



INTE 2014

## Teachers' understanding about the brain in East China

Pei, X.<sup>a</sup>, Howard-Jones, P.A.<sup>b\*</sup>, Zhang, S.<sup>a</sup>, Liu, X.<sup>c</sup>, Jin, Y.<sup>a</sup>

<sup>a</sup>School of Education Science, East China University, Shanghai, China

<sup>b</sup>Graduate School of Education, University of Bristol BS5 8HZ, United Kingdom

<sup>c</sup>Shandong Normal University, Jinan, China

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### Abstract

Here, we report the first survey of teachers' ideas about the brain in East China (N=238), aimed at identifying the prevalence of "neuromyths" thought to detract from effective classroom practice. Analysis identified many neuromyths popular in Europe (e.g. value in teaching to learning styles, left-brained or right-brained learners and in using only 10% of the brain). However, some important differences with the European data also emerged (e.g. greater belief in the importance of attention and avoiding emotional disruption of thought). An inverse relationship between favouring genetic influence and a belief in a biological limit to student achievement was also observed.

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Peer-review under responsibility of the Sakarya University

*Keywords:* Brain; neuroscience; neuromyth; China; genetics

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### 1. Introduction

A global field of enterprise is developing around attempts to bridge the gap between education and neuroscience. Formal organised initiatives to build bridges between neuroscience and education are so recent that their many progenitors are still settling on a name for this enterprise, with "Brain, Mind and Education", "Neuroeducation" and "Educational Neuroscience" all currently contending. Efforts in the last decade have included a supranational project on "Learning Sciences and Brain Research" by the Organization for Economic Cooperation and Development (OECD)'s Centre for Educational Research and Innovation (CERI) from 1999 to 2006, and the formation of the International Mind, Brain and Education Society in the US which launched its journal "Mind, Brain and Education" in 2007. A second journal "Trends in neuroscience and education" was launched last year. Research centres

\* Corresponding author. Tel.: +0-000-000-0000  
E-mail address: [paul.howard-jones@bris.ac.uk](mailto:paul.howard-jones@bris.ac.uk)

combining neuroscience and education are springing up around the world, often associated with popular postgraduate courses. East China Normal University (Shanghai) has now opened its centre in Educational

Neuroscience and this year, supported by the OECD and UNESCO, the School of Education Science at East China University hosted the International Convention on Science of Learning. Here, global and local experts in education mingled with neuroscientists to discuss news forward in developing a new scientific basis for educational practice. Given the current Western interest in the high-performance (PISA) of schools in cities such as Shanghai, such initiatives in the East may have global political significance.

However, as the dialogue increases between neuroscience and education, there is a growing concern about the prevalence of neuromyths in many schools. In 2002, OECD defined “neuromyth” as “a misconception generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established” (OECD, 2002). These myths are related to the practices of teachers and are often promoted by brain-based programmes and books marketed to teachers that are intended to inform their teaching strategies. There is good reason, therefore, to consider these misunderstandings contribute to poor practice in the classroom.

Studies have found high levels of neuromyths amongst teachers in the UK, Netherlands, Portugal, Brazil, China and Turkey. Beyond the impact of commercial brain-based programmes in promoting myths, it seems likely that cultural contexts will influence the types of myth that become prevalent in a particular country. Neuromyths may provide the opportunity for our biases to distort scientific fact and create misunderstandings about the brain that become popular. However, given that different cultural forces and biases exist amongst the peoples of different nations, it cannot be assumed that the prevalence of all neuromyths will be the same across international boundaries. For example, only half of the UK population report any affiliation with any religion (Park, Clery, Curtice, Philips, & Utting, 2012) and here, only 15% of trainee teachers believed that the mind results from the spirit, or the soul, acting on the brain (Howard-Jones et al., 2009). The people of Greece, however, have notably high religious involvement. High levels of religiosity characterize a large proportion of the Greek people (Hirschon, 2009) and the majority of this population are Christian Orthodox. Here, 72% agreed with the statement that “The mind is the result of the action of the spirit, or of the soul, on the brain”.

Here, we report the first survey of neuromyths amongst teachers in China, using a questionnaire used to assess levels of misunderstandings about the brain in Europe.

## **2. Method**

### *2.1. Participants*

Participants were 238 primary, secondary and high school teachers recruited in Shanghai, Shandong, Jiangsu and Zhejiang provinces.

### *2.2. Procedure*

The translation and suitability of the survey was first validated through preliminary interviews and piloting with teachers not included in the final survey sample. The research was presented as a study of how teachers think about the brain and its influence on learning.

### *2.3. Instruments*

Participants were asked to complete a survey used in a previous study of UK trainee teachers (Howard-Jones et al., 2009). This consisted of 40 assertions (15 correct and 16 incorrect factual assertions, and 9 open to subjective opinion) to which participants were asked to respond agree, don't know or disagree and is provided in Appendix 1. Of these 40 assertions in our survey, 38 statements were originally created by combining assertions used in a study of public neuroscience literacy (Herculano-Houzel, 2002) with ideas that have arisen in interviews with educators (see Howard-Jones et al., 2009 for further details concerning the underlying rationale for including these statements). The survey included the two additional statements of subjective opinion (“There is a biological limit to what some

individuals can achieve in their education”, “There is no biological limit to what any individual can achieve in their education”) that Howard-Jones et al. (2009) used in a follow-up survey to explore ideas around genetic determination. Related to this issue, respondents were asked what percentage of educational outcome they attributed to a student’s genes, their educational environment and their home environment. Participants also provided background information for the purpose of characterizing the sample (type of school, years of experience, gender, age, etc.) and whether they were familiar with a range of brain-based programmes common in the US and Europe (Brain Gym, Multiple Intelligences, Learning Styles). 15 of these participants were then randomly selected for in-depth interview in which they explained their responses.

### 3. Results

The summary of responses of our sample of teachers to our 9 statements of subjective opinion is shown in Table 1. Summaries of responses to assertions related to general knowledge and educational issues regarding the brain are shown in Tables 2 and 3.

Table 1. Beliefs of our sample of teachers in East China regarding 9 statements that might be regarded as open to subjective opinion, including the mind-brain relationship, the impact of developmental difference on moral responsibility and belief in a biological limit to achievement.

	Response as percentage % of sample		
	Agree	Don't know	Disagree
The mind is the result of the action of the spirit, or of the soul, on the brain	85	11	4
State of mind is a reflection of the brain state in a given moment	82	14	4
If there are ways to study brain activity, the mind can be studied through them	60	31	9
The mind is a product of the working of the brain	88	9	3
Without a brain, consciousness is not possible	75	11	14
Intuition is a "special sense" that can't be explained by brain	71	15	14
Individuals are not responsible for behavior associated with a developmental difference in brain function	24	20	57
There is a biological limit to what some individuals can achieve in their education	61	29	10
There is no biological limit to what any individual can achieve in their education	27	25	48

Table 2. Responses of our sample of teachers in East China to general assertions regarding the brain (C = correct statement, I = incorrect statement). It should be noted that some scientific evidence supporting one statement (marked C\*) has recently been found, raising questions about the correctness, or otherwise, of this statement.

	Response as percentage % of sample		
	Agree	Don't know	Disagree
Brain activity depends entirely on the external environment: with no senses stimulated, we don't see, hear or feel anything (I)	34	8	57
Emotional brain processes interrupt those brain processes involved with reasoning (I)	93	4	3
Cognitive abilities are inherited and cannot be modified by the environment or by life experience (I)	8	4	88
Learning is not due to the addition of new cells to the brain (C*)	53	36	12
One's environment can influence hormone production and, in turn, personality (C)	88	12	0
We use our brains 24 hours a day (C)	57	16	27
To learn how to do something, it is necessary to pay attention to it (C).	89	3	8
Learning occurs through modification of the brain's neural connections(C)	68	29	3
Performance in activities such as playing the piano improves as a function of hours spent practicing (C)	37	7	56
It is with the brain, and not the heart, that we experience happiness, anger, and fear (C)	65	11	25
Hormones influence the body's internal state, and not their personality (I)	36	27	37
Memory is stored in the brain much like as in a computer. That is, each memory goes into a tiny piece of the brain (I)	78	16	5
We mostly only use 10% of our brain (I)	59	36	5
Memory is stored in networks of cells distributed throughout the brain (C)	53	31	16
Keeping a phone number in memory until dialing, recalling recent events & distant experiences, all use the same memory system (I)	24	44	32
When we sleep, the brain shuts down (I)	8	9	82

Table 3. Responses of our sample of teachers in East China to assertions regarding the brain that are related to educational practice (C = correct statement, I = incorrect statement).

	Response as percentage % of sample		
	Agree	Don't Know	Disagree
Children are less attentive after sugary drinks and snacks (I)	62	29	10
Omega 3 supplements do not enhance the mental capacity of children in the general population (C)	44	42	14
Extended rehearsal of some mental processes can change the shape and structure of some parts of the brain (C)	66	26	8
Environments that are rich in stimulus improve the brains of preschool children (I)	89	6	5
Individuals learn better when they receive information in their preferred learning style (e.g. visual, auditory, kinaesthetic) (I)	97	3	1
Short bouts of co-ordination exercises can improve integration of left and right hemispheric brain function (I)	84	13	3
Regular drinking of caffeinated soft drinks reduces alertness (C)	52	37	11
Differences in hemispheric dominance (left brain, right brain) can help explain individual differences amongst learners (I)	71	23	7
Learning problems associated with developmental differences in brain function cannot be remediated by education (I)	50	19	31
There are no critical periods in childhood after which you can't learn some things, just sensitive periods when it's easier (C)	80	7	14
Vigorous exercise can improve mental function (C)	40	15	46
Individual learners show preferences for the mode in which they receive information (e.g. visual, auditory, kinaesthetic) (C)	93	6	1
Drinking less than 6-8 glasses of water a day can cause the brain to shrink (I)	5	30	65
Exercises that rehearse co-ordination of motor-perception skills can improve literacy skills(I)	79	18	3
Production of new connections in the brain can continue into old age (C)	44	40	16

The mean percentage of educational outcome that participants attributed to genetics, home environment and school environment were 28 (SD= 16), 36 (SD=14) and 35 (SD=15) respectively. The mean percentage of educational outcome attributed to genetics that participants who agreed (N=140) and disagreed (N=23) with the statement “There is a biological limit to what some individuals can achieve in their education” was 29% (SD 16%) and 22% (SD 12%) respectively. An independent samples one-tailed t-test revealed this difference to be significant ( $t(161)=1.84$ ,  $p=0.033$ ). The mean percentage of educational outcome attributed to genetics that participants who agreed (N=62) and disagreed (N=110) with the statement “There is no biological limit to what any individual can achieve in their education” was 23% (SD 11%) and 30% (SD 16%) respectively. An independent samples one-tailed

t-test revealed this difference to be significant ( $t(169)=3.01$ ,  $p=0.001$ ). The percentage of teachers who were familiar with Brain Gym, Multiple Intelligences, Learning Styles were 6%, 61%, and 53% respectively.

#### 4. Discussion

The research revealed that teachers in East China held many neuromyths and misconceptions about the brain that have been recorded elsewhere in Europe. These include almost three-quarters (71%) of teachers (compared with 91% and 86% in UK and Netherlands, Dekker et al. (2012)) believing that differences in hemispheric dominance (left brain, right brain) can help explain individual differences amongst learners, and the great majority (97%) believing in the effectiveness of teaching to learning styles (compared with 93% and 96% in UK and Netherlands respectively).

However, there were also appeared to be some differences between responses of teachers in our sample and those collated in previous studies elsewhere. For example, fewer teachers (only 40%) in East China appeared enthusiastic about the potential for vigorous exercise to improve mental function, compared with 65% teachers in Greece, 63% of UK trainee teachers. However, this result may need to be treated with caution. Through our interviews with teachers, it became apparent that vigorous exercise was being interpreted as meaning a highly repetitive task rather than aerobic physical activity. This points to difficulties we encountered in translating the language and concepts used in our survey which designed for Western teachers. This process of translation creates many opportunities for both linguistic and cultural misunderstandings. Indeed, a high number of teachers in East China were enthusiastic about co-ordination exercises improving integration of left and right hemispheric brain function (84%), and about exercises aimed at motor-perception skills improving literacy (79%). These figures, respectively, are similar to and sometimes higher than those from surveys in European countries. They can be compared, respectively, with 88% and 78% for UK teachers and 82%, 63% for teachers in the Netherlands (Dekker et al. 2012), or 65%, 35% for trainee UK teachers and 56%, 72% for teachers in Greece (Deligiannidi and Howard-Jones, 2014). Popularity in these other countries has been attributed to programmes such as Brain Gym, but in our sample of teachers in East China, only 6% were familiar with this programme. Some insights into the popularity of physical exercise arose from the interviews, in which 6 teachers offered rationales to justify their enthusiasm for it. Two teachers explained in terms of oxygen provision to the brain, two teachers in terms of improved attentional abilities, and another recounted his observations that coordination skills in sport (e.g. basketball) appeared associated with literacy skills. Another teacher referred to her own tendency to walk around when learning a foreign language, and also to the film *Akeelah and the Bee* in which Akeelah remembers her spellings better while skipping with a rope. It may be that programmes such as Brain Gym exploit a popular association between exercise and learning that already exists in many cultures.

Compared with UK trainee teachers, teachers in East China appear more enthusiastic about attention (89% believe “To learn how to do something, it is necessary to pay attention to it” compared with 43% in the UK) and less enthusiastic about emotion in reasoning (93% believe “Emotional brain processes interrupt those brain processes involved with reasoning” compared with 69% in the UK). These may reflect genuine cultural differences. For example, while the Western media is fascinated with the idea of multitasking, there is an old Chinese saying that “a man cannot spin and weave at the same time”. In terms of attitudes to emotion, European American individuals have been shown to value high-arousal positive affect (e.g., excitement) more than do Hong Kong Chinese, while Hong-Kong Chinese value low-arousal positive affect (e.g., calm) more than do European American individuals (Tsai et al., 2006). The American philosopher Ralph Waldo Emerson (1841/2000, p262) believed that “Nothing great was ever achieved without enthusiasm,” while the Chinese philosopher Lao-tzu (6th century; as cited in Cleary 1989, p2) believed “If people can be clear and calm, heaven and earth will come to them.”

The fact that 50% of our sample of teachers from East China agreed that “Learning problems associated with developmental differences in brain function cannot be remediated by education” can be interpreted in a number of ways. It appears considerably higher than the 9% of UK trainee teachers (Howard-Jones, et al., 2009), or 16% of UK teachers and 19% of Dutch teachers in the Dekker et al. (2012) study. This may reflect differences in how the phrase “Learning problems” is interpreted compared with participants in these other studies. That is, it may communicate more problematic disorders (e.g. amentia) than those it may associate itself with amongst European teachers (e.g. dyslexia). Alternatively, it may suggest teachers in East China consider the brain is less plastic than those in Europe.

In either respect, further research on this topic may be illuminating and helpful in understanding different cultural attitudes towards the brain and learning disorders.

We also believe the somewhat contrary results we derived for opinions with regard to the mind-brain relationship also point towards the need for further research. Our current results suggest 85% of Chinese teachers believe “The mind is the result of the action of the spirit, or of the soul, on the brain” but at the same time 88% believe “The mind is a product of the working of the brain”. However, in Chinese, this first statement used words without religious association for spirit, or soul. This resulted in there being little potential conflict between these statements. Further research is planned that is intended to disentangle beliefs of teachers more carefully regarding the mind-brain relationship.

Our finding that there was a relationship between belief in genetic influence and a diminished sense of student’s potential (or a biological limit to their achievement) emphasises the potential importance of teachers gaining a better understanding of neurodevelopment and genetics. There is increasing scientific and media interest in the role of genetics in education, but if these messages are misinterpreted then our results suggest this will influence the attitudes of teachers in the classroom.

## **5. Conclusions and recommendations**

In summary, since many of the myths and ideas we report here are directly related to practice, we conclude that the knowledge and practice of teachers in East China would benefit from more accurate knowledge of the brain, as might be received from teacher training and in-service professional development. This may be an important first step for future efforts in China to enrich education with insights from neuroscience. Comparison of our results with international data sets suggests cultural factors influence teachers’ understanding of the brain, and better understanding of these factors would be a valuable target area for future research.

**Appendix A. The complete set of statements used in the questionnaire. Participants were asked to indicate their agreement with these statements as agree, don't know or disagree.**

The mind is the result of the action of the spirit, or of the soul, on the brain  
 "State of mind" is a reflection of the brain state in a given moment  
 If there are ways to study brain activity, the mind can be studied through them  
 The mind is a product of the working of the brain  
 Without a brain, consciousness is not possible  
 Intuition is a "special sense" that cannot be explained by the brain  
 Individuals are not responsible for behavior associated with a developmental difference in brain function  
 There is a biological limit to what some individuals can achieve in their education  
 There is no biological limit to what any individual can achieve in their education  
 One's environment can influence hormone production and, in turn, personality (C)  
 We use our brains 24 hours a day (C)  
 To learn how to do something, it is necessary to pay attention to it (C).  
 Learning occurs through modification of the brain's neural connections(C)  
 Performance in activities such as playing the piano improves as a function of hours spent practicing (C)  
 It is with the brain, and not the heart, that we experience happiness, anger, and fear (C)  
 Hormones influence the body's internal state, and not their personality (I)  
 Memory is stored in the brain much like as in a computer. That is, each memory goes into a tiny piece of the brain (I)  
 Memory is stored in networks of cells distributed throughout the brain (C)  
 Keeping a phone number in memory until dialing, recalling recent events & distant experiences, all use the same memory system (I)  
 When we sleep, the brain shuts down (I)  
 Learning is not due to the addition of new cells to the brain (C\*)  
 Brain activity depends entirely on the external environment: with no senses stimulated, we don't see, hear or feel anything (I)  
 Emotional brain processes interrupt those brain processes involved with reasoning (I)  
 Cognitive abilities are inherited and cannot be modified by the environment or by life experience (I)  
 We mostly only use 10% of our brains (I)  
 Children are less attentive after sugary drinks and snacks (I)  
 Omega 3 supplements do not enhance children's mental capacity in the general population (C)  
 Environments that are rich in stimulus improve the brains of preschool children (I)

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