Trends in Neuroscience and Education 34 (2024) 100221

Contents lists available at ScienceDirect

Trends in Neuroscience and Education

journal homepage: www.elsevier.com/locate/tine

Research paper

Educational neuromyths and instructional practices: The case of inclusive education teachers in Hong Kong

Po-yin Tsang *, Gill Althia Francis, Elpis Pavlidou

Department of Education, the University of York, York, England, UK. YO10 5DD

ARTICLE INFO

Keywords:
Neuromyths
Instructional practices
General knowledge of the brain
Special education needs
Teachers

ABSTRACT

Background: Educational neuromyths are known to exist amongst teachers in Western countries, and some researchers argue that neuromyths may affect classroom teaching.
Method: An online survey was designed and distributed to sixty-four Hong Kong inclusive education teachers. Descriptive statistics, Pearson's correlation, Hierarchical Multiple Regression, and Thematic analysis were used to analyzed the collected data.
Results: First, there is a relatively low prevalence of neuromyths among Hong Kong teachers. Second, neuromyths were not significantly correlated with inclusive teachers' instructional practices. Third, teachers' general knowledge of the brain was significantly correlated with neuromyths and is a significant predictor of neuromyths. Fourth, the work-related stress of teachers was the main barrier to learning about neuroscience and adopting evidence-based practices in classroom teaching in Hong Kong.
Conclusion: Our findings raise awareness of environmental and cultural factors that need to be considered and might affect the prevalence of neuromyths studies in non-WEIRD contexts.

1. Introduction

For the past two decades, research has focused on exploring neuromyths as a potential threat to evidence-based pedagogy. A neuromyth refers to "a misconception generated by a misunderstanding, a misreading, or a misquoting of facts scientifically established (by brain research) to make a case for the use of brain research in education and other context" (Organization for Economic Co-operation and Development ([1], p.111). Torrijos-Meulas [2] reviewed 24 neuromyths studies and found that teachers from at least ten countries (i.e., the majority in Europe and America) generally agreed with around 40 %–80 % of the neuromyths statements; this prevalence is also consistent with findings from individual studies (e.g., [3–5]). These neuromyths studies implied that educational neuromyths are popular amongst teachers in different nations. However, only a handful of studies report the prevalence rates of neuromyths in Asia and none of the studies consider its effect on inclusive education teachers in Asia. Although there is a high volume of neuromyths studies in Western countries, these studies may not be appropriate to understand how neuromyths influence pedagogy in Asian contexts because of cultural or environmental differences. Hence, this study aimed to investigate the prevalence of educational neuromyths in Hong Kong and the potential effect of Hong Kong teachers' instructional practices when working with special education needs (SEN) students.

Many studies report that those educational neuromyths which are prevailing among teachers are related to learning styles, hemispheric dominance, and perceptual-motor training (e.g., [3,6–9]). As OECD warned, at the heart of these myths is a misinterpretation of neuroscience findings, which consequently may threaten classroom teaching [1]. However, the proposed effect of neuromyths on classroom teaching and other pedagogical practices is controversial largely due to a lack of studies exploring the relationship between neuromyths and instructional practices. To our knowledge, a survey by Ruhaak and Cook [10] is the only one exploring the relationship between neuromyths and instructional practices in special education. They recruited 129 pre-service special education teachers in the USA to gauge their views on neuromyths, general knowledge of the brain, and intent to implement instructional practices. Their findings showed that the teachers' ability to identify neuromyths were positively correlated with effective instructional practices for special education needs (SEN) students. In other words, teachers with a higher ability to identify neuromyths were more likely to select effective, evidence-based instructional practices. Ruhaak and Cook [10] also mentioned that some neuromyths-based

* Corresponding author.
E-mail address: pauline.t@alumni.york.ac.uk (P.-y. Tsang).

https://doi.org/10.1016/j.tine.2024.100221
Received 15 October 2023; Received in revised form 25 January 2024; Accepted 25 January 2024
Available online 1 February 2024

instructional practices have been frequently used by special education teachers. For instance, perceptual-motor training is found to have a mean effect size of approximately zero [11]; nevertheless, Ruhaak and Cook [10] found that nearly 30 % of special education teachers responded that they used perceptual-motor training at least once weekly. These findings suggest that neuromyths-based instructional practice may be used fairly frequently with SEN students but this might be avoided if teachers are able to identify neuromyths.

A range of variables may be associated with educational neuromyths including general knowledge of the brain, neuroscience training, and a habit of watching or reading popular science or scientific journals [2]. Having an accurate general knowledge of the brain is found to be associated with fewer neuromyths (e.g., [8,12,13]). Alternatively, several researchers have argued that a general knowledge of the brain fails to prevent the spreading of neuromyths (e.g., [3,14,15]). Consequently, findings about the influence of general brain knowledge on educational neuromyths remain controversial. Similarly, with regard to professional training in neuroscience, on the one hand, researchers found that teachers with fewer neuromyths had more training in neuroscience (e.g., [6,10,16–18]). On the other hand, some researchers argued that professional training had no impact on educational neuromyths (e.g., [19–21]). It appears that the effectiveness of professional training in reducing neuromyths' prevalence amongst teachers is also inconclusive. Likewise, the habit of watching or reading popular science and scientific journals is also under debate. Some researchers found that improving the knowledge of neuroscience through popular science or scientific journals could predict fewer neuromyths, thereby preventing the spreading of neuromyths (e.g., [12,16,22]). Whilst, other researchers claim that popular science may serve to strengthen neuromyths belief due to oversimplified and overinterpreted information by the media [23,24]. Moreover, some findings indicate that further work is needed to identify factors that are likely to predict the prevalence of neuromyths in education or moderate the influence of educational neuromyths on instructional practice (e.g., [3,25]).

In light of the aforementioned discussion, this study addressed the gap in knowledge about the potential risk of neuromyths in teaching SEN students amongst in-service inclusive education teachers from Hong Kong. Hence, the purpose of this study was not only to investigate the prevalence of educational neuromyths, but also to examine the potential effect of educational neuromyths on the instructional practices of SEN teachers. Additionally, likely predictors of neuromyths and teachers' interest in learning about neuroscience were also investigated. Four research questions (RQ) guided this study:

RQ1: What is the prevalence of neuromyths, general knowledge of the brain, and instructional practices for SEN amongst Hong Kong inclusive education teachers?

RQ2: Are neuromyths correlated to instructional practices for SEN students and general knowledge of the brain?

RQ3: Does general knowledge of the brain account for unique variance in educational neuromyths?

RQ4: What factors influence teachers' interest in learning neuroscience?

2. Methods

2.1. Participants

The study comprised a total sample of 64 (females $n = 54$ and males $n = 10$) in-service inclusive education teachers with experience in teaching SEN students at kindergarten, primary, secondary, and tertiary education schools in Hong Kong. Participants' ages ranged from 22 to 56 ($M = 35.6$, $SD = 7.8$), and on average had approximately 9 years of teaching experience. Nearly 77 % of the participants did not have an educational background in neuroscience and more than half of the participants never received neuroscience training. Ethical approval for this study was obtained from the Department of Education, University of York. An a-priori statistical power was undertaken using G*power software version 3.1 [26] to determine the minimum sample size to answer the research questions. Previously, Hughes et al. [27] and Tardif et al. [17] reported medium effect sizes $d = 0.32$ and $d = 0.47$, respectively, for their work investigating the educational neuromyths amongst teachers and student teachers; hence a medium effect was used for the power analysis. The G*power analysis results indicated the required sample to achieve 95 % power for detecting a medium effect ($d = 0.5$), at a significance criterion of $\alpha = 0.05$ was $n = 42$ for multiple regression analyses. Therefore, the sample size ($n = 64$) obtained was adequate for this study.

2.2. Measures

2.2.1. Questionnaire

An online questionnaire comprising four sections was administered. The first section collected demographic information about participants' age, gender, educational background, and teaching experience as well as information on participants' reading habits and sources of learning about neuroscience. The second section is the subscale of neuromyths and general knowledge of the brain; it contains 35 statements (10 statements of educational neuromyths and 15 statements of general knowledge of the brain) with three response options (i.e., *true, false,* or *do not know*) developed by [3]. These statements have been validated in many neuromyths studies (e.g., [10,12,18]). The third section is the subscale of 12 instructional practices for SEN students with a 4-point Likert scale (*always, often, not often*, and *never*). The subscale was originally designed by [10] using the findings of the meta-analysis studies of effective and ineffective instructional practices among special education teachers by [11] and [28]. The subscale has a short briefing for the 12 instructional practices and those descriptions mainly reference [11,28], and [29]. The fourth section is an open-ended question "*Would you like to learn more about neuroscience?"* to explore the reason to learn (or not learn) neuroscience. This open-ended question was added to learn more about Hong Kong teachers' interest in neuroscience which could help understand the motivation and barrier to learning neuroscience amongst Hong Kong teachers and to consider whether teachers could benefit from professional training in the future.

2.2.2. Validity and reliability of questionnaire

Back translation using a collaborative approach was implemented to ensure the reliable and effective translation between Chinese and English and also to avoid cultural bias in the questionnaire. The procedure of the back translation, a collaborative approach, was adopted from the suggestions of Harkness [30] and Douglas and Craig [31]. Five experts or professionals formed a team who worked together to translate the questionnaire. All translators held psychology degrees and had academic qualifications and working experience in education and bilinguistics (Chinese and English). At first, the team held an online meeting to agree on the meaning equivalence in the translation. Then, an author translated the original version (English) into Chinese. After that, two Hong Kong translators reviewed the translation quality and back-translated it into English, respectively. Finally, the other two Chinese British translators compared and proofread the translations.

Pilot testing was also used to evaluate the survey before formal data collection. Three Hong Kong teachers with experience in early childhood, primary, secondary, or tertiary education were invited to this test. The use of jargon in the background information and open-ended sections of the questionnaire was found as a main concern, for example, the term "educational neuroscience" is difficult to translate into Chinese and could not be understood by Hong Kong teachers, so it was replaced with "brain-based education". Therefore, the revision reduced the professional words in section 1 (background information) and section 4 (open-ended question) but the three subscales were retained.

Moreover, the reliability of the questionnaire was also processed after the data collection. Cronbach's alpha (α) for the whole questionnaire was calculated as $\alpha = 0.814$ (Subscale 1: Neuromyths' statements, $\alpha = 0.62$; Subscale 2: Statements of general knowledge of the brain, $\alpha = 0.80$; Subscale 3: Instructional practices for SEN students, $\alpha = 0.80$) which indicated that the instrument had good internal consistency.

2.3. Procedure

Inclusive education teachers working with SEN students in Hong Kong were invited to spend 20 min completing an online questionnaire via *Qualtrics*, which was promoted on social media (i.e., *Facebook* and *WhatsApp*). All contents were presented in traditional Chinese at first and followed in English. The research purposes and the participants' rights were mentioned on the webpage of the *Qualtric* system. The visitor could choose the button "yes" (agree) to complete the questionnaire or "no" (disagree) to log out of the system. All questions were set closed (compulsory) to minimise the likelihood of missing data. The research invitation was posted for two weeks.

2.4. Data analysis approach

2.4.1. Scoring procedures

The study's three main variables are neuromyths (prevalence and accuracy), general knowledge of the brain, and instructional practices for SEN students. The prevalence of neuromyths was calculated from incorrect responses ("do not know" was not included), while the accuracy of neuromyths was computed from correct responses to the 10 statements. These presentations were adopted from the relevant studies (e.g., [3,10]). Similarly, the variable of general knowledge of the brain was also calculated from the accurate and inaccurate responses of the 15 statements. In addition, the instructional practices for SEN students were quantified into the "practice differential score" (PDS), which was adopted from Ruhaak and Cook [10]. PDS results from the difference between the mean rating of effective instructional practices (i.e., *always*= 3, *often*= 2, *not often*= 1, *never*= 0) and the mean rating of neuromyth-based instructional practices. Therefore, PDS is used to indicate if participants tend to implement instructional practice effectively (PDS over 0) or if instructional practices are based on neuromyths (PDS under 0).

2.5. Statistical analyses

The data were analyzed using the Statistical Package for the Social Science (SPSS) version 28.0 for Windows. Thirty-one participant responses were excluded from the analyses because the questionnaire was incomplete. Descriptive statistics summarized the prevalence of neuromyths, general knowledge of the brain, and instructional practices for SEN amongst Hong Kong inclusive education teachers (RQ1). Pearson's *r* correlation coefficient was computed to examine the relationship between neuromyths and instructional practices for SEN students (RQ2) and between neuromyths and general knowledge of the brain (RQ2). Hierarchical multiple regression (HMR) analysis determined whether general knowledge of the brain was uniquely associated with educational neuromyths (RQ3). Demographic background variables - age, gender, education level, years of teaching experience, and interest in neuroscience were controlled for in block 1; neuroscience training, watching or reading popular science and scientific journals in block 2; and general knowledge of the brain in block 3.

2.5.1. Qualitative data analysis

Qualitative data were collected to understand the factors that influence teachers' interest in learning about neuroscience (RQ4) and analyzed using a thematic analysis approach. Themes were checked using inter-coder reliability following the suggestions from Haney et al. [32] and Stemler [33]. Two coders who were registered teachers in Hong Kong identified primary codes and listed out the features of the data. After classifying and categorizing the features of the data; the coders edited a codebook for data coding individually. Finally, the 98 % inter-coder reliability was slightly more than the suggested 95 % by Stemler [33].

3. Results

3.1. RQ1. What is the prevalence of neuromyths, general knowledge of the brain, and instructional practices for SEN students amongst Hong Kong inclusive education teachers?

3.1.1. Educational neuromyths

On average, the prevalence of educational neuromyths in this study was 39 % (*SD* = 16 %) which means that participants agreed with 39 % of the neuromyths statements (i.e., answered inaccurately). Table 1 shows that more than half of the participants agreed with the learning styles (item 1), followed by perceptual-motor training (items 1 and 2) and supplement effects (item 4). Notably, one statement of learning styles (item 10) had the highest accuracy rate, whereas another had the

Table 1
Percentage of responses to the neuromyths statements.

Item	**Neuromyths statements**	Inaccurate (%)	Accurate (%)	Do not know (%)
1	Individuals learn better when they receive information in their preferred learning style. (F) *	90.6	6.3	3.1
2	Short bouts of coordination exercises can improve integration of left and right hemispheric brain function. (F) #	68.8	23.4	7.8
3	Exercises that rehearse coordination of motor-perception skills can improve literacy skills. (F) #	67.2	9.4	23.4
4	It has been scientifically proven that fatty acid supplements (omega-3 and omega-6) have a positive effect on academic achievement. (F) ˆ	57.8	18.8	23.4
5	Differences in hemispheric dominance (left brain, right brain) can help explain individual differences among learners. (F)	57.8	28.1	14.1
6	Children must acquire their native language before a second language is learned. If they do not do so, neither language will be fully acquired. (F)	18.8	70.3	10.9
7	Learning problems associated with developmental differences in brain function cannot be remediated by education. (F)	10.9	82.8	6.3
8	Extended rehearsal of some mental processes can change the shape and structure of some parts of the brain. (T)	9.4	64.1	26.6
9	There are critical periods in childhood in which certain things can no longer be learned. (F)	9.4	85.9	4.7
10	Individual learners show preferences for the mode in which they receive information (e.g., visual, auditory, or kinesthetic). (T) *	1.6	96.9	1.6

Note. F=false; T= true.
* Statement is related to learning styles. # Statement is related to perceptual-motor training.
ˆ Statement is related to supplements effects.

lowest (item 1).

3.2. General knowledge of the brain

Concerning the general knowledge of the brain, participants answered correctly to nine out of 15 statements, an average ($M = 63$ %, $SD = 17$ %). Over 50 % of participants answered at least eleven statements correctly which shows that participants had a good general knowledge understanding of the brain (see Table 2).

3.3. Instructional practices for SEN students

Participants' use of effective instructional practices or neuromyth-based practices was explored. As previously mentioned, PDS is used to show if participants tend to use effective instructional practices (PDS over 0) or neuromyth-based practices (PDS under 0). In this study, approximately 95 % of participants had PDS scores greater than 0 indicating that they tended to implement effective practices for SEN students instead of neuromyth-based practices. Table 3 demonstrates that the most used forms of instruction were formative evaluation ($n = 39$, 61 %), followed by mnemonic strategies ($n = 29$, 45 %), and applied behavior analysis ($n = 28$, 44 %). It is notable that the top three instructional practices were evidenced as effective practices for SEN students. By contrast, neuromyth-based instructions were used less. Approximately, one-third of participants responded that they "never" implemented the neuromyth-based instructions of neurological repatterning ($n = 31$, 48 %), hemispheric dominance training ($n = 30$, 37 %), and multiple intelligences questionnaires ($n = 23$, 36 %).

Table 2
Percentage of responses to the general knowledge of brain statements.

Item	General knowledge of brain statements	Inaccurate (%)	Accurate (%)	Do not know (%)
1	We only use 10 % of our brain. (F)	59.4	17.2	23.4
2	When a brain region is damaged other parts of the brain can take up its function. (T)	35.9	45.3	18.8
3	Circadian rhythms ("body-clock") shift during adolescence, causing students to be tired during the first lessons of the school day. (T)	31.3	25.0	43.8
4	Vigorous exercise can improve mental function. (T)	28.1	43.8	28.1
5	Learning is due to the addition of new cells in the brain. (F)	21.9	50.0	28.1
6	Brain development has finished by the time children reach secondary school. (F)	18.8	68.8	12.54
7	Learning occurs through modification of the brain's neural connections. (T)	14.1	56.3	29.7
8	Production of new connections in the brain can continue into old age. (T)	12.5	60.9	26.6
9	We use our brains 24 hr a day. (T)	12.5	82.8	4.7
10	The brains of boys and girls develop at the same rate. (F)	9.4	68.8	21.9
11	The left and right hemispheres of the brain always work together. (T)	9.4	84.4	6.3
12	Information is stored in the brain in a network of cells distributed throughout the brain. (T)	7.8	75.0	17.2
13	Mental capacity is hereditary and cannot be changed by the environment or experience. (F)	6.3	89.1	4.7
14	Normal development of the human brain involves the birth and death of brain cells. (T)	3.1	84.4	12.5
15	There are sensitive periods in childhood when it is easier to learn things. (T)	1.6	93.8	4.7

Note. F=false; T= true.

Table 3
Percentage of responses to the implementation of instructional practices for SEN students.

Instructional practices	Always (%)	Often (%)	Not often (%)	Never (%)
Formative evaluation[a]	60.9	23.8	4.7	1.6
Mnemonic strategies[a]	45.3	50.0	4.7	0.0
Applied behavior analysis[a]	43.8	42.2	10.9	3.1
Modality training[b]	40.6	39.1	12.5	7.8
Direct instruction[a]	37.5	51.6	10.9	0.0
Learning style inventories[b]	20.3	26.6	32.8	20.3
Teaching to multiple intelligences[b]	18.8	51.6	21.9	7.8
Psycholinguistic training[b]	14.1	48.4	20.3	17.2
Perceptual motor training[b]	7.8	35.9	40.6	15.6
Multiple intelligences questionnaires[b]	6.3	20.3	37.5	35.9
Hemispheric dominance training[b]	4.7	6.3	42.2	46.9
Neurological repatterning[b]	3.1	17.2	31.3	48.4

[a] *Note.* Effective instructional practice was proved by [29] and [28].
[b] Neuromyth-based or ineffective instructional practice, which lacks evidence to support it is effective or evidenced as small size effect by [29] and [28].

3.4. RQ2. Are neuromyths correlated to instructional practices for SEN students and general knowledge of brain?

3.4.1. Correlation results

Table 4 shows Pearson's r correlations coefficient for the three main variables (neuromyths, general knowledge of brain, and instructional practices). Neuromyths accuracy had a significantly medium and positive correlation with the accuracy of general knowledge of brain [r (62) = 0.46, $p < 0.001$]. However, the accuracy of the neuromyths was not significantly correlated with the instructional practices for SEN students [r (62) = 0.12, $p = 0.360$]. In other words, the participants who were accurate in answering neuromyths statements responded more accurately to general knowledge of the brain; however, both neuromyths and general knowledge of the brain had no significant correlation with the instructional practices for SEN students.

3.5. RQ3: do general knowledge of brain account for unique variance in educational neuromyths?

3.5.1. Predictors of the educational neuromyths

A Hierarchical Multiple Regression (HMR) was used to examine if general knowledge of the brain accounted for unique variance in educational neuromyths over and beyond age, gender, education level, years of teaching experience, and interest in neuroscience in block 1; while neuroscience training, watching or reading popular science and scientific journals in block 2. In Table 5, block 1 was not significant but

Table 4
Pearson's r correlations coefficient for three main variables.

Variables	1	2	3
• Practice differential score (PDS)	—		
• Accuracy of the neuromyths	.116	—	
• Accuracy of the general knowledge of brain	.030	.462**	—

Note. **$p < 0.01$.
Three main variables were neuromyths ($M = 4.86$, SD=1.71), instructional practices for SEN students (presents as PDS) ($M = 1.02$, SD=0.73), and general knowledge of the brain ($M = 9.45$, SD=2.47).

Table 5
Hierarchical multiple regression of the predictors to predict the accuracy of neuromyths.

Predictor variables	Step 1			Step 2			Step 3		
	B	R^2	ΔR^2	B	R^2	ΔR^2	B	R^2	ΔR^2
		.11	.11		.26	.16*		.37	.11**
Constant	50.604*			61.222**			43.156*		
Age	0.815			0.459			0.275		
Gender	−0.935			−2.932			−1.895		
Education level	−5.852			−5.031			−6.277		
Years of teaching experience	−0.995*			−0.569			−0.619		
Interest in neuroscience	−3.217			−7.103			−6.411		
Popular science				−1.772			−1.477		
Scientific journals				6.341			4.149		
Neuroscience training				5.534			3.314		
Accuracy of the general knowledge of brain							2.938**		

Note. $^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

accounted for 11 % variance [F (5,55) = 1.29, p = 0.280] and block 2 significantly accounted for 26 % variance [F (8,52) = 2.31, p = 0.034]. General knowledge of the brain added in Block 3 significantly accounted for 37 % variance [F (9,51) = 3.29, p = 0.003] in educational neuromyths. Moreover, general knowledge of the brain was a significant predictor of the neuromyths (β = 2.94, t = 2.91, p < 0.005) adding an additional 11 % of variance to the final model. By contrast, none of the other teachers' characteristics (i.e., age, gender, education level, years of teaching experience, interest in neuroscience, popular science, scientific journal, and neuroscience training) were significant predictors; although years of teaching experience years of teaching experience was significant in block 1 (β = −1.0, p = 0.029) but it failed to retain significance in block 2 (β = −0.57, p = 0.200) and block 3 (β = −0.62, p = 0.138). Furthermore, although Pearson's correlation analysis showed that scientific journals [r (62) = 0.342, (p = 0.006)] and neuroscience training [r (62) = 0.346, (p = 0.005)] were linearly correlated to the neuromyths; however, these associations did not retain significance once important factors were controlled suggesting that scientific journals and neuroscience training might not directly affect the neuromyths.

3.6. RQ 4. what factors influence teachers' interest in learning neuroscience?

3.6.1. Qualitative result

In total, 62 participants out of 64 responded to the open-ended question, "Would you like to learn more about neuroscience?". Over half of the participants (n = 41, 64 %) were interested in learning neuroscience, whereas nearly one-third were not keen to learn (n = 32, 33 %). Table 6 shows that most participants willing to learn neuroscience responded that students' learning and teachers' teaching could benefit from the knowledge of neuroscience. In addition, personal interest was another reason that inspired teachers. In terms of unwillingness, the main factors were work stress and neuroscience's complexity and inapplicability.

Table 6
Frequency and percentage of responses for willingness to learn neuroscience.

Categories	Reasons	Participants' response	
		Frequency	%
Willingness	Benefits of learning or teaching	24	34.78
	Interesting	13	18.84
	Reply 'yes' only (without reason)	4	5.80
	Useful and applicable for living	4	5.80
No willingness	Working stress	7	10.14
	Reply 'no' only (without reason)	4	5.80
	Useless or cannot apply for job duties or living	4	5.80
	Neuroscience is difficult to learn	4	5.80
	Not interesting	3	4.35
No response		2	2.90

Note. N = 64, frequency = 69.
Participants responded to the question, "*Would you like to learn more about brain-based education? Why do you want/do not want to know more about it?*".

4. Discussion

The present study aimed to investigate the prevalence of educational neuromyths (RQ1), and then examine the potential effect of educational neuromyths on the instructional practices of SEN teachers (RQ 2) in Hong Kong. Moreover, we explored a number of predictors of such neuromyths as well as SEN teachers' interest in learning neuroscience (RQ3 and RQ4). The findings are discussed below in the context of the available literature on the topic.

4.1. Prevalence

To begin, we found that the prevalence rate of neuromyths in Hong Kong was 39 % in line with the percentages reported by [2] who reported approximately 40 % to 85 % rates across ten countries. For example, 42 % in the UK [14]; 40 % in Caribbean nations [6]; 48 % in the USA, UK, and Australia [34], and 41 % in the USA [35]. However, this result is inconsistent with previously reported prevalence rates in China: Pei et al. [9] reported 57 % and Zhang et al. [18] found 61 %. One possible explanation for this discrepancy could be the urban-rural disparity in China. The studies by Pei et al. [9] and Zhang et al. [18] were conducted in rural provinces (e.g. Shandong, Jiangsu, Zhejiang, and Gansu) where there is a shortage of resources to acquire education. By contrast, Hong Kong is an international urban hub that presents far more opportunities for access to education, including the nine-year compulsory education policy. Hence, such marked differences in educational opportunities could partially account for the prevalence rate reported in our study.

4.2. Types

In terms of the main neuromyths identified, learning styles were the most prevalent. However, most participants agreed with both true (e.g. "*Individual learners show preferences for the mode in which they receive information.")* and false (e.g.*"Individuals learn better when they receive information in their preferred learning style.")* statements on learning styles, suggesting that their pattern of response might reflect their endorsement of neuromyths, but could also suggest the presence of acquiescence bias. Acquiescence bias is when the participant tends to agree with the statements despite those statements not truly reflecting their thoughts [36]. Interestingly and relevant to our findings, Papadatou-Pastou and colleagues [8] also identified acquiescence bias in neuromyths research which further strengthens this possibility in our sample too.

Furthermore, the supplement's myth (i.e., omega-3 and omega-6 have a positive effect on academic achievement) seems to be a unique finding to Hong Kong. A possible reason is related to the dominant health belief about supplements in Hong Kong.: A survey of "Hong Kong public knowledge of health supplements" indicated that approximately 50 % of Hong Kong residents spent over $20,000 (approximately US $2550) on the supplements monthly [37]. This suggests that supplements are popular in Hong Kong.

4.3. Impact on SEN instructional practices

Interestingly, we found that having accurate knowledge of educational neuromyths was not significantly correlated with the instructional practices for SEN students. This finding is inconsistent with the results of Ruhaak and Cook [10] in the USA. One possible explanation for this discrepancy may lie in the fact that in Hong Kong, teachers are expected to strictly follow and implement the government's guidelines and policies instead of their personal beliefs or thoughts in their teaching. In other words, the neuromyth-based instructional practice would not be widely implemented since it does not align with government policies. Another argument is that work stress may affect their willingness to apply evidenced-based instructional practices or promote the debunking of neuromyths in their classrooms. This possibility is further supported by teachers' open-ended responses where they highlight work-induced stress as the main reason for not pursuing further training on learning about neuroscience. Additionally, an original finding that is inconsistent with most studies in English-speaking countries involving WEIRD samples is that accurate knowledge of neuromyths had a significant positive correlation with the accuracy of general knowledge about the brain (e.g., [3,10,14,15,27]; but see [8,12,13] for opposite results in non-English and/or non-WEIRD studies). Given that Hong Kong has strict teaching policies it may mean that neuromyths are less likely to 'creep into' teachers' practice.

4.4. Predictors

Importantly, this study identified general knowledge of the brain as a key predictor of educational neuromyths (see [8,12] for similar findings) but not neuroscience training. Recent research argues that the quality of neuroscience training may be a confounding factor that affects the spread of neuromyths (e.g., [15,19,38]). Existing neuroscience training appears to be predominantly focused on transmitting basic neuroscience knowledge and much less on the importance of its application as well as the critical thinking skills that are fundamental to debunking neuromyths. In other words, neuroscience training as it is currently designed, does not act as a 'protective factor' in the prevention of the spreading of neuromyths.

Notably, many participants expressed interest in learning about neuroscience on the perceived benefit this knowledge might have on their classroom teaching and/or students' learning in line with Ruhaak and Cook [10] findings. On the other hand, when looking at what could stop teachers from engaging with neuroscience, the complexity of the brain appears to be a dominant factor (e.g., [3,10,39]). However, our study brought to light another potential barrier, that of work stress which reveals that teachers may 'resist' learning about neuroscience as a result of increased workload or "burn-out". Overall, our present study confirmed a number of findings surrounding neuromyths in WEIRD contexts that seem to apply to non-WEIRD contexts. But it also identified and highlighted new factors or barriers that might contribute to the prevalence, persistence, or debunking of neuromyths in non-WEIRD contexts and which should be explored in other contexts as well.

4.5. Limitations and future recommendations

This study highlighted the need to investigate a number of environmental and/or cultural factors that might contribute to the generation and persistence of neuromyths. Although some of those factors were explored in the qualitative component of our study (e.g., work-related stress); there are yet others, such as government policy and language barrier that were not. Clarifying the role of environmental or cultural factors is warranted in future research with the use of cross-cultural research designs and tools. We were also only able to focus on four evidence-based instructional practices. It is therefore clear that there is a need to explore more evidence-based instructional practices for SEN students in the future. Additionally, opting for a survey as a methodological tool has limited the exploration of in-depth attitudes and behaviors. The adoption of more qualitative methods such as focus groups or observations is suggested in further studies.

Moreover, the participants' invitations were distributed on social media (i.e., *Facebook* and *WhatsApp*), which limits participation in the study to only those who are active on these social media platforms (e.g., younger teachers may be more likely to respond to the survey in contrast to older teachers who may not be avid users of social media). A caveat of social media surveys is the extent to which it is representative of the target population by virtue of excluding participants that do not use the internet. This raises concerns that recruits are primarily participants with interest in the topic (e.g., only teachers with interest in brain based education will likely participate); hence they are over-represented in the sample, leading to concerns around the external validity of such studies [40]. To address this, future research could include other forms of recruitment like face-to-face, post, telephone, or other methods that can recruit participants who may not be found on social media; thereby increasing the representativeness of the sample. Additionally, researchers may also consider sampling participants from a defined population list so that socio-demographic data on non-responses can be collected upon recruitment and compared to respondents' data to ensure that there are no systematic differences between responders and non-responders [41]. Over 90 % of participants (n = 58) had teaching experience in primary school education, followed by early years (n = 18, 28 %) and secondary school education (n = 16, 25 %). A more balanced sample across all levels of education could be useful in future work to explore potential differences in the endorsement of neuromyths.

With the aforementioned in mind, a larger-scale study is recommended to provide more extensive data on neuromyths amongst teachers in Hong Kong. Second, we suggest that environmental or cultural factors are placed at the heart of neuromyths studies, especially for non-WEIRD samples. For instance, this study estimated that the differences in the prevalence of neuromyths might be influenced by the urban-rural disparity and language barrier and that the relationship between educational neuromyths and instructional practices may involve environmental characteristics (e.g., government policy or work-related stress).

5. Conclusion

Our study provided a much-needed set of preliminary data on the prevalence and types of neuromyths in Hong Kong, which will hopefully increase awareness of the spreading of such neuromyths in Asia. Although it appears that those educational neuromyths may not currently affect the instructional practices adopted by SEN teachers, they are yet subject to a number of environmental and cultural factors that should be given consideration in future studies with non-WEIRD populations. Placing an emphasis on promoting general knowledge of the brain in teacher training programmes, may be the key to designing tailor-made prevention policies to minimize the effects of neuromyths in Asian contexts. Nevertheless, identifying the range of factors contributing to the development and persistence of educational neuromyths in non-WEIRD contexts should be a continuous and imperative pursuit: It will allow for informed, evidence-based practices to enter the classroom so that all students are aided in reaching their full potential.

Ethical statement

Ethical approval for this study was provided by the ethics committee at the Department of Education, University of York.

Financial disclosure

There are no financial conflicts of interest to disclose.

CRediT authorship contribution statement

Po-yin Tsang: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gill Althia Francis:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Formal analysis, Conceptualization. **Elpis Pavlidou:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tine.2024.100221.

References

[1] Organisation for Economic Co-operation and Development, Understanding the Brain: Towards a New Learning Science, OECD, Paris, 2002.

[2] M. Torrijos-Muelas, S. Gonzalez-Villora, A.R. Bodoque-Osma, The persistence of neuromyths in the educational settings: a systematic review, Front. Psychol. 11 (2021), https://doi.org/10.3389/fpsyg.2020.591923, 591923–591923.

[3] S.J. Dekker, N.C. Lee, P. Howard-Jones, J. Jolles, Neuromyths in education: prevalence and predictors of misconceptions among teachers, Front. Psychol. 3 (2012) 1–8, https://doi.org/10.3389/fpsyg.2012.00429.

[4] P.A. Howard-Jones, Neuroscience and education: myths and messages. Nature reviews, Neuroscience 15 (12) (2014) 817–824, https://doi.org/10.1038/nrn3817.

[5] G. Krammer, S.E. Vogel, R.H. Grabner, Believing in neuromyths makes neither a bad nor good student-teacher: the relationship between neuromyths and academic achievement in teacher education, Mind Brain Educ. 15 (1) (2021) 54–60, https://doi.org/10.1111/mbe.12266.

[6] S. Bissessar, F.F. Youssef, A cross-sectional study of neuromyths among teachers in a Caribbean nation, Trend. Neurosci. Educ. 23 (2021) 100155, https://doi.org/10.1016/j.tine.2021.100155.

[7] J. Blanchette-Sarrasin, M. Riopel, S. Masson, Neuromyths and their origin among teachers in Quebec, Mind Brain Educ. 13 (2) (2019) 100–109, https://doi.org/10.1111/mbe.12193.

[8] M. Papadatou-Pastou, E. Haliou, F. Vlachos, Brain knowledge and the prevalence of neuromyths among prospective teachers in Greece, Front. Psychol. 8 (2017), https://doi.org/10.3389/fpsyg.2017.00804, 804–804.

[9] X. Pei, P.A. Howard-Jones, S. Zhang, X. Liu, Y. Jin, Teachers' understanding about the brain in East China, Procedia - Soc. Behav. Sci. 174 (2015) 3681–3688, https://doi.org/10.1016/j.sbspro.2015.01.1091.

[10] A.E. Ruhaak, B.G. Cook, The prevalence of educational neuromyths among pre-service special education teachers, Mind Brain Educ. 12 (3) (2018) 155–161, https://doi.org/10.1111/mbe.12181.

[11] M.K. Burns, J.E. Ysseldyke, Reported prevalence of evidence-based instructional practices in special education, J. Spec. Educ. 43 (1) (2009) 3–11, https://doi.org/10.1177/0022466908315563.

[12] M. Ferrero, P. Garaizar, M.A. Vadillo, Neuromyths in education: prevalence among Spanish teachers and an exploration of cross-cultural variation, Front. Hum. Neurosci. 10 (2016), https://doi.org/10.3389/fnhum.2016.00496, 496–496.

[13] E. Gleichgerrcht, B. Lira Luttges, F. Salvarezza, A.L. Campos, Educational neuromyths among teachers in Latin America, Mind Brain Educ. 9 (3) (2015) 170–178, https://doi.org/10.1111/mbe.12086.

[14] R.P. Bailey, D.J. Madigan, E. Cope, A.R. Nicholls, The Prevalence of Pseudoscientific Ideas and Neuromyths Among Sports Coaches, Front. Psychol. 9 (2018), https://doi.org/10.3389/fpsyg.2018.00641, 641–641.

[15] M. Kim, D. Sankey, Philosophy, neuroscience and pre-service teachers' beliefs in neuromyths: a call for remedial action, Educ. Philos. Theo. 50 (13) (2018) 1214–1227, https://doi.org/10.1080/00131857.2017.1395736.

[16] K. Macdonald, L. Germine, A. Anderson, J. Christodoulou, L.M. McGrath, Dispelling the myth: training in education or neuroscience decreases but does not eliminate beliefs in neuromyths, Front. Psychol. 8 (2017) 1314. https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01314.

[17] E. Tardif, P.-A. Doudin, N. Meylan, Neuromyths among teachers and student teachers, Mind Brain Educ. 9 (1) (2015) 50–59, https://doi.org/10.1111/mbe.12070.

[18] R. Zhang, Y. Jiang, B. Dang, A. Zhou, Neuromyths in Chinese classrooms: evidence from headmasters in an underdeveloped region of China, Front. Educ. (Lausanne) 4 (2019) 1–6. https://www.frontiersin.org/article/10.3389/feduc.2019.00008.

[19] S. Im, J.Y. Cho, J.M. Dubinsky, S. Varma, Taking an educational psychology course improves neuroscience literacy but does not reduce belief in neuromyths, PLoS. One 13 (2) (2018) e0192163, https://doi.org/10.1371/journal.pone.0192163.

[20] K. McMahon, C.S.-H. Yeh, P.J. Etchells, The impact of a modified initial teacher education on challenging trainees' understanding of neuromyths, Mind Brain Educ. 13 (4) (2019) 288–297, https://doi.org/10.1111/mbe.12219.

[21] A. Tovazzi, S. Giovannini, D. Basso, A new method for evaluating knowledge, beliefs, and neuromyths about the mind and brain among Italian teachers, Mind Brain Educ. 14 (2) (2020) 187–198, https://doi.org/10.1111/mbe.12249.

[22] S. Herculano-Houzel, Do you know your brain? A survey on public neuroscience literacy at the closing of the decade of the brain, Neuroscient. 8 (2) (2002) 98–110, https://doi.org/10.1177/107385840200800206.

[23] D.M. Beck, The appeal of the brain in the popular press, Perspect. Psycholog. Sci. 5 (6) (2010) 762–766, https://doi.org/10.1177/1745691610388779.

[24] D. Zambo, R. Zambo, What future teachers think about brain research, Teach. Educ. Psychol. 5 (2) (2009) 39–49.

[25] P. Varas-Genestier, R.A. Ferreira, Neuromyths among Chilean teachers: origins and predictors, Estudios Pedagógicos (Valdivia) 43 (3) (2017) 341–360, https://doi.org/10.4067/S0718-07052017000300020.

[26] F. Faul, E. Erdfelder, A. Buchner, A.-G. Lang, Statistical power analyzes using G*Power 3.1: tests for correlation and regression analyses, Behav. Res. Methods 41 (2009) 1149–1160.

[27] B. Hughes, K.A. Sullivan, L. Gilmore, Why do teachers believe educational neuromyths? Trend. Neurosci. Educ. 21 (2020) 100145 https://doi.org/10.1016/j.tine.2020.100145.

[28] S.R. Forness, Special education and related services: what have we learned from meta-analysis? Exceptionality 9 (4) (2001) 185–197, https://doi.org/10.1207/S15327035EX0904_3.

[29] K.A. Kavale, S.R. Forness, Policy decisions in special education: the role of meta-analysis, in: R. Gersten, E.P. Schiller, S. Vaughn (Eds.), Contemporary Special Education research: Synthesis of the Knowledge Base On Critical Instructional Issues, Lawrence Erlbaum, Mahway, NJ, 2000, pp. 281–326.

[30] van de Vijver J.A. Harkness, Questionnaire translation, in: J.A. Harkness, J.R. Fons, P.P. Mohler (Eds.), Cross-Cultural Survey Methods, John Wiley & Sons, New York, 2003, pp. 35–56.

[31] S.P. Douglas, C.S. Craig, Collaborative and iterative translation: an alternative approach to back translation, J. Int. Market. 15 (1) (2007) 30–43, https://doi.org/10.1509/jimk.15.1.030.

[32] W. Haney, M. Russell, C. Gulek, E. Fierros, Drawing on education: using student drawings to promote middle school improvement, School. Middle 7 (3) (1998) 38–43.

[33] S. Stemler, An overview of content analysis, Pract. Assessm. Res. Evaluat. 7 (1) (2001), https://doi.org/10.7275/z6fm-2e34.

[34] J.C. Horvath, G.M. Donoghue, A.J. Horton, J.M. Lodge, J.A.C. Hattie, On the irrelevance of neuromyths to teacher effectiveness: comparing neuro-literacy levels amongst award-winning and non-award winning teachers, Front. Psychol. 9 (2018), https://doi.org/10.3389/fpsyg.2018.01666, 1666–1666.

[35] W. Van Dijk, H.B. Lane, The brain and the US education system: perpetuation of neuromyths, Exception.: Off. J. Divisi. Res. Counc. Exception. Child. 28 (1) (2020) 16–29, https://doi.org/10.1080/09362835.2018.1480954.

[36] O. Kuru, J. Pasek, Improving social media measurement in surveys: avoiding acquiescence bias in Facebook research, Comput. Human. Behav. 57 (2016) 82–92, https://doi.org/10.1016/j.chb.2015.12.008.

[37] Social Sciences Research Centre of the University of Hong Kong, "Hong Kong Public Knowledge of Health Supplements" Survey Findings, Hong Kong: the University of Hong Kong, 2014 [e-book]Retrieved 12 July 2022, from, https://www.hku.hk/press/press-releases/detail/12065.html.

[38] K. McMahon, C.S.-H. Yeh, P.J. Etchells, The impact of a modified initial teacher education on challenging trainees' understanding of neuromyths, Mind. Brain. Educ. 13 (4) (2019) 288–297, https://doi.org/10.1111/mbe.12219.

[39] C. Matta, Neuroscience and educational practice – A critical assessment from the perspective of philosophy of science, Educ. Philos. Theo. 53 (2) (2021) 197–211, https://doi.org/10.1080/00131857.2020.1773801.

[40] E. Grewenig, P. Lergetporer, L. Simon, K. Werner, L. Woessmann, Can internet surveys represent the entire population? A practitioners' analysis, Eur. J. Polit. Econ. 78 (2023) 102382, https://doi.org/10.1016/j.ejpoleco.2023.102382.

[41] V. Menon, A. Muraleedharan, Internet-based surveys: relevance, methodological considerations and troubleshooting strategies, Gen. Psychiatr. 33 (5) (2020) e100264, https://doi.org/10.1136/gpsych-2020-100264.