**Teacher beliefs about the aetiology of individual differences in cognitive ability, and the relevance of behavioural genetics to education**

**Abstract**

*Background*

Despite a large body of research that has explored the influence of genetic and environmental factors on educationally relevant traits few studies have explored teachers’ beliefs about, or knowledge of, developments in behavioural genetics related to education.

*Aims*

This study aimed to describe the beliefs and knowledge of UK teachers about behavioural genetics and its relevance to education, and to test for differences between groups of teachers based on factors including years of experience and age of children taught.

*Sample*

Data were gathered from n=402 teachers from a representative sample of UK schools. Teachers from primary and secondary schools, and from across the state and independent sectors, were recruited.

*Methods*

An on-line questionnaire was used to gather demographic data (gender, age, years of experience, age of children taught and state vs. independent) and also data on beliefs about the relative influence of nature and nurture on cognitive ability; knowledge of behavioural genetics; openness to genetic research in education; and mindset. Data were analysed using descriptive statistics, ANOVA, correlations and multiple regression.

*Results*

Teachers perceived genetic and environmental factors as equally important influences on cognitive ability, and tended towards a growth mindset. Knowledge about behavioural genetics was low but openness to learning more about genetics was high. Statistically significant differences were observed between groups based on age of children taught (openness higher among primary teachers) and state vs. independent (more growth-minded in state sector).

*Conclusions*

Although teachers have a limited knowledge of behavioural genetics they are keen to learn more.

**Introduction and literature review**

Behavioural geneticists study the aetiology of individual differences in human behaviour and have claimed that this research is relevant to teaching and learning in schools (Asbury & Plomin, 2013; Kovas, Malykh & Gaysina, 2016).While a large body of robust and well replicated evidence supports the idea that educationally-relevant behaviour has both genetic and environmental roots (Kovas et al., 2007; Krapohl, Rimfeld et al., 2014; Polderman et al., 2015) much less is known about teachers’ knowledge, beliefs and understanding of this evidence-base, and its relevance in a real world setting such as a school or a classroom. The major exception to this was published over a decade ago (Walker & Plomin, 2005).

Walker and Plomin (2005) surveyed 556 UK primary school teachers and explored their beliefs about the extent to which genetic and environmental factors influence a range of educationally relevant traits (personality, intelligence, behaviour problems, learning difficulties and mental illness). They found that teachers tended to believe that genetic and environmental factors (termed nature and nurture) were equally important. In this sense, teachers’ beliefs accurately reflect behavioural genetic findings (Polderman et al., 2015). In light of these accurate perceptions it is interesting that 80% of participants reported no coverage of genetics during their teacher training. It is reasonable therefore to suggest that their impressions were rooted in their classroom experiences, and perhaps personal beliefs and biases, rather than in explicit training. It is important to note that the science of genetics, particularly molecular genetics, has advanced rapidly since 2005 and genetics has become a more prominent topic for discussion in education over the same time period (Asbury & Plomin, 2013; Plucker and Shelton, 2015). This raises the question of whether Walker and Plomin’s (2005) findings still hold true today, in light of new findings and more public discussion. Furthermore, in the Walker & Plomin (2005) study only primary school teachers were surveyed, leaving a gap in our knowledge of UK secondary school teachers’ beliefs about genetics.

Some relevant research has been conducted in settings outside of the UK, including a study of Greek-Cypriot teachers’ beliefs about the aetiology of academic achievement (Georgiou, 2008). This study found that experienced teachers were significantly more likely to attribute achievement to internal child factors such as intelligence and gender, whereas novice (student) teachers were more likely to attribute achievement to environmental factors such as teacher effort. A similar pattern, of different teacher beliefs at different career stages, has been found in studies in countries such as the US (Hilderbrandt & Eom, 2011).

Castéra and Clément (2014) carried out a comprehensive global study of teachers’ perceptions of genetic and biological influences on general human behaviour, not specific to education. They surveyed n=8,285 teachers across 23 countries (n=154 responses from the UK) and found significant differences in beliefs between countries. For example, teachers’ perceptions in African countries and Lebanon were more inclined towards a biologically-based view of behaviour than those of teachers in European countries, Brazil and Australia. When analysed with the effect of the country in which the teacher resided in suppressed, the level of knowledge a teacher had about biology did not explain a significant proportion of variance in how likely teachers were to cite biological explanations for behaviour. However, the study found that the number of years a teacher had spent in higher education was a significant influence, with teachers who had spent less time in higher education more likely to offer genetic or biological explanations (Castéra and Clément, 2014). These findings suggest that contextual factors may be associated with what teachers believe.

It is also possible that teacher beliefs about the aetiology of cognitive ability are linked with their personal theory of intelligence, that is, whether they have a fixed or a growth mindset (Dweck, 1999). A growth mindset represents an incremental theory of intelligence which posits that intelligence can be improved, whereas a fixed mindset represents an entity theory of intelligence which posits that our intelligence is set at birth and cannot be changed. Hypothetically, a strong proponent of genetic influence should have an extreme fixed mindset (there’s no point trying too hard if your destiny is in your genes) whereas a strong proponent of the role of environment should have an extreme growth mindset (there are no limits to what you can achieve). It is likely, however, that most people fall between these two extremes. It is therefore possible that if individuals’ mindsets are associated with their perceptions of the relative roles of nature and nurture this could offer insight into their approach to teaching (Pretzlik, Olssonn, Nabuco and Cruz, 2003; Georgiou, 2008; Jonsson, Beach, Korp and Erlandson, 2012; Burnette, O’Boyle, VanEpps, Pollack, & Finkel, 2013). If an entity theory of intelligence is associated with greater emphasis on genes, and vice-versa for an incremental theory, then teachers’ views of the relative influence of nature and nurture may influence how they see their role in the classroom and how they perceive the factors that affect student success. If perceptions of genetics affect teachers’ behaviour and their attitudes to teaching, then the implications of this must be considered.

This study therefore asks:

1. What attitudes towards, and perceptions of, behavioural genetic research into cognitive ability do teachers in the UK have?
2. How growth minded are UK teachers?
3. Do teachers in the UK have a good factual knowledge of behavioural genetics?
4. How open are teachers in the UK to applying findings from behavioural genetics in education now and in the future?
5. Do beliefs, attitudes and knowledge vary according to factors including gender, age, years of teaching experience, age of pupils taught, state vs. independent, subject taught, geographical location, or SENCO role?
6. Are perceptions of the relative influence of nature and nurture, mindset, openness to genetic research in education (OGRE) and knowledge about the genetics of cognitive ability associated with, or predictive of, each other?

**Method**

*Participants*

The population for the study was all full or part-time teachers in the UK working in mainstream primary, secondary, state or independent schools. A stratified random sampling technique was used to recruit a sample that would adequately represent this population.

Based on the most up to date statistics available to the researchers there are n=456,900 teachers currently teaching in UK state schools (Department for Education, 2017). It was estimated that an additional n=113,300 teachers work in independent schools. This figure was based on statistics provided by the Independent Schools Council (ISC).

Overall, this suggested that there are approximately 570,200 teachers working in mainstream state and independent schools in the UK. In order to achieve a confidence level of 95%, and a margin of error of 5%, a sample size of n=384 was sought and a sample of n=402 was recruited to the study.

Publicly available data were used to create a sampling frame based around the idea that for each local authority, a high, middle and low achieving primary and secondary school would be contacted in the first wave of data collection. Once schools in each local authority had been contacted a second wave of data collection began. Where it was not possible to sample by local authority (primary schools in Scotland and Northern Ireland) random alphabetical selection was used to achieve the most comprehensive and representative spread possible. For schools in the private sector local authorities were searched in the Independent Schools Council’s database, and an independent primary and secondary school was chosen from each local authority in each wave of data collection. No performance data was used for independent schools because in many local authorities there was in fact only one preparatory or senior independent school and, as such, there was only one school to contact. Following the first and second waves of data collection a ‘booster’ wave of state primary schools in Wales and Scotland was conducted as the response rate was low in these areas. Finally, a fourth wave of data collection from state primary schools across the UK was conducted following low responses from Welsh and Scottish primary schools. A sample of n=285 teachers was recruited in this way.

In addition to this carefully selected sample a convenience sample of n=117 teachers was recruited via social media. These two samples were compared using independent samples *t*-tests and were found to be sufficiently similar to justify being combined into a single sample (See Table 1).

TABLE 1 HERE

Only one statistically significant difference was found between the two samples and that was for a measure of teachers’ knowledge of behavioural genetic findings related to cognitive ability (small to medium effect, *d*=0.33, Cohen, 2013). Given that, with this one exception the samples were not significantly different the two samples were combined. In this way a combined sample of n=402 teachers, broadly representative of the UK teaching population, was recruited to the study.

**Measures**

All measures were tested and revised on the basis of a pilot study (full details available from the first author).

*Demographic Information*

Items relating to the demographic characteristics of the participants were included as a means of checking the extent to which our sample adequately represented the UK teaching population. Eight items asked participants to report their gender, age, years employed as a teacher, age of children taught (primary or secondary school teacher), state or independent, geographical area, majority subject and whether or not they hold a SENCO (special educational needs coordinator) role within their school.

*The relative influence of nature and nurture on cognitive ability*

Teachers’ beliefs about the relative influence of nature and nurture were measured using a single item drawn from Walker and Plomin (2005). Participants were asked to what extent they believe that cognitive ability is influenced by nature (genes) or nurture (environment). They were asked to respond using a 5-point scale in which: 1= all environment, 2=mostly environment, 3=Even split between genes and environment, 4=mostly genes and 5=all genes.

*Mindset*

Teacher mindset was measured using the Theories of Intelligence-Other scale (Dweck, 1999). This 6-item measure, with a 6 point Likert response scale, has been used in other studies which have supported its validity and reliability (α= .94 to .98) (Blackwell, Trzesniewski, & Dweck, 2007; Jonsson, Beach, Korp and Erlandson, 2012). Composite scores were created in all cases where participants had answered at least 4 out of the 6 items. Internal reliability in the current study was α=.94.

*Knowledge about Behavioural Genetics*

It was necessary to develop a new measure to explore teachers’ factual knowledge of behavioural genetic findings regarding intelligence, as no such measure is, to our knowledge, currently available. Our knowledge measure was based on a recent paper entitled ‘Top 10 replicated findings from behavioural genetics’ (Plomin, DeFries, Knopik and Neiderhiser, 2016). The summary of key findings in this paper represents the most up to date and rigorous summary of knowledge available with which to ‘test’ teachers. Some statements from the paper were re-worded in lay terms and terminology was explained as necessary. For example, ‘Phenotypic correlations between psychological traits show significant and substantial genetic mediation’ (Plomin et. al, 2016, p.7) was reworded to ‘Some traits and behaviours are linked to each other for genetic reasons’ with an example provided. Therefore, it was hoped that the language of the statements would be clear to participants. The 10 items in this knowledge test are presented below. Participants were asked to rate each statement as true or false:

- All psychological traits show substantial genetic influence.

- No psychological traits are 100% heritable.

- The heritability of traits and behaviour is caused by many genes each with a very small effect.

-Some traits and behaviours are linked to each other for genetic reasons e.g. IQ is related to school test results because the same genes influence both.

-There is likely to be a single gene that is responsible for the differences between people in intelligence. It is just a matter of time before it is identified.

-Our intelligence becomes more heritable as we get older.

-The neighbourhood we live in and the parenting we experience are influenced by our genes.

-Behaviour problems are usually explained by parenting.

-Most psychological disorders (e.g. ADHD, anxiety) are the extremes of normal behaviour, rather than genetically distinct disorders.

-Most mild to moderate learning disorders (e.g. dyslexia) are the extremes of normal behaviour, rather than genetically distinct disorders.

Participants were given 1 point for each correct true/false judgement, and 0 for each incorrect judgement, yielding a score out of 10.

Participants who answered fewer than 6 items were excluded from analysis.

*Openness to Genetic Research in Education (OGRE)*

A new five item measure of ‘openness to genetic research in education (OGRE)’ was developed for this study. It comprises five items with a 5-point Likert-style response format. Items are phrased both positively e.g. ‘I would like to know more about behavioural genetics and its implications for child development’ and negatively ‘Personally I would not like to see findings from behavioural genetics influencing my day-to-day classroom decisions.’ The five items were coded so that 1= low openness to behavioural genetics and 5 = high openness, before composite scores were generated. Participants who answered fewer than 3 items were excluded from analysis. Reliability in the current sample was α= .80. An exploratory factor analysis found that the first principal component explained 57% of the variance and all items loaded onto it with loadings ranging from .61 to .82. Full details available on request from the first author.

This measure has recently been tested in a sample of Greek teachers, yielding a similar level of internal reliability, α= .73 (BLINDED).

**Procedure**

An online questionnaire, using Qualtrics, was sent to head teachers or receptionists in schools identified by the sampling strategy. They were asked to circulate the invitation to all teachers in their school. However, because data were anonymous at the point of collection there was no way of checking the extent to which this happened. Once a wave of schools had been contacted and been given, on average, one month to respond a reminder was sent. This process continued for around eight months until a sufficiently large sample had been recruited. At around five months into the systematic sampling, the decision was made to also recruit a convenience sample via social media. Once the sample was sufficiently powerful to address the research questions the online questionnaire was closed and analysis began.

**Analysis**

The first stage of analysis was to establish the demographic breakdown of the sample. Simple frequencies were run to establish how close the sample was to the UK teaching population based on the information available. Overall, the sample appeared reasonably similar to the UK teaching population. The biggest disparity between the sample and the population was in the age of children taught. Here the sample consisted of 27% of teachers from early years or primary settings and 70% from secondary or sixth form settings (the remaining 3% were teachers who taught across the age groups and these were excluded from analysis due to low numbers). The most recent UK statistics that show 48% of teachers work in primary schools and 46% in secondary (Department for Education, 2017). There was also a slight overrepresentation of independent schools. The sample consisted of 61.9% state school teachers and 32.3% independent school teachers (the remaining 5.8% were from free schools, special schools or other and were excluded from analysis due to low numbers). This is in comparison to the UK population where roughly 75% are state school teachers and 20% teach in independent schools (remaining 5% from special schools or free schools). Despite attempts to try to even out these inequalities during the ‘booster wave’ of data collection process, they remain a limitation of the study.

Descriptive statistics were calculated to establish means for the four main study measures: nature-nurture, mindset, knowledge and OGRE. MANOVA, ANOVA and post-hoc tests (Tukey) were used to explore group differences based on background factors such as experience and state vs. independent. Finally, correlations and multiple regressions were run to explore associations between study variables.

**Results**

*Descriptive statistics*

Means and standard deviations were calculated for all study variables. Table 2 shows that teachers reported balanced beliefs regarding the relative influence of nature and nurture on cognitive ability, seeing them as playing a roughly equal role (3 = equal split between nature and nurture).

TABLE 2 HERE

Table 2 also shows that teachers tended towards a growth mindset. Knowledge test scores were low with the average number of correct answers being 4 out of 10. Finally, results for OGRE suggested that, on average, teachers report being relatively open to a role for genetic research in education.

To illustrate these statistics in a little more detail, Figure 1 shows the distribution of teachers’ responses to each of the main study measures. The item regarding their perceptions of the relative influence of nature and nurture on children’s’ cognitive ability, shows clearly that an ‘even split’ represented the view of the greatest number of participants, followed by a belief in the relatively greater influence of the environment. Those who believed cognitive ability was down to ‘all genes’ made up the smallest proportion of the sample with only n=1 individual stating this position. Looking at the distribution of mindset scores, it is clear that the majority of participants leaned slightly more towards a growth mindset but that there was good variability with a small number of participants reporting both extreme fixed (1) and growth (6) mindset beliefs.

With regards to knowledge test scores, very few participants scored over 8 (out of a possible 10), but equally few scored 0. Overall, participants’ knowledge was low but 22.4% of the sample did score more than 50%. As can be seen in Figure 1, the biggest percentage of teachers scored 4 out of ten. Given that we would expect a score of 50% (5/10) just by chance, the fact that the majority (77.6%) scored below this chance threshold suggests that many were actually misinformed.

For OGRE most participants leaned towards being open to genetic research in education; with very few being completely closed to the possibility, however caution should be applied when generalising this to the population as the sample was self-selecting and so there is likely to be some bias in the data.

*Differences based on demographic characteristics*

We asked whether participants’ responses varied on the basis of demographic characteristics or background factors. One-way MANOVAs were conducted to explore whether each demographic factor had an overall effect on the main study variables. Findings are shown in Table 3.

TABLE 3 HERE

Where an effect was detected univariate analysis of variance (ANOVA) was conducted for all significant variables. These were followed by post-hoc tests (Tukey) to identify the precise source of any effect. No effect on any of the main study variables was found based on gender, teacher age, years of teaching experience, school geographical location, subject taught or SENCO role. However, the age of the children a teacher taught and state vs. independent were found to have a significant effect on one or more study variables.

*Relative influence of nature and nurture on cognitive ability*

One way ANOVAs found no significant differences in teachers’ perceptions of nature-nurture based on any of the demographic characteristics studied.

*Mindset*

*School type*

MANOVA identified an overall effect of school type, [*F*(4, 291)=2.97, *p*=.020, η2=.039], on study measures. One way ANOVAs showed significant variation for the mindset measure [*F*(1, 294)=11.31, *p*=.001, η2=.037]. Teachers from state schools reported significantly higher levels of growth mindset (*M=*4.28, *SD*=1.04) than teachers from independent schools (*M*=3.85, *SD*=1.10). Mindset is measured on a scale of 1-6 with 1 suggesting a completely fixed Mindset and 6 suggesting a completely growth Mindset. So, from this analysis we can see that although both state and independent school teachers on average lean towards a more growth mindset, state school teachers tend to be significantly more growth minded than teachers at independent schools.

*OGRE*

*Age of children taught*

Results from the MANOVA suggested that age of children taught had a significant effect on OGRE *F*(16, 923.3)=1.950, *p*=.013, η2=.025. One way ANOVAs identified a significant effect [*F*(4,305)=2.48, *p*=.044, η2=.032] between teachers who taught children of different ages. Following post-hoc tests (Tukey) it emerged that those teachers who taught children at a primary school level were significantly more open to genetic research being used or considered in education (*M*=4.16, SD=.532) than those teaching in secondary schools (*M*=3.90, *SD*=.654).

*Knowledge Test*

*Age of children taught*

MANOVA results suggested that age of children taught had a significant effect *F*(16, 923.3)=1.950, *p*=.013, η2=.025. One way ANOVAs identified a significant effect on knowledge test [*F*(4,305)=3.08, *p*=.017, η2=.039] between teachers who taught children of different ages. Following post-hoc tests it emerged that those teachers who taught children in early years were significantly less knowledgeable about behavioural genetics (*M*=3.00, SD=1.69) than those who taught sixth form (*M*=4.95, SD=1.12).

*Correlational analyses*

Table 4 shows that the relationship between nature-nurture beliefs and mindset was significant and moderately strong (*r=*-.501, *p*<0.01); having a belief that genes exert more influence than environment on cognitive ability was associated with having a more fixed mindset (all environment =1, all genes=5; fixed mindset=1, growth mindset=6).

TABLE 4 HERE

A belief in the relative importance of genetics also had a small but significant positive association with knowledge test scores (*r*=.138, *p*<0.05). Those with greater knowledge of the genetics of cognitive ability were slightly more likely to see a role for genes.

Mindset and knowledge test scores were also significantly negatively correlated suggesting that teachers who know more about genetics, scoring higher on the knowledge test, were slightly more likely to lean towards a fixed mindset (*r*=-.253, *p*<0.01).

No significant correlations were found between OGRE and the other main study variables.

Correlations were also explored between the only demographic factor to have a significant effect in MANOVA that was also an ordinal variable suitable for correlational analysis, age of children taught. Age of children taught was weakly but positively correlated with knowledge test scores (*r*=0.11, p < .05) but no other significant associations were identified. Knowledge was significantly higher among teachers of older pupils, but only slightly.

The group differences and correlational findings already presented were used to select potential predictors of nature-nurture beliefs, OGRE, mindset and knowledge for multiple regression analysis. For belief in the relative importance of nature and nurture: mindset and knowledge were tested as predictor variables. For mindset: school type, beliefs about nature-nurture and knowledge were selected. For openness to genetic research in education (OGRE): age of children taught was selected. For knowledge: age of children taught, nature-nurture beliefs and mindset were tested as potential predictors.

*Multiple regression analysis*

Table 5 shows that multiple regression analysis found that, for nature-nurture beliefs, teacher mindset significantly explained 27% (R²=.270) of the variance, and knowledge was not a significant predictor.

TABLE 5 HERE

Three variables significantly predicted mindset. However, school type only explained 2.9% of the variance while the addition of nature-nurture beliefs and knowledge score increased the amount of variance explained to 27.2%. Finally, for knowledge, the study variables only explained 6.5% of the variance, with mindset as the only significant predictor.

**Discussion**

We explored UK teachers’ beliefs about, and perceptions of, the genetics of cognitive ability and the role of behavioural genetics in education as well as their knowledge of behavioural genetics. Overall, the picture emerging from the research is a positive one. Results indicated that teachers see genetic and environmental factors as playing roughly equal roles in explaining individual differences in cognitive ability; that they lean towards a growth mindset; and that they are open to a potential role for behavioural genetics in education. However, it was also clear that teachers lacked knowledge and were potentially even misinformed about behavioural genetics (with most scoring below chance on our knowledge test).

Regarding the relative influence of nature and nurture, findings were in line with previous studies (Walker and Plomin, 2005) with teachers perceiving nature and nurture as playing a relatively equal role in explaining individual differences in cognitive ability. Very few teachers placed themselves at either extreme, with only one individual seeing differences in cognitive ability as being fully explained by genes. This finding strengthens what we know already about teacher perceptions of the aetiology of cognitive ability and suggests that this view has remained stable over the past 10 years. This belief amongst teachers is relatively accurate in terms of the evidence which estimates the heritability of cognitive ability at approximately 50% on average (Polderman et al., 2015). However, we also know that, over time, cognitive ability becomes increasingly heritable with genetic factors explaining more variance than environmental factors by the end of schooling so we may have expected teachers of older pupils to err more in favour of genetic explanations (Haworth et al., 2010). Age of children taught did not have a significant effect on teachers’ beliefs in the current study. Their views do not fully match the evidence, suggesting a need for further education.

It was also found that aetiological beliefs were significantly predicted by mindset and that a growth mindset was associated with a tendency towards an environmental explanation for individual differences in cognitive ability that is incorrect, certainly beyond the early years (Haworth et al., 2010). In terms of mindset, participants expressed a similar mindset to those in previous studies (Patterson, Kravchenko, Chen-Bouck and Kelley, 2016), that is, a group tendency towards a growth mindset. However, there was variation in responses, with some teachers leaning towards the extremes of both growth and fixed mindsets. Mindset significantly predicted both nature-nurture beliefs, as discussed above, and knowledge of behaviour genetics. More growth minded individuals preferred environmental explanations and also had lower knowledge of behavioural genetics. This perhaps highlights a common misconception that heritability implies determinism. This may represent a key area of misunderstanding that should be targeted, particularly as science makes increasing progress in the development of genomewide polygenic scores (GPS) that are highly relevant to education (e.g. Selzam et al., 2017). That said, it is important to note that these data are correlational and we cannot assess direction of effects.

Knowledge of behavioural genetics was tested using a variation of the ‘Top 10 replicated findings from behavioural genetics’ (Plomin, DeFries,Knopik and Neiderhiser, 2016). It was found that teacher knowledge of the subject was low with a below chance mean score of only four out of a possible ten that suggests genuine misunderstanding or misinformation. This was not a surprising finding as behavioural genetics is not covered in school or in teacher training. Most teachers with knowledge of the area would have to have sufficient awareness and interest to find it for themselves. This study suggests that if we want teachers to understand behavioural genetics, and for findings in behavioural genetics to be considered by those on the front line of education, then there remains some way to go before teachers can be considered to have a basic grasp of the science, avoiding the misconceptions and myths that so often arise around educationally relevant findings from research (Dekker, Lee, Howard-Jones & Jolles, 2012).

The study also showed that teachers are open to learning more and to improving their knowledge. It is encouraging that most teachers gave positive responses to OGRE items. The overall distribution sat toward the open end of the scale with almost no participants at either extreme. Therefore, although no one was extremely open, nor was anyone extremely closed to the idea of behavioural genetics playing a role in education. This openness, combined with low current levels of knowledge, suggests that a working relationship between education professionals and researchers could benefit teachers and help them to consider their teaching practice in a new way. How these benefits might look in practice is beyond the scope and purpose of this study but it does suggest that a better partnership between the field of behavioural genetics and educationalists would not be unwelcome.

Not many group differences were observed. The age of children taught and the type of school participants taught at were the only demographic characteristics studied that had a significant effect on study variables. Teachers who taught at primary schools were significantly more open to behavioural genetic research in education. This was surprising but could possibly reflect a view that there is more time to make effective changes for their pupils. However, this is speculative and qualitative research exploring why teachers report openness to genetic research in education would be a useful next step. It is interesting to note that, although primary school teachers were more open to genetic research, teachers of younger pupils were also less knowledgeable about the science than teachers of older children.

The type of school a teacher taught at (state or independent) appeared to be linked with teacher mindset. Teachers from state schools reported a significantly more growth mindset than those from independent schools. The reasons for this are unclear but would be interesting to consider in future research, especially given the association between mindset and other study variables.

Overall, this study offers a clearer picture of how the UK teaching population perceives behavioural genetics in 2017, after a period in which behavioural genetics and education has been discussed more widely in the media, and in which scientific progress has been fast, particularly in relation to the development of GPSs (Plomin & von Stumm, 2018) This rapid progress means that listening to the voice of teachers in the field is essential. .The findings are positive, suggesting that researchers and teachers can work together on co-constructing a genetically-informed discussion about education.

**Limitations and future research**

There are a number of limitations to this study that should be addressed. Firstly, the sample was self-selecting. Teachers could choose whether or not to take part and as such we may not have garnered opinions from teachers not interested in the topic. Moreover, we relied on the receptionist in most cases to pass on the email; so some teachers, although included in our sampling strategy, may never have had chance to respond. Also, despite attempts to boost underrepresented groups we still did not manage to recruit a representative number of teachers from Wales and Northern Ireland, or from state primary schools. However primary schools teachers have been focused on in previous studies (Walker & Plomin, 2005).

In terms of future research directions, this study has laid foundations for further research using both quantitative and qualitative methodologies. Further quantitative research could look into diversity of opinions in other teaching demographics such as nationality or religious views. Such research might also explore how a working relationship between scientists in the field and teachers in the profession could look. There is also more research potential to see how teachers view the heritability of other educationally relevant traits may differ if at all. A particularly relevant trait would be school achievement which has been found to be even more heritable than cognitive ability (Kovas et al., 2013; Krapohl, 2014). In terms of qualitative research, it would be interesting and valuable to further investigate the demographic differences that emerged (primary vs. secondary and state vs. independent) to try and better understand the driving forces behind these differences. Finally, it would be interesting to explore the views of teachers in Alternative Provision settings and to ask whether teachers who work closely with children with learning and/or behaviour problems view behavioural genetics differently to teachers in mainstream settings.

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**Table 1.** Independent samples *t*-tests to explore similarity of systematic and convenience samples.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Study variable | Systematic N | M(*SD*) Systematic | Convenience N | M(*SD*) Convenience | *t* | *p* |
| Nature-nurture | 271 | 2.77 (.704) | 111 | 2.79 (.764) | -.265 | .791 |
| Mindset | 274 | 4.10 (1.03) | 113 | 3.97 (1.19) | 1.07 | .286 |
| Knowledge Test | 228 | 4 (1.60) | 97 | 4.58 (1.91) | -2.67 | .005\*\* |
| OGRE | 219 | 3.93 (.644) | 91 | 4.03 (.645) | -1.21 | .229 |

**Table 2.** Descriptive statistics for all main study measures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mean | SD | Response scale | N |
| Nature-nurture | 2.78 | .721 | 1-5 | 382 |
| Mindset | 4.1 | 1.1 | 1-6 | 387 |
| Knowledge test | 4.1 | 1.7 | 1-10 | 325 |
| OGRE | 4 | .65 | 1-5 | 310 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable(s) | Wilks’ Lambda | *F* | *df* | Error *df* | Partial  η2 |
| Gender | .115 | 1.87 | 4 | 303 | .024 |
| Teacher age | .087 | 1.42 | 24 | 1047.9 | .028 |
| Years of experience | .724 | .794 | 20 | 992.6 | .013 |
| Age of children taught | .013\* | 1.97 | 16 | 923.26 | .025 |
| School type | .020\* | 2.97 | 4 | 291 | .039 |
| School geographical location | .866 | .625 | 16 | 917.15 | .008 |
| Subject taught | .570 | .963 | 76 | 1132.90 | .060 |
| SENCO role | .451 | .923 | 4 | 303 | .012 |

**Table 3.** ANOVA findings (significant at *p*<.05\* or *p* < .01\*\*level)

**Table 4.** Correlations between main study variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Main study measures | 1 | 2 | 3 | 4 |
| Nature-nurture | 1.0 |  |  |  |
| Mindset | -.501\*\* | 1.0 |  |  |
| OGRE | .078 | .002 | 1.0 |  |
| Knowledge test score | .138\* | -.253\*\* | .069 | 1.0 |

**Table 5.** Multiple linear regression analyses

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Step 1 | Nature-nurture | |  |  | Mindset | |  |  | Knowledge test | | |  |
| Variables | β | *t* | *p* | Variables | β | *t* | *p* | Variables | β | *t* | | *p* |
| Mindset  Knowledge test | -.511  .007 | -11.26 | .000\*\*  .887 | School type | -.179 | -3.21 | .001\*\* | Age of children | .114 | 2.06 | | .041\* |
|  | R²=.270 | *F*(1, 379)=126.8 | |  | R²=.029 | *F*(1, 309)=10.28 | |  | R²=.013 | *F*(1, 323)=4.29 | | |
| **Step 2** |  |  |  |  | β | *t* | *p* |  | β | *t* | *p* | |
|  |  |  |  | School type | -.137 | -2.82 | .001\*\* | Age of children | .097 | 1.80 | .073 | |
|  |  |  |  | Nature-nurture | -.461 | -9.46 | .000\*\* | Nature-nurture | .009 | .146 | .884 | |
|  |  |  |  | Knowledge test | -.152 | -3.13 | .002\*\* | Mindset | -.242 | -3.84 | .000\*\* | |
|  |  |  |  |  | R²=.272 | *F*(3, 307)=39.59 | |  | R²=.065 | *F*(3, 321)=8.51 | | |

Note: R² value reported is adjusted R² and β value is standardized coefficients Beta. Significance \*p<0.05 and \*\*p<0.01

**Figure 1.** Distribution of responses for main study measures.

