

How neuroscience is affecting education: Report of teacher and parent surveys

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Summary

This report presents data from a series of surveys that explored how neuroscience is affecting education and learning. A range of online approaches were used to survey teachers and parents to establish which educational interventions they use (or have come across) that they think are based upon neuroscience. The surveys were not intended to be fully representative of these groups, but the responses illustrate the considerable interest in this area.

More than nine out of ten teacher respondents say their understanding of neuroscience influences their practice, and more than eight out of ten say they would collaborate with neuroscientists doing research in education. Unfortunately, many teachers use or have used unproven techniques, such as Brain Gym®. Most teachers say that the interventions they use or have used have had some impact on academic performance but that it was difficult to measure. In general, teachers learn about interventions from schools and other teachers, rather than from scientific or academic sources, but they express a desire for new interventions to be supported by evidence.

Parents also seek to improve their children's learning: just over half of respondents had used specific products or activities to boost their children's performance, and many had bought commercial products aiming to achieve this. Parents typically find out about these activities or products by searching online, through the media or through friends.

We conclude that teachers' desire to implement interventions based upon neuroscience is evident, but it is running ahead of the evidence base. There is thus an urgent need to improve this evidence base and to support teachers in developing both their understanding of neuroscience and their ability to judge the evidence for these and other educational interventions. The Wellcome Trust is now working in partnership with the Education Endowment Foundation with the aim of creating a better understanding and application of neuroscience in education.

Background

Neuroscience is continually furthering our understanding of the mechanisms of learning, and we are interested in how this knowledge could be applied to improve education. In other areas, neuroscience findings have been more effectively translated (e.g. in developing novel rehabilitation techniques), but the transition from laboratory to classroom seems more challenging. Nevertheless, many neuroscientists emphasise the potential of their research to improve education, although they rarely have the impetus or educational or methodological expertise to translate their findings into practical education interventions. Likewise, many educators are interested in how neuroscience might advance their practice, but few are equipped to judge the best approaches to take.

The aims of the Wellcome Trust's Education and Learning Strategy 2010–20 include 'to explore how neuroscience is being used to inform teaching and learning', 'to evaluate the strength of the evidence' and, where possible, 'to develop further investigations into how neuroscience can improve the quality of education'.¹ To further the first of these aims, we conducted surveys of teachers and parents from April to June 2013. The surveys were not intended to be representative of each of these groups but were designed to indicate the sorts of ideas that claim to be based on neuroscience that are being applied in education, how they are selected and evaluated, and the appetite for further interventions based upon neuroscience.

Methodology

The Wellcome Trust used a range of online approaches to survey teachers and parents (with children of all ages), as described below. These surveys were intended to establish which educational interventions respondents use (or have come across) that they think (or have been told) are based upon neuroscience. The surveys also explored teachers' attitudes to neuroscience and its potential to improve education and their interest in collaborating with neuroscientists.

¹ Wellcome Trust Education Strategy 2010–2020: Inspiring science education: extraordinary opportunities (www.wellcome.ac.uk/Education-resources/Education-and-learning/Our-work/index.htm).

We conducted two online surveys directly through the Wellcome Trust website: one aimed at teachers and one aimed at parents. The surveys were shared through emails to the teachers on the Trust's database of contacts, an article on the Trust's blog and the Trust's Twitter profile, and they were also mentioned on BBC Radio 4's *All in the Mind*. All teachers were invited to respond, from a range of school types, key stages and subject specialisms. A separate teacher survey was commissioned by the Wellcome Trust through Schoolzone, an online community with a profiled database of more than 95 000 teachers.² Mumsnet, the UK's biggest network for parents (which generates more than 50 million page views and 9 million visits per month), was also used to survey views from parents.³

In this report, we present responses from the UK, as outlined below. (A further 56 teachers and 35 parents responded from overseas.) In addition, a small number of students of all ages – 57 from the UK and nine from overseas – responded to a survey. Some details from the student survey are included in the appendix, but student responses are not included in the report itself, owing to the small numbers involved (only 28, half of the student respondents, indicated that they do particular activities to try to improve their academic performance).

This report presents data from UK respondents to the following surveys:

- Wellcome Trust teacher survey (292 responses, open 30 April 2013 to 14 June 2013)
- Schoolzone teacher survey (908 responses, open for a 24-hour period on 13 May 2013)⁴
- Wellcome Trust parent survey (109 responses, open 30 April 2013 to 14 June 2013)
- Mumsnet parent survey (100 posts from 86 respondents, open 5 June 2013 to 19 June 2013).⁵

In general, the same questions were asked in both teacher surveys. Total responses across the two surveys are reported together, unless otherwise indicated. To analyse free-response questions, categories were used to allow the responses to be quantified; coding was conducted by an independent data-processing company. Not all respondents answered all questions, so results are based on the number of respondents answering each question.

It is important to bear in mind that the survey results are unlikely to be representative of all teachers and parents – it might be expected that people who are more interested in neuroscience would be more likely to respond. Indeed, as detailed in the sections below, survey respondents are considerably more likely to say that they are interested in the brain than the general population (as sampled by the Wellcome Trust Monitor, a survey with a population representative sample), although it may also be that teachers and parents are more interested in neuroscience than other adults.⁶

In the following sections, we highlight the most frequent or relevant responses. The results are presented in more detail in the Appendix, and further data are available from the Wellcome Trust on request. Table references including 'A' indicate that the table is to be found in the Appendix.

Main findings from the teacher surveys

As described in more detail below, the teacher surveys revealed a keen interest in linking neuroscience and education. Teachers demonstrated how much their understanding of neuroscience is already affecting their practice and the extent to which they would like this to develop in future. The surveys also revealed how teachers choose which interventions to use. There were examples of teachers using certain approaches (e.g. Brain Gym® and Learning Styles) for different purposes or in ways for which they were not originally developed or conceived.

² www.schoolzone.co.uk

³ www.mumsnet.com

⁴ Each teacher who submitted a valid response via Schoolzone was paid £2 and was entered into the monthly cash prize draw, which is usually for around £1000.

⁵ Each respondent in the Mumsnet discussion forum was entered into a prize draw for a £50 Amazon voucher.

⁶ Wellcome Trust Monitor Report, Wave 2: Tracking public views on science, research and science education, May 2013 (www.wellcome.ac.uk/monitor).

Although only 25 per cent of teachers report having a good or fair amount of knowledge about neuroscience, the responses demonstrate that there is a high level of interest in neuroscience in our respondents compared to a population representative sample of adults surveyed in 2012 in the Wellcome Trust Monitor.⁶ The majority (82 per cent) of teachers responding to our surveys say that they are interested in how the brain works, compared with 45 per cent of adults in the Wellcome Trust Monitor. Likewise, 91 per cent of teachers responding to our surveys say that they are interested in mental health issues, compared with 48 per cent of adults in the Monitor. Our teacher surveys also asked whether respondents had looked up any information on the brain in the past four weeks: 54 per cent had, 71 per cent of whom had researched general aspects of neuroscience and 29 per cent of whom had looked at education-specific aspects, such as resources for students or information related to learning.

Which activities or techniques linked to neuroscience are currently used?

The Wellcome Trust survey asked teachers in a free response question to name specific activities or techniques they use because they think they will improve academic performance, based on their understanding of neuroscience. Twenty-eight per cent mentioned that they use a variety of learning styles and teaching methods (see Table A8 in the Appendix). Other specific examples volunteered by many respondents include memory techniques, such as mnemonics or repetition (8 per cent), and mindmaps (5 per cent). Only 3 per cent mentioned Brain Gym[®] and 2 per cent mentioned teaching students about neuroscience. These teachers were then asked to indicate whether they had used particular approaches named in a list, in addition to their previous responses, yielding a much higher level of reporting: 74 per cent for learning styles, 31 per cent for Brain Gym[®], 15 per cent for the left/right brain distinction and 3 per cent for biofeedback.

The Schoolzone survey asked for more detail about whether teachers had heard of, use, or had previously used specific approaches from a list (without the free response question). Overall, the Schoolzone survey yielded a higher level of reporting. This may have been because the question eliciting reporting was more detailed; in addition, this survey drew upon a wider range of views, with three times as many respondents. The Schoolzone survey asked where teachers had heard of the approaches they had identified, and both surveys asked what impact teachers thought these approaches had on students' academic performance and whether they had received any support from someone outside their institution (e.g. a teacher from a different institution or an external mentor) when using the activities or techniques.

Data on four techniques are presented in Table 1, illustrating a range of familiarity and use, and they are considered individually in the sections that follow. Overall, most teachers came across these techniques through their school or other teachers; the techniques are sometimes discovered through trainers, educational media and conferences, but rarely through academic or scientific literature. Around a quarter of respondents say that learning styles had a significant impact on pupils, and around 10 per cent report that using the left/right brain distinction has a significant impact. More than two-fifths say that the latter two approaches have some impact, which was difficult to measure, and just over half say this about learning styles. Most of the time (in three out of four cases), implementation does not receive external support.

Table 1. Teacher responses on whether they have heard of or used different approaches received (both Schoolzone and Wellcome Trust surveys) and where they came across the information (Schoolzone survey), as well as what impact they thought they had and the support they receive (both Schoolzone and Wellcome Trust surveys).

Which of the following methods or techniques have you heard of or used to improve students' academic performance?				
	Learning styles	Brain Gym®	Left/right brain	Biofeedback
Haven't heard of	1% (8)	7% (59)	11% (103)	67% (606)
Heard of but not used	7% (59)	38% (342)	54% (485)	31% (274)
Used to use	16% (148)	39% (354)	16% (142)	1% (5)
Currently use	76% (687)	16% (149)	18% (162)	1% (13)
Planning to start using	0% (3)	0% (2)	1% (8)	0% (0)
Total respondents (<i>Schoolzone</i>)	906	905	900	898
Where did you come across these methods or techniques?				
	Learning styles	Brain Gym®	Left/right brain	Biofeedback
Through my institution	68% (484)	53% (227)	39% (90)	9% (1)
From other teachers	47% (335)	41% (175)	27% (63)	18% (2)
Through an external training provider	38% (271)	30% (129)	32% (74)	27% (3)
Educational media	26% (186)	17% (71)	24% (56)	9% (1)
Conferences	19% (136)	9% (37)	16% (38)	0
In an academic journal	8% (58)	5% (23)	14% (32)	18% (2)
Other	8% (58)	3% (13)	3% (7)	9% (1)
The public media	5% (34)	3% (14)	4% (10)	9% (1)
Commercial products	3% (19)	2% (9)	3% (8)	0
In a popular science magazine	2% (17)	3% (11)	4% (9)	18% (2)
Can't remember	2% (17)	3% (11)	6% (14)	0
In a scientific journal	1% (9)	1% (4)	6% (13)	18% (2)
Total respondents (<i>Schoolzone</i>)	716	429	234	11
What impact has it had on students' academic performance?				
	Learning styles	Brain Gym®	Left/right brain	Biofeedback
A significant impact	26% (209)	4% (20)	9% (21)	13% (2)
Some impact but difficult to measure	51% (413)	43% (202)	45% (110)	33% (5)
Not sure	14% (113)	28% (13)	35% (86)	33% (5)
No impact on academic performance but other benefits noted	6% (49)	18% (86)	5% (11)	0
No discernible impact	2% (20)	6% (29)	6% (15)	20% (3)
Total respondents (<i>both surveys</i>)	804	435	240	15
Did you receive any support from someone outside your institution when using any of these methods?				
	Learning styles	Brain Gym®	Left/right brain	Biofeedback
Yes	24% (177)	23% (101)	17% (41)	14% (2)
No	76% (561)	77% (334)	83% (200)	86% (12)
Total respondents (<i>both surveys</i>)	738	435	241	14

Learning styles

'Learning styles' conveys the idea that different students learn best when materials are presented in a particular format, traditionally one of three: visual, auditory or kinaesthetic. In the past, this had led to learners being labelled as, say, 'visual learners' and having content delivered primarily visually. There is little evidence to support this form of intervention and some evidence suggesting it might be detrimental.^{7,8} A large majority (76 per cent) of teachers surveyed currently use learning styles, while 16 per cent of teachers used to use learning styles, 7 per cent had heard of it but not used it and 11 per cent had not heard of it. The majority of teachers who explained how they use or have used learning styles (61 per cent) referred to using more than just the three traditional approaches – this is different from how this approach was originally conceived and may be of some benefit, by offering variety and increased motivation from the ability to make choices.⁹ Teachers responding to the *Schoolzone* survey were also asked how they applied the idea of learning styles: 25 per cent built it into lesson planning, 14 per cent used it to try to reach all learners and benefit all types of students, 14 per cent used it in all or most lessons, 11 per cent discussed it with the students for them to decide their best style, and 6 per cent used a questionnaire or assessment to find students' learning styles (see Table A15 in the appendix).

Brain Gym®

Brain Gym® is an exercise programme defined as "a series of specifically conceived movements that addresses the physical skills of learning (for example: visual, auditory)".¹⁰ Many schools have purchased the programme, which is based upon the claim that "moving with intention leads to optimal learning".¹¹ There is no neuroscientific basis for this claim, and its effect on academic performance remains to be systematically tested.^{12,13,14} The website explains that it is based on "empirical experience rather than neurological research"¹⁵ and "the primary evidence comes from the countless anecdotal stories reported to us since 1986".¹⁵ No peer-reviewed study has found that using Brain Gym® leads to improved general academic performance. A 2007 review paper identified only five peer-reviewed studies that had investigated the effectiveness of Brain Gym®, and all five were judged to contain "serious methodological flaws".¹³ This judgement was confirmed in a more recent review paper.¹⁴ Nevertheless, our survey found that 39 per cent of teachers used to use Brain Gym®, and 16 per cent continue to do so; 38 per cent of teachers have heard of Brain Gym® but not used it, and 7 per cent have not heard of it.

Brain Gym® was mostly used as a starter or warm-up (48 per cent), or during lessons to refocus or re-energise students (45 per cent) (Table A16). This seems to suggest that teachers use it as a way of keeping students active and alert, rather than because of its intended use (e.g. by massaging "Brain Buttons" on the body to activate specific areas of the brain to enhance learning).

Left/right brain distinction

The left/right brain distinction is related to learning styles. It suggests that different tasks can depend upon different hemispheres, or sides, of the brain; according to the theory, students can be identified as favouring one hemisphere and would benefit from tasks adapted to capitalise on this or tasks to develop the other side. This notion suggests that people who are logical and analytical are left-brain dominant, whereas creative and artistic people are right-brain dominant. The increased use of one hemisphere over another for particular tasks – known as lateralisation – does exist: in most right-handed people, for example, language recruits the left hemisphere more than the right. However, this does not mean that the right hemisphere is not used, nor does it mean that the left hemisphere is dominant in every cognitive function. Neuroimaging has not provided support for claims that personality and cognitive function are based on hemispherical

⁷ Kratzig GP, Arbuthnott KD. Perceptual learning style and learning proficiency: a test of the hypothesis. *J Ed Psych* 2006;98:238-46.

⁸ Geake J. Neuromythologies in education. *Ed Res* 2008;50:123-33.

⁹ Patal EA et al. The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psych Bull* 2008;134:270-300, doi:10.1037/0033-2909.134.2.270.

¹⁰ Edu-K Style Guide, 2011 (www.braingym.org/brochures/Edu-K%20Style%20Guide%202011.pdf)

¹¹ www.braingym.org/about

¹² Sense about Science has collated more information of the marketing of Brain Gym in their publication *Sense about Brain Gym* (www.senseaboutscience.org/resources.php/55/sense-about-brain-gym).

¹³ Hyatt KJ. Brain Gym® Building Stronger Brains or Wishful Thinking? *Remedial and Special Education* 2007;28:117-24.

¹⁴ Spaulding LS et al. Is Brain Gym an Effective Educational Intervention? *Exceptionality* 2010;18:18-30.

¹⁵ www.braingym.org/faq

dominance, and a recent study based on more than 1000 participants demonstrated that participants used both hemispheres equally throughout the experiment.¹⁶

In our survey, just over half of teachers (54 per cent) had heard of this distinction but not used it, 18 per cent currently use it, 16 per cent used to use it, 11 per cent hadn't heard of it and 1 per cent were planning to use it. More specifically, in terms of implementation: 15 per cent of teachers mentioned certain activities they had used that draw upon these ideas, without mentioning a specific type of activity to target a particular side; 11 per cent mentioned activities that are designed to use both sides (e.g. including logic and creativity or words and pictures); 9 per cent adapted the idea to include variety in teaching and learning; 8 per cent used tasks as a starter or warm-up exercise; and 7 per cent allowed students to think or work in the style that uses their favoured side of the brain (Table A17). Nine teachers (4 per cent) reported that they had assessed pupils to find out which side they favour.

Biofeedback

We asked teachers about biofeedback, a relatively new approach in which students are given real-time feedback on their own physiological states, such as heart rate or brainwaves.¹⁷ It is proposed that by monitoring their brain activity through the use of neurofeedback, students are able to train their brains to produce specific patterns of activity that are optimal for learning.¹⁸ There is an interesting neuroscience basis to this approach and some studies on its effect on learning are emerging, but it has yet to be properly tested for its educational value.^{19,20} Most teachers have not heard of biofeedback (68 per cent); a further 31 per cent have heard of it but not used it, just 1 per cent currently use it, and 1 per cent used to use it.

Using neuroscience to inform teaching practice

Teachers were asked which aspects of teaching were informed by their understanding of neuroscience (Table 2): 75 per cent had used it to inform classroom practice, 65 per cent for lesson planning, 57 per cent for provision for special needs, 39 per cent for student lifestyle (e.g. specific foods, hydration and sleep), 34 per cent for curriculum content, 24 per cent as early screening for learning problems, and 19 per cent for the general structure of the school (e.g. hours and physical environment).

Table 2. Using neuroscience to inform education

Which of the following, if any, have you used your knowledge about how the brain works to inform? (1073 respondents)	
	Percentage of all responses (<i>n</i>)
Lesson planning	65% (699)
Classroom practice	75% (808)
Provision for special needs	57% (612)
Early screening for learning problems	24% (253)
Curriculum content	34% (362)
General structure of the school	19% (209)
Student lifestyle	39% (418)
Other	4% (42)

Most teachers (60 per cent) said that they knew “just a little” about neuroscience, with a quarter saying they knew more than this. In general, 91 per cent of teachers have used their knowledge of neuroscience to inform at least one aspect of teaching and learning. This percentage was similar for teachers who reported any level of knowledge of neuroscience: 95 per cent (*n* = 28) of teachers who knew a great deal about neuroscience had used the knowledge to inform at least one aspect of teaching and learning, compared with 98 per cent (*n* = 250) of those who knew a fair amount and 93 per cent (*n* = 648) of those who knew just a

¹⁶ Nielsen JA et al. An evaluation of the left-brain vs. right-brain hypothesis with resting state functional connectivity magnetic resonance imaging. *PLoS One* 2013, DOI: 10.1371/journal.pone.0071275.

¹⁷ Gruzeliier JH (2013). EEG-neurofeedback for optimising performance. I: A review of cognitive and affective outcome in healthy participants. *Neurosci Biobehavioral Rev* 2013, doi: 10.1016/j.neubiorev.2013.09.015.

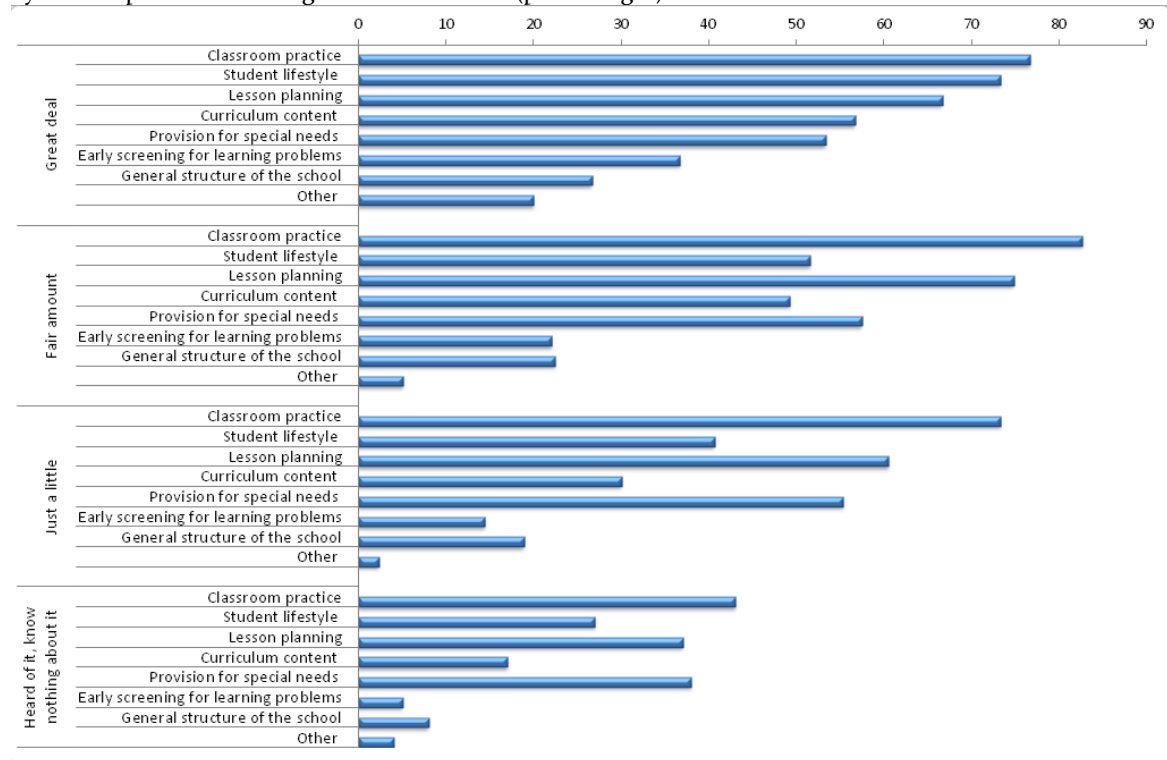
¹⁸ Enriquez-Geppert S et al. Modulation of frontal-midline theta by neurofeedback. *Biol Psych* 2013, doi: 10.1016/j.biopsycho.2013.02.019.

¹⁹ Meisel V et al. Neurofeedback and standard pharmacological intervention in ADHD: a randomized controlled trial with six-month follow up. *Biol Psych* 2013;94:12-21.

²⁰ Howard-Jones P. *Neuroscience and Educational Intervention*, Education Endowment Foundation (November, 2013).

little. Interestingly, 74 per cent ($n = 124$) of teachers who say that they have heard of neuroscience but know nothing about it say that they have still used it to inform at least one aspect of teaching and learning. This suggests that these teachers rely on what they are told by others and highlights the need to support teachers' knowledge. As one respondent commented: "Teachers love practical classroom-based strategies which are easy to implement, but quite often they use them simply because they have been told they work. My experience is that teachers often employ the strategies but do not check their validity or scientific basis." Figure 1 presents these data in more detail, showing which aspects of teachers' practice they report as having been informed by their knowledge of neuroscience, shown by their reported level of knowledge.

Figure 1. Teachers' reported use of their knowledge of how the brain works to inform their practice, shown by their reported knowledge of neuroscience (percentages).



Trying out new activities

When asked what would encourage them to try out a new activity or technique linked to neuroscience, teachers most frequently say evidence from research (52 per cent) and training (12 per cent), as illustrated in Figure 2. The value placed on evidence is particularly interesting given that teachers also say that they find out about interventions most often from their school and other teachers, rather than academic and scientific literature (Table 1). This is considered further in the Discussion. One respondent clearly summed up what seemed to be common opinions by saying, "Two things would encourage: 1. Does it work in practice? 2. Is it easy to implement?" The teachers we surveyed were also critical of "advertising hype and propaganda" and "pseudoscience promoted by those who simply wish to sell a technique or idea". When asked what would deter teachers from trying out a new activity or technique, the most frequent responses are a lack of time, the activity being too time-consuming, bureaucratic or complex (31 per cent) and a lack of evidence (22 per cent), as illustrated in Figure 3.

neuroscientists doing research in education, perhaps in the form of trying new learning resources and approaches with students or allowing the researchers to observe lessons. We received many extremely enthusiastic responses; as one said, “How else will we find out what works?”

Factors that would encourage teachers to collaborate with neuroscientists doing research in education are a reduction in teaching hours to allow time for the collaboration (41 per cent), being introduced to someone with expertise in neuroscience who would explain the research clearly (28 per cent), and being able to use the experience to apply for a Teaching and Learning Responsibility Allowance (10 per cent).

Should neuroscience be included in teacher training?

The majority of respondents (77 per cent) say that knowledge of how the brain works should be included in both initial teacher training and ongoing professional development. The need for adequate training was highlighted by one respondent, who commented: “I am really concerned that the value that neuroscience can bring to education will be lost if it is applied inappropriately by people who really don’t have sufficient understanding of the science.”

Main findings from the Mumsnet discussion thread

In this discussion thread, we introduced our interest in exploring how the latest developments in neuroscience (explained as the science of how our brains work) can help improve how children learn, at home or in the classroom. Respondents were then asked to post about any activities, products or techniques they may have come across that are aimed at boosting their child’s learning. We gave examples such as games designed to affect how the brain learns, or products and techniques that might be used to make changes to a child’s diet or lifestyle. We also asked if parents had tried anything themselves to improve or enhance their child’s learning, what influenced their decision to try it and how effective they thought it had been.

There were 86 respondents to our discussion thread and 499 mentions of activities that had been used to improve learning. The majority of activities mentioned were not linked directly to neuroscience but to learning and development more generally, such as engaging children in conversation and allowing them to explore their own interests. About a quarter (23 per cent) of respondents said they had used commercial packages (e.g. Baby Einstein DVDs²³) to boost their child’s learning, and 65 per cent of those reported a positive effect on learning. About a sixth of parents (16 per cent) used educational toys such as Lamaze²⁴, and 43 per cent of those reported a positive effect. A few parents (13 per cent) mentioned the importance of understanding brain development and knowing what children do at which stages, and most of those parents reported that their increased knowledge had a positive effect on their child’s learning. Table A24 presents the most frequently mentioned approaches and their perceived impact.

Main findings from the parent survey

The parents who responded to our survey had a distribution of children ranging in age up to and over 18 (Table A25). As in the teacher survey, respondents are more interested in neuroscience than the general population is, as described in the Wellcome Trust Monitor survey.²⁵ Almost all (97 per cent) are interested in how the brain works, and most (89 per cent) say they are interested in mental health issues. In the past four weeks, 57 per cent of parents had looked up information on the brain, which reflected a broad interest in neuroscience. There were two examples of parents researching specific disorders that their child might have and one example of looking up information to help with their children’s homework, and all other examples were parents finding out about the brain for their own interest.

Parents were asked whether they had ever used any specific activities or products that are intended to boost their child’s academic performance; 53 per cent said they had. Just under a third (27 per cent) had used commercial products, and 53 per cent of those thought the commercial products had improved academic performance. The same amount of respondents (27 per cent) had used vitamins or supplements, of whom

²³ www.babyeinstein.com/home/

²⁴ www.lamazetoy.com/

²⁵ Wellcome Trust Monitor Report, Wave 2: Tracking public views on science, research and science education, May 2013. www.wellcome.ac.uk/monitor

7 per cent said they had improved academic performance. When asked where they had found out about these activities or products, 41 per cent of parents had done so by searching online, 34 per cent had done so through the public media, 29 per cent had taken recommendations from a friend, and 14 per cent had done so through the child's school.

Discussion

These surveys were carried out to assess how neuroscience is being used in educational settings. The surveys were not meant to be representative, and it is clear that respondents were more interested in neuroscience than the population in general is. Nevertheless, it is worth noting that neuroscience is an area of wide interest among teachers and parents – the Mumsnet discussion thread had three times the average number of views and an above-average dwell time. Schoolzone typically receives 600 to 1100 responses within 48 hours, and our survey received 908 responses in less than 24 hours.

The teachers responding to our surveys display a wide knowledge and use of interventions that they believe to be based upon neuroscience. They show great optimism in the benefits that neuroscience could bring to education, an appetite to engage in furthering research in this area and a wish for more neuroscience to be delivered in their training and professional development.

Unfortunately, teachers' desire to implement interventions based upon neuroscience is running ahead of the evidence base. There are few, if any, interventions that have been developed from insights from neuroscience and have been systematically proven to have academic impact in classroom settings.^{26,27,28,29} It may therefore be unsurprising that teachers have learned about the interventions they implement not from scientific or academic sources but from schools, other teachers, trainers and the media. Our survey of parents also revealed a great appetite for and use of interventions that will improve their children's performances and indicated that the parents found out about the options predominantly from searching online, through friends and through the media, as well as through schools.

It is notable that teachers thought that evidence and research would be the most important factors in encouraging them to adopt a new intervention. Interestingly, few teachers said they had much evidence of significant impact of the interventions they were using or had used on academic performance in the classroom; most believed that there was impact but that it was difficult to measure. Teachers might be willing to accept unproven advice (either from other teachers or from marketing) or they might be aware that some of these techniques do not have robust evidence behind them, but because of an overall shortage of evidence about neuroscience-based interventions in general, they are simply proceeding without.

We conclude that there is a need to improve the evidence base on neuroscience-based educational interventions and a need to support teachers in developing their understanding of neuroscience and their ability to judge the evidence base for any educational intervention. Although it is not without its challenges, the implications of applying neuroscientific insights to education have previously been reviewed, identifying potential benefits.^{30,31,32,33,34} There is also a growing movement towards educational practice becoming more evidence informed, both from the grassroots up (as seen by the teacher-led conference on this issue in September 2013³⁵) and at the policy level. The Department for Education recently published a paper advocating use of a more rigorous evidence base for educational practice, and the same department founded the Education Endowment Foundation in 2011, charged with improving and better disseminating

²⁶ Howard-Jones, P. *Neuroscience and Educational Intervention*, Education Endowment Foundation (November, 2013).

²⁷ *Brain Waves 2: Neuroscience: implications for education and lifelong learning*, Royal Society (February, 2011).

²⁸ Bruer, JT. Education and the brain: a bridge too far. *Ed Res* 1997;26:4–16.

²⁹ Varma S et al. Scientific and pragmatic challenges for bridging education and neuroscience. *Ed Res* 2008; 37:140–52.

³⁰ Willingham DT. Three problems in the marriage of neuroscience and education. *Cortex* 2009;45(4):544–5. doi:10.1016/j.cortex.2008.05.009

³¹ Byrnes JP, Fox NA. The educational relevance of research in cognitive neuroscience. *Ed Psych Rev* 1998;10:297–342.

³² Blakemore SJ, Frith U. (2000). *Report on the implications of recent developments in neuroscience for research on teaching and learning*, a consultation paper commissioned by the Teaching and Learning Research Programme, ESRC.

³³ Geake JG, Cooper PW. Implications of cognitive neuroscience for education. *Westminster Studies Ed*, 2003;26:7–20.

³⁴ Goswami U. Neuroscience and education: from research to practice? *Nat Rev Neurosci* 2006;7:406–13.

³⁵ ResearchEd (www.researched2013.co.uk).

the evidence base for education.^{36,37} The Wellcome Trust is now working in partnership with the Education Endowment Foundation with the aim of creating a better understanding and application of neuroscience in education.

³⁶ Building Evidence in Education, Ben Goldacre, March 2013
(media.education.gov.uk/assets/files/pdf/b/ben%20goldacre%20paper.pdf).

³⁷ educationendowmentfoundation.org.uk/

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