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Abbreviations

OECD: Organization for Economic Cooperation and Development; SPSS: Social Sciences Statistics Package

Research Article

True or False? The Effect of Neuromyths on Education in Israel

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Abstract

Scientific literacy is required in making well-established and informed decisions in various areas of life. In the field of education, decisions are sometimes made based on misunderstandings or misinterpretations of neuroscience, or by their common name: "neuromyths". Neuromyths in the field of education may encourage ineffective education policies and teaching methods that might affect learning outcomes. This study seeks to examine the neuromyths that teachers in Israel believe to be a scientific fact. The findings suggest an urgent need to address the problems of neuromyths in teacher's education in Israel, as they mislead educational learning-teaching processes, misdirect valuable resources and lead to the mislabeling of students. This study is unique as it suggests the importance of providing teachers with the basic knowledge of neuroscientific understanding in education.

Neuromyths and their Definitions

Neuromyths are false beliefs that stem from misconceptions or misunderstandings about brain functions, often associated with teaching and learning processes. Alan Crockard [1], first coined the term "neuromyths" following frustration with the spread of false scientific ideas about the brain in the medical field. Later on the Brain and Learning Project of the Organization for Economic Cooperation and Development (OECD) adapted the term within the educational field, sending out a warning that neuromyths were beginning to have a strong impact on educational policy [2]; thus redefining the term "neuromyths" as a "misconception 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" [2]. Howard-Jones [3], describes neuromyths as the most popular idea across the world, which is not based on scientific understanding and may even contradict scientific findings. If that's the case, the question arises, why do neuromyths convince so many people? The common perception is that, like cognitive illusions or biases, even after they have been proven as false, they continue to seem correct [4].

Classic neuromyths

Many educators hold a wide range of neuromyths. One of the most popular neuromyths is that "we use only 10% of our brains" [5]. Some argue that this myth originated from contemporary imaging techniques that emphasize specific active areas of the brain alongside the 'off' zones [6]. This neuromyth of course has no scientific basis, since we use all parts of the brain, however, not all parts are equally active at any given moment. Brain imaging shows that even during sleep there are no areas of the brain that are completely "shutdown" [7]. Even people with neurodegenerative disorders such as Alzheimer's and Parkinson's disease still use more than 10% of their brains. Other intertwined neuromyths refer to "critical periods for learning", and that "optimal learning occurs until the age of 3". In these neuromyths, there is a kernel of truth, according to which certain things can be easily learned during childhood [6]. However, this understanding has drawn erroneous conclusions, such as that children are able to learn indefinitely in their early years, that exposure to certain stimuli in early childhood may affect cognitive performance in adulthood and that optimal learning abilities end at a young age. These conclusions, as mentioned above, do not have a scientific basis [8,9].

Another group of neuromyths refers to the concept of 'right brain learners versus left brain learners', according to which learning should be adapted to the hemisphere dominance and intelligence of the learner [10]. This misconception relies both on an inaccurate interpretation of Gardner's multiple intelligence theory [11] and on the basis of scientific findings that indicate that we perceive the world differently and that hemispheric asymmetry exists. In fact, the brain is constructed of two hemispheres that are not entirely anatomically and functionally identical [12], but work collaboratively, simultaneously and together through the corpus callosum [9]. One of the most common neuromyths in the world, and perhaps even the most influential, refers to the understanding that 'students learn best according to their preferred learning style' [13,14]. This neuromyth has created popular educational programs, such as "The VAK Approach" [15] or "Brain Gym"[16]. These programs rely on a popular model of learning styles, and they try to locate the way the learner's preferred information is processed (visual, auditory or movement) adapting, as a result, the teaching methods which will lead to the highest achievements [16,17]. Such an assumption lacks scientific support [18,19], and in fact, the opposite is true: The more a student is exposed to the same information through different learning channels, the more likely the information will be stored and recalled at a later stage, suggesting that exposure to a variety of learning channels is especially beneficial for learning and memory.

Causes of neuromyths

Several factors might explain the popularity of neuromyths [20]. First, there are differences between the field of neuroscience and the field of educational science. These differences generate misunderstandings [8]; Second, the inaccessibility of neuroscience studies to educators and teachers, and reliance on media reports or interpretations of pseudo-science, are also partly to blame the creation of neuromyths [6,21]. In addition, the attractiveness and ease of putting into practice explanations that seem to be based on neuroscience evidence and have a strong marketing foundation (McCabe & Castel (2008); Weisberg et al. (2008), and the so-called media hype that is evident in the fact that the media often by presenting new reports, bypass relevant information (e.g. research methodology), and provides information that is irrelevant having only a marketing character [4,22].

Worldwide neuromyths

The influence of neuromyths is of great interest to researchers around the world such as, Austria [23], England [24], Italy [25] and others indicating the strength of neuromyths among teachers. In addition, these findings show the universal grip on neuromyths, despite not having a scientific basis [26]. This strongly reinforces the value of explicit teaching in the field of teacher training around the world and in Israel.

Possible solution: Neuro-pedagogy

The urgency in dealing with the influence of neuromyths and the desire to base teaching on decision-making based on empirical information, led to the development of neuro-pedagogy, merging neuroscience, psychology and education. This field allows for a better understanding of teaching-learning processes on a theoretical and practical level [27,28]. This interdisciplinary approach may influence education policy, resource allocation and planning and intelligent implementation of teaching-learning methods based on scientific evidence [29,30].

The implementation of neuro-pedagogy in Israel

In Israel, the field of neuro-pedagogy is fairly new; however, it is expanding and growing. Many universities and colleges in Israel are starting to understand the importance of neuro-pedagogy courses in debunking neuromyths. In 2016, a College of Education in Israel established a model for neuro-pedagogy (The Achva Model of Neuro-pedagogy). The Achva college created a special center of neuro-pedagogy, whose main purpose was to make the connection between neuroscience and education in teaching; however, so far, their program was tested on only a few students undertaking their masters' degree. In other colleges of education, it is possible to find some elective courses and seminars on the topic, but the topic is almost always presented in a set curriculum, and not implemented in other courses. In addition, this year, for the first time, the "Applied Neuro-pedagogy" specialization was opened at the Mofet Institute. The internship is led by a team of neuroscientists and pedagogues. This specialization is the beginning of the assimilation of the field among education leaders in Israel. Despite, the changes and awareness of the importance in neuro-pedagogy in Israel, this field is still quite new and many of the Israeli teachers are not yet familiar with neuromyths and their effects on education. This study, therefore, suggests that in-order to find a solution for neuromyths in Israel we must educate our teachers about neuroscience and its effects on education, transforming neuromyths to neuro-truths. This approach may affect education policy, resource allocation and inform planning and implementation of teaching-learning methods based on scientific evidence [29,30].

Materials and Methods

Participants

This research study was conducted among 86 teachers from Israel. Most of the participants were women (90,7%) under the age of 30. The demographic characteristics of the sample are presented in (Table 1):

Table 1: Distribution N, (%) of teachers-subjects, According to personal characteristics.

		N	%	Total
Sex	Women	78	90,7	100%
	Men	8	8,3	
Age	under 30	34	39,4	100%
	31-40	15	17,5	
	41-50	22	25,6	
	more that 51	15	17,5	
Seniority	Up to 5 lat	49	57	100%
	06-Oct	10	11,6	
	Nov-15	4	4,7	
	16-20	8	9,3	
	More than 20	29	17,4	
Profession	student	28	32,6	100%
	teacher	19	22,1	
	educator	25	29,1	
	other	14	16,2	

Procedure

The subjects of the study were recruited from selected regions of Israel. An e-mail with a link to the online questionnaire was sent to the management team, with a request to send it to the employed teachers. The study was presented as an attempt to gather information on teachers' views on the application of brain research findings to education. The term neuromyths was not mentioned in the information for teachers. The online neuromyths questionnaire contained 28 statements about the brain and its effects on learning. Of these, 21 statements were educational neuromyths as defined by the Organization for Economic Co-operation and Development (2002) and Howard-Jones et al. questionnaire (2009). The accuracy of the selection and division (into myths and facts) of questions made is confirmed, among others, by the publication of Torrijos-Muelas et al. [20]. The remaining seven statements were general factual statements about the brain. The order in which the statements about myths and facts were presented was random. The questionnaire consisted of a three-option answer format with participants answering "correct", "incorrect" or "I don't know". The dependent variables were the percentage of the above-mentioned responses to neuromyth statements (where a higher percentage of adverse responses reflects more faith in myths) and the percentage of the above-mentioned responses to factual statements (where a higher percentage of correct answers indicates a higher level of knowledge). In addition, teachers provided basic information about their age, gender, seniority, profession.

Data Analysis

Data was analysed using the Social Sciences Statistics Package (SPSS) version 26.0 for windows. The statistical threshold of α=0.05 was used in all analyses. Rho-Spearman correlation tests were performed to investigate the relationship between the dependent and independent variables. In another analysis, the correlation between the percentage of incorrect answers to questions about neuromyths and the percentage of correct answers to questions about neurofacts was checked. In addition, the correlation between the independent variables was also checked.

Results

Overall, about 55% of teachers believe in every third neuromyths (including 14% which indicate support for half of the neuromyths included in the questionnaire). The most popular myths in Israel are: Positive emotions increase the amount of dopamine in the brain and children achieve better academic results (86,0%); People learn better when they receive information in their preferred learning style (e.g. auditory, visual, kinesthetic) (93,0%); Children have many types of intelligence (95,3%). On the other hand, the following neuromyths were not commonly believed: Less than 10% of respondents believe that when we sleep, the brain turns off (2,3%); Excessive media use does not change the brain in children (5,8%); Mental abilities are hereditary and cannot be changed by the environment or experience (5,8%). Some surprising results included the following: 34,9% of responders answered, "I don't know" when responding to the neuromyth "Learning difficulties related to differences in brain development cannot be corrected by education", which is surprising as it was expected that educators, both new and ones with several years teaching experience, would know that of the effect that education can have on learning difficulties (Table 2).

Table 2: The answers for each neuromyth and correlations between them and gender, age and seniority

Neuromyths	Correlations					
	% answer			Gender	Age	Seniority
	% correct	% incorrect	% I don't know	Rs	Rs	Rs
When we sleep, the brain turns off.	93,0	2,3	4,7	0,049	0,031	0,002
Excessive media use does not change the brain in children.	61,6	5,8	32,6	0,080	-0,086	-0,221*
Mental abilities are hereditary and cannot be changed by the environment or experience.	77,9	5,8	16,3	0,080	0,148	0,086
If students don't drink enough water (= 6-8 glasses a day), their brains will shrink.	38,4	8,1	53,5	0,095	-0,079	-0,121
Learning difficulties related to differences in brain development cannot be corrected by education.	57,0	8,1	34,9	0,095	0,133	0,110
The brains of boys and girls develop at the same rate.	58,1	12,8	29,1	0,123	0,038	0,018
The enhancement of the sense of touch in blind people is due to an increase in the number of receptors in the fingers and not to changes in the brain (this is called the compensation process).	40,7	14,0	45,3	0,129	0,240*	0,172
Children are less attentive after eating sweet drinks and / or snacks.	51,2	22,1	26,7	-0,119	-0,086	-0,094
Multitasking increases work efficiency.	65,1	22,1	12,8	0,074	0,134	0,127
Children must acquire their native language before learning a second language. If they don't, no language will be fully mastered.	55,8	29,1	15,1	0,117	0,140	0,048
People can learn new information, such as new languages, while they sleep.	33,7	30,2	36,0	-0,051	-0,183	-0,095
There are critical periods in childhood regarding the learning of different skills. If the child does not master them at that time, then it will be impossible.	52,3	33,7	14,0	-0,026	0,219*	0,089
We use only 10% of our brain.	16,3	44,2	39,5	0,043	-0,199	-0,150
Human memory works like a tape recorder or video camera and accurately records the events we've experienced.	39,5	48,8	11,6	0,233*	-0,081	-0,029
Differences in the dominance of the hemisphere (left / right) can help explain individual differences between students.	10,5	48,8	40,7	-0,088	-0,112	-0,134
It has been scientifically proven that fatty acid supplements (omega-3 and omega-6) have a positive effect on academic achievement.	5,8	48,8	45,3	0,153	0,034	0,028
Children from stimulus-rich environments have a better developed nervous system.	16,3	60,5	23,3	0,069	-0,288**	-0,190
Short exercises in educational kinesiology can improve the integration of the left and right hemispheres of the brain.	0	60,5	39,5	-0,095	-0,177	-0,134
Positive emotions increase the amount of dopamine in the brain and children achieve better academic results.	3,5	86,0	10,5	-0,013	-0,081	-0,056
People learn better when they receive information in their preferred learning style (e.g. auditory, visual, kinesthetic).	4,7	93,0	2,3	0,069	0,267*	0,365**
Chldren have many types of intelligence.	0,0	95,3	4,7	0,119	-0,045	-0,050

Source: **correlation significant at the level of 0.01; *correlation significant at the level of 0.05.

Detailed analyses with the Spearman's rho test in relation to individual neuromyths revealed significant correlations. Gender turned out to be a factor differentiating responses to the perception of human memory (Rs=0,233, p=0,05). Men more often presented a low level of faith that the human brain is able to "register" everything that is going on around (M: 12,5%, F: 52,6%). The seniority differentiated the respondents' results regarding the harmful influence of the media (Rs=-0,221, p=0,05) and the individualization of teaching based on the styles of education (Rs=0,365, p=0,01). The age of the respondents was the factor differentiating the answers to the greatest number of statements. With the age of the respondents, the level of faith in the need to provide the child with a maximally stimulating environment is lower (under 30 age: 57, 6%; more than 51 age: 20% incorrect answers). A similar correlation is seen with regard to the stability of IQ level (no possibility of developing it through school activities) (Under 30: 51, 5%; more than 51: 13, 3%). With regard to the learning style, the level of belief in this myth decreased with the age of the respondents (Under 30: 100%; more than 51: 86.6%). The same relationship concerned the belief in the existence of critical periods in development (under 30: 51.5%; more than 51: 40%) and the lack of compensatory changes in the brain after injuries (under 30: 27.3%; more than 51: 13, 3%). Teachers who have been teaching the longest were more likely to believe that the media had no harmful effect on the children's brain (up to 5 years of work: 2,1%; more than 20 years: 20%), and were less often convinced of the unconditional effectiveness of the use of teaching styles in education (up to 5 years of work: 100%; more than 20 years: 86,7%) (Table 2).

With regard to neurofacts, only about 13% of the respondents gave correct answers to 7 out of 9 statements. Every third respondent gave a correct answer to less than 4 statements. The least correct answers concerned "Regular drinking of caffeinated beverages reduces mindfulness" (27,9%), "Girls and boys can see differences: why dyslexia and autism are common in boys and depression in girls" (34,9%) and "Learning occurs through the use of modifications to the neural connections in the brain" (39,5%) (Figure 1).

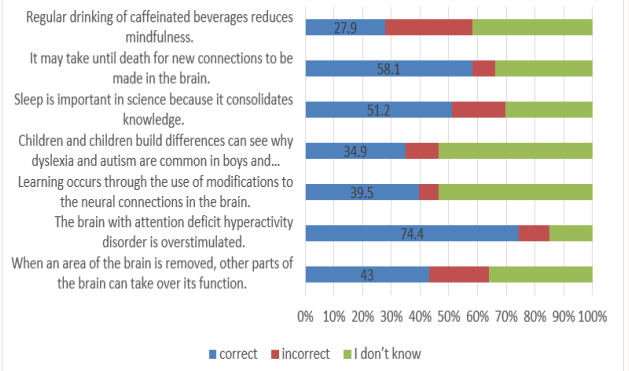

Figure 1: The % of correct answers for each neurofact statement.

The analysis of correlation did not show any dependence of the general level of knowledge on gender. The age of teachers correlated with knowledge in terms of 4 items. The older the teacher who was tested, the less often he/she gave correct answers in terms of brain plasticity and lifelong learning (under 30 years old: 100% correct answer; more than 51: 73,3%) and specifically in terms of brains in children with different disorders (Under 30: 84,8%; more than 51: 66,7%). The opposite was the case with knowledge about the compensatory plasticity of the brain (under 30: 21.2%; more than 51: 66.7%) and developmental plasticity (under 30: 39,4%; more than 51: 73,3%). Seniority negatively correlated with the level of knowledge about brain plasticity (Under 5 years of work: 36,2%; more than 20: 60%), the consequences of differences in the brain structure of girls and boys (22,5%; 53,3%), and the ability to learn until death (46,9%; 80%). Generally, teachers with more seniority, gave more correct answers (Table 3). The Rho-Spearman analysis also showed a positive correlation between the general level of belief in neuromyths and the level of knowledge in the field of neurofacts. The less knowledge in the field of neurobiology, the greater the belief in neuromyths (Rs= 0.709; p=0.01).

Table 3: Correlation between neurofacts and gender, age and seniority.

Neurofacts	Gender	Age	Seniority
	Rs	Rs	Rs
To learn how to do something, pay attention to it.	0,021	0,302**	0,065
When an area of the brain is damaged, other parts of the brain can take over its function.	0,036	-0,372**	-0,281**
By knowing more about our brain, we can improve our quality of life.	-0,013	-0,117	-0,172
The brain of children with attention deficit hyperactivity disorder (ADHD) is over-stimulated.	0,179	0,215*	0,152
The learning process takes place through the modification of brain neurons.	0,066	-0,015	0,136
Differences in the structure of the boys 'and girls' brains may explain why dyslexia or autism are more common in boys and depression in girls.	0,066	-0,101	-0,256*
Sleep is important in science, because during this dream phase we consolidate what we learn.	0,007	-0,066	-0,110
Students show preferences regarding the mode in which they absorb information more easily (e.g. visual, auditory, kinesthetic)	0,021	-0,104	0,003
Making new connections in the brain can last until death	-0,041	-0,332**	-0,264*

Source: **Correlation significant at the level of 0.01; *Correlation significant at the level of 0.05.

Discussion

The aim of the research was to investigate the perception of neuromyths and neurofacts among teachers in Israel. 86 educators were included in the research. The obtained results illustrated the great popularity of neuromyths among teachers. As in other countries, the most popular were claims about multiple intelligences, teaching styles, stress-free learning, educational kinesiology. Over 80% of respondents believe that myths related to these topics are true. The following independent variables influenced the obtained answers: age, gender and seniority of the respondents, with the responses most often differentiated by the age of teachers (5 out of 24 statements). Neuromyths conditioned by both age and seniority was the level of belief in the positive impact of individualization of teaching based on learning styles. A high level of belief in neuromyths is associated with a low level of basic knowledge in the field of neurobiology. Only 13% of the teachers answered correctly to all the statements marked as neurofacts. Age and seniority differentiated the answers in 5 out of 9 statements, mainly concerning the problems of brain plasticity (compensatory and developmental) and the consequences of gender differences on the frequency of occurrence of selected developmental disorders in children. With regards to the latter, these insights into developmental disorders are recent discoveries and this may explain why older teachers are not familiar with the studies. It can therefore be assumed that increasing the availability of the latest neurobiological knowledge among senior teachers would contribute to an increased number of correct answers to test tasks in the field of neurofact and a decrease in the level of faith in neuromyths.

Conclusion

Based on the results from this study, it would be justified to suggest that additional training for educators in neuroeducation would be beneficial. This is reinforced by the fact that over 90% of the surveyed teachers expressed an interest in increasing their competencies in this field through training, with more availability of relevant articles or courses during their teaching studies. These assumptions are consistent with published studies or reviews to date, in which the authors suggest the effectiveness of this type of additional training. Further research would be valuable in order to obtain information on the use of neuromyths in educational practice among teachers in Israel. This would make it possible to clarify the content scope of additional neuroeducational training to help determine whether it should primarily contain general knowledge about the brain that incorporates the latest neuroscientific research and shapes the ability to think critically, or rather whether it should focus on debunking existing myths and presenting the truth behind these myths according to scientific research.

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