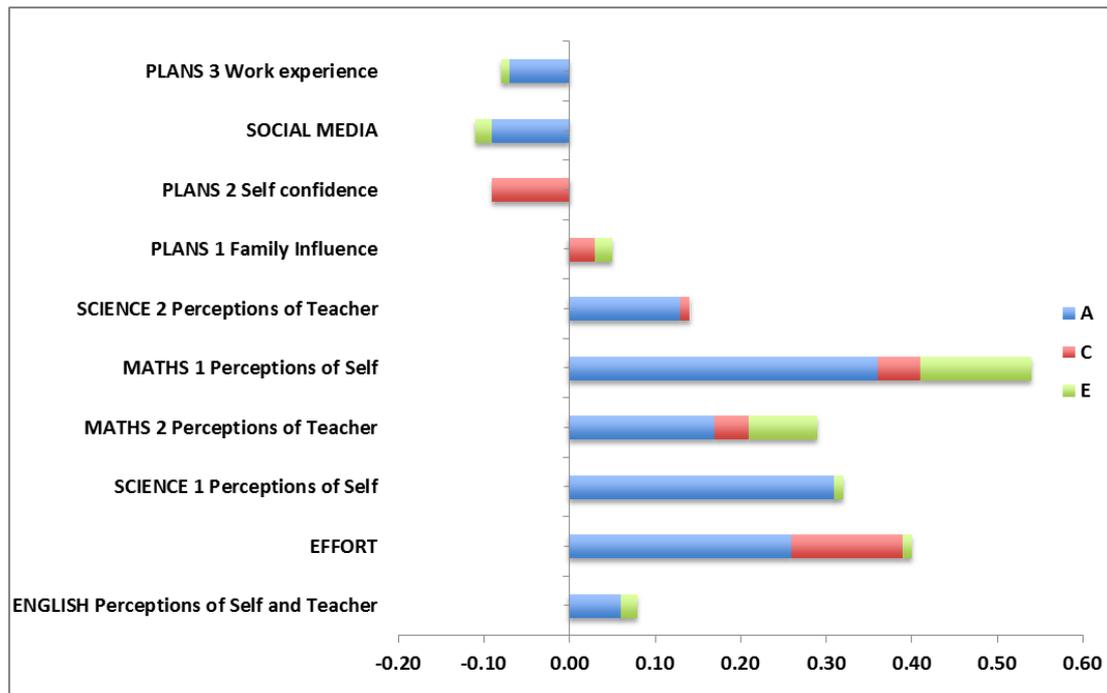


Figure 1b: Bivariate Analysis of relationship between SENSES factors and achievement in GCSE Maths

Correlations between SENSES factors and GCSE mathematics achievement were also primarily explained by shared genetic influences. As with English, shared environment was a strong mediator of the phenotypic correlation ($r=.40$) between effort and achievement, explaining 33% of the association. The correlation between perception of self in Maths and GCSE Maths showed most NSE mediation. Of the correlation of $r=.54$, 24% was explained by NSE influences common to the two variables. Most of the remainder of the correlation was explained by genetic factors. This suggests that NSE common to both self-perceptions and achievement in Maths can explain one-quarter of the association between them (similar to English). It is not, however, clear from these data what the shared NSE effect actually is. This is an important avenue for future research.

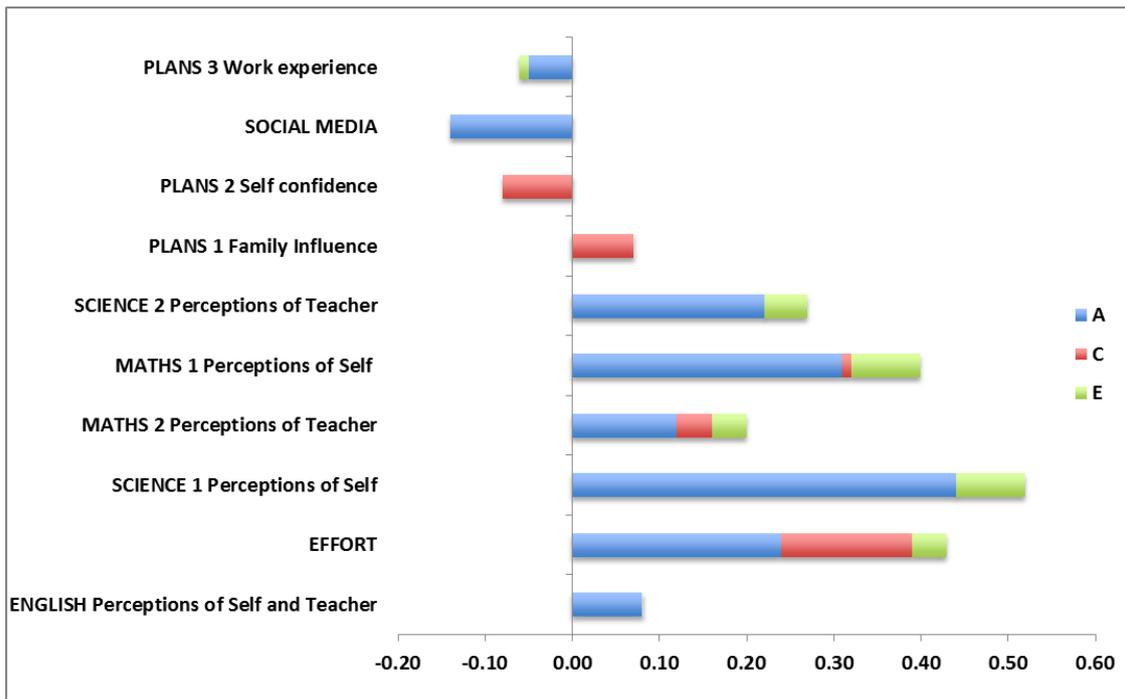


Figure 1c: Bivariate Analysis of relationship between SENSES factors and achievement in GCSE Science

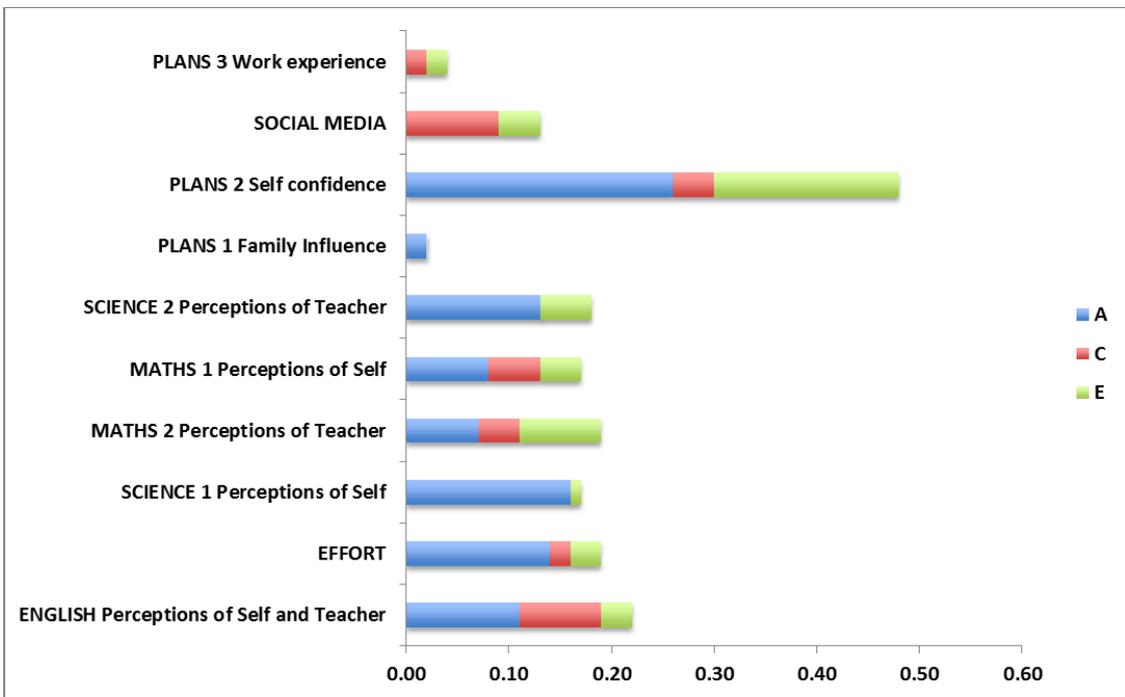
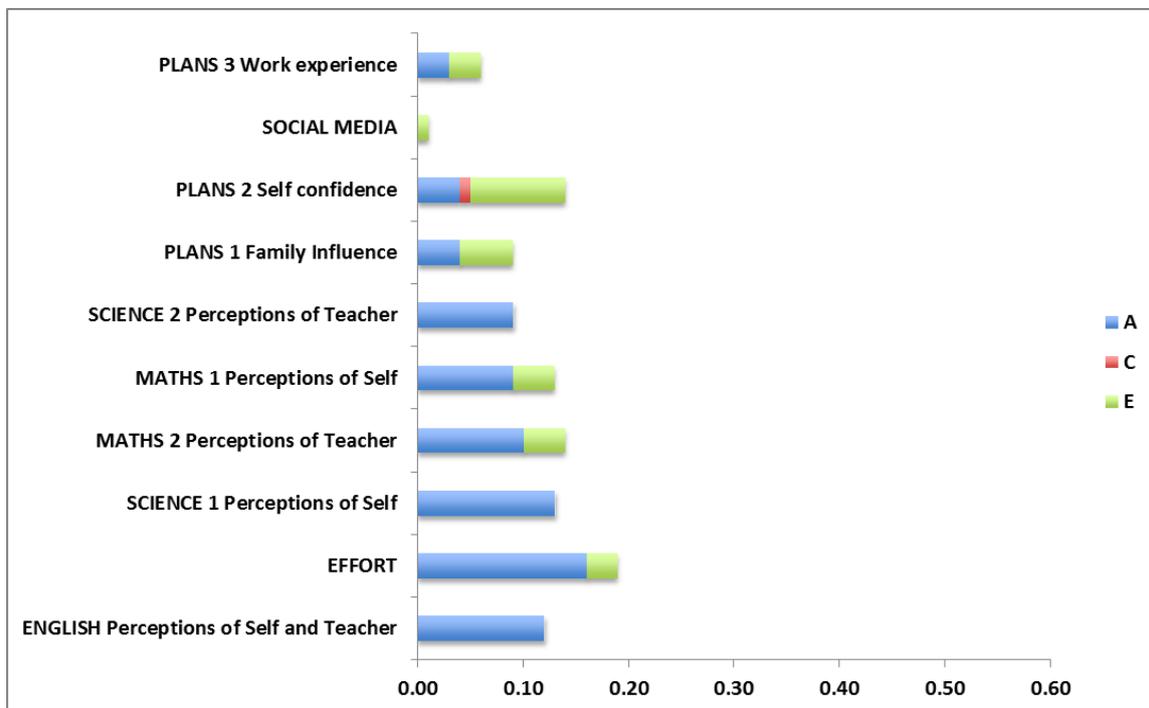


Figure 1d: Bivariate Analysis of relationship between SENSES factors and Life Satisfaction

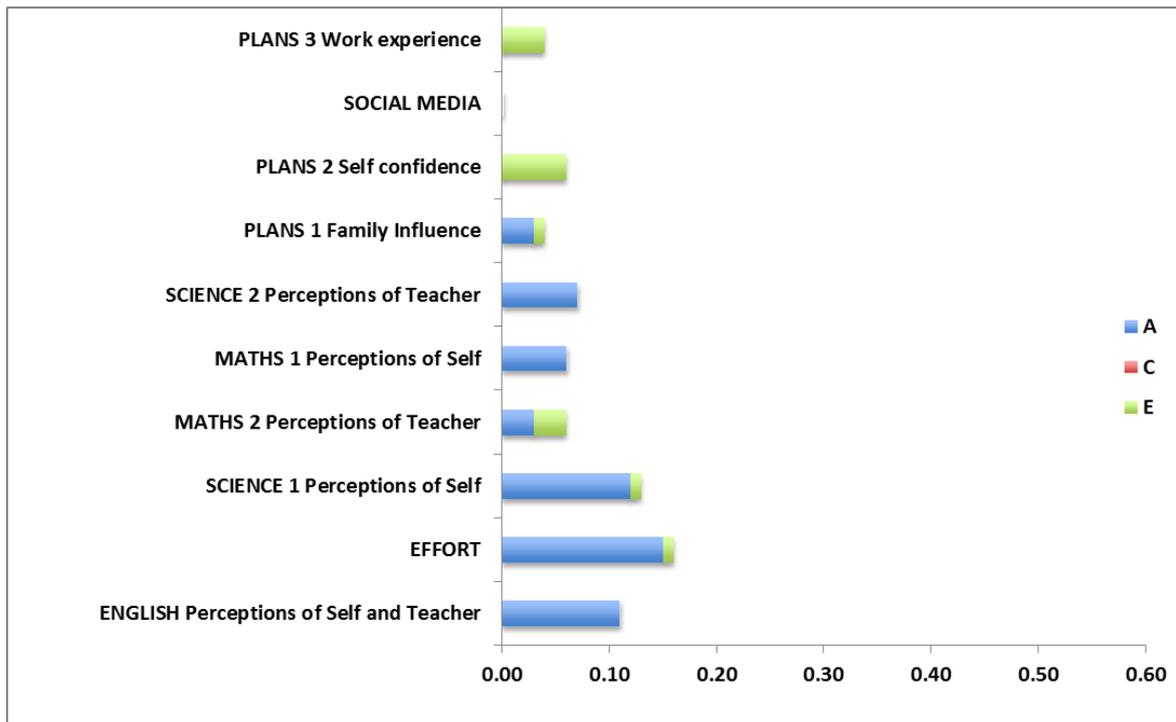
A similar pattern of moderate to substantial genetic mediation, with a smaller role for shared environment in the association between effort and achievement, was observed for GCSE Science. Small amounts of NSE mediation were noted for 6 of the 10 SENSES factors, explaining proportions of variance ranging from 9% (of a correlation of $r=.43$ between effort and achievement) to 20% of correlations between perception of self and perception of Maths teacher with Science achievement ($r=.20$ and $r=.40$ respectively).

Self-confidence about the future and life satisfaction correlated $r=.48$, and 38% of this correlation was explained by NSE influences common to both variables. Shared genes explained 54% and shared environmental influences common to both variables explained 8% of the relationship.

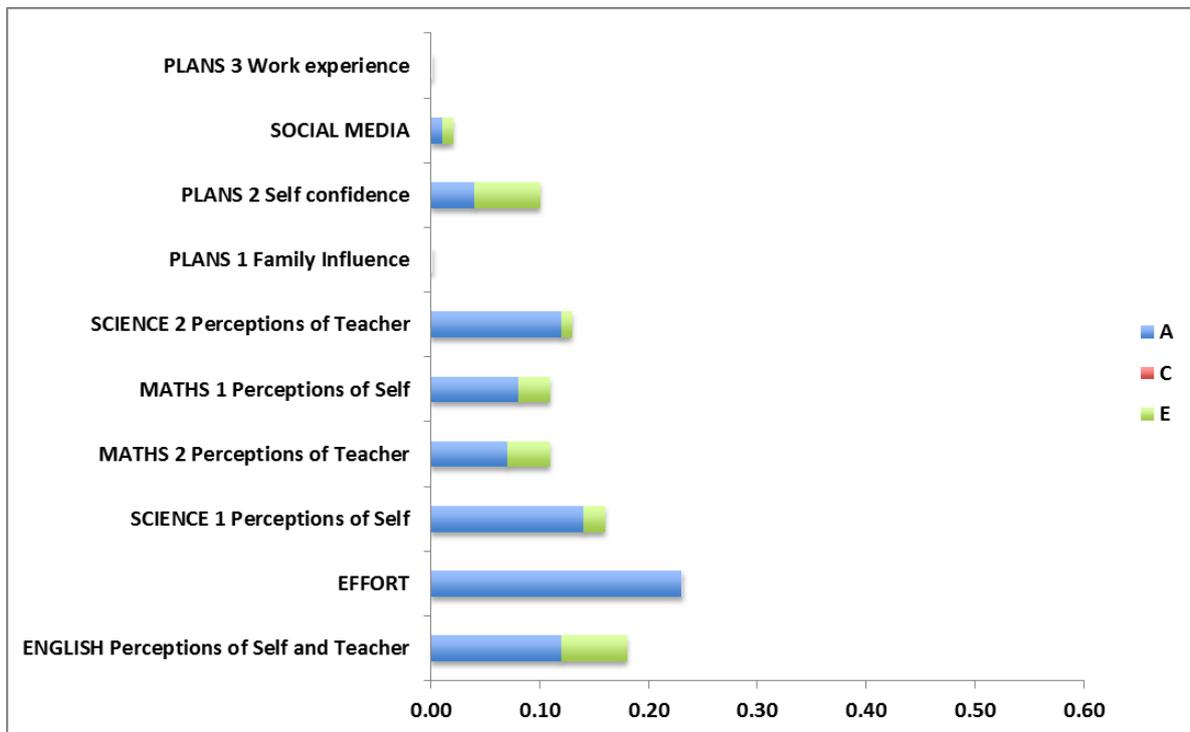
NSE factors were the strongest mediator of a small correlation ($r=0.19$) between perceptions of Math teachers and life satisfaction, explaining 42% of the association. There was some NSE mediation of 9 of the 10 relationships, ranging from explaining a non-significant proportion of a correlation of $r=.17$ between perception of self and life satisfaction to the already mentioned 48% of the association between confidence about achieving future plans and life satisfaction. This relationship appears to be a potentially important one for future research.



Figures 1e: Bivariate Analysis of relationship between SENSES factors and Planning Ahead



Figures 1f: Bivariate Analysis of relationship between SENSES factors and Time Perspective



Figures 1g: Bivariate Analysis of relationship between SENSES factors and Future Consequences

Correlations between SENSES factors and the three future orientation measures ranged from $r=.00$ to $r=.23$ (Effort and Consideration of Future Consequences) and were, for the most part, mediated by genes rather than environmental factors. The main exception to this was for self confidence about plans for the future and planning ahead in which 64% of a small correlation of $r=.14$ was explained by NSE influences common to both variables. Given the substantial influence of NSE effects on future orientation further work in different areas of experience is needed as SENSES factors do not appear to be very strong candidates.

In summary, variance in the SENSES factors is moderately to strongly influenced by NSE effects. However, for the most part associations between SENSES factors and achievement, life satisfaction and future orientation are mediated by genetic factors. Exceptions, in which NSE plays a larger mediating role, include the relationships between self-perceptions and GCSE achievement, and self-confidence about ability to make future plans real and self-reported life satisfaction. Both of these associations could prove fertile ground for future research. An incidental finding is the shared environmental mediation of associations between effort and achievement. This too represents an important avenue for future research.

Phase 3: Group differences in experience and outcome in adolescence

In Phase 3 we addressed Research Question 2 by asking whether SENSES factors were affected (at the behavioural or the genetic level of analysis) by belonging to a particular group. We looked for group differences based on sex, socio-economic status (SES) and general cognitive ability.

Findings

Sex

When we compared girls and boys on the ten SENSES factors we saw sex differences for effort (girls reported higher levels of effort); perceptions of self in Science (higher for boys); perceptions of self and teachers in Maths (higher for boys) and self-confidence about one's ability to achieve future plans (higher for boys). See Table 4a. Although these five differences were statistically significant it is important to note that they had only small effects (highest Cohen's $d = 0.3$ for perceptions of Maths teacher).

SES

Socio-economic status (SES) was defined as parent's occupational and educational status. We divided the sample into quartiles (G1 to G4) with, as shown in Table 4b, G1 representing the lowest level of SES in the sample and G4 the highest. Groups were compared using ANOVA and significant differences were found for five of the ten SENSES factors (English, effort, perceptions of self in both Maths and Science, and family influence on future plans). None of the differences were very large – the largest and most significant was for effort where it was observed that pupils from the lowest SES quartile reported working less hard for their GCSE assessments than pupils from the other quartiles. The other differences were negligible and all effect sizes (eta-squared), even the largest ($\eta^2 = .03$ for effort), were small.

General cognitive ability (g)

As with SES we divided our sample into quartiles on the basis of g score. This group comparison was where we saw the strongest differences with statistically significant group differences found for seven of the ten SENSES factors (family influence on future plans, self-confidence in own ability to carry out future plans, and use of social media were the exceptions). The smallest significant difference was for work experience and had a very small effect size ($\eta^2 = .01$) but it was interesting to note the

direction of the relationship, with those pupils with the lowest levels of *g* reporting a higher level of influence of work experience on future plans. The largest and most significant differences were for effort, perception of self in Science and perception of teacher in Maths. For perceptions of self in Science and perception of teacher in Maths effect sizes were medium ($\eta^2 = .09$) while other effects were small. In all of these cases being in a higher *g* group was associated with a higher SENSES score. That is, pupils with higher levels of general cognitive ability reported working harder for their GCSE assessments, feeling more confident about their ability to do what they needed to do in Science and feeling more positive about their Maths teacher. A similar, but less strong, effect was noted for English and for perceptions of Science teachers. See Table 4c.

SENSES	Full Sample	Gender			d
		M	F	<i>t</i> (864)	
ENGLISH Perceptions of Self and Teacher	3.54 (0.81)	3.52 -0.79	3.55 -0.82	0.41	0.03
EFFORT	3.48 (1.02)	3.32 -1.07	3.57 -0.98	3.57**	0.24
SCIENCE 1 Perceptions of Self	3.59 (0.99)	3.74 -0.98	3.5 -0.98	3.55**	0.24
MATHS 2 Perception of Teacher	3.40 (1.12)	3.63 -1.07	3.26 -1.12	4.80**	0.33
MATHS 1 Perception of Self	3.74 (1.02)	3.81 -0.95	3.69 -1.06	1.67	0.11
SCIENCE 2 Perceptions of Teacher	3.66 (0.92)	3.77 -0.89	3.59 -0.93	2.87*	0.19
PLANS 1 Family Influence	1.78 (0.77)	1.83 -0.82	1.74 -0.74	1.61	0.11
PLANS 2 Self confidence	3.67 (0.88)	3.79 -0.79	3.59 -0.92	3.21**	0.22
SOCIAL MEDIA	3.39 (0.82)	3.35 -0.88	3.41 -0.78	0.96	0.06
PLANS 3 Work experience	2.00 (0.97)	1.93 -0.88	2.04 -0.98	1.68	0.11

Table 4a: Do SENSES scores differ by sex?

SENSES	Full Sample	SES					η^2
		G1	G2	G3	G4	F	
ENGLISH Perceptions of Self and Teacher	3.54 (0.81)	3.45 (0.83)	3.52 (0.79)	3.54 (0.82)	3.54 (0.82)	2.97*	0.01
EFFORT	3.48 (1.02)	3.24 (1.03)	3.46 (1.03)	3.52 (1.04)	3.52 (1.04)	9.06**	0.03
SCIENCE 1 Perceptions of Self	3.59 (0.99)	3.48 (1.05)	3.53 (0.94)	3.71 (0.95)	3.71 (0.95)	3.25*	0.01
MATHS 2 Perception of Teacher	3.40 (1.12)	3.27 (1.08)	3.38 (1.08)	3.48 (1.13)	3.48 (1.13)	2.36	0.01
MATHS 1 Perception of Self	3.74 (1.02)	3.57 (1.11)	3.76 (1.02)	3.88 (0.99)	3.88 (0.99)	3.27*	0.01
SCIENCE 2 Perceptions of Teacher	3.66 (0.92)	3.61 (1.05)	3.63 (0.91)	3.81 (0.85)	3.81 (0.85)	1.92	0.01
PLANS 1 Family Influence	1.78 (0.77)	1.67 (0.74)	1.72 (0.77)	1.84 (0.77)	1.84 (0.77)	2.92*	0.01
PLANS 2 Self confidence	3.67 (0.88)	3.78 (0.83)	3.65 (0.91)	3.66 (0.91)	3.66 (0.91)	2.22	0.01
SOCIAL MEDIA	3.39 (0.82)	3.43 (0.80)	3.31 (0.86)	3.40 (0.77)	3.40 (0.77)	0.91	0.003
PLANS 3 Work experience	2.00 (0.97)	1.95 (0.93)	1.93 (0.92)	2.08 (0.92)	2.08 (0.92)	1.06	0.004

Table 4b: Do SENSES scores differ by SES?

SENSES	Full Sample	g					F	η^2
		G1	G2	G3	G4			
ENGLISH Perceptions of Self and Teacher	3.54 (0.81)	3.41 (0.85)	3.47 (0.75)	3.61 (0.78)	3.70 (0.79)	4.71*	0.02	
EFFORT	3.48 (1.02)	3.19 (1.05)	3.33 (0.99)	3.55 (1.02)	3.90 (0.89)	17.32**	0.07	
SCIENCE 1 Perceptions of Self	3.59 (0.99)	3.35 (1.01)	3.38 (0.96)	3.68 (0.89)	4.07 (0.88)	22.94**	0.09	
MATHS 2 Perception of Teacher	3.40 (1.12)	3.00 (1.13)	3.27 (1.08)	3.48 (1.07)	3.91 (1.01)	22.85**	0.09	
MATHS 1 Perception of Self	3.74 (1.02)	3.54 (1.10)	3.61 (1.04)	3.75 (0.99)	4.02 (0.92)	7.58**	0.03	
SCIENCE 2 Perceptions of Teacher	3.66 (0.92)	3.53 (1.06)	3.53 (0.90)	3.77 (0.82)	3.90 (0.79)	7.18**	0.03	
PLANS 1 Family Influence	1.78 (0.77)	1.78 (0.97)	1.74 (0.76)	1.73 (0.75)	1.90 (0.73)	1.8	0.01	
PLANS 2 Self confidence	3.67 (0.88)	3.66 (0.88)	3.67 (0.91)	3.71 (0.83)	3.65 (0.83)	0.15	0	
SOCIAL MEDIA	3.39 (0.82)	3.40 (0.88)	3.37 (0.91)	3.46 (0.75)	3.24 (0.75)	2.36	0.01	
PLANS 3 Work experience	2.00 (0.97)	2.11 (1.04)	2.09 (0.92)	1.92 (0.94)	1.87 (0.96)	2.84*	0.01	

Table 4c: Do SENSES scores differ by g?

(* $p < .05$; ** $p < .01$ in all tables).

In summary, although some group differences were noted for SENSES factors these differences mainly had small effects or no effect at all. The only medium-sized effects observed were for Science self-perceptions and Maths perceptions of teachers. In both of these cases pupils with higher levels of general cognitive ability were more positive than pupils with lower levels of general cognitive ability. While these effects are still not large it may be worth considering why more cognitively able pupils would report higher levels of self-belief in Science (perhaps obvious) and why they were more positive about their mathematics teachers (perhaps less so). Is it possible, for example, that the highest ability groups get the best teachers, something suggested by families in the Phase 1 qualitative data?

Discussion of Findings

The final research question for this project was:

Could these environments be used for the benefit of more young people as they prepare to make the transition out of compulsory education?

This question was predicated on the assumption that we would identify potential 'environmental' influences on adolescent behaviour. This would be useful from an intervention point of view as NSE effects operate independently of genetic effects. We did indeed identify some such potential influences, which we discuss here, but it is also true to say that less evidence of systematic NSE influence emerged than we had hoped for. More common in this rich dataset were examples of the unique, non-generalisable experiences that have been dubbed a 'gloomy prospect' for NSE research (Plomin & Daniels, 1987). They are considered a gloomy prospect because their effects appear unsystematic, rendering them difficult to study and to generalise in a meaningful way.

In terms of potential NSE influences on GCSE achievement we identified teacher quality and teacher-pupil relationships (as perceived by pupils and/or their parents) in our Phase 1 data collection. We then incorporated these factors into our SENSES measure and tested them quantitatively. We found perceptions of teachers in English, Maths and Science to be substantially influenced by NSE effects and to be moderately correlated with GCSE achievement in the relevant subject. We also found that these correlations were partially mediated by NSE effects shared by both perceptions of teachers and GCSE achievement.

This information takes our understanding of NSE effects on achievement forward a step but we need to know more. In particular, we need to identify NSE effects that are common to both perceptions of teachers and academic achievement. The data collected here suggests, simply, that pupils who like and admire their teachers perform better than students for whom this is not the case, and this is partly for environmental reasons. It is important to note that our study design does not allow us to identify the direction of effects and a positive teacher-pupil relationship could as easily be a consequence as a cause of high achievement. A related point is that Phase 3 analyses noted that pupils with relatively high *g* expressed higher average opinions of their teachers. This was particularly clear for Maths and Science.

So what can we do with this evidence? The next step has to be further research and there are good grounds here for exploring teachers' NSE influences on achievement. We could also discuss whether there would be any benefit to giving pupils some choice, where practically possible, in who teaches them. If, for example, there are three or four Maths teachers teaching middle-ability groups in a school could pupils express a preference rather than just being allocated to a class? There could of course

be problems if, for instance, a teacher is widely perceived as weak or unpleasant. This is likely to be a wider problem though and our data strongly supports the idea that pupil perceptions matter. However, although behavioural genetic research has led us to become proponents of choice in education we want to be clear that this is not a recommendation, just a suggestion for discussion and further research.

Our qualitative data also identified young people's experiences of friendship and peer relationships as a notable area of NSE experience, as predicted by Judith Rich Harris in *The Nurture Assumption* (1998). This was particularly true for peer victimisation, peer rejection, popularity (fewer friends) and peer group (different friends). Families suggested hypotheses linking problematic peer experiences (which were generally viewed as a result of chance or enhanced vulnerability) with self-confidence, social isolation, future plans and mental illness. Friendships (not problematic) were seen as influences on personality, confidence, interests and social life. Hypotheses based on these findings need to be tested quantitatively in a genetically informed design and this seems like an important line of inquiry, particularly as problematic peer relationships appear to have severe consequences for some pupils. Although schools already have, and implement, anti-bullying policies there is a chance that a focus on the outcomes indicated here may help schools (and parents) to support pupils who have experienced peer relationship problems in a more beneficial way.

For example, finding a way to simply stop the problem might not be enough. A focus on restoring self-confidence, hope and mental well-being, even when things are better, is likely to be beneficial. Also, it may be a good idea to consider interventions to boost confidence and well-being in pupils who may not be overtly victimised or rejected but may nonetheless feel unpopular and wish for more, or better, friends. We can see from the SENSES data that a lack of self-belief is associated with long-term outcomes related to achievement and life-satisfaction. If a lack of popularity can explain NSE variance in self-confidence – a hypothesis to be tested – then maybe there is something that can be done at school to help. This is a question that student support teams could perhaps usefully consider.

The data we have gathered in this study also indicate a need for genetically-informed research to conduct a detailed anatomy of effort. Effort is a strong predictor of achievement. Unsurprisingly, pupils who work harder tend to do better. Our data show that even genetically identical twins show discordance in the amount of effort they are willing to put in to their schoolwork. This clearly demonstrates that effort is subject to NSE influences and, indeed, NSE effects were found to explain almost half of the variance in the SENSES effort factor. Our qualitative data suggested some possible candidates for NSE influence, including peer relationships and plans for the future. There was some suggestion that adolescents worked harder when they were working towards a particular goal that, in some cases, required a

particular grade. This can be tested and, if found to be the case, could have implications for careers education in childhood and adolescence.

A surprising finding with regard to effort was that the correlation between effort and achievement was substantially mediated (approximately one-third) by shared environmental effects i.e. experiences that influence individuals growing up in the same family in the same way. It would be worth looking more closely at schools and homes to identify experiences that may lead to higher or lower levels of effort as the link with achievement, and therefore future opportunity, is clear.

Variants of self-confidence (self-belief, self-efficacy) also emerged as important in this study of NSE. Associations between perceptions of self and achievement tended to be mediated by genes and, to a lesser extent, NSE effects. However, the relationship between self-confidence about the ability to achieve future plans and life satisfaction was substantially mediated by environmental factors. Our analysis of peer relationship discordance suggests a role for peer relationships as an influence on self-confidence that could be usefully explored in further research in this area. Indeed, the current study strongly suggests that the development of a quantitative measure of non-shared peer experiences could yield important insights into the environmental roots of effort, self-confidence, wellbeing and mental health. This focus may prove a fruitful addition to the antisocial behaviour focus that currently dominates the field of genetics and peer relationships.

In summary, it remains unclear whether and how we can influence pupils' choices and behaviour at this important developmental stage. However, our study has identified some key areas for discussion and further exploration. Given the prevalence of idiosyncratic experiences in our data we would also emphasise a need for 'sensitive schooling' in the form of personalisation and attention to individual differences. Great swathes of empirical data, including that presented here, suggests that all pupils are 'special snowflakes' who are likely to be helped (not harmed) by being recognised as such.

“We would also emphasise a need for ‘sensitive schooling’ in the form of personalisation and attention to individual differences.”

Some questions for future research arising from the current study

- Do perceptions of teacher quality and the teacher-pupil relationship influence concurrent and future academic achievement?
- Which NSE factors are common to perceptions of teachers and academic achievement?
- Should pupils be able to choose their teachers?
- Can behavioural traits such as self-confidence be boosted by responding to problematic experiences of friendship in new, targeted ways?
- Can academic achievement (and/or life satisfaction) be boosted by using NSE levers to increase self-confidence/self-efficacy?
- What NSE factors can explain individual differences in future orientation? (Current data suggest peer relationships (not included in SENSES) may be one factor.)
- Which are the shared environmental factors that influence effort and mediate associations between effort and achievement?
- Is the SENSES measure reliable and valid in other samples and populations?
- Would a peers-focused version of SENSES yield useful insights?

References

Asbury, K., Moran, N. & Plomin, R. (2016). Non-Shared Environmental Influences on Academic Achievement at Age 16: A Qualitative Hypothesis-Generating Monozygotic Twin Differences Study. *AERA Open*, 2 (4) 2332858416673596.

Asbury, K., Moran, N. & Plomin, R. (submitted). Do MZ twins have discordant experiences of friendship? A Qualitative Hypothesis-Generating MZ twin differences study.

Asbury, K., Yerdelen, S., Durksen, T.D., Rimfeld, K. & Plomin, R. (in revision) Non-Shared Environmental Influences on exam performance and life satisfaction in adolescence: A twin study.

Bartels, M. (2015). Genetics of wellbeing and its components satisfaction with life, happiness, and quality of life: A review and meta-analysis of heritability studies. *Behavior Genetics*, 45(2), 137-156.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of personality assessment*, 49(1), 71-75.

Harris, J. R. (1998). *The Nurture Assumption: Why Children Turn Out the Way they Do*. New York: Free Press.

Haworth, C. M., Davis, O. S., & Plomin, R. (2013). Twins Early Development Study (TEDS): A genetically sensitive investigation of cognitive and behavioral development from childhood to young adulthood. *Twin Research and Human Genetics*, 16(01), 117-125.

Krapohl, E., Rimfeld, K., Shakeshaft, N. G., Trzaskowski, M., McMillan, A., Pingault, J. B., ... & Plomin, R. (2014). The high heritability of educational achievement reflects many genetically influenced traits, not just intelligence. *Proceedings of the National Academy of Sciences*, 111(42), 15273-15278.

Plomin, R., & Daniels, D. (1987). Why are children in the same family so different from one another?. *Behavioral and Brain Sciences*, 10(01), 1-16.

Shakeshaft, N. G., Trzaskowski, M., McMillan, A., Rimfeld, K., Krapohl, E., Haworth, C. M., ... & Plomin, R. (2013). Strong genetic influence on a UK nationwide test of educational achievement at the end of compulsory education at age 16. *PLoS One*, 8(12), e80341.

Steinberg, L., Graham, S., O'Brien, L., Woolard, J., Cauffman, E., & Banich, M. (2009). Age differences in future orientation and delay discounting. *Child Development*, 80(1), 28-44.

Turkheimer, E., & Waldron, M. (2000). Nonshared environment: a theoretical, methodological, and quantitative review. *Psychological Bulletin*, 126(1), 78.

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Finally, the research presented here involved contributions from a large team of skilful and dedicated people. Special thanks go to Patricia Busfield who conducted half of the interviews with her characteristic sensitivity and warmth. Rachel Ogden, Andy McMillan, Kathryn Carter, Neil Harvey and Rae Gardner-Kimball worked hard to recruit participants, gather questionnaire data and manage the data once it was collected. Nicola Moran, Sundus Yerdelen, Tracy Durksen, Kaili Rimfeld, Jonathan Asbury, Amandeep Sandhu and Maria Turkenburg were all involved in coding and analysing data and in writing up findings.

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RP and KA, February 2017



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More information is available at www.nuffieldfoundation.org

Appendix 1: SENSES



Twin ID: <twin ID>

Name: <Twin name>

This questionnaire asks how you feel about your time at secondary school. Please indicate your answers with a cross using **BLACK INK**. If you make a mistake, shade it out and cross the appropriate box.

The following statements are about your experiences during your GCSEs. **Thinking back to Years 10 and 11** please read each statement and place an X in the box that describes how true it was for you.

	1	2	3	4	5
	Not at all true		Somewhat true		Very true
My English teacher(s) made sure I understood what I needed to do in the course	<input type="checkbox"/>				
My English teacher(s) was excellent	<input type="checkbox"/>				
I felt confident I could live up to what my English teacher(s) expected	<input type="checkbox"/>				
I was good at English	<input type="checkbox"/>				
I felt confident I could master the skills we learned in English	<input type="checkbox"/>				
My English teacher(s) answered my questions fully and carefully	<input type="checkbox"/>				
My English teacher(s) encouraged me to ask questions	<input type="checkbox"/>				
I felt confident that I would get an excellent grade in my English GCSE(s)	<input type="checkbox"/>				
I felt interested in what we were studying in English	<input type="checkbox"/>				
I should have worked harder on my English coursework.	<input type="checkbox"/>				

	1 Not at all true	2	3 Somewhat true	4	5 Very true
I should have revised harder for my English exams	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Maths teacher(s) answered my questions fully and carefully	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Maths teacher(s) made sure I understood what I needed to do in the course	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Maths teacher(s) encouraged me to ask questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Maths teacher(s) was excellent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt confident that I would get an excellent grade in my Maths GCSE(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I was good at Maths	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt confident I could live up to what my Maths teacher(s) expected	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt interested in what we were studying in Maths	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt confident I could master the skills we learned in Maths	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I should have revised harder for my Maths exams	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I should have worked harder on my Maths coursework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Science teacher(s) answered my questions fully and carefully	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Science teacher(s) made sure I understood what I needed to do in the course	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Science teacher(s) was excellent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My Science teacher(s) encouraged me to ask questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	1 Not at all true	2	3 Somewhat true	4	5 Very true
I felt confident I could master the skills we learned in Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt interested in what we were studying in Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I was good at Science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt confident that I would get an excellent grade in my Science GCSE(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I felt confident I could live up to what my Science teacher(s) expected	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I should have revised harder for my Science exams	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I should have worked harder on my Science coursework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by my father's career choice or life experience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by an adult role model or mentor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by my mother's career choice or life experience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by my twin (or other sibling)'s plans—I want a similar future	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by competitiveness between me and my twin (or another sibling)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by volunteering experiences	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by part-time job experiences	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My plans for after Year 11 were influenced by interesting work training/experience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

We are interested in how you use social media. How true are each of these statements for you?

	Not at all true	Not that true	Somewhat true	Fairly true	Very true
When using social media sites, I feel connected with others	<input type="checkbox"/>				
My social media posts are well received (e.g., Like, Favourite, RT)	<input type="checkbox"/>				
I have a wide social media network (e.g. Facebook friends)	<input type="checkbox"/>				
I get a lot of useful information through social media sites	<input type="checkbox"/>				

We are interested in how confident you feel about your future. Please indicate how true each of these statements are for you?

	Not at all true	Not that true	Somewhat true	Fairly true	Very true
I am confident I can live up to what my parents expect of me	<input type="checkbox"/>				
I am confident I can live up to what my teachers expect of me	<input type="checkbox"/>				
I am confident I can live up to what I expect of myself	<input type="checkbox"/>				
I have a clear plan for what I hope to do next	<input type="checkbox"/>				

Thank you for your time and your help.