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Running head: *Evaluation of a Science Outreach Intervention*

‘I Have Seen the Opportunities that Science Brings’: An Evaluation of an Intervention to Encourage Girls to Persist in Science Subjects

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Abstract

Women are underrepresented in science; it is therefore important to examine how to encourage girls to study science post-compulsory. This intervention involved girls aged 12-14 attending interactive science sessions at a university. Girls completed pre and post-test questionnaires. Girls became more likely to believe they could succeed in science and see it as useful and interesting. However, many girls had already decided on a career and would still be unlikely to continue in science.

Keywords: intervention, women in science, gender, subject choice

Introduction

Between 2010 and 2020 there is predicted to be an increase of 14% in jobs in Science, Technology, Engineering and Mathematics (STEM) and there has been international concern that the number of graduates will not keep up with demand in the future workforce (Science and Technology Committee, 2012; U.S. Department of Education, 2016). The number of students taking science subjects in the U.S. (U.S. Department of Education, 2016) and internationally (Chang & Kono, 2014) is relatively low compared to the predicted future demand for graduates. This may be particularly challenging due to the fact that even non-science employers often seek to employ science graduates because of their advanced numerical and analytical skills (Department for Business Innovation and Skills, 2011). Furthermore, it appears that there is little aspiration to science careers—even at age 13, children are ranking careers in science as being of very low interest (ASPIRES, 2013). Therefore, in recent years there has been increasing focus on how to encourage more people to pursue science subjects.

Crucially, when we examine the composition of the group of people who do pursue science subjects and careers, it is clear that women are underrepresented, both in the USA (National Science Foundation, 2015) and across Europe (European Roundtable of Industrialists, 2009). At every stage in their education, girls are dropping science subjects, giving rise to the metaphor of the 'leaky pipeline'. According to Cronin and Roger (1999) the issue is progressive in that the further along the 'pipeline' you go, the fewer women you find, and persistent in that the issue exists regardless of a raft of interventions. However, girls are not leaving science subjects because they perform poorly in them. Indeed, in 2013 the gender gap increased with girls outperforming boys in GCSEs with 72.3% of girls awarded A* to C, compared with 63.7% of boys (Topping, 2013). This pattern is also found in many science subjects, including physics and engineering, with girls receiving higher proportions of A* and

A grades than boys (Joint Council for Qualifications, 2013). However, these talented girls are less likely to go on to study science subjects at A-level, university and to pursue careers in scientific fields. It is therefore important to examine why these girls may be leaving science subjects behind and how they could be encouraged to persist in them.

Eccles (1983, 1994) proposes an expectancy-value model of achievement-related choices, suggesting that young people choose an occupation, and before this, select academic courses to prepare them for their career based on two factors: expectations of success and perceptions of value. This means that students choose courses and careers that they think they can succeed in and which they value (Wigfield & Eccles, 2000). According to this model, encouraging girls to feel that they are likely to succeed and encouraging them to value the subject more should inspire them to study science subjects at a higher level, and possibly pursue scientific careers. This is not to say that girls should be pushed into choosing science subjects if they are not interested in them. Instead, it is argued that every person should have an equal opportunity to study and work in the discipline they choose (Blickenstaff, 2005), and that girls should not leave science subjects for the 'wrong' reasons such as the perception that girls are less likely than boys to succeed in science.

One way in which to enhance both expectations of success and perceptions of the value of science is via outreach initiatives such as a Women in Science Day. The current paper reports on the efficacy of an outreach initiative in which girls came to a university for the day and participated in four hands-on science sessions led by female academics. We examined how this impacted girls' feelings about their likelihood of success in science, their perceptions of the usefulness and enjoyment of science.

Expectations of success

According to Eccles et al. (1983) expecting that they could be successful can lead students to consider studying subjects. Indeed, Vidal Rodeiro (2007) found that expectation of success was the key factor that predicted A-level subject choice. Furthermore, findings from the Wellcome Trust (2010) indicated that most students stated that they would choose an A-level subject because they had performed well at GCSE (69.1% of respondents) or because they felt that they were likely to do well (68.8% of respondents). In a similar vein, the perceived difficulty of science subjects has been cited as being one of the main barriers to studying them at A-level (ibid.).

It could therefore be argued that one way of increasing the likelihood of girls opting to continue to study science post-compulsory could be to change their expectations of success in them. As previously discussed, girls often outperform boys in science. Therefore, perhaps it is not the case that interventions should focus on improving knowledge, but instead should try to influence girls' perceptions of their likelihood of success. Indeed, previous literature suggests that boys have higher science learning self-efficacy than girls, i.e. they are more likely to believe that they can succeed in science than girls (Wang & Tsai, 2015; Huang, 2013). Women in Science days are likely to change expectations of success as girls are given the opportunity to participate in hands-on activities which increase their science knowledge. They can also meet women who have succeeded in science who may be seen as models in line with social learning theory (Bandura, 1977). Social learning theory suggests that models provide examples of behaviour which we can observe and imitate. Seeing others succeed has also been found to be a powerful influence on beliefs about likely success. This may be particularly powerful for girls as literature suggests that while men's feelings about their ability in science are often based on their performance, women relied more on their interactions with others to build a concept of their abilities (Zeldin, Britner & Pajares, 2008; Zeldin & Pajares, 2000).

Models may be a particularly powerful way of encouraging girls into science because seeing female models might go some way to breaking stereotypes that maths and science are a male domain (Steele, 1997). Young, Rudman, Buettner and McLean (2013) found that having female science lecturers, who were viewed by female undergraduate students as positive models, was associated with pro-science career aspirations and attitudes and reduced the view of science as a masculine profession. Also, Carrell, Page and West (2010) identified that for female undergraduates, having female science lecturers improved performance in mathematics and science classes, increased their likelihood of taking further mathematics and science courses and increased their likelihood of graduating with a science degree. This illustrates that female models can have a positive impact on undergraduates remaining in science. Additionally, Bottia, Stearns, Mickelson, Moller and Valentino (2015) found that girls who attended a high school with a higher proportion of female science teachers were more likely to continue to study these subjects at university. Boys, on the other hand, were unaffected by the gender of their teachers. Furthermore, girls tend to choose models when they have personal connections such as friendships or direct contact (Buck, Clark, Leslie-Pelecky, Lu & Cerda- Lizarraga, 2008). Therefore, meeting and interacting with female scientists at Women in Science Day may help girls to make connections with female scientists. These women may then act as models and thus encourage girls to remain in science.

Subjective task value

Subjective task value is also important in influencing subject and career choices. It is composed of four key elements, namely, attainment value (importance of the task for self and identity), intrinsic value (enjoyment or interest), utility value (usefulness or relevance), and cost (loss of valued alternatives, stress). In the current research the decision was made to focus on intrinsic value (i.e. enjoyment or interest) and utility value (i.e. usefulness or

relevance). This is because it would be unlikely that an intervention lasting only a day would change perceptions of self and identity (attainment value). Furthermore, perceptions of the costs may be indirectly influenced by increasing liking and relevance of science. The 'cost' may then come to be seen as worth paying (Eccles et al., 1983).

Intrinsic value, i.e. enjoyment and interest, has been found to have a positive impact on achievement—Spinath, Spinath, Harlaar and Plomin (2006) found that intrinsic value could be used to predict subject achievement beyond academic ability. Similarly, Koller, Baumert and Schnabel (2001) found that an interest in maths (i.e. its' intrinsic value) impacted the likelihood of persistence in maths and achievement in maths. Furthermore, interest in and enjoyment of subjects were some of the most frequently cited reasons for educational choice (Purcell, Elias, Ellison, Atfield, Adam & Livanos, 2008). Thus if girls enjoy and are interested in science they may be more likely to perform well in it, which may lead to an upward spiral with girls achieving, valuing and remaining in science.

Furthermore, seeing science as useful and perceiving that it will benefit everyday activities or have relevance for the future, i.e. as having high utility value, may also encourage girls to study it further. Perceiving a subject as useful has been associated with enhanced performance and interest in subjects (Hulleman & Harackiewicz, 2009). Perceived usefulness of the subject has also been found to be associated with increased likelihood of choosing subjects (Meece, Wigfield, & Eccles, 1990). In the early stages of learning, it has been suggested that utility value can encourage learners to continue to engage with the subject. This will then lead to improved performance and deeper engagement with the subject (Hidi & Renninger, 2006). Therefore, enhancing girls' views of the usefulness of science may also increase their likelihood of persisting.

Existing interventions

A number of interventions currently exist which aim to encourage girls into science. Long-term programmes, such as the American Museum of Natural History's *Lang Science Program*, attempt to engage youth who are underrepresented in science to increase their expectations of success and perceptions of value of science (Adams, Gupta & Cotumaccio, 2014). This programme involves a seven-year extracurricular partnership, which includes a three-week summer school and fortnightly weekend classes—a total of approximately 165 contact hours. Students take part in hands-on activities led by scientists in biology, anthropology and physical sciences. The programme allows children to develop their interest in science as well as their skills, knowledge and efficacy. In focus groups, alumni said that it introduced them to a broad range of careers and gave them a sense of belonging. Indeed, intensive summer programmes are a popular way of engaging science minorities and developing their skills to increase their self-confidence. *Discover!*, a Saturday science-activity club based in Cardiff, targets secondary school girls and aims to increase their feelings of belonging within science (Watermeyer, 2012). Attendees have reported that having a 'girls only' environment allowed them to talk more freely without fear of boys dominating the session or creating competition. Finally, *GEMS* (*Girls in Engineering, Maths and Science*—a four hour Saturday activity club) also used a girls only environment and practical hands-on activities and found that around 70% of girls showed increased interest in science (Dubetz & Wilson, 2013).

However, such out-of-school programmes are resource intensive, involving both substantial time and money, and require great investment from partner organisations and the children. Additionally, summer schools can only accept a limited number of children each year, and with over 1.3 million girls aged between 11 and 15 attending secondary school in the UK in 2015, these interventions would only be able to target a small proportion of girls (Department for Education, 2015). It could therefore be argued that science interventions should be

integrated into the school setting. However, there are some potential issues and barriers to the successful implementation of school based interventions. For example, it is often impractical to set aside a sufficient amount of time during the normal course of the school day because of the already extensive curriculum that schools have to cover. Schools could offer after school clubs. However, if girls do not value science then it is unlikely that they would volunteer to attend extracurricular interventions. In addition, schools may not have the expertise or resources required to deliver sessions on the wide variety of science subjects, meaning that the focus is usually on the typical school sciences of physics, chemistry and biology, which does not fully reflect diversity in science. Finally, as previously discussed, female models may be particularly powerful in engaging girls in science, while science teachers within the school settings are often male, particularly in physics (71.7% male; The Royal Society, 2007).

One way of overcoming these issues is for schools to partner with universities. Universities employ specialists in a range of science subjects and are able to give students a flavour of the bigger questions and different areas involved in science. This variety may enhance students' perceptions of the utility value of science. In addition, a number of female staff work in science subjects at universities and have been successful in their respective fields. They can act as models for young women illustrating that other women have been successful in these fields. Furthermore, Women in Science days can minimise some of the issues previously identified with engaging girls in science. For example, taking a single day out of the curriculum is less time intensive for schools and teachers do not need to prepare material themselves. In addition, even girls who are not particularly interested in science may still value the opportunity to attend university for a day. There are also benefits to the university in terms of student recruitment. This suggests that a partnership between universities and schools in encouraging girls into science could be mutually beneficial. It was therefore

decided to trial a Women in Science Day, hosted at a university by female academics to ascertain the impact this would have on girls' feelings about their likelihood of success and value (utility and intrinsic) of science. This involved low time and financial input and therefore if it was found to be successful, the model could be rolled out to many secondary school age girls across the UK.

Outreach programmes have previously been found to be successful in giving students a taste of university life and raising their aspirations (Scull & Cuthill, 2010). However, although universities run a range of outreach days, few are robustly evaluated. In fact, many only achieve evaluation of Kirkpatrick (1994) level 1 'reaction', where students rate satisfaction with the day. It is unsurprising that participants generally show a positive reaction to outreach interventions because they often include exciting and hands-on activities and are a break from the school routine. Data on student 'reaction' does not necessarily mean that the day has led to any real changes. It is therefore important to explore level 2, student 'learning' across the course of the day and whether this leads to changes in 'behaviour' (level 3). It is also important to include pre- and post-test questions rather than simply asking whether participants feel that the day has led to changes as due to demand characteristics, the majority of participants are likely to respond positively to these forms of questions.

Therefore, the aim of the current research was to rigorously evaluate whether participating in a Women in Science Day in a university setting would lead girls to feel more positive about their likelihood of success in science, value it more in terms of seeing it as useful and interesting and see it as possible area of further study or a career. Girls were given questionnaires at the beginning and end of the day to measure changes in their views of science from pre-intervention to post-intervention. It was hypothesised that participating in the day would lead students to view their likelihood of success more positively and see science as having higher utility and intrinsic value, i.e. being more useful and interesting at

the end of the day compared to the beginning. We also included a qualitative element to the study where we asked free response questions to girls to examine the research question 'What impact does attending a Women in Science Day have on girls?'

Method

Participants

Participants were 66 girls aged between 12 and 14 years; 48 were White British while others were from a variety of ethnic groups including ten South East Asian and three mixed race. Participants were recruited from four local schools who were invited to attend the University Outreach Women in Science Day. The schools were recruited due to the fact that they were geographically close to the university and included a large number of students from Widening Participation (WP) groups such as those from ethnic minorities and lower socioeconomic status (SES) groups. All the girls who attended the day were invited to participate in the study.

Materials

Participants completed the same questionnaire at the beginning and end of the day in order to examine changes over time. The questionnaire consisted of a number of scales, measuring the girls' expectations of success and the value of science which included questions on both the intrinsic and utility value of science. The questionnaire also included a free response section examining career choices and perceptions of science at the beginning and end of the day.

The first section used Likert scales to measure girls' perceptions of their expectation of success in science (e.g. "I think I am able to manage science classes"). It also measured their perceptions of the utility value of science, i.e. usefulness of science (e.g. "It is useful for my future to be good at science"). These questions were answered on a scale of 1-5 from

'Strongly Disagree' to 'Strongly Agree'. This measure was taken from Eccles and Wigfield (1995).

The next section measured girls' perceptions of the intrinsic value of science subjects, using an adjective rating scale. Students were presented with five, five-point scales from 1 which was linked to the negative adjective and 5 which was linked to the positive adjective (e.g. mundane to fascinating; means nothing to means a lot; unappealing to appealing; unexciting to exciting; boring to interesting). Girls were asked to choose one number to indicate how they felt about science for each pair. This measure was taken from The Science Techology Engineering and Mathematics (STEM) Semantics Survey (Tyler-Wood, Knezek, & Christensen, 2010).

The final section used free response to examine girls' reasons for wanting (or not wanting) to study science further and their career aspirations in order to gain a deeper understanding of their own reasoning behind their answers to earlier questions. Girls were asked open ended questions. Before the intervention, these were "What would you like to do when you leave school?" and "How likely are you to choose to study science further? And why?". After the intervention girls were asked "Has participating in the workshops today made you think about science differently? If so, how? If not, why not?", "Has participating in the workshops today made you consider studying science further and/or going into careers in science?".

Procedure

Before attending Women in Science Day, letters were sent home to guardians explaining the aims of the day and of the research project. Guardians were given the opportunity to opt out of the study on behalf of their daughter and it was made clear to them that this would not affect their daughter's participation in Women in Science Day. Once the participants arrived at the university they were welcomed into the main lecture theatre. The aims of the study

were explained to them and they completed an informed consent form. Again, it was made clear to them that whether they completed the questionnaire or not, they would still be able to fully participate in the Women in Science Day activities. They were told that if they did not want to participate they should leave the questionnaires blank. Students then worked through the paper and pencil questionnaires alone.

The students then attended four sessions about different fields of science including psychology (eye witness testimony), chemistry (polymer chemistry), biology (insects and parasites) and earth sciences (understanding environmental change). Each session ran for approximately forty minutes and was led by one or two female members of staff to act as ambassadors for women in science. At the end of the day, students again completed the same questionnaire with the appropriate free response questions. They were then fully debriefed and given the opportunity to ask questions before returning to school.

Results

Data preparation

Before data could be analysed, the means were calculated for each sub-scale on the questionnaire. Paired samples t-tests were then used to examine changes from Time 1 to Time 2. For means and standard deviations for these analyses, see Table 1.

Perceptions of science

Over the course of the day, girls' perceptions of their likelihood of success in science improved, $t(56)=-3.57$, $p=.001$. In terms of valuing science, for utility value, girls came to see science as more useful at the end of the day compared to the beginning, $t(62)=-2.15$, $p=.036$.

In terms of perceptions of the intrinsic value of science subjects, over the course of the day, the adjectives used to describe science subjects became significantly more positive. Using the combined measure illustrated that over the day girls found it, for example, less boring and mundane, and more interesting and exciting, $t(52)=-3.45$, $p=.001$. This suggests that Women in Science Day improved girls' perceptions of the intrinsic value of science.

INSERT TABLE 1 HERE

Free response questions

Due to the fact that most participants wrote only a sentence in answer to the free response questions, a light touch content analysis was performed to give a flavour of the common responses. A more detailed qualitative analysis would not have been appropriate due to the very small extracts. In addition, a number of participants did not answer all of the questions, which means that the dataset was incomplete. To begin, participants' responses were read a number of times until common clusters (categories) of similar answers became apparent. The number of times these clusters appeared was noted and is reported as a percentage, for clarity.

At Time 1 girls were asked about their career aspirations. These can be seen in Table 2.

INSERT TABLE 2 HERE

We also asked the girls why they had chosen their career. If girls had given two reasons then both were included. The vast majority stated that they had chosen a career because they thought they would enjoy it (47%), e.g. "I like English" and "I am a biology freak and also love the human anatomy" and "Because I really like drawing and it would be fun". The next

most common reason was that they wanted to help people (15%), e.g. “Due to personal reasons with children I want to help them in hospital with illnesses such as cancer” and “Because I would like to help people with their problems” and “Because I would love to help people”. Only 6% said that they would choose a career based on interest: “I find law interesting” and “Because it is interesting”. Only 3% chose careers for the pay: “You get a lot of money from it”. Other reasons (29%) included long holidays, feeling that they would be good at it and wanting to be like someone they admired: “Because I want to take after my mum”.

Interestingly, of the two girls who had chosen science careers, one did not give a reason for their choice, while the other said they had chosen science out of enjoyment: “I love geography and physics”. In contrast, of those who chose medical careers, 50% of those who gave a reason for their choice said that it was because they wanted to help others.

Girls were also asked about the likelihood of continuing to study science and the reasons behind this. 50% (33 girls) intended to study science and 23% (15 girls) definitely did not intend to, around 12% (8 girls) did not answer the question and 15% (10 girls) were undecided. Of those who intended to take science, 29% said this was because they would need it for their careers, e.g. “Because to become a nurse you need to study science”, 14% because it was enjoyable, e.g. “Because I enjoy it”, 8% because it was interesting, e.g. “Yes I think I will choose to study science further because I find especially biology really interesting”, 6% because it was useful, e.g. “Because it is good to have a knowledge of how stuff works” and “Yes because you don’t know when you will need science in your life” and only 5% said because they were good at it: “I am good at it”.

Of those who did not intend to take science 75% said this was because they would not need it for their job, e.g. “No because I won’t be needing science in the job I’m doing”, 19% because

they did not enjoy it, e.g. “I don’t think I will study science further because I don’t really enjoy it” and “No because it doesn't particularly appeal to me”. 6% said it was too hard or they were not good at it, e.g. “No because although I try hard in chemistry I didn’t improve and got a bad grade” and “No because I don't understand it”. Furthermore, of the students who were unsure, 50% stated that it depended on their future job choice: “I’m not sure as I don’t know what I want to do when I am older”.

When we combine data from all girls, regardless of their intention to take science, 55% stated that the reason for their decision was whether they would need it for their future career. Furthermore, 9% of participants stated that they would take (or not take) science because of their enjoyment and 8% for their interest of the subject. 8% of girls discussed the usefulness of science and 8% also discussed the difficulty of science. Therefore, the overwhelming reason behind most girls’ decisions about taking science was whether they would need it for their career.

At Time 2, girls were asked about whether the day had led them to think about science differently. In response, 24% of participants stated that they had not previously realised the variety involved in science, for example the breadth of subjects. This included comments such as “Yes, I thought science was just chemistry, biology and physics but it is more”. Similarly, 14% stated that they had underestimated the hands on and practical side of science. 6% stated that they had not realised how enjoyable science could be, they often stated that they enjoyed these hands-on and practical elements of science. Quotes included “It has made me think about science differently in a fun exciting way”, “I always thought that scientists do boring stuff but it turns out they do fun stuff like experiments” and “Yes because the practical work has been great and has inspired me”. Furthermore, 18% said it had been more interesting and important than they had previously thought, for example “Yes, they made me

see that science can be interesting" and "Yes because now I realise that it is interesting and important".

Finally, at Time 2, girls were asked whether participating in the day had led them to consider studying science further or choosing a career in science. Results suggested that 47% said that it had encouraged them to study science, 24% said that it had not and 9% were unsure with others not giving an answer. For the girls who had already decided on a science-based career path, the day did not really change their aspiration, but for some, it did confirm their interest in science. For example, girls said things like "Yes it made me have a look at what science is like in uni and how it is different" and "Yes it would be exciting to learn more things in science and do experiments". For those who had already decided on a non-science career path, and who felt they did not need science for their future plans, participating in Women in Science Day did not change their aspirations or encourage them to study sciences at a higher level. These girls gave answers such as "No, I do enjoy it but it isn't really needed in my career choice" and "No I want to work in law".

However, for the girls who were undecided on a career path, the day changed the way they thought about science. Of the 5 girls who answered the questions, all agreed that it had encouraged them to think about science more positively, for example "Yes because I found it interesting and fun to participate". However, while 2 agreed that they might consider studying science further, 1 was unsure and 2 others did not intend to study science further even though they felt positive about it.

Discussion

Results suggested that, in line with our hypothesis, participating in Women in Science Day led the girls to feel more positive about their likelihood of success in science. They also came to view science as more useful and enjoyable.

The intervention aimed to increase girls' perceptions that they were likely to succeed in science and was successful in this. By the end of the day, quantitative measures suggested that girls felt more confident that they could succeed in science classes. This may have been due to seeing female models. However, girls did not mention this explicitly in their free responses. This is interesting as it suggests that the day had a more implicit impact on girls' perceptions of their likely success, but not one which they would necessarily explicitly notice and comment on. This may be because in the course of only a single day, girls may not have been likely to learn much new content, but perhaps seeing other women who were successful in science may have led them to believe that they too could succeed (Zeldin et al., 2008; Zeldin & Pajares, 2000). This suggests that girls' perceptions of their likelihood of success can be influenced in even a short intervention using female models. This in turn should encourage girls to persist in science (Vidal Rodeiro, 2007).

Over the course of the day, girls also came to see science as more interesting and enjoyable, i.e. as having higher intrinsic value. Qualitative data suggested that this was due to the variety of topics covered and the hands-on activities they participated in. Therefore, it would be advisable for future interventions to ensure that activities are varied and that participants are actively engaged in activities. This higher level of interest and enjoyment is likely to encourage girls to persist and perform better in science subjects (Spinath, Spinath, Harlaar & Plomin, 2006).

The current intervention also aimed to increase girls' perceptions of the utility value of science to encourage girls to persist in science (Hulleman & Harackiewicz, 2009). This was done implicitly during the intervention as girls experienced a variety of science subjects and participated in hands-on experiments focussed on real world applications. This may have led them to see science as more useful.

Therefore, data illustrates that Women in Science Day had a positive impact on likelihood of success, utility and intrinsic value of science which should in turn encourage girls to persist in science. However, qualitative analyses revealed that at Time 1 the main reason girls gave for taking or not taking science was whether they 'needed' it for their career, i.e. they focussed on utility value for their career. Interest and enjoyment did have some bearing on decisions, particularly when girls were unsure of their career path, but very few girls mentioned likelihood of success as being important in their decision. Thus, although each of these variables has previously been found to encourage girls to persist in science, within this sample, utility value was the most powerful influence. This may be explained because girls wrote very little in answer to the free response questions, usually only giving one answer. It may have been that likelihood of success and intrinsic value were secondary concerns for them.

Therefore, future interventions could focus on utility value of science for careers, for example by including discussion of the relevance of science to other careers. This may allow girls to see science as broadly relevant and that further study of science does not constrain them to a career in the field. However, it does give them the option to consider science in future while other GCSE choices do not. Furthermore, while the current intervention implicitly focussed on utility value, in this case meaning how science can have real world applications, future interventions could also explicitly promote the utility value of science in solving global problems. Many girls are interested in environmental issues and concerned about helping people (Haste, 2004; Schreiner & Sjoberg, 2007). Thus, girls often choose careers because they wish to 'help' and we also found this in the current study. Promoting science as being 'helpful' on a global level may increase its utility value to girls and this may in turn further encourage girls to consider science. In addition to promoting utility value, particularly when working with those who have not decided on a career path, it may also be advisable to also

focus on trying to increase girls' interest and enjoyment of science as well as their perception of their likely success to ensure the broadest impact.

Referring to Eccles' (1983, 1994) expectancy-value model of achievement-related choices, it should follow that because this intervention leads to positive changes in girls' perceptions of their likelihood of success and their perceptions of the intrinsic and utility value of science subjects they should in turn be more likely to choose them for future study. However, while the day did encourage some of those who were undecided on a career path to consider taking science subjects, the results indicated that the intervention did not change the aspirations of the girls who already had an idea about what they wanted to do. This is a similar finding to that of Archer, DeWitt and Dillon (2014) who evaluated a six-week science careers intervention for year nine girls at a London grammar school. They also found that although the intervention widened the girls' understandings of what sciences are useful for, their aspirations were resistant to change. This suggests that interventions would be more effective at encouraging girls to study and work in science if done at an earlier stage in the students' education, perhaps at primary school or early in secondary school. Indeed, in a study by The Royal Society (2006), 28% of respondents began to think of careers in science before the age of 11 and a further 35% between 12 and 14. Furthermore, there is some evidence that science learning self-efficacy decreases with age (Diseth, Meland, & Breidablik, 2014; Güngören & Sungur, 2009; Wang & Tsai, 2016) thus highlighting the importance of working with younger participants to try and prevent this dip in science self-efficacy. It is also important to consider that in the UK students choose their GCSE options at age 13-14. Thus, interventions should be in place before this because a GCSE in a given subject is often a prerequisite to take an A-level and in turn, a degree.

It is possible that even if the intervention does not encourage these girls to study or work in science, perhaps in the future they will pass on their positive perceptions to other girls.

Tyler-Wood, Ellison, Lim and Periathiruvadi (2012) found that eight years after the conclusion of *BUGS* (*Bringing Up Girls in Science*, an afterschool programme in the US for 4th and 5th grade girls), participants maintained significantly more positive perceptions of science in comparison to the control group; this effect was even found for those who did not pursue science careers. Although *BUGS* was a long-term project and so is likely to have had a greater impact on participants than the current intervention, perhaps even a brief exposure to applications of science can encourage lasting positive perceptions. They may pass these on to peers and over time this may change the overarching perceptions of women's involvement in science.

This paper therefore provides preliminary evidence that short-term interventions which are neither time nor resource intensive may be able to encourage girls in science. As previously discussed, a number of existing interventions are summer programmes which involve girls participating in a number of sessions over a long period of time. However, results from this study illustrate that changes may be observed from a shorter intervention which is easier to deliver to a larger number of girls.

The day highlighted the importance of rigorously evaluating interventions. While this study illustrates that the intervention led to changes in attitudes and behavioural intentions it only measured changes in the short term. To establish whether the positive effects of increased perceptions of likelihood of success in science and value of science were not transient and actually led to behavioural change, it would be beneficial to follow the girls through the rest of their education. Surveying them during GCSE subject selection and also when they complete school, asking whether they intend to go on to university to study science, would reveal whether their intentions were followed through.

Furthermore, while this study rigorously evaluates the short-term impact of the intervention, it cannot pinpoint exactly what about the day led to the positive changes. For example, girls worked on hands-on experiments, focussed on real world problems and were led by female academics in a university setting. Therefore, it is impossible to ascertain which specific elements, or combination thereof, have led to the positive outcomes. It is likely that all elements have had some positive impact but future research could examine which individual elements have been most successful. This would allow future interventions to include the most important elements in a cost and time effective way.

In conclusion, the current intervention appears to have been successful in enhancing girls' perceptions of their abilities in science and the utility and intrinsic value of science. This led girls to say that they were more likely to consider taking science, but only if they did not have a clear idea of what they would like to do for their future careers. This suggests that short-term interventions like this could be a useful way of encouraging girls into science. Results also suggest potential benefits of focussing on the utility value of science in interventions. However, the current results also suggest that interventions such as these should be trialled with girls at a younger age before they have firm career plans.

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Table 1: Means and standard deviations of perceptions of science at Time 1 and Time 2

	Time 1		Time 2	
	Mean	SD	Mean	SD
Likelihood of success*	3.83	.48	4.05	.59
Utility value*	3.84	.80	3.98	.72
Intrinsic value*	3.69	.85	4.01	.83

*indicates significant change from Time 1 to Time 2

Table 2: Girls' career aspirations, reported as percentages.

Career	Percentage	Examples
Scientific career	3	forensic scientist, geographical scientist
Medical career	24	doctor, nurse, surgeon
Teaching	17	teacher, German teacher
Beauty and fashion	9	hairdresser, fashion designer
Veterinary profession	5	vet, veterinary nurse
Social work	5	Social worker
Varied	22	accountant, law, police, sports
Did not know	9	
Did not answer	6	