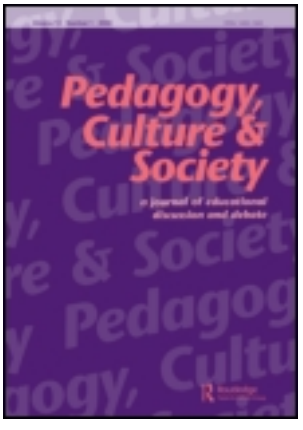

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Louise Archer [a], Jennifer DeWitt [a], Jonathan Osborne [b], Justin Dillon [a], Beatrice Willis [a] & Billy Wong [a]

[a] Department of Education and Professional Studies, King's College London, London, UK

[b] School of Education, Stanford University, Palo Alto, California, USA

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'Not girly, not sexy, not glamorous': primary school girls' and parents' constructions of science aspirations[1]

Louise Archer[a]*, Jennifer DeWitt[a], Jonathan Osborne[b], Justin Dillon[a], Beatrice Willis[a] and Billy Wong[a]

[a]*Department of Education and Professional Studies, King's College London, London, UK;* [b]*School of Education, Stanford University, Palo Alto, California, USA*

Internationally, there is widespread concern about the need to increase participation in the sciences (particularly the physical sciences), especially among girls/women. This paper draws on data from a five-year, longitudinal study of 10–14-year-old children's science aspirations and career choice to explore the reasons why, even from a young age, many girls may see science aspirations as 'not for me'. We discuss data from phase one – a survey of over 9000 primary school children (aged 10/11) and interviews with 92 children and 78 parents, focusing in particular on those girls who did *not* hold science aspirations. Using a feminist post-structuralist analytic lens, we argue that science aspirations are largely 'unthinkable' for these girls because they do not fit with either their constructions of desirable/intelligible femininity nor with their sense of themselves as learners/students. We argue that an underpinning construction of science careers as 'clever'/'brainy', 'not nurturing' and 'geeky' sits in opposition to the girls' self-identifications as 'normal', 'girly', 'caring' and 'active'. Moreover, we suggest that this lack of fit is exacerbated by social inequalities, which render science aspirations potentially less thinkable for working-class girls in particular. The paper concludes with a discussion of potential implications for increasing women's greater participation in STEM (Science, Technology, Engineering and Mathematics).

Keywords: gender; science; aspirations; children; parents

Introduction

There have been significant advancements and improvements in gender equity within science over the last 40 years in many countries, with greater numbers of women and girls now taking STEM (Science, Technology, Engineering and Mathematics) qualifications, entering STEM careers and contributing to the wealth of STEM knowledge and research (American Association of University Women (AAUW) 2010; Harding 1998). However,

*Corresponding author. Email: louise.archer@kcl.ac.uk

entrenched gender differences still persist, both in terms of students' *attitudes* to science/mathematics and their patterns of *participation* in post-16 science/mathematics, particularly in the physical sciences and engineering, where women remain markedly under-represented (Smith 2010a, 2010b). These inequalities persist despite little, if any, gender differences in terms of pupils' attainment in science (Haworth, Dale, and Plomin 2008; Smith 2011) and mathematics (Boaler 1997; Boaler 2002; Boaler and Sengupta-Irving 2006). Moreover, evidence suggests that boys exhibit consistently more positive attitudes to science than do girls (e.g. Brotman and Moore 2008; Haste 2004; Murphy and Whitelegg 2006; Sjoberg and Schreiner 2005), particularly in relation to the physical sciences (Scantlebury and Baker 2007; Schreiner 2006; Schreiner and Sjoberg 2004), but these are the result of social, not biological, factors (Ceci, Williams, and Barnett 2009).

The reasons for these continued differences between male and female attitudes to and participation in science are complex. For instance, a 2011 report by the English education regulatory body, Ofsted, highlights that although many girls consider that gender is not a barrier to participation and that they will be able to follow 'any' courses and careers in the future, their *actual* choices (of subjects and careers) remain gender-traditional. Indeed, while many interventions aimed at encouraging more girls into science may improve girls' attitudes to science, they frequently have little effect on girls' actual subsequent choices (Darke, Clewell, and Sevo 2002). Hence, while progress is being made (AAUW 2010), undergraduates in the physical sciences remain largely high-achieving, white, middle-class young men (Smith 2010a). These gendered patterns do not reflect differences in achievement or ability (Tytler et al. 2008). Rather, as the review by Osborne, Simon, and Collins (2003) outlines, female under-representation in particular areas of science is the result of an intersecting cluster of social, cultural and structural factors.

The association of science and mathematics with 'masculinity' has long been a concern for feminist theorists (e.g. Burton 1990; Haraway 1988; Harding 1998; Walkerdine 1990) and evidence suggests that most children are aware that mathematics and/or science (but particularly the physical sciences) are 'for boys' (Adamuti-Trache and Andres 2008; Baker and Leary 1995; Breakwell, Vignoles, & Robertson 2003; Calabrese Barton and Tan 2009; Caleon and Subramaniam 2008; Carlone 2003; Farenga and Joyce 1999; Fennema and Peterson 1985; Francis 2000; Greenfield 1996; Jones, Howe, and Rua 2000; Hughes 2001; Lightbody and Durndell 1996; Mendick 2005) and that scientists are male (Baker and Leary 1995; Buck et al. 2008). Indeed, even children as young as six have been found to associate science with masculinity/males (Hughes 2001). Likewise, Haste's (2004) UK survey of 704 young people aged 11–21 years found that those who are 'alienated from science' tend to be female whereas the 'science-orientated' tend to be male. Moreover, evidence indicates that girls tend not to

pursue the physical sciences because they see the identities of engineers and physicists as incongruent with their own (Sjøberg and Schreiner 2007).

As Baker and Leary observed, many girls in primary and secondary schools report enjoying science but 'could not imagine themselves as scientists' (1995, 3). Likewise, Carlone's (2003) research in the USA found that girls who do not regard themselves as 'science people' resist the further pursuit of science, even when they are capable of continuing with it. In this paper we explore some of the reasons why girls may not consider science aspirations as 'for me'. We investigate whether there is something about their perceptions of science (and careers in/from science) that renders science 'unthinkable' (undesirable/inconceivable) for them. We do this through an examination of the discourses of those girls in our interview sample who did *not* express science aspirations, based on the assumption that their constructions of (non-science) aspirations may reveal some of the unsaid and unarticulated reasons for why they do not view science-related careers as attractive or desirable aspirations.

To do so, we employ a conceptual framework that draws on feminist poststructuralist theorisations of 'identity' as a means for understanding children's identifications with science and how they reconcile their science aspirations with gendered identity performances. This approach includes Judith Butler's (1990, 1993) theorisations of gender as 'performance' and integrates it with a conceptualisation of gender as intersecting with, and mediated by, other social axes, such as 'race'/ethnicity and social class (Archer and Francis 2007; Calabrese Barton and Brickhouse 2006).

From this perspective, identity is understood as non-essentialised, fluid, contested and produced through discourse (Burman and Parker 1993; Gee 1996). That is, 'identification is an enactment that does not entail fixity or permanence' (Anthias 2001, 633) and identities are 'always in process and always constituted within, not outside, representation' (Hall 1990, 222). Moreover, we treat identities as social products, produced within and through discourse and social relations: they are 'real fictions' that are produced and constructed through social life and relations of power (Foucault 1978; Weeks 1981). Our approach to identity is integrated with the work of Judith Butler, to provide a gender lens for analysing girls' aspirations. Butler (1990) conceptualises gender as performative. That is, gender is not the 'result' of a person's sex – it does not emanate 'naturally' from particular (sexed, racialised, classed) bodies – but is produced through discursive and bodily 'acts'. Gender is, therefore, not something you 'are' or 'have' but rather is something that you 'do' (perform) and continually re-do. Gender is a powerful illusion (Butler 1990, 185–6) that is 'actualized through a series of repetitive performances that constitute the illusion of a "proper", "natural" or "fixed" gender' (Renold 2005, 4). In other words, gender is created through a myriad of verbal and bodily performances in which subjects 'do girl' (or 'do boy') (Butler 1990, 185–6).

We also use Butler's concept of 'intelligibility' to understand the context within which children and adults produce gender identities and the social pressures that they experience to perform particular (normative, socially sanctioned) identities:

> 'Intelligible' genders are those which in some sense institute and maintain relations of coherence and continuity among sex, gender, sexual practice, and desire. (Butler 1990, 23)

Consequently, Butler argues, some gender performances (i.e. those which are more subversive or counter-hegemonic) are rendered 'unintelligible'. That is, 'the cultural matrix through which gender identity has become intelligible requires that certain kinds of "identities" cannot "exist"' (Butler 1990, 24). For instance, children experience considerable pressures to perform particular heterosexualised versions of masculinity and femininity (Renold 2005).

Study details

The ASPIRES project is funded by the UK's Economic and Social Research Council as part of its Targeted Initiative on Science and Mathematics Education (TISME). The study is a five-year, longitudinal exploration of science aspirations and career choice among 10–14-year-olds in England. It comprises a quantitative online survey that was administered to a sample of over 9000 10/11-year-old students in the first phase (students will be tracked and surveyed again in subsequent phases at ages 12 and 14) and in-depth, repeat interviews with pupils (at age 10/11; age 12/13 and age 13/14) and their parents (who are interviewed twice, once when their children are age 10/11 and again at age 13/14).

Over 10,000 students from 279 schools (248 state schools; 31 independent schools) completed the Phase 1 questionnaire between October and December 2009. (The Phase 2 survey took place in autumn 2011 and phase 3 in autumn 2012.) Following data cleansing (including removal of students who were not actually in Year 6 from the sample), 9319 students remained in the sample for analysis. The sample represented all regions of the country and was roughly proportional to the overall national distribution of schools in England by attainment and proportion of students eligible for free school meals. Of the students who completed the survey there were: 50.6% boys, 49.3% girls; 846 (9.1%) in private schools, 8473 (90.9%) in state schools; 74.9% White, 8.9% Asian (Indian, Pakistani, Bangladeshi heritage), 7.5% Black (Black African, Black Caribbean), 1.4% Far Eastern, 7.8% mixed or other (N.B. because the study focuses in part on the impact of ethnicity on students' aspirations, schools with higher populations of ethnic minority students were deliberately over-recruited to ensure sufficient numbers for

analysis). The survey itself covered topics such as: aspirations in science; attitudes towards school science; self-concept in science; images of scientists; participation in science-related activities outside school; parental expectations; parental school involvement; parental attitudes towards science; and peer attitudes towards school and towards school science.

This paper is primarily based on analysis of the Phase 1 qualitative dataset, which comprises 170 interviews with 78 parents and 92 children age 10/11 (Year 6), drawn from 11 schools in England. At points throughout the paper, contextual information is provided from the survey as a means for framing the qualitative data analysis, although full details of the survey and its methods, analyses and findings are discussed in separate publications (DeWitt et al. 2010, 2011).

The students and parents who were interviewed were recruited from 11 primary schools in England (one in the Midlands, two in the Eastern region, two in the South East, four in London and one in the South), which were sampled from the 279 schools that responded to the Phase 1 survey as part of the wider study. A sampling frame was constructed to represent six target categories of school (e.g. 'multiethnic urban/inner city schools'; 'working-class suburban'; 'predominantly white, middle-class suburban schools'; 'independent single sex') to ensure a range of school contexts and populations, and prospective schools were purposively sampled from within these target categories. Nine of the schools were state-funded primaries and two were private/independent schools. Students came from a broad range of socioeconomic classes and ethnic backgrounds. Social class categorisations were assigned by the lead author and second author using the National Statistics Socio-economic Classification as a guide to categorise parental occupations. Ethnicity was assigned based on self/parental reported ethnic background.

Following extensive reviews of literature from relevant work within the fields of science education and sociology of education, two topic guides (for use with children and parents) were developed and piloted, covering areas such as: aspirations (and sources of these aspirations); interests in school and out; what they like/dislike about school; attitudes towards and engagement in school science; broader perceptions of science. Parental interviews focused on: family context; perceptions and experience of the child's schooling; involvement in education; child's personality and interests; their child's aspirations, their own perceptions of and relationship with science and engineering, including their thoughts about why so few children pursue science post-16.

Interviews were conducted by four of the paper's authors, with the majority of the interviews being conducted by the second author. Of the interviewers, three (LA, JDW, BW) are White middle-class women (with English, American and French national backgrounds) and one (BWg) is a British-Chinese male PhD student. Interviewees were invited to choose their

own pseudonyms, hence the majority of pseudonyms cited in this paper reflect the personal choices of interviewees.

All interviews were digitally audio-recorded and transcribed. In line with the study's conceptual approach outlined earlier, data were analysed using an analysis of discourse approach (Burman and Parker 1993). Initial coding and sorting of the data (on key topic areas, themes and by responses to particular questions) was undertaken by two authors (LA, JDW) using the NVivo software package, with the lead author providing a check on reliability of coded extracts for the specified codes. The lead author then searched coded extracts to identify discursive gender repertoires and patterns of aspirations/relationships with science, which were then tested and refined through successive phases of coding and analysis, iteratively testing emergent themes across the data set to establish 'strength' and prevalence (Miles and Huberman 1994). In line with the stated conceptual framework, the lead author then developed and tested theoretically informed hypotheses to see if they were supported or challenged by the data, for instance to identify interplays of power and practices of power and gendered discourses within respondents' talk. Draft analyses were then fed back to other authors (especially those who conducted fieldwork, BW, BWg) for checking against their readings of the data.

'I like science … but it's not for me'

Our survey of over 9000 10- and 11-year-olds indicated that the majority (over 70%) of children reported enjoying science, held positive views of scientists, took part in science-related activities in their spare time and felt that their parents valued science. However, a much smaller proportion (under 17%) aspired to careers in science. There was no notable gender difference within the 648 children who were classified as 'uninterested in science' (i.e. those who recorded the lowest scores on all the five science aspirations items), but notably fewer girls (n = 92, 37%) than boys (n = 159, 63%) were classified as being 'science keen' (n = 251) (i.e. those scoring very highly on all five science aspirations items). That is, of the overall sample, 3.4% of the boys were classified as 'science keen' and 2.0% of girls. Moreover, our data suggest that children from 'middle-class' backgrounds are more likely to develop and sustain science aspirations which, as we discuss elsewhere, reflects differences and interactions between family practices, values and science capital. Science capital is defined as the material and cultural science-related resources that a family may be able to draw on, such as science-related qualifications, knowledge, understanding ('scientific literacy') and social contacts and, as we discuss elsewhere, interacts with family habitus to shape the likelihood of children developing science aspirations (see Archer et al. 2012a). For instance, of the 92 'science-keen' girls who completed the survey, only 10.9% (n = 10) were classified as having very

low/low cultural capital (cf. 25.3% of the total sample with very/low cultural capital) whereas 59.7% (n = 55) of science-keen girls had high or very high cultural capital (cf. 40.6% of the total sample with very/high cultural capital). Analysis of the qualitative data also indicated that those girls who did express science aspirations tended to be middle class and undertook considerable identity 'work' to reconcile their science aspirations with acceptable discourses of femininity (Archer et al., 2012b).

In this paper, we attempt to explore why many girls did not aspire to careers in science, even though most of these girls also reported enjoying science in and out of school. In particular, we try to understand why the working-class girls in our sample were proportionally less likely to express science aspirations than their middle-class counterparts and we discuss the reasons why science aspirations may be less 'thinkable' for these girls.

Of the 55 girls in the interview sample, 17 expressed science aspirations, 13 identified science-related aspirations and 25 expressed aspirations unrelated to science. The discourses of girls who aspired to careers in/from science (and their constructions of femininity) are discussed elsewhere (Archer et al., 2012b), and in this paper we focus on the 25 girls who did *not* aspire to science-related careers. Of these 25 girls, nine were categorised as working class, eight middle class, six were on borders of working/middle class and two were unassigned due to lack of data.[2]

As detailed in Table 1, while these girls expressed a range of aspirations (often holding more than one aspiration at a time), these tended to coalesce around traditionally gendered careers in the fields of the nurturing/caring professions, expressive/artistic/glamorous jobs and sports/active jobs – although other areas such as law, business and the police were also mentioned.

As Francis (2000) discusses, vocational career motivations ('to help others') are among the most common concerns that girls express when discussing their career aspirations – and are consistently found among girls

Table 1. Classification of aspirations expressed by 25 girls who did not hold science-related aspirations.

Coding of job type	No. of girls expressing aspiration
Nurturing jobs (e.g. teacher, childcare)	15
'Glamorous' and 'girly' jobs (e.g. show business, fashion designer, model, hair and beauty)	14
Active/sporty (e.g. athlete; swimming instructor)	11
Other professional (e.g. psychologist, architect, lawyer)	5
Businesswoman (e.g. own business)	2
Other (shop work)	1

Note: Most girls expressed more than one aspiration.

irrespective of their ethnic and/or social class backgrounds (e.g. see also Archer and Francis 2007). Indeed, notions of care (of others and of the self) are integral to 'traditional' (dominant) constructions of femininity (Francis 2005) and tend not to be voiced by boys to the same extent. As noted in Table 1, the girls' aspirations also reflect high levels of interest in the body and appearance, which also resonate with dominant discourses of hetero-femininity (Renold 2001), although as we shall discuss, these also intersect with classed discourses (e.g. see Skeggs 1997; Skeggs 2004).

In the analyses that follow, we suggest that science aspirations are largely unthinkable for these 25 girls because they do not see science as fitting with either (1) their constructions of desirable/intelligible femininity or (2) their learner identities and student self-concept. Moreover, we shall suggest that this lack of fit appears to be exacerbated by social inequalities, which render science aspirations less thinkable for working-class girls in particular.

Tensions between girls' constructions of science and their constructions of desirable femininity (science as not 'caring' and not 'girly')

As detailed in Table 1, the two categories of aspiration most commonly cited by the non-science aspirant girls were for 'nurturing' (n = 15) and 'glamorous/girly' (n = 14) jobs. The most popular 'nurturing' aspirations were to work in teaching and/or childcare, which were widely recognised by girls and their parents as 'good jobs'. When asked to explain why they aspired to these jobs, the girls' responses evoked dominant discursive associations between femininity and 'caring' and they frequently named specific female family members and teachers (who had nurturing roles) as the people that they most admired and wanted to emulate in the future. For instance, Celina (white English, working class, Metropolitan School) explained that she wanted to become a primary school teacher because of her positive experiences of school, her desire to nurture children ('I just want to help children learn for the future, like the teachers are doing for us now") and because she admires her mother's nurturing femininity:

> Because she [mum] has a way with children, like when my sister is crying and I can't stop her, like she can stop her and she can calm her down and that when she's really angry, yeah and she gets me to calm down when I'm really angry and I just wish I could be like her.

Likewise, Mary (Pakistani, working class, Metropolitan School) explained her rationale for wanting to become a primary school teacher as: 'I like it because you're teaching someone else education and that's a good thing. And when someone needs help you're teaching them what they need to know for when they grow up'. Mary also named her sister (who works in childcare) as the person she most looks up to and wants to emulate in the

future ('cos she's [working] at a nursery so she would be a role model to me when I grow up because she wants to be a primary teacher as well').

In line with dominant societal gendered constructions of femininity (Francis 2000), these girls' visions of 'good' (desirable) femininity were characterised by nurturing and caring for others. We might infer from the absence of science aspirations among these girls that they did not perceive science to offer an obvious arena for performing this interpersonal caring role. Moreover, a small number of these girls explained their reasons for not aspiring to science-related careers as due to a perception of science as *not* nurturing. For instance, Flower (White Eastern European, working class, Metropolitan School), who aspired to become a teacher, explained that she would not want to become a scientist 'because I love animals and I don't want to harm them'. This view seemed to derive from her sister's account of dissection at secondary school ('because my sister said when she was in school she used to do science in secondary school, they used to have to cut frogs and mouses [*sic*] and she loves animals and she doesn't want to harm them').

The second most popular category of career aspirations was for 'girly' and 'glamorous' jobs (n = 14). Although an interest in fame was common across both boys and girls in the survey sample (with 64.8% of all children replying that 'being famous' is very or fairly important to them), analysis of the interview transcripts revealed a stereotypically feminine flavour to girls' aspirations for 'glamorous' careers (notably in acting, dancing and singing). Of the non-science aspirant girls, these were the most likely to say that they would definitely not want to work in science in the future and were more likely to be preoccupied with celebrity culture. For instance, as Louise (white English, working class, Woodstock School) reflected:

> Actually I don't know what I'd like to be if I didn't get into show business. I'd have to like figure it out … Like I'm obsessed with Cheryl Cole[3] at the minute. I've got her biography, her book. Um, I'm just obsessed with her at the minute.

Similarly, Celina2 (white, working class/lower middle-class, South Coast School) explained how 'when I'm older I want to be an actress and, um, I've got loads of role models that are actresses'. Celina2 was adamant that she did not want to continue with science or pursue a science-related career when she grows up. Instead, her aspirations were firmly entrenched within a clear gendered, classed trajectory ('I really want to do beauty, as well as acting'). Pop stars such as Lady Gaga were also mentioned as being the inspiration for girls' aspirations to become celebrity fashion designers. For instance, Lucy (white English, working class, Midlands School) shared how 'I've got a book which is just little sketches and I've got – there are loads of Hollywood starlets and all the dresses'.

Some mothers recognised that science does not fit easily with girls' performances of 'girling'. As Sandra (mother of Danielle, white, lower middle class, Midlands School) put it, 'girls are more interested in fashion usually and things with peers. You know and it seems to be a bit geeky to be into science', although Sandra also stressed that she was very concerned that Danielle should not get the impression that science is 'all geeks' ('I don't want [Danielle] to get that impression. I don't want you thinking it's geeks'). She continued:

> I said so how do you feel about science? And she said it's really interesting, I love it, but don't only geeks do it? [Int: Oh did she?] I know and this is why I wanted to get away a bit from her thinking that science is only for people I don't know who … because she's got this impression that only people who don't have a life do science, which is terrible.

Sandra felt that TV was largely to blame for promulgating these stereotypes:

> I have to blame TV … Oh she watches these things, you know on TV if somebody is good at something like science don't they always say they're a boffin and they just sit at the computer or they do something and they don't have a life. They're like geeks. [I: Yeah] They put them with big heads and glasses. [I: Yeah] It's just stereotyping.

Danielle herself explained her aspirations as 'I'd like to be either a hairdresser or, um, like someone who works with children, you know like a teacher. I just really like making people's hair and I enjoy doing my own hair and I like to do my mum's'. Likewise, another mother, Ella, felt that girls are often put off science because 'it's not very girly … it's not a very sexy job, it's not glamorous'. While the above girls' interests in fashion, appearance and celebrity culture can be found among girls from different social class backgrounds, research indicates that such interests can assume particular significance for working-class girls. Since the 1980s, feminist academics have drawn attention to how working-class girls may resist education through hyper-heterosexual femininities that are organised around themes of heterosexuality, appearance and romance (e.g. Griffin 1985; Hey 1997; McRobbie 1978; Skeggs 1997).

The girls' interest in 'glamorous' jobs (focusing on clothes and appearance, as exemplified by the fashion and beauty industries) was also clearly rooted within their interest in performing desirable hetero-femininity within their daily lives. For instance, Rachel (British Indian, middle class, Midlands School) was interested in becoming a fashion designer, which seemed to reflect her everyday performance of femininity ('I just like shopping with loads of clothes and that. I like accessorising and all that'). Against this, science did not seem to be popularly perceived as congruent with performances of ('girly') popular hetero-femininity. As feminist theorists (e.g. Francis 2000;

Paechter 2000) argue, femininity and masculinity are inherently relational concepts, such that a characterisation of science as 'not feminine' implies a construction of science as masculine. In this way, we suggest that an underlying association of science with masculinity can be detected in these girls' constructions of their preferred career aspirations as caring and/or expressive and 'girly'. That is, science appears by default as an imagined space that is incompatible with girls' performances of popular/desirable hetero-femininity.

The disconnect, between these girls' constructions of science aspirations and their performances of femininity may reflect a wider popular public discourse in which science careers (especially in the physical sciences) are aligned with masculinity. The majority of parents in our study felt that science careers are associated with masculinity and held a perception of science as being an area that more men than women study and work in (as one mother, Shelley, put it: 'it's always seen as men, isn't it? But geeky men – sorry!'). Although most parents did not subscribe to Shelley's characterisation of scientists as 'geeks', over half did view the sciences as dominated by men, although views differed considerably among parents as to the reasons for this imbalance, being divided between biological/genetic arguments (in which boys are assumed to be 'naturally' more interested in and inclined towards the sciences) and socio-cultural/structural arguments (which saw imbalances as the result of socialisation and structural inequalities).

Pupils tended to express slightly less clear-cut views of the gendered nature of science than parents although there was still a widespread recognition that popular discourses align science with masculinity (for instance, even those children who did hold science aspirations recognised that they were unusual among their class mates – such as Demi (White English, middle class, South Coast School) who said that although she personally held science-related aspirations, most of the girls in her class do not like science and prefer 'girly stuff': 'they just like … all like girly stuff, like singing and hairdressers'). Thus, it might be noted that although Demi is able to negotiate femininity in such a way as to be congruent with holding personal science aspirations, she is still subject to patriarchal norms and discourses, as demonstrated by her dismissal of other girls' 'non-science' aspirations and interests, as 'girly stuff'.[4]

This association of science with masculinity was both representational and experiential, with some parents and girls recounting experiences of having felt outnumbered or excluded in particular science spaces. For example, Sandra described how her daughter, Danielle, had stopped attending an after-school science club because 'it was all boys' and how this had impacted on Danielle's perception that science is 'a boy thing':

> Sandra: I said why can't you do science? She [Danielle] said well, 'oh no it's a boy thing'. And I said 'it's not'. They had [science club name] at school. It's an after-school club on Monday and she said 'I'm not going because it's

> all boys'. You can see what I mean when you're fighting against it aren't you? I said 'well you should at least go along and see if you enjoy it. It's all these experiments' and she said 'oh, it's fun, we did all this'…
>
> Int: Sorry, is she going to this science after-school club?
>
> Sandra: She went twice [Int: She went twice] and then she stopped going because it was all boys and she had no girls to talk to.

The gendered construction of science as masculine was further reinforced by a popular discourse in which the arts and sciences are perceived as being dichotomous (as encapsulated by C.P. Snow's (1959) famous reference to the 'two cultures' of the arts and sciences). This dichotomy was realised through the notion that children who are creative/arty are, therefore, not likely to also aspire to science careers) and was brought up mostly (although by no means exclusively) by girls and/or by parents in relation to their daughters. For instance, Mary (mother of Amy, white English, middle class, Clover School) explained that her daughter's aspiration to be a teacher reflected her 'creative' nature and Sally-Ann (the mother of LemonOnion, South Coast School) described her daughter (and friends) as being into the 'arty side of things' rather than science. As a comment by Lucy (White English, working class, Midlands School), that 'girls are more into literacy and boys more into science') illustrates, a number of parents and children were generally aware of a popular societal discourse that aligns femininity with the arts and masculinity with science, reflecting the historical alignment of science with masculinity and continuing gendered differences in science and arts participation.

Research has found that young people in advanced Western societies generally express less positive attitudes to science than their counterparts in the less-economically developed world (Schreiner and Sjoberg 2004). One contributing factor to this pattern may be that the arts and creative industries appear to offer a closer fit with the current 'age of desire' (Kenway and Bullen 2001, 7) that is prevalent in capitalist developed economies, where consumerism has become a key aspect of identity (Bauman 2000). In such societies, consumer-media culture plays a key role in young people's lives, the ways they see themselves and even their dis/engagement with education (Archer et al. 2007, 2010) and some tenets of this were already evident in these (young) girls' descriptions of their aspirations and interests (for instance in fashion and celebrity culture).

The disconnect between science and girls' constructions of their learner identities and competencies (science as 'clever'/'brainy')

Across the survey and interview data, children strongly associated science with 'cleverness'. For instance, over 81% of the 9000+ survey respondents

agreed or strongly agreed that 'scientists are brainy' and an association between science and 'cleverness' was evident across both parent and child interviewees. The association between science and cleverness/braininess was voiced both by those who personally aspired to science-related careers and by those who resisted science aspirations, reflecting a historic discourse of the sciences as 'hard', difficult and high-status subjects. Consequently, those expressing science aspirations also performed (and were required to negotiate) 'clever' student identities (see Archer et al., unpublished manuscript) – identities which can be difficult to occupy comfortably (see also Mendick 2005 in the context of mathematics). Moreover, as we now move to discuss, this popular association of science with cleverness played an influential role in rendering science aspirations 'unthinkable' for many of the girls in our study.

As discussed earlier, analysis of the survey data suggested that a relatively small proportion of children were not at all interested in science, which was similarly reflected in the interviews, with just a handful of children claiming to strongly dislike science and/or the idea of a future job that might use science in some way. However, children from working-class backgrounds (who constituted a minority of study participants overall) were over-represented among the 'uninterested' category. Moreover, within the interview sample, those from working-class backgrounds were much more likely to not identify themselves as 'clever' – those who identified themselves as clever and/or who were identified by parents as being clever/bright were more likely to express science aspirations. For example, Louise (White English, working class, Woodstock School) expressed some of the most resistant views of science within the interview sample. When asked by the interviewer 'who is into science?', Louise replied 'Well the clever ones are. Like the ones that are going to the grammar school are into like every subject … They don't mind having lessons'. She continued 'its just strange how all the clever ones are into science'. Likewise, Victoria2 (white Eastern European, working class, Metropolitan School) gave her reasons for not wanting to become a scientist as 'cos most scientists are brainy and I don't want to be brainy'. Interestingly, Victoria2 did like some areas of science (notably animals and biology) but did not enjoy what she called 'the normal subject' of science. Despite her resistance to being 'brainy', she also held some more general, positive views of science, describing it as 'awesome' – suggesting a disconnect between her interest and respect for (some areas of) science and her view of herself as a learner and the capacity to see herself as a 'science person'. Flower (White, Eastern European, working class, Metropolitan School) also agreed that you have to be clever to be into science and was adamant that personally she would not want to follow a science career 'because I'm not that smart'. Likewise, Celina (white, working class, Metropolitan School) described those who are 'really into science' as 'brainiacs, because they just want to do science, they don't want to do anything else in their life'.

In other words, the popular association of science with cleverness means that science aspirations are not experienced as viable or appropriate for all students – and can be notably problematic for those who do not perform (and/or who do not consider themselves as performing) academic success and 'cleverness'. Even where parents attempted to encourage their daughters' science interests and challenged negative stereotypes of science (e.g. as being 'geeky' or 'for boys'), the dominant association of science with cleverness remained as a fundamental, taken-for-granted inherent feature of science by most of those interviewed. This is exemplified by the case of Danielle and her mother, Sandra. Danielle describes herself as a 'middle' student, a view that her mother, Sandra, concurs with ('Um, I think she's more of a middle of the range child. There's nothing really that she excels in') but among her various interests, Danielle does enjoy science and says it is one of her favourite lessons ('I'm not being a kiss-up[5] but my favourite lesson is actually science), her mother is strongly supportive and her father works as a mechanical engineer. Yet, science aspirations are unthinkable for Danielle, who feels 'I'm not clever enough to be good at science'. As Sandra explained:

> Sandra: Yeah, that's what she said to me. I said why? She said oh, you have to be really clever, you have to be a geek.
>
> Int: Mmm, how did you respond?
>
> Sandra: [I said] 'What do you mean, what do you mean you have to be really clever and be a geek?' She said 'well, you do don't you? Everybody sees it. You have to … you see it on TV and [scientist character], she's a geek, no friends, got glasses'. … She said 'well, you have to be really clever and I'm not'. I said you are clever. You could do anything you want.

We suggest that the disconnect that Danielle feels between her construction of science (as 'clever') and her own self-concept as a 'middling' pupil plays an influential role in preventing her from seeing science aspirations as 'for me'.

Other work that has sought to interrogate and deconstruct dominant educational discourses highlights how the characteristics commonly associated with the 'ideal pupil' tend to be gendered, racialised and classed in particular ways (Archer 2008; Archer and Francis 2007), such that notions such as 'natural brilliance' tend to be associated with masculinity. Carlone's (2003) US research suggests that the popular association of science with 'cleverness' (and 'natural' academic brilliance) is often reinforced in particularly gendered ways by science teachers. She found that teachers in an Advanced Physics class made unconscious but stark gendered attributions of student aptitude, perceiving boys as more naturally able in physics than girls, despite girls tending to achieve higher marks. Echoing wider gender and

education research (e.g. Francis 2000), girls' achievement was attributed to their plodding diligence and 'hard work' whereas boys' lower achievements were explained as due to a lack of application (rather than a lack of aptitude). The study of Carlone et al. (2008) found that teacher approaches can make a difference to the extent that some students, but notably poor, minority ethnic girls, feel they can identify with science and be a good science student – irrespective of their actual attainment in the subject.

Moreover, as others have written, gender is a relational construction in which intelligence and 'the mind' have been historically configured as masculine, against which femininity has been associated with 'the body' (e.g. Paechter 2000). Consequently, as the sciences (and mathematics) are associated with cleverness which is linked to masculinity, so a sustainable science identity may be 'more challenging for girls than it is for boys' (Carlone and Johnson 2007; Ong 2005). We suggest that this relationship is further exacerbated in the case of working-class girls due to the intersection of classed discourses which align middle-class students with achievement/the mind and working-class students with the body/underachievement (see Archer 2008), resulting in the exclusion of working-class girls not only from the identity of the ideal student but also, in particular, from science-related future aspirations.

For instance, a number of pupils distinguished between those who are 'academic' and those who are 'practical', reflecting a discourse of the 'academic–vocational divide, which is long-standing within UK education (e.g. see Leathwood and Hutchings 2003 for discussion and critique). Within this discourse, working-class learners have traditionally been associated with 'practical' and vocational subject routes (as preferences and as fitting their assumed skills and aptitudes). Girls' preferences for 'hands-on' jobs in show-business, the beauty industry and sports-related careers (see Table 1) can all be understood as reflecting this longstanding discourse of the academic–vocational divide. For instance, LemonOnion described how she generally liked science classes at school but felt that science played little role in her wider life or aspirations. Instead, she and her friends identified with artistic/creative subjects, which SallyAnn (her mother) attributed to the girls not being 'academic' ('I wouldn't say they are all academic. I think most of the children she likes to mix with, like the arts – drama, singing, drawing, making, doing. I think that's more where they are').

Consequently, we would argue that the powerful popular association of science with 'cleverness' (and its perception as being a highly academic subject) means that identifying with science (seeing oneself as a potential 'science person') requires taking up (and being recognised by others for occupying) a 'good student' identity. Research suggests that this can be more difficult for working-class learners, girls and those from some minority ethnic backgrounds due to dominant educational discourses that construct the 'ideal learner' as white, male and middle class (Archer 2008). Moreover,

we would suggest that the popular association of science with cleverness constructs science as an exclusive, distinct and exceptional field – something that is for the 'clever' few, and is not seen as 'for me' by the majority of students.

The girls' non-science aspirations tended to be rooted within those areas of their life in which they felt they had (or were developing) practical competencies, and which they were reinforcing and developing through their everyday activities. For instance, those girls who saw themselves as 'good at sport' often named sports-related aspirations and those who aspired to work with children tended to have younger siblings or extended family members who they looked after regularly. Moreover, the girls described receiving considerable support and reinforcement of their capabilities from their parents, which bolstered their sense of being competent and well suited for this particular area (e.g. as 'good with children'). Parents concurred with these views, for instance, Celina's mother (Leah2) describes her daughter as 'good with children' and emphasised that she felt Celina would make a good teacher. Many girls recounted the explicit encouragement and reinforcement they received from home in this respect. As Charlie, who aspired to be a teacher, explained:

> When I go round my nan's and my cousins, mum and dad come in and all that and they go 'oh you're so good with babies … they say you're really good with babies and you should be like someone who looks after children … like a childminder or a babysitter or something. (Charlie, white English, middle class)

Elsewhere we have discussed the importance of science capital (science-related qualifications, resources, knowledge/literacy and contacts) for 'growing' children's science aspirations, outlining the ways in which capital interacts with family habitus to make science aspirations more, or less, thinkable for children (Archer et al., forthcoming) and how a lack of science capital can hinder the development of science aspirations. The data from the girls without science aspirations reinforce the importance of capital in that their stated aspirations are clearly rooted within particular forms of social and cultural capital (family contacts, everyday experiences of e.g. babysitting/childcare, fashion and sport). The absence of science capital within their daily lives renders science aspirations less conceivable (and achievable), not only reducing their opportunities for developing a practical 'feel' for science but also of being able to see science as a 'thinkable' performance of femininity. Although only a small minority of children in the survey and interviews reported unambiguously negative attitudes to science, that these children tended to be girls from working-class or lower-middle-class backgrounds is noteworthy and underlines the 'distance' between science (as male and middle class) and working-class femininity. As discussed elsewhere, that

science capital is unevenly spread across families and tends to be concentrated in the middle classes (Archer et al., forthcoming), means that other girls are particularly likely to lack opportunities to see science as fitting with their constructions of femininity and everyday lives. In short, for many girls – even those in primary school who tend to enjoy science – science aspirations are already undesirable and 'unthinkable'.

Discussion/conclusion

In this paper we have explored possible reasons for why many girls in our sample liked and enjoyed science but did not consider science aspirations as 'for me'. By looking at some of the reasons they gave for their non-science aspirations, we have sought to understand the 'unsaid' aspects of their constructions of science, probing in particular the ways in which these are inflected by gender.

Our analysis suggests that the highly gendered nature of these girls' alternative aspirations is not coincidental or by chance but rather indicates their underlying constructions of science careers as 'masculine'. Their discourses reveal the extent to which science careers are imagined (and/or experienced) as being incompatible with girls' performances of popular femininity. Indeed, we might argue that science aspirations are 'unthinkable' for these girls due to their perceptions of science as not nurturing, not glamorous/girly and not 'practical' (being too 'clever' and academic). Moreover, these perceptions appear to be exacerbated by social class inequalities and may be amplified for working-class girls, given the resonance between discourses of 'glamour', 'girliness', 'hands on' (vocational) education and popular performances of working-class femininity. Notably, we suggest that those girls and boys who feel excluded from high academic achievement will learn from an early age that science aspirations are 'not for me', even if they otherwise enjoy science in and out of school.

Given that existing research shows that hetero-femininity continues to be a defining feature of many girls' sense of self and their ways of 'doing girl' (Ali 2003; Renold 2005), we might anticipate such constructions of identity continuing to intensify with age as these 10/11-year-old girls progress through secondary school. Moreover, popular constructions of science, as aligned with 'cleverness' and 'the mind' (abstract/academic, cerebral) do not fit easily with many of our girls' interests in the body, appearance and celebrity culture, nor with their 'non-academic' learner identities. Indeed, some research indicates that highly feminised ('girly') STEM role models can actually decrease non-STEM interested girls' STEM interests and aspirations because they are perceived by these girls as particularly unobtainable (Betz and Sekaquaptewa 2012). We might similarly speculate that for some of our girls, science is an 'unthinkable' identity due to its profound incongruence with key elements of popular femininity.

Our analysis of the girls' discourses indicates an underlying binary construction of science and non-science aspirations (see Table 2), in which science aspirations are constructed relationally to the three main categories of non-science aspirations (nurturing, girly and sports-related aspirations). That is, key elements within each set of constructions (of science versus non-science aspirations) can be configured in oppositional terms (what one 'is' illuminates and implies what the other 'is not').

We suggest that there is a close alignment between the right-hand column of Table 2 (of non-science aspirations) and these girls' everyday performances of hetero-femininity, which renders such aspirations 'obvious'/thinkable. Against this, science is constructed as an undesirable and unthinkable aspiration – it simply does not 'fit' with these girls' sense of identity. Moreover, the prevalence of popular discourses that align the qualities within the left-hand ('science') column with masculinity and middle-classness (and conversely the right-hand column with femininity and working-classness) would imply that science aspirations are less likely to be experienced as a conceivable and achievable option for working-class girls in particular – who may need to engage in considerable identity work if they are to come to see science aspirations as 'for me'.

The discursive mapping in Table 2 indicates potential opportunities for opening up and challenging popular representations of science (including those promulgated by the scientific community). For instance, our analyses suggest that work might usefully be undertaken to open up popular perceptions of the sciences, and the cultures that operate within the sciences, to render them more accessible for 'non-traditional' groups. In particular, careful attention might be paid to how the sciences might encourage and value broader forms of participation and engagement, such that children can see that careers in/from science welcome and embrace a wide range of identity performances (e.g. not just being 'clever' and geeky).

It would also appear valuable to increase the potential for (and/or families' awareness of) more diverse forms of participation in post-compulsory science. The children and parents in our study largely saw science jobs only in terms of becoming a scientist (or doctor or science teacher), suggesting little public awareness of either the diversity contained within 'being a

Table 2. Binary constructions of science and non-science aspirations.

Science	Non-science aspirations
Academic, 'clever', 'brainy', *cerebral/'the mind'*	Practical/*vocational*, 'normal', 'hands-on', active, *'the body'*
Not nurturing/*dispassionate*	Nurturing
Geeky	Glam, fashionable
Other, *unknown*, *distant*	*Known*, *everyday*

Note: Inferred attributes are in italics.

scientist' (e.g. see the Science Council's campaign on 'Ten Types of Scientist), nor of the immense diversity of jobs from science (e.g. jobs that are science-related or that are informed by science). Work to increase teachers', families' and children's awareness of the wide diversity of careers in/from science would seem important for increasing future participation. Indeed, it is particularly ironic that the KS4[6] programme of science study in England contains not a single reference to the need to educate students about possible future careers in/from science, even though one of the main rationales given for the importance of science to the UK curriculum is the preparation of the next generation of future scientists. Yet changing perceptions of the value of science for future careers is not only a matter of increasing public awareness of diverse routes – there is also a case for increasing the actual diversity of available routes in/from science that go beyond the 'gold standard' of A level and university degree routes in order to broaden participation in the sciences. This is not only a STEM 'pipeline' issue but, in our view, is an important social equity issue. Currently, the potential material and cultural benefits that are offered by post-16 science qualifications and/or careers are largely the preserve of particular, privileged social groups (notably white, middle-class men).

We do not see the challenge, however, as merely an issue of changing students' (and parents') perceptions: there is also a need to ensure that the cultures operating within post-16 science (in colleges, universities and workplaces) are indeed equitable and do not alienate or disadvantaged 'non-traditional' participants. Existing evidence suggests that there are still a number of challenges on this front (e.g. Carlone 2004; Ong 2005). This will require scrutinising the cultures that currently operate within the sciences, to make sure that they are fair and inclusive.

Finally, we feel there is a strong case to be made for the implementation of strategies designed to increase science capital (Archer et al., forthcoming) within UK families, to help make science (and hence science aspirations) more 'known' and familiar within families' everyday lives. In other words, there is still a considerable challenge facing the science education community to enable and encourage more girls to see science aspirations as desirable and 'thinkable' for them. As Pamela (Black Caribbean girl at Chestnut Junior School, who aspires to be an actress, dance teacher or sports teacher) explained, although she enjoys science and does well in it, a science-related future career would be 'good for some people but not for me'.

Notes

1. This paper arises from the UK Economic and Social Research Council-funded seminar series 'Young Women in Movement: Sexualities, Vulnerabilities, Needs and Norms' (ESRC RES-451-26-0715), based at Goldsmiths, University of London, 2009–2011.

2. Cf. the science-aspirant girls who were predominantly middle class (only one working-class girl) – see Archer et al. (forthcoming).
3. Cheryl Cole is a very popular English pop star and celebrity. She rose to fame through a reality pop competition and joined the manufactured girl band Girls Aloud. She has since enjoyed success as a solo artist, TV personality, model and as the face of international cosmetics company L'Oreal. She is frequently featured in the tabloid press and fashion/ lifestyle magazines.
4. We are grateful to the anonymous reviewers for suggesting this point.
5. Kiss up' means to falsely flatter or in this case, to express a false opinion in order to curry favour with the interviewer.
6. The two years of schooling in England for pupils between the ages of 14 and 16, which incorporates GCSEs, the national examinations taken by pupils at the end of this period.

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