Module 2 - Neuromyths in Education

UPATRAS

NEUROPEDAGOGY

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NEUROMYTHS IN EDUCATION

Summary

Through this section, the neuromyths that dominate education are presented. The reasons why they are so widely accepted by teachers and their sustainability are analyzed. Reference is also made to the important effects of neuromyths in education. Finally, scientific research that deconstructs neuromyths and tools to further reduce their spread are listed in detail.

Keywords: Neuromyths, Neuroscience, Neuropedagogy, Education

Presentation of the article

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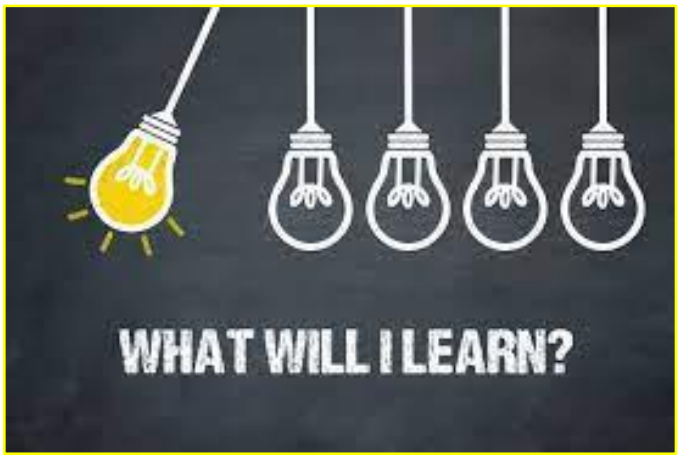
Learning Objectives



When you have studied this section, you will be able to:

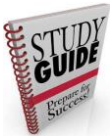
- ***Self-Assess*** your understanding on Neuroscience and Neuropedagogy
- ***Explore*** your ideas about Neuromyths and their effects in teaching and learning
- ***Be aware*** about the concepts and meaning of Neuromyths
- ***Explore*** the core Neuromyths that affect Higher Education teaching and learning
- ***Disuse*** about neuromyths' controversies
- ***Analyse*** the fundamental neuromyth in education concepts and the forces they have helped them grow
- ***Outline*** the impact of Neuromyths issues and problems in the educational field,
- ***Explain*** the extent which neuroscience, educational science and cognitive psychology can contribute to reducing the prevalence of neuromyths in education
- ***Recement*** how communication between neuroscience and education might be improved in the future

NEUROMYTHS IN EDUCATION

The purpose of the text is to present the Neuromyths that dominate students and teachers, their effects on teaching and learning and in general in the educational sector, and the factors that can contribute to reducing their spread. Neuromyths are defined as the misconception created by misunderstanding, by misreading or misquoting scientific data from brain research, misconceptions that, to a small or large extent, affect the educational practices of the teachers who apply them.

Purpose

At this point we should point out that on the right margin of the text you will find small icons which are hyperlinks that lead to different sources of information such as:



Study guide

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MODULE STEPS

STEP 1

Formulation of the problem/current belief

Diagnostic Assessment Quiz: "Do you believe in Neuromyths?" (Appendix 1)

Follow the link to play the quiz below. This process will help you figure out what you know about the following topic before you start studying it.

What other educators believe about Neuromyths?

Research Evidences

In the past decade, numerous surveys have been conducted in more than 20 countries around the world to measure the prevalence of neuromyth beliefs among educators (Torrijos-Muelas et al., 2021). Ferrero et al. (2016) conducted an exhaustive meta-analysis to report cultural influence in the prevalence of 12 neuromyths among teachers, as some others had previously suggested (Pasquinelli, 2012· Howard-Jones, 2014· Deligiannidi and Howard-Jones, 2015· Pei et al., 2015). Ferrero's findings (Ferrero et al., 2016) showed the presence of cross-cultural differences even for neuromyths with consistent responses across ten countries (UK, Netherlands, Greece, Turkey, Peru, Argentina, Chile, other Latin American countries, China, and Spain). However, as the authors stated, similar widespread misunderstandings can be found in neuromyths in different countries (Dekker et al., 2012· Howard-Jones, 2014· Gleichgerrcht et al., 2015· Ferrero et al., 2016· Bailey et al., 2018). Since 2016, much more scientific information about neuromyths has become available, given the significant and exponential advance of neuroeducation. Howard-Jones, P. A. (2014) mention that teachers in countries with very different cultures have revealed similarly high levels of belief in several neuromyths (TABLE 1). This prevalence may reflect the fact that neuro-science is rarely included in the training of teachers, who are therefore ill-prepared to be critical of ideas and educational programmes that claim a neuroscientific basis.

STEP 2

Input

What is a Neuromyth?

Torrijos-Muelas M, González-Víllora S, Bodoque-Osma AR (2021) mention that Neuromyth is not a new concept, as was first coined during the 1980s from the neurosurgeon Alan Crockard. It has been described as a scientifically inaccurate understandings of the brain in medical culture (Howard-Jones, 2010). Afterwards, research studies start to emphasize the widespread presence of the neuromyths and their persistence, especially among individuals in contact with education (Howard-Jones et al., 2009· Dekker et al., 2012· Howard-Jones, 2014· Ferrero et al., 2016· Düvel et al., 2017· among others). Neuroscience influences education, and these two areas have converged in a new field denominated "Neuroeducation" or "Neuropedagogy". However, the growing interest in the education–brain relationship does not match the proper use of research findings. In 2007, the Organization for Economic Cooperation and Development (OECD) warned of the misunderstandings about the brain among teachers, labeling them as neuromyths. Howard-Jones, P. A. (2014) mention that Organisation for Economic Co-operation and Development (Organisation for Economic Co-operation and Development [OECD], 2002) defines-neuromyths as "misconception[s] generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research in education and other contexts" (p. 111). The same period of time Herculano-Houzel (2002) published the first survey about knowledge of the brain. She included 95 multiple-choice assertions, 83 related to the information that the general public has about brain research and several neuromyths. Five years later, the OECD wrote about the proliferation of the neuromyths around (a) critical periods, (b) the age of three as the time when everything important is decided, (c) multilingualism, (d) left vs. right brain people, and (e) the 10% of the use of our brain, as the most widely spread neuromyths.

Why do Neuromyths persist in schools and colleges?

Taking an in-depth look into recent years of research in neuromyths, we can affirm they exist and persist among students, teachers, coaches, educators, and head teachers. The distance between neuroscience and education is still too great. Additionally, they have difficulties in accessing to the latest findings due to the absence of scientific literature in their mother tongue or the weakness of science communication. Howard-Jones, P. A. (2014) found reasons for the lack of knowledge among educators about science and the brain. Some of them are mentioning below:

- **Promises goes along with Recommendations:** interested teachers and learners often fail to consider that neurodidactics is more than just a plausible concept – it can also be a myth when applied incorrectly. For example, the promises above often go along with recommendations such as *Our brain wants us to use all of it and not just a small fraction*", "*Address both brain hemispheres in equal measure*", or "*Pay attention to whether you are a visual, auditory or haptic learner*".
- **Recommendations go along with Neuromyths** Numerous empirical studies reveal widespread endorsement of such misconceptions on the topic of learning and the brain both among the public at large and among pre-service and in-service teachers (e.g., Dekker et al., 2012· Ferrero et al., 2016). Even school principals, award-winning teachers and university instructors widely endorse neuromyths like "*we only use 10% of our brains*", "*learning differences due to hemispheric use*", or the "*existence of learning styles*" (Horvath et al., 2018· Zhang et al., 2019).
- **Neuromyths go along with Educational Problems** On the one hand, this is problematic because it could lead lecturers to pass on incorrect content and/or ineffective learning strategies to their students. On the other hand, it could waste the education system's "money, time and effort" (Dekker et al., 2012, p. 1) and deprive both lecturers and learners of opportunities to expend resources on more effective theories and methods (e.g., teaching learning strategies or cognitive activation.

- **Educational Problems can be addressed with Interdisciplinary Communication** The study of neuromyths and how they develop may provide a valuable source of insight into the challenges of interdisciplinary communication between neuroscience and education, and into how these challenges might be addressed. Understanding the cultural distance to be travelled between neuroscience and education and the biases that distort communications along the way — may support a dispassionate assessment of the progress in developing a bridge across these diverse disciplines and of what is needed to complete it.

Additional Resources

- A lesson in Neuromyths, **Dr. Christian Jarret, Author of "Great Myths in the Brain" (2019).**
- 'Neuromyths' (2019). Prof. Paul Howard Jones, Bristol University - Extract from full lecture @ BNA2017 *((2.45', English)*
- Neuromyths in Education (2019)**. Dr. Duncak Astle, University of Cambridge,** *(2.45', English)*
- **What is t**he problem with the n**e**uromyths**?** **(2019) Prof. Helen Joffe, UCL** *(1.19, English)*

Matching Activity: "Neuroscience-Neuropedagogy and Education: The connection": Appendix 2

Follow the link to do the activity. This process will help you understand whether you have understood the above topic.

Example Neuromyths in Higher Education

Although many theoretical descriptions of individual neuromyths exist that delineate certain individual arguments or counterarguments, only some of them have been systematically described with respect to their kernel of truth, individual erroneous conclusions and appropriate counterarguments (Grospietsch and Mayer, 2018· 2019· 2021a· 2021b· Grospietsch 2019). We selected those that University educators could possibly meet in Higher Education.

1st NEUROMYTH: Learning Styles

Introductory video

"Learning Styles- The Biggest Myth in Education" (14.26')	

Torrijos-Muelas M., González-Víllora S., Bodoque-Osma, A. (2021) mention that closely related to education, we can find the neuromyth of the visual, auditory, and kinaesthetic (VAK) learning styles. There are three mythical conclusions about the learning styles. The first erroneous conclusion that can be drawn from this kernel of truth is that there are auditory, visual, haptic and intellectual learning styles, as Vester (1975). The next erroneous conclusion drawn is that people learn better when they obtain information in accordance with their preferred learning style. Finally, the third erroneous yet widely disseminated conclusion is that teachers must diagnose their students' learning styles and take them into account in instruction. According to Grospietsch and Mayer (2021b), the ***kernel of truth*** behind this neuromyth is that people differ in the mode in which they prefer to receive information (visually or verbally; e.g., Höffler et al., 2017).

Description of the Neuromyth

As Torrijos-Muelas M., González-Víllora S., Bodoque-Osma, A. (2021) mention, even there is lack of evidence the neuromyth of the learning styles, it is one of the most deeply rooted belief among teachers, educators, and students. (Rodrigues Rato et al., 2013, Deligiannidi and Howard-Jones, 2015· Papadatou-Pastou et al., 2017, 2018· Varas-Genestier and Ferreira, 2017· Zhang et al., 2019). Educators report having been taught about the existence of learning styles during training courses organized by their schools or the educational authorities of their governments (Lethaby and Harries, 2016· Kim and Sankey, 2017· McMahon et al., 2019).

The effects of the Neuromyth on Education

Torrijos-Muelas M., González-Víllora S., Bodoque-Osma, A. (2021) also add that the educators in Higher Education use this neuromyth in their practice, and what is even more dramatic is that when a professor indicated there was no empirical evidence for VAK learning (Rohrer and Pashler, 2012· Grospietsch and Mayer, 2018), 46% claimed they would find benefits from using it in class (Newton and Miah, 2017). However, previous reports confirm that there is no relation between a student's self-evaluation about their preferred learning style and the style the teacher attributes to them (Papadatou-Pastou et al., 2018), with <50% of agreement between student self-report and a learning style questionnaire (Krätzig and Arbuthnott, 2006). The fact is that we do not learn using just one sense, and VAK learning does not explain how the brain learns (Geake,

2008· Dekker et al., 2012). Using this as a theory or a valid explanation is just a teaching heuristic based on observations (Schwartz, 2015), an over-simplification (Purdy and Morrison, 2009), and a more than questionable practice (Bailey et al., 2018). In line with previous studies, this neuromyth still appears in training, education degrees, universities, or books (Gleichgerrcht et al., 2015· Lethaby and Harries, 2016; Kim and Sankey, 2017· Grospietsch and Mayer, 2018; McMahon et al., 2019· Tan and Amiel, 2019), sometimes as a general educational trend (Papadatou-Pastou et al., 2018). Moreover, some educators insist they intend to continue working under this perspective in their classrooms, even knowing that it is a neuromyth (Newton and Miah, 2017· Tan and Amiel, 2019).

To spot a neuromyth you need to look for scientific evidence. Even it is true that there may be preferences and, perhaps more importantly, that presenting information in multiple sensory modes can support learning, Vester's model of learning styles is not even logically consistent, because it compares three sensory channels to an 'intellectual' learning style (Grospietsch & Lins, 2021). Tests of learning styles are unreliable from a measurement perspective and are unable to accurately categorize heterogenous groups of learners (Coffield et al., 2004· Pashler et al., 2008). Moreover, there is no **empirical evidence** confirming the effectiveness of considering students' learning styles in instruction (Willingham et al., 2015). Regardless of the mode in which it is presented, information must be meaningfully processed, repeated and elaborated. In addition Howard-Jones, P. A. (2014) mention that if a person feels that they learn best by writing the content down in their own words, this is not because they then see what they have written down, but rather because *writing something down in one's own words* serves as an elaboration strategy (Grospietsch and Mayer, 2021b).

Additional Resources

Learning styles-A complete myth -Video Animation (14.26min.)

Newton, P. M., & Miah, M. (2017). Evidence-Based Higher Education – Is the Learning Styles 'Myth' Important? Frontiers in Psychology, 8, 444.

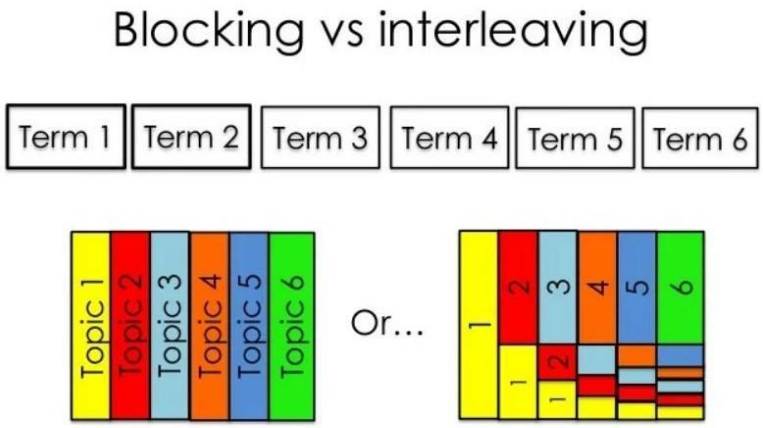
Furey, W. (2020). THE STUBBORN MYTH OF "LEARNING STYLES": State teacher-license prep materials peddle a debunked theory. Education Next, 20, 8+

Learning Styles (Greek content)

https://physiart.com/2018/07/12/02-learning-myth-learning-styles/

among students (e.g., Hattie, 2009).

2nd NEUROMYTH: Blocked learning is better than interleaved



A neuromyth that has to date largely been addressed in the context of cognitive psychology and 'desirable difficulties' (e.g., Bjork and Bjork, 2011; Lipowsky et al., 2015) is the notion that blocked learning is better than interleaved (Grospietsch and Mayer, 2019). According to Grospietsch (2019), the kernel of truth underlying this neuromyth is that instructional designs in which the learning

content is systematically structured facilitate positive learning effects among students (e.g., Hattie, 2009).

Description of the Neuromyth and Mythical Assumptions

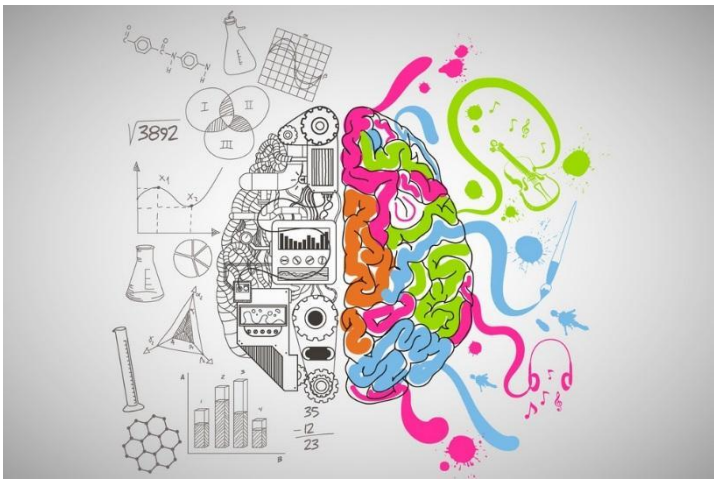
From this, it is erroneously concluded that students become overwhelmed when instructional topics are not taught one after another in a structured, sequential way. Hence, educators who believe in this neuromyth may design learning activities accordingly. A related assumption is that students' knowledge acquisition is more sustainable when the learning process is simplified, and quick and easy success during learning improves students' long-term retention of the learning content. Thus, it is recommended that teachers follow the structure of school textbooks and teach topics one after another chronologically.

The effects of the Neuromyth on Education-Mythical Conclusions

From a scientifically accurate perspective, however, students who engage in interleaved learning (mixed, juxtaposed learning of different topics) have better scores on long-term performance tests (after several weeks or months have passed) and develop fewer misconceptions than students who sequentially learn content on one topic after another (e.g., Rohrer and Taylor, 2007· Ziegler and Stern, 2014). Research findings on desirable difficulties demonstrate the positive effects on students' knowledge acquisition of deliberately making learning processes more difficult (e.g., Bjork and Bjork, 2011· Dunlosky et al., 2013· Lipowsky et al., 2015) and that interleaved learning is superior to blocked learning in the long term (e.g., Mayfield and Chase, 2002). Cognitively demanding activities result in slow, not immediately visible learning successes, yet improve long-term retention of what has been learned (e.g., Carvalho and Goldstone, 2014· Bjork and Kroll, 2015).

How to 'spot' Learning Styles Neuromyth-The Scientific Perspective

3rd NEUROMYTH: Logic is located in the left hemisphere, creativity in the right



Introductory Videos

Neuromyths-Concerning the Left and the Right Brain	
Left Brain vs Right Brain myth	

Description of the Neuromyth-Mythical Assumptions

The neuromyth is that *logic is located in the left hemisphere, creativity in the right* (e.g., Hines, 1991). Several theoretical descriptions of the neuromyth regarding *learning differences due to hemispheric use* also exist (Organisation for Economic Co-operation and Development [OECD], 2002· Becker, 2006· Geake, 2008; Alferink and Farmer-Dougan, 2010; Lilienfeld et al., 2010· Lindell and Kidd, 2011; Adey and Dillon, 2012; Jarrett, 2014; Tokuhama-Espinosa, 2018). Based on this kernel of truth, it is erroneously concluded that the two brain hemispheres have different strengths and weaknesses. According to Grospietsch and Mayer (2019), the cerebrum contains two hemispheres that are not completely identical from an anatomical or functional perspective (*hemispheric asymmetry*; e.g., Jäncke, 2013· Ocklenburg et al., 2014).

It is assumed that every learner has a dominant hemisphere that they rely upon more strongly than the other, and that student (cognitive) characteristics are rooted in this 'hemispheric dominance' – misinterpreted as the strength of the two hemispheres. For example, analogously to the neuromyth that logic is located in the left hemisphere, creativity in the right (see below), it is allegedly the case that 'left brain dominant' learners are more talented in mathematics, while 'right brain dominant' learners are better able to complete creative tasks. Ultimately, the erroneous conclusion is drawn that learners cannot complete tasks that misalign with their hemispheric dominance or can do so only with great difficulty; thus, educators need to take into account whether learners are *left-brained* or *right-brained* in their instruction. Torrijos-Muelas M., González-Víllora S., Bodoque-Osma, A. (2021) mention that educators who believe in this Neuromyth, with 41.7% of references among the studies, have the idea that each hemisphere works autonomously and has a different function. Hence, students' left hemisphere is responsible for intellectual, rational, verbal and analytical thinking, while the right hemisphere is responsible for creative, intuitive and non-verbal thought processes. Accordingly they can organize the learning activities.

From a scientifically accurate perspective, however, the two hemispheres are linked to one another via the corpus collosum, as mentioned above (Bloom and Hynd, 2005). They work together on all processing tasks (Singh and O'Boyle, 2004), as can be illustrated with the example of language: The left hemisphere is predominant in many but not all verbal processes. A few components of language are processed in the right hemisphere, including intonation and reading between the lines (Lai et al., 2015). Thus, the process is not completely lateralized (Nielsen et al., 2013). Learners themselves rather than brain hemispheres that possess different strengths and weaknesses rooted in their intelligence, use of learning strategies, interest, motivation, attention, etc. (Gruber, 2018).). Hemispheric dominance merely means that one of the two hemispheres is more strongly involved in a specific cognitive process than the other. Functions are lateralized only to a certain extent. Generally speaking, information is stored throughout the entire architecture of a given neural network and thus in memory traces (engrams) throughout the brain. As long as the corpus collosum, the band of nerves linking the two hemispheres, remains intact, a constant exchange of information between

the two hemispheres takes place, regardless of the type of activity being conducted (Bear et al., 2016).

How to 'spot' this Neuromyth - The Scientific Perspective

n Gym

Introductory Video:

Brain Gym Exercise for Students	

A further neuromyth related to the relationship between the brain hemispheres concerns the *effectiveness of Brain Gym* (Becker, 2006· Hyatt, 2007· Stephenson, 2009· Howard-Jones, 2010· Adey and Dillon, 2012· Tokuhama-Espinosa, 2018). According to Grospietsch and Mayer (2021a), the kernel of truth underlying this neuromyth is that a crossed neural pathway links the left hemisphere of the brain to the right side of the body and vice versa (e.g., De Lussanet and Osse, 2012· Kinsbourne, 2013).

Mythical Assumptions

Based on this kernel of truth, it is erroneously concluded that motor problems during cross-body coordination exercises result from a lack of coordination between the two hemispheres. Learning difficulties are also said to result from a lack of cooperation between the two hemispheres. it is further erroneously concluded that cooperation between the two hemispheres can be

improved by increasing the number of synaptic connections between them and that cross-body coordination exercises can improve one's mental abilities. Ultimately, it is claimed that 'Brain Gym' programs available for sale can prevent learning difficulties, improve students' learning or creativity, and even raise their intelligence.

Mythical Conclusions

From a scientifically accurate perspective, however, the two brain hemispheres are constantly exchanging information in coordination with one another as long as the corpus collosum, the band of nerves linking the two hemispheres, remains intact (Blais et al., 2018). Learning difficulties are instead attributable to differences in working memory capacity or processing speed (Willcutt et al., 2013). They can also be caused by a lack of attention, unfavorable motivational conditions, or deficits in the use of learning strategies (Creß and Friedrich, 2000· Grube and Ricken, 2016). We cannot consciously influence where synapses arise, and their formation is not a unique occurrence. New synaptic links form during each and every cognitive process (Zheng et al., 2013). While coordination exercises can improve students' physical fitness levels and motor skills, they do not improve their cognitive performance (Cancela et al., 2015). Any subjectively or objectively perceived cognitive improvements result instead from the break from learning/improved circulation that accompanies such exercises (Budde et al., 2008).

The Scientific Perspective

5th NEUROMYTH: Learning while you sleep

Introductory video

Common myths compromise good sleep	

The neuromyth on *learning while you sleep* is theoretically described much more rarely compared to the aforementioned neuromyths (Centre for Educational Research and Innovation [CERI], and Organisation for Economic Co-operation and Development [OECD], 2007· Lilienfeld et al., 2010· Tokuhama-Espinosa, 2018). Based on the kernel of truth (Grospietsch and Mayer, 2019) nighttime restructuring (consolidation) processes in the brain and can lead to new insights.

Description of the Neuromyth and Mythical Assumptions

Students can learn completely new content while they sleep; they can use the time they spend sleeping for learning by exposing themselves to acoustic stimuli. This leads to the recommendation that learners should play audio files (e.g., vocabulary words in a new language) while they sleep.

The effects of the Neuromyth on Education

From a scientifically accurate perspective, however, information is encoded when a person is awake, and consolidated while they sleep. Both processes are necessary to store knowledge in long-term memory – in other words, to learn (Gais and Born, 2004). it is not possible to learn new content while one sleeps (Stickgold, 2012). Encoding new information during sleep would disturb the consolidation process for information (Gais and Born, 2004).During sleep, the brain is relatively strongly sealed off from the outside world (Muzet, 2007),

although it can react to sensory inputs like smells by modifying the intensity of breathing (Stickgold, 2012), making conditioning possible (Arzi et al., 2012).

How to 'spot' Learning Styles Neuromyth - The Scientific Perspective

Multiple Intelligence Theory. IS IT A NEUROMYTH???

Multiple Intelligences theory has proved popular with teachers as a welcome argument against intelligence quotient (IQ)-based education. MI theory posits that every individual has, at their disposal, a *full* intellectual profile of eight intelligences. From one individual to another, some intelligences exhibit low, some exhibit average, and some others exhibit strong biopsychological potentials. We need to take into consideration that Gardner (2020) argues that MI theory does not qualify as a neuromyth.

Description of the Neuromyth- Mythical Assumptions

A large-scale survey conducted in Quebec, Canada, by Blanchette Sarrasin et al. (2019) revealed that 68% of teachers somewhat or strongly agreed (rating of 4 or 5 on a 5-point scale) with the following neuromyth statement: Students have a predominant intelligence profile, for example logico-mathematical, musical, or interpersonal, which must be considered in teaching. This is not an idiosyncratic case in the field (see Table 1). In another survey conducted in Spain, Ferrero et al. (2020) reported that teachers gave an average rating of 4.47 [on a 5-point scale, from 1 (definitely false) to 5 (definitely true)] to a closely similar neuromyth statement: Adapting teaching methods to the "multiple intelligences" of students leads to better learning. The believe in this neuromyth encourages educators to characterize learners in terms of a small number of relatively independent 'intelligences' — for example, linguistic, musical and interpersonal. Consider that Gardner and his research team spent an entire decade, through the Spectrum Project, contemplating the hypothesis—embedded into the opening survey

statement—that matching modes of instruction to MI intelligence profiles promotes learning. When taken for granted, such an unproven research hypothesis is considered as a false belief—a neuromyth derived from MI theory.

However, the general processing complexity of the brain makes it unlikely that anything resembling Multiple Intelligences theory can ever be used to describe it, and it seems neither accurate nor useful to reduce the vast range of complex individual differences at neural and cognitive levels to any limited number of capabilities.

Rousseau Luk (2020) argues that the neuro-mythological part of Multiple Intelligences theory (that is, its relation to neuroscience) is difficult to test, not least because the task for Multiple Intelligences theorists of defining the types and number of intelligences remains a work in progress.

OTHER NEUROMYTHS

Apart from the studies applied by Grospietsch and Mayer (2018, 2019, 2021a, band Grospietsch 2019) to provide a *scientific clarification* (Kattmann et al., 1997) of the aforementioned neuromyths, few further theoretical descriptions of other neuromyths exist (e.g., in Jarrett, 2014· Beck, 2016· Tokuhama-Espinosa, 2018). For example there is the neuromyth that we use only the 10% of our brain. According to Grospietsch and Mayer (2019), the kernel of truth underlying this neuromyth is that contemporary imaging techniques can show which specific regions of the brain are involved in

certain mental or physical activities. For example, many fMRI images exist in which only a portion of the brain is highlighted in color.

Further neuromyth that tends to be described in research on school students' (mis)conceptions is the *existence of specific storage locations(hard drive)* in the brain (cf. Schletter and Bayrhuber, 1998). According to Grospietsch (2019), the kernel of truth underlying this neuromyth is that the cerebrum contains various cortical regions with a functional division of tasks. There is also a neuromyth about the existence of *critical time periods for learning*. The kernel of truth underlying the neuromyth concerning *critical time periods for learning* (Howard-Jones, 2010· Adey and Dillon, 2012· Tokuhama-Espinosa, 2018), according to Grospietsch and Mayer (2020), is that certain things can be learned more easily during particular sensitive phases during childhood (Thomas and Johnson, 2008· Carter, 2014).

HOW TO SPOT NEUROMYTHS?

Paul A. Howard-Jones (2014) argues that more interdisciplinary collaboration between neuroscience and education may help to "spot" Neuromyths identify and to address misunderstandings as they arise, and may help to develop concepts and messages that are both scientifically valid and educationally informative. A new field focused on such collaboration is now emerging, although it is too new for its many proponents to have settled on a name for it — 'Brain, Mind and Education', 'Neuroeducation' and 'Educational Neuroscience' being current contenders. Afield dedicated to the interaction between neuroscience and education will not only inform educational approaches but also may encourage scientific insight regarding the relationship of neural processes to the complex behaviours that are observed in the classroom (ibid).

ADDITIONAL STUDY MATERIAL

RESEARCH

Campana, W. (2017). Prevalentie en voorspellers van neuromythes in Vlaanderen bij leerkrachten,studenten en CLB-medewerkers (Prevalence and predictors of neuromyths in Flanders among teachers, students and student guidance employees).	Faculty of Psychology & Educational Sciences, master thesis. In this master thesis, a survey was conducted among 597 participants: 173 Flemish teachers, 258 students Educational Sciences (Educational neuroscience, Catholic University Leuven), 101 students Postgraduate Special Education (University College Leuven) and 65 employees of the Student Guidance Centre. The results show that an average of 6.74 of the 19 neuromyths (35.47%) is believed across all groups. The most prevalent neuromyths are related to left-brain/right-brain thinking and the use of different learning styles (auditory/visual). However, statements about neuromyths are believed significantly less often when compared with the average myth score (M = 7.35, 49%) from the international study by Dekker et al. (2012). Striking is the significant difference in belief in neuromyths between the students Educational Sciences and teachers. The results showed that the group of students believes significantly fewer neuromyths than the group of teachers

Scientific researches

	($p < .001$). This difference might be explained by the Educational Neuroscience course in which the students are enrolled. This research also shows that a positive correlation is initially found between the myth score and the score on the knowledge one has about the brain. This positive correlation implies that the more knowledge you have about the brain, the more likely you believe in neuromyths. A multiple regression analysis revealed that the knowledge score proved to be the best predictor of the number of myths believed by the different groups. This conclusion is in line with the international study by Dekker et al. Campana concludes that his research demonstrates the need for transparent communication between neuroscience and education.
Betts, K., Miller, M., Tokuhama-Espinosa, T., Shewokis, P., Anderson, A., Borja, C., Galoyan, T., Delaney, B., Eigenauer, J., & Dekker, S. (2019). **International report: Neuromyths and evidence-based practices in higher education. Online Learning Consortium: Newburyport, MA.**	The purpose of this international, non-experimental study was threefold. First, this study examined the awareness of neuromyths and general knowledge about the brain in higher education among instructors, instructional designers, and administrators who work with professional development (referred to as administrators) in two- and four year

	institutions of higher education (IHE) across on-campus, blended/hybrid, and online programs. Second, this study examined the awareness of evidence-based practices from the learning sciences and Mind (psychology), Brain (neuroscience) and Education (pedagogy and didactics; MBE) science, among these different professional groups within higher education. Third, this study examined predictors of awareness of (a) neuromyths and general knowledge about the brain, and (b) evidence-based practices in higher education. A total of 1,290 surveys were completed, of which 929 met the criteria for inclusion, which is described in Section Five: Methodology. Respondents included fulltime instructors (33%; n = 305), part-time instructors (13%; n = 122), instructional designers (26%; n = 239), and administrators involved in professional development (18%; n = 172). Ten percent (n = 91) selected "other" **Key Findings** Correct responses to the 23 statements, which included neuromyths and general information about the brain, ranged from 11% to

	94% for instructors, instructional designers, and administrators. Neuromyths to which respondents were most susceptible included: o Listening to classical music increases reasoning ability. o A primary indicator of dyslexia is seeing letters backwards. o Individuals learn better when they receive information in their preferred learning styles (e.g., auditory, visual, kinesthetic). o Some of us are "left-brained" and some are "right-brained" due to hemispheric dominance, and this helps explain differences in how we learn. o We only use 10% of our brain. Instructional designers had greater awareness of neuromyths,

	knowledge about the brain, and evidence-based practices than instructors and administrators. There were no significant differences in (a) awareness of neuromyths and knowledge about the brain, Reading journals related to neuroscience, psychology, and MBE science increased awareness of (a) neuromyths and general information about the brain, and (b) evidence-based practices. Professional development is a predictor of awareness of (a) neuromyths and general knowledge about the brain, and (b) evidence-based practices among education instructors, instructional designers, and administrators.

STEP 3

Reflection

THE SUSTAINABILITY OF THE NEUROMYTHS

Grospietsch and Mayer (2021a) argues that neuromyths can spread rapidly, can be highly resistant to change, and can be facilitated or strengthened by the some backfire effects. For istance, that is happening because the mere mention of a memorable scientific myth can lead to its long-term retention (*familiarity backfire effect*). Moreover too many scientific arguments against a scientific myth can make the more simply formulated myth seem even more attractive (*overkill backfire effect*). In addition when people are strongly convinced of a scientific myth, their processing of counterarguments may be skewed, leading – whether consciously or unconsciously – to a further strengthening of the scientific myth (*worldview backfire effect*).

Paul A. Howard-Jones (2014) says that that Neuromyths are misconceptions about the brain that flourish when cultural conditions protect them from scrutiny. Some long-standing neuromyths are present in products for educators and this has helped them to spread in classrooms across the world. Genuine communication between neuroscience and education has developed considerably in recent years, but many of the biases and conditions responsible for neuromyths still remain and can be observed hampering efforts to introduce ideas about the brain into educational thinking.

Reflective Quiz: "Do I still believe in Neuromyths?"(Appendix 3)

Follow the link to do the activity - Quiz. This process will help you understand whether you have understood the above topic.

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**The above mentioned references were used to support this chapter. All other mentioned references could be found in these articles reference unit.*

Appendixes

Appendix 1

A. Self-Assessment Quiz: "Do you believe in Neuromyths?" (Appendix 1)

Question Number	TRUE or FALSE?	The ANSWER
1	***Neuromyth No 1: Learning Styles*** People learn better when they obtain information in accordance with their preferred learning style.	False
2	***Neuromyth No 1: Learning Styles*** Educators must diagnose their students' learning styles and take them into account in instruction.	False
3	***Neuromyth No 1: Learning Styles*** Learners differ in the mode in which they prefer to receive information (e.g. visually or verbally)	TRUE (Kernel of true)
4	***Neuromyth No 1: Learning Styles*** if a student feels that they learn best by writing the content down in their own words, this is because they then see what they have written down	False
5	**2nd Neuromyth: *Blocked learning is better than interleaved*** that instructional designs in which the learning content is systematically structured facilitate positive learning effects among students.	True (kernel of true)
6	**2nd Neuromyth: *Blocked learning is better than interleaved*** Students become overwhelmed when instructional topics are not taught one after another in a structured, sequential way.	False
7	**2nd Neuromyth: *Blocked learning is better than interleaved*** Students' knowledge acquisition is more sustainable when the learning process is simplified	False
8	**2nd Neuromyth: *Blocked learning is better than interleaved*** Educators should follow the structure of school textbooks and teach topics one after another chronologically in order to avoid students' misconceptions in their teaching topic.	False
9	**2nd Neuromyth: *Blocked learning is better than interleaved***	False

	Quick and easy success during learning improves students' long-term retention of the learning content.	
10	**3d Neuromyth: *Learning differences due to hemispheric use*** One brain hemisphere is more strongly involved in certain cognitive processes than the other (*hemispheric dominance*)	True (kernel of true)
11	**3d Neuromyth: *Learning differences due to hemispheric use*** Learners two brain hemispheres have different strengths and weaknesses.	False
12	**3d Neuromyth: *Learning differences due to hemispheric use*** Every learner has a dominant hemisphere that they rely upon more strongly than the other, and student (cognitive) characteristics are rooted in this 'hemispheric.	False
13	**3d Neuromyth: *Learning differences due to hemispheric use*** Educators should not take into account whether learners are *left-brained* or *right-brained* in their instruction, because hemispheric dominance merely means that one of the two hemispheres is more strongly involved in a specific cognitive process than the other.	True
14	**3d Neuromyth: *Logic is located in the left hemisphere, creativity in the right*** The first part of the brain (the cerebrum) contains two hemispheres that are not completely identical from an anatomical or functional perspective (*hemispheric asymmetry),*	True (kernel of true)
15	**3d Neuromyth: *Logic is located in the left hemisphere, creativity in the right*** The two hemispheres are linked to one another and work together on all processing tasks.	True
16	**3d Neuromyth: *Logic is located in the left hemisphere, creativity in the right*** Students' left hemisphere is responsible for intellectual, rational, verbal and analytical thinking, while the right hemisphere is responsible for creative, intuitive and non-verbal thought processes.	False
17	**4th Neuromyth: the *effectiveness of Brain Gym*** A crossed neural pathway links the left hemisphere of the brain to the right side of the body and vice versa.	True (kernel of true)
18	**4th Neuromyth: the *effectiveness of Brain Gym***	False

	Brain Gym' programs available for sale can prevent learning difficulties, improve students' learning or creativity, and even raise their intelligence.	
19	**5th Neuromyth: *Learning while you sleep*** Nighttime restructuring (consolidation) processes in the brain and can lead to new insights.	True (Kernel of True)
20	**5th Neuromyth: *Learning while you sleep*** *Learning while you sleep* is a time-value learning process, while students can learn completely new content while they sleep;	False

Appendix 2

Matching Activity (for self-assessing of Part A and Part. B understanding)

Match the items in column A with the appropriate items in the column:

Colum A	**Eg. 1.c**	**Colum B**	**Explanation of the write answer**
1. Research based evidence argue that educators in countries with very different cultures	1.a	a) have revealed similarly high levels of belief in several neuromyths b) are aware of most neuromyths and avoid them during the teaching and learning process c) are aware of most neuromyths, as they are well trained in this domain during their studies	1.a.) Teachers have revealed similarly high levels of belief in several neuromyths because of the fact that neuro-science is rarely included in the training of their training, who are therefore ill-prepared to be critical of ideas and educational programmes that claim a neuroscientific basis.
2. Neuromyths defines	2.c.	a) lies about the brain functionality purposely established (by neurologists) to influence Pedagogy.	2.c.) defines-neuromyths as "misconception[s] generated by a misunderstanding, a

		b) false ideas about the functionality of the neurons and the muscles. c) misconception[s] generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established (by brain research)	misreading, or a misquoting of facts scientifically established (by brain research) to make a case for use of brain research in education and other contexts"
3. Neuromyths	2.b	a) Has nothing to do with Educational Problems concerns Neurology and not Pedagogy b) go along with Educational Problems and this create educational problems c) go along with Educational dimensions but this has nothing to do with educational problems	2.b.) go along with Educational Problems On the one hand, this is problematic because it could lead lecturers to pass on incorrect content and/or ineffective learning strategies to their students

Appendix 3

Final Self- Assessment QUIZ: "Do I still believe in Neuromyths"?

Question Number	**TRUE or FALSE?**	**The ANSWER**	**Explanation if false**
1	***Neuromyth No 1: Learning Styles*** People learn better when they obtain information in accordance with their preferred learning style.	False	Research-based evidence shows that people do not learn better when they obtain information in accordance with their preferred learning style, even there is a kernel of truth that learners differ in the mode in which they prefer to receive information (e.g. visually or verbally). The fact is that we do not learn using just one sense, and t explain how the brain learns

2	***Neuromyth No 1: Learning Styles*** Educators must diagnose their students' learning styles and take them into account in instruction.	False	*Educators u*sing this as a theory or a valid explanation is just a teaching heuristic based on observations, an over-simplification, and a more than questionable practice. Tests of learning styles are unreliable from a measurement perspective and are unable to accurately categorize heterogenous groups of learners. Moreover, there is no empirical evidence confirming the effectiveness of considering students' learning styles in instruction
3	***Neuromyth No 1: Learning Styles*** Learners differ in the mode in which they prefer to receive information (e.g. visually or verbally)	TRUE (Kernel of true)	
4	***Neuromyth No 1: Learning Styles*** if a student feels that they learn best by writing the content down in their own words, this is because they then see what they have written down	False	if a person feels that they learn best by writing the content down in their own words, it is because *writing something down in one's own words* serves as an elaboration strategy.
5	**2nd Neuromyth: *Blocked learning is better than interleaved*** that instructional designs in which the learning content is systematically structured facilitate positive learning effects among students.	True (kernel of true)	Explanation if false:
6	**2nd Neuromyth: *Blocked learning is better than interleaved*** Students become overwhelmed when instructional topics are not taught one after another in a structured, sequential way.	False	Explanation if false: From a scientifically accurate perspectiv students who engage in interleaved learning (mixed, juxtaposed learning of different topics) have better scores on long-term performance tests and develop fewer misconceptions than students who sequentially learn content on one topic after another.

7	**2nd Neuromyth: *Blocked learning is better than interleaved*** Students' knowledge acquisition is more sustainable when the learning process is simplified	False	Explanation if false: Research findings on desirable difficulties demonstrate the positive effects on students' knowledge acquisition of deliberately making learning processes more and that interleaved learning is superior to blocked learning in the long term.
8	**2nd Neuromyth: *Blocked learning is better than interleaved*** Educators should follow the structure of school textbooks and teach topics one after another chronologically in order to avoid students' misconceptions in their teaching topic.		Explanation if false: Educators should try not to follow a strict-chronologically structure, concerning their teaching practice, because it is research-based that students develop fewer misconceptions than those who sequentially learn content on one topic after another
9	**2nd Neuromyth: *Blocked learning is better than interleaved*** Quick and easy success during learning improves students' long-term retention of the learning content.		Explanation if false: Cognitively demanding activities result in slow, not immediately visible learning successes, yet improve long-term retention of what has been learned
10	**3d neuromyth: *Learning differences due to hemispheric use*** One brain hemisphere is more strongly involved in certain cognitive processes than the other (*hemispheric dominance*)	True (kernel of true)	Explanation if false:
11	**3d neuromyth: *Learning differences due to hemispheric use*** Learners two brain hemispheres have different strengths and weaknesses.	False	Explanation if false: From a scientifically accurate perspective, however, it is learners themselves rather than brain hemispheres that possess different strengths and weaknesses rooted in their intelligence, use of learning strategies, interest, motivation, attention, etc.

12	**3d neuromyth: *Learning differences due to hemispheric use*** Every learner has a dominant hemisphere that they rely upon more strongly than the other, and student (cognitive) characteristics are rooted in this 'hemispheric.	False	Explanation if false: Hemispheric dominance merely means that one of the two hemispheres is more strongly involved in a specific cognitive process than the other. Functions are lateralized only to a certain extent. Generally speaking, information is stored throughout the entire architecture of a given neural network and thus in memory traces (engrams) throughout the brain. As long as the corpus collosum, the band of nerves linking the two hemispheres, remains intact, a constant exchange of information between the two hemispheres takes place, regardless of the type of activity being conducted
13	**3d neuromyth: *Learning differences due to hemispheric use*** Educators should not take into account whether learners are *left-brained* or *right-brained* in their instruction, because hemispheric dominance merely means that one of the two hemispheres is more strongly involved in a specific cognitive process than the other.	True	Explanation if false:
14	**3d Neuromyth: *Logic is located in the left hemisphere, creativity in the right*** The first part of the brain (the cerebrum) contains two hemispheres that are not completely identical from an anatomical or functional perspective (*hemispheric asymmetry),*	True (kernel of true)	
15	**3d Neuromyth: *Logic is located in the left hemisphere, creativity in the right*** The two hemispheres are linked to one another and work together on all processing tasks.	True	

16	**3d Neuromyth: *Logic is located in the left hemisphere, creativity in the right*** Students' left hemisphere is responsible for intellectual, rational, verbal and analytical thinking, while the right hemisphere is responsible for creative, intuitive and non-verbal thought processes.	False	From a scientifically accurate perspective, the two hemispheres are linked to one another via the corpus collosum. They work together on all processing tasks, as can be illustrated with the example of language: The left hemisphere is predominant in many but not all verbal processes. A few components of language are processed in the right hemisphere, including intonation and reading between the lines. Thus, the process is not completely lateralized.
17	**3d NEUROMYTH: the *effectiveness of Brain Gym*** A crossed neural pathway links the left hemisphere of the brain to the right side of the body and vice versa.	True (kernel of true)	
18	**4th NEUROMYTH:** **the *effectiveness of Brain Gym*** Brain Gym' programs available for sale can prevent learning difficulties, improve students' learning or creativity, and even raise their intelligence.	False	While coordination exercises can improve students' physical fitness levels and motor skills, they do not improve their cognitive performance.
19	**5th NEUROMYTH: *Learning while you sleep*** Nighttime restructuring (consolidation) processes in the brain and can lead to new insights.	True (Kernel of True)	
20	**5th NEUROMYTH: *Learning while you sleep*** *Learning while you sleep* is a time-value learning process, while	False	From a scientifically accurate perspective, information is encoded when a person is awake, and consolidated while they sleep. Both processes are necessary to learn. it is not possible to learn new content while one sleeps. Encoding new information during sleep would disturb the consolidation process for information. During sleep, the brain is relatively

	students can learn completely new content while they sleep;		strongly sealed off from the outside world, although it can react to sensory inputs like smells by modifying the intensity of breathing, making conditioning possible