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Opinion

Neuromyths in Teachers: How does this Reflect Imperfect Rationality?

Eric Tardif*

University of Teacher Education, Haute école pédagogique Vaud, Switzerland

Abstract

The idea that results from research in cognitive neuroscience may be used in the classroom to improve student learning seems appealing. However, this trend faces several obstacles and has received mixed support from experts. Teachers, who are actually at the center of this debate, may not be equipped to critically apprehend the enormous variety of information they are confronted to. In this paper, I will first provide a general review of the role that neuroscience may play in the field of education, with an emphasis on the high prevalence of neuromyths among teachers. In a second part, I will defend the idea that the development of rational thought should be included in the training of pre-service teachers as a way to help them critically examine the learning methods that can be offered to them.

Keywords: Education; Neuromyths; Rational thought; Teacher

Bringing cognitive neuroscience advances into the classroom is a seductive idea but it has raised several criticisms from researchers. At the same time, several so-called "brain-based" educational methods are available for teachers and some have gained relatively high popularity. Unfortunately, a number of these methods are based on false assumptions regarding brain functioning and claim unrealistic gains in learning without being supported by any empirical evidence. Nonetheless, several studies around the world have shown the high prevalence of teachers who believe in neuromyths and adhere to teaching methods based on highly doubtful concepts. In this paper, I will try to highlight the complexity of an alliance between cognitive neuroscience, psychology and education, with an emphasis on the problem of neuromyths. More specifically, I will elaborate on the idea that the high prevalence of neuromyths among teachers could reflect imperfect rationality and review the results of interventions that may help reduce such false beliefs.

Does Neuroscience have a Place in the Classroom?

The idea of integrating cognitive sciences in the teacher training curriculum has a long tradition. Back in 1892, eminent psychologist William James was asked to give lectures to teachers about basic psychology. He stated: "And yet I confess that, acquainted as I am with the height of some of your expectations, I feel a little anxious lest, at the end of these simple talks of mine, not a few of you experience some disappointment at the net results" (p.5) [1]. Nowadays, notwithstanding the great advances of cognitive neuroscience and the growing interest toward integrating such findings about brain functioning (and its development) within the field of education, my personal feeling still resembles what James had expressed at the time. As a former neuroscientist, a part of my current job is to teach student teachers and in-service teachers about cognitive functions relevant to education, including some underlying brain mechanisms. Undoubtedly, this helps to better understand how people learn and the limits of some cognitive processes, including inter-individual differences. However, the question of how new data about brain functioning can help developing new teaching methods remains very difficult to answer from my point of view. One problem is that although some new neuroscientific results on topics relevant to education may emerge from very well-built studies and provide extremely important data for fundamental research, the extent to which they bring new insights for the development of teaching methods is less obvious. Frequently, such studies highlight the underlying brain mechanism of learning processes that were themselves already known from purely cognitive studies.Take for example the study of Iuculano et al. [2] in which children with mathematical learning disabilities are trained using a particular intervention. Results show that prior to the teaching intervention, children with such disabilities display a particular pattern of brain activity while they perform an arithmetic task as compared to children with no particular disability. After the remediation, children with initial disabilities show great improvement, which is accompanied by functional neuroplasticity in a wide range of brain areas, with the post-intervention activity resembling more that of typically developing children. At first glance, these results could be viewed as important for the development of new "brain-based" teaching methods that may be relevant for teachers. A closer look at the study reveals that the intervention used was shown to be efficient much earlier through purely cognitive psychological studies [3]. As mentioned before, results such as those of Iuculano et al. [2] are greatly important to better understand the mechanisms of learning but not as much to develop new teaching methods. Several papers have raised some doubts about how the results from cognitive neuroscience could be of real help for education as compared to cognitive psychology [4-7].

My opinion is more nuanced and resemble that of Thomas [8] in that I believed neuroscience has an importance in education and must be part of an interdisciplinary research process. One reason is simply that one better knows all aspects of a phenomenon in order to improve the

***Corresponding author:** Eric Tardif, University of Teacher Education, Haute école pédagogique Vaud, Avenue de Cour 33, 1014 Lausanne, Switzerland, Tel: +41 213163394; E-mail: eric.tardif@hepl.ch

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methods that are used to work on it. In addition, some neuroscientific findings have already shown results that could be very promising in the future. As example, EEG recordings in very young infants (combined with other behavioral measures) could help determine the extent to which the child will face difficulties in learning to read in the future [9], which could in turn be of great help to guide early interventions. Notwithstanding the fact that several obstacles remain to be overcome before such interventions can be effective, the idea of considering cognitive neuroscience into educational practices should not be abandoned. Nonetheless, one must acknowledge that at the moment, few neuroscientific data have led to such "brain-based" teaching practices. However, I seriously doubt that teachers are aware of this situation. In fact, they may believe many such new methods do exist and that they should use them in their practice. This belief may partly explain why neuromyths are so prevalent among teachers and pre-service teachers.

Neuromyths and Rational Thinking

The term neuromyth was probably coined by neurosurgeon Alan Crockard to describe false representations of the brain in medical culture [10,11]. The Organization of Economic Co-operation and Development (OECD) has defined a neuromyth as a "Misconception generated by a misunderstanding, a misreading or misquoting of facts scientifically established (by brain research) to make a case for use of brain research, in education and other contexts" (p.258) [12].The prevalence of neuromyths has been studied intensively in teachers and to a lesser extend in student teachers. In general, studies show high levels of adherence by teachers to several neuromyths in a number of countries including Australia [13], Canada [14], China [15], Greece [16,17], Latin America [18,19], Morocco [20], Portugal [21], South Korea [22], Switzerland [23], Turkey [24,25], The United Kingdom and the Netherlands [26], as well as the United States [27,28]. Although all these studies have limits and it has not been shown that adherence to neuromyths have an impact on the quality of teaching [13], it remains quite troubling that experts in learning (i.e.,teachers) hold false beliefs about the way one might improve learning. Furthermore, once such beliefs are disseminated among students, they may be difficult to challenge. As a matter of fact, recent studies have shown that individuals often "back the wrong horse" as they think that their preferred learning method will lead to actual better learning while the results show the opposite [29,30]. In addition, subjects seem to resist changing their opinion about the more efficient way to learn. When faced with the actual results showing that about 80% of subjects learned better with a given method and that only 10% learned better with another (the remaining 10% did not show any difference with the two methods), subjects agreed with the results but 80% of them claimed that they belong to the 10% who learned better with the less efficient method [31].

Several hypotheses have been proposed to explain such persistence of neuromyths within the teaching domain [32,33]. The idea that I would like to advance here is that it may reflect (at least in some aspects) an inherent imperfection in rational thinking. Rational thinking is a very large construct that must be differentiated from intelligence [34]. Cognitive psychologists distinguish two aspects of rationality: instrumental and epistemic. Instrumental rationality refers to "behaving in the world so that you get exactly what you most want, given the resources (physical and mental) available to you" [34]. Epistemic rationality concerns "how well beliefs map onto the actual structure of the world" [34]. As far as neuromyths within the school context are concerned, they represent a failure in both instrumental and epistemic rationality. Take for example what is probably the most widespread myth in education, namely that people learn better if they receive information through their preferred modality (visual, auditory or kinesthetic; the so-called "VAK" approach). There are actually no evidence whatsoever to support such a belief, and studies that have tried to match learning material to subjects' preferred modality have failed to demonstrate any interaction [35-41]. That is, the VAK approach does not reflect the reality (epistemic rationality) and is unlikely to bring teachers what they want (i.e., persistent learning from their pupils; instrumental rationality). Teachers may believe in the VAK approach simply because it seems intuitively coherent and logical [33]. Another reasoning bias that could help explain the persistence of neuromyths is the vividness effect [42]. This bias illustrates how subjects will ignore information from a large number of observations to the benefit of isolated cases from which they are closer (and which are therefore more vivid). The classical example is the Saab-Volvo experiment [43]. In this dilemma, the subject is asked to choose between two otherwise equal cars brands. The subject is informed that the Volvo has better scores from large surveys and statistics documenting mechanical troubles. At the same time, a close friend tells the subject that he had a severe mechanical problem with his own Volvo. Subjects tend to rely more on the close friend's advice than on the "law of large numbers". Similarly, a teacher may give more credit to the emotional testimony of a colleague claiming that Brain Gym® had miraculous effects on a student with learning difficulties than on the literature review showing negative results [44-47].

What can be Done to Prevent Neuromyths in Education?

Recently, a number of studies have used interventions aiming at reducing beliefs in neuromyths among teachers andstudents and have yield mixed results [22,48]. Im et al. [22] hypothesized that taking an educational psychology course could enhance neuroscience literacy and decrease beliefs in neuromyths in pre-service teachers. Their reasoning was that cognitive and educational psychology could fill the gap that exists between neuroscience and education. Results show an improvement in neuroscience literacy in the experimental group but no decrease as far as beliefs in neuromyths are concerned. This result is somewhat reminiscent of that of Dekker et al. [26] showing that teachers with higher general knowledge about the brain also had high beliefs in neuromyths. That is, it appears that knowledge about the brain (e.g. through an introductory class in neuroscience) is not enough to prevent neuromyths, a result that was previously shown by Weisberg, Keil, Goodstein, Rawson and Gray [49]. McMahon et al. [48] used a short workshop about neuroscience (including the problematic of neuromyths) and compared pre- and post-intervention surveys about neuromyths. Encouragingly, belief in neuromyths decreased following the intervention. For example, the VAK neuromyth, known to be particularly persistent, tended to move from "agree" to "don't know" opinion following the intervention.

As a former neuroscientist now working at training pre-service teachers, my personal feeling is that interventions aiming at debunking neuromyths should include the construction of neuroscientific knowledge but also (and maybe more importantly) a discussion about rational thinking and the scientific process. Teachers are not meant to be experts in neurosciences nor in cognitive psychology but they should be aware of the differences between pseudoscientific literature such as that surrounding Brain Gym®, peer reviewed studies and meta-analyses. They should be sensitized to the fact that even studies published in prestigious journals can sometimes be severely questioned. The most promising route towards better discrimination between pseudoscientific and evidence-based approaches in education may be to improve rational thinking. Studies have shown encouraging results in educating college and university students about rational thought [50]. In fact, evidence-based models have been proposed to develop training structures that are likely to help students develop their rational thought [51]. A great challenge that needs to be met through such interventions is that of transfer: thinking skills that have been trained must be available to solve other, real-life situations. That is, education for rational though should be structured in such a way that individuals would be able to recognize that particular thinking skills are required to face new problems they encounter.This could greatly helpfuture teachers to critically examine teaching methods that are suggested to them.

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References

1. James W (1983) Talks to teachers on psychology; and to students on some of life's ideals. Harvard University Press, USA.

2. Iuculano T, Rosenberg-Lee M, Richardson J, Tenison C, Fuchs L, et al. (2015) Cognitive tutoring induces widespread neuroplasticity and remediates brain function in children with mathematical learning disabilities. Nature Commun 6: 8453.

3. Fuchs LS, Powell SR, Hamlett CL, Fuchs D, Cirino PT, et al. (2008) Remediating computational deficits at third grade: A randomized field trial. J Res Educ Eff 1: 232.

4. Bowers JS (2016) The practical and principled problems with educational neuroscience. Psych Rev 123: 600-612.

5. Bruer JT (1997) Education and the brain: A bridge too far. Educ Res 26: 416.

6. Bruer JT (2006) Points of view: On the implications of neuroscience research for science teaching and learning: Are there any ? A skeptical theme and variations: The primacy of psychology in the science of learning. CBE Life Sci Educ 5: 104110.

7. Dougherty MR, Robey A (2018) Neuroscience and education: A bridge astray? Curr Dir Psychol Sci 27: 401406.

8. Thomas MS (2019) Response to Dougherty and Robey (2018) on neuroscience and education: Enough bridge metaphors-Interdisciplinary research offers the best hope for progress. Curr Direct Psychol Sci 28: 337340.

9. Ozernov-Palchik O, Gaab N (2016) Tackling the 'dyslexia paradox': Reading brain and behavior for early markers of developmental dyslexia. Wiley Interdiscip Rev Cogn Sci 7: 156176.

10. Crockard A (1996) Review: Confessions of a brain surgeon. New Sci 2061: 68.

11. Howard-Jones P (2010) Introducing Neuroeducational Research – Neuroscience, Education and the Brain from Contexts to Practice. Routledge (1st Edn), USA.

12. Organisation for Economic Co-operation, and Development (2002) Understanding the Brain: Towards a New Learning Science. OECD Publishing, Paris, France.

13. Horvath JC, Donoghue GM, Horton AJ, Lodge JM, Hattie JA (2018) On the irrelevance of neuromyths to teacher effectiveness: Comparing neuro-literacy levels amongst award-winning and non-award winning teachers. Front Psychol 9: 1666.

14. Blanchette Sarrasin J, Riopel M, Masson S (2019) Neuromyths and their origin among teachers in Quebec. Mind Brain Educ 13: 100109.

15. Pei X, Howard-Jones P, Zhang S, Liu X, Jin Y (2015) Teachers' understanding about the brain in East China. Proc-Soc Behav Sci 174: 36813688.

16. Deligiannidi K, Howard-Jones P (2015) The neuroscience literacy of teachers in Greece. Proc-Soc Behav Sci 174: 39093915.

17. Papadatou-Pastou M, Haliou E, Vlachos F (2017) Brain knowledge and the prevalence of neuromyths among prospective teachers in Greece. Front Psychol 8: 804.

18. Gleichgerrcht E, Lira Luttges B, Salvarezza F, Campos AL (2015) Educational neuromyths among teachers in Latin America. Mind Brain Educ 9: 170178.

19. Hermida MJ, Segretin MS, SoniGarcía A, Lipina SJ (2016) Conceptions and misconceptions about neuroscience in preschool teachers: A study from Argentina. Educ Res 58: 457472.

20. Idrissi AJ, Alami M, Lamkaddem A, Souirti Z (2020) Brain knowledge and predictors of neuromyths among teachers in Morocco. Trends Neurosci Educ 20: 100135.

21. Rato JR, Abreu AM, Castro-Caldas A. (2013) Neuromyths in education: What is fact and what is fiction for Portuguese teachers? Educ Res 55: 441453.

22. Im S, Cho J-Y, Dubinsky JM, Varma S (2018) Taking an educational psychology course improves neuroscience literacy but does not reduce belief in neuromyths. PloS One 13: e0192163.

23. Tardif E, Doudin P, Meylan, N (2015) Neuromyths among teachers and student teachers. Mind Brain Educ 9: 5059.

24. Dündar S, Gündüz N (2016) Misconceptions regarding the brain: The neuromyths of preservice teachers. Mind Brain Educ 10: 212232.

25. Karakus O, Howard-Jones P, Jay T (2015) Primary and secondary school teachers' knowledge and misconceptions about the brain in Turkey. Proc Soc Behav Sci 174: 19331940.

26. Dekker S, Lee NC, Howard-Jones P, Jolles J (2012) Neuromyths in education: Prevalence and predictors of misconceptions among teachers. Front Psychol 3: 429.

27. Macdonald K, Germine L, Anderson A, Christodoulou J, McGrath LM (2017) Dispelling the myth: Training in education or neuroscience decreases but does not eliminate beliefs in neuromyths. Front Psychol 8: 1314.

28. Ruhaak AE, Cook BG (2018) The prevalence of educational neuromyths among pre-service special education teachers. Mind Brain Educ 12: 155161.

29. Karpicke JD, Blunt JR (2011) Retrieval practice produces more learning than elaborative studying with concept mapping. Science 331: 772775.

30. Kornell N, Bjork RA (2008) Learning concepts and categories: Is spacing the "enemy of induction"? Psychol Sci 19: 585592.

31. Yan V (2014) Learning Concepts and Categories from Examples: How Learners' Beliefs Match and Mismatch the Empirical Evidence. Doctoral dissertation: UCLA.

32. Howard-Jones PA (2014) Neuroscience and education: Myths and messages. Nat Rev Neurosci 15: 817824.

33. Pasquinelli E (2012) Neuromyths: Why do they exist and persist? Mind Brain Educ 6: 89-96.

34. Stanovich KE (2012) On the distinction between rationality and intelligence: Implications for understanding individual differences in reasoning. In. Keith J Holyoak KJ, et al. (eds.). The Oxford handbook of thinking and reasoning. Oxford University Press, Georgia, USA.

35. Arter JA, Jenkins JR (1977) Examining the benefits and prevalence of modality considerations in special education. J Spec Educ 11: 281298.

36. Kampwirth TJ, Bates M (1980) Modality preference and teaching method: A review of the research. Acad Ther 15: 597605.

37. Kavale KA, Forness SR (1987) Substance over style: Assessing the efficacy of modality testing and teaching. Excep Child 54: 228239.

38. Krätzig GP, Arbuthnott KD (2006) Perceptual learning style and learning proficiency: A test of the hypothesis. J Educ Psychol 98: 238-246.

39. Pashler H, McDaniel M, Rohrer D, Bjork R (2008) Learning styles: Concepts and evidence. Psychol Sci Publ Int 9: 105119.

40. Rogowsky BA, Calhoun BM, Tallal P (2015) Matching learning style to instructional method: Effects on comprehension. J Educ Psychol 107: 64-78.

41. Tarver SG, Dawson MM (1978) Modality preference and the teaching of reading: A review. J Learn Disabil 11: 5-17.

42. Stanovich KE, Toplak ME, West RF (2008) The development of rational thought: A taxonomy of heuristics and biases. Adv Child Dev Behav 36: 251-285.

43. Fong GT, Krantz DH, Nisbett RE (1986) The effects of statistical training on thinking about everyday problems. Cogn Psychol 18: 253292.

44. Hyatt KJ (2007) Brain gym®: Building stronger brains or wishful thinking? Remedial Spec Educ 28: 117124.

45. Kroeze K, Hyatt KJ, Lambert MC (2016) Brain Gym: Pseudoscientific Practice. J Am Acad Spec Educ Prof 75-80.

46. Spaulding LS, Mostert MP, Beam AP (2010) Is Brain Gym® an effective educational intervention? Exceptionality 18: 1830.

47. Watson A, Kelso GL (2014) The Effect of Brain Gym® on Academic Engagement for Children with Developmental Disabilities. Int J Spec Educ 29: 7583.

48. McMahon K, Yeh CS, Etchells PJ (2019) The Impact of a Modified Initial Teacher Education on Challenging Trainees' Understanding of Neuromyths. Mind Brain Educ 13: 288297.

49. Weisberg DS, Keil FC, Goodstein J, Rawson E, Gray JR (2008) The seductive allure of neuroscience explanations. J Cogn Neurosci 20: 470477.

50. Toplak M, West R, Stanovich K (2012) Education for Rational Thought. In Kirby JR, et al. (Eds.). Enhancing the Quality of Learning: Dispositions, Instruction, and Learning Processes. Cambridge University Press, Cambridge, United Kingdom.

51. Halpern DF (1998) Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. Am Psychol 53: 449-455.