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Research paper

Neuromyths: Misconceptions about neurodevelopment by Italian teachers.

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ABSTRACT

Background: Neuromyths are commonly held misconceptions about the brain, often generated by a misunderstanding of scientifically established facts. To date, limited research has explored the pervalence of neuromyths about neurodevelopmental disorders in the teacher population. Method: The current study investigated the prevalence of teachers' general and neurodevelopmental neuromyths among 820 Italian teachers. Results: Italian teachers correctly identified 73% of general neuromyths and 70% of neurodevelopmental neuromyths. The difference between general and neurodevelopmental neuromyths endorsement was significant. Frequency of accessing relevant information emerged as a protective factor. A mediation analysis showed that higher need for cognition was significantly associated with a higher frequency of accessing relevant information about the brain, which in turn led to lower endorsement of neuromyths. Conclusion: In line with our findings, we suggest that teachers can benefit from neuroeducation initiatives aimed to enhance neuroscience literacy in both the initial education and continuous professional development of teachers.

1. Introduction

Over the past few decades, there has been a growing interest among the scientific community to establish connections between brain science and education. This has led to increased attention on the issue of neuroscience literacy among the general public and specifically among educators, with an increased focus on the dissemination of knowledge in the field of educational neuroscience [1]. Yet, the increasing interest in the relationship between education and the brain is not always matched by appropriate implementation of research findings. Despite the collective efforts of the scientific community to the development and implementation of evidence-based guidelines for educational practices, underpinned by a strong empirical foundation, neuromyths about the brain are still prevalent [2–3].

Neuromyths are generally defined as commonly held misconceptions about the brain - often generated by a misunderstanding of scientifically established facts - believed or endorsed by the general public but also by educators [4–6]. Three examples of common neuromyths include: “Students only use 10% of their brains”; “There are right-brain and left-brain learners,” and “Students learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinaesthetic)” [7,8]. The prevalence of neuromyths is often rooted in scientifically established findings which have undergone alteration and have been misinterpreted over time. Such alterations can be traced back to various processes, including the oversimplification of scientific results, sensationalistic reporting, and the omission of critical information [5,9]. For instance, the popular misconception that students use only 10% of their brain may have arisen from the fact that neurons constitute 10% of the brain, while the remaining 90% are comprised of glial cells [10]. As with many neuromyths, the exact source of the 10% neuromyth is challenging to pinpoint, but it is often associated with William James' assertion from 1907: "We are making use of only a small part of our possible mental and physical resource." [11]. The perpetuation of this statement by the popular media contributed to the widespread dissemination of the myth over time.

The Organization for Economic Cooperation and Development has previously warned that popular misconceptions and neuromyths could result in the use of ineffective and non-evidence-based teaching programs and practices, with serious adverse effects on educational systems and learner outcomes globally [6]. In addition, in their recent review, Jolles and Jolles [12] emphasized the potential harm associated with neuromyths, underscoring that the inappropriate application of these

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myths in the classroom may not only lead to less effective teaching and learning outcomes but also undermine confidence in the field of neuroscience for educators. The field of neuroscience is rich with established facts that enhance our understanding of the learning process [13]. The existence of neuromyths and misconceptions highlight the critical need for a reliable and comprehensive knowledge base in neuroscience, often referred to as "neuroscience literacy." Such literacy is essential as it equips educators with the understanding of neuroscience necessary to avoid the propagation of misconceptions about the brain, and resist the acceptance of educational products that cannot withstand scrutiny [12].

1.1. Neurodevelopmental neuromyths

To date, while several studies have investigated the prevalence of neuromyths in relation to the typically developing brain, less attention has been devoted to the prevalence of teachers' neuromyths about neurodevelopmental disorders in children with Special Educational Needs and Disabilities (SEND) [5]. According to the diagnostic criteria outlined in the DSM-5, "neurodevelopmental disorders" encompass a diverse array of conditions, including intellectual disabilities, communication disorders, Autism Spectrum Disorders (ASD), Attention Deficit Hyperactivity Disorder (ADHD), specific learning disorders (e.g., dyslexia), motor disorders, Tourette's, and tic disorders [14]. While a limited number of studies have investigated neuromyths related to a single neurodevelopmental disorder [15,16], there is a scarcity of research examining neuromyths about more than one neurodevelopmental disorder and their endorsement among educators [5]. In their recent study, Gini et al. [5] developed a questionnaire specifically addressing neuromyths on neurodevelopmental disorders including ASD, ADHD, Down syndrome, dyslexia and nonspecific neurodevelopmental disorders, which was administered in a UK-based sample of members of the general public and individuals working in education. The authors found that both members of the general public and teachers endorsed more neurodevelopmental than general neuromyths [5].

Given the limited research on the topic, it is essential to further understand and explore the unique characteristics of neurodevelopmental neuromyths compared to general neuromyths. Unlike general neuromyths, which primarily involve misconceptions about brain function in typically developing children, neurodevelopmental neuromyths are specifically concerned with misconceptions about the brain function of children with SEND. For instance, consider the neuromyth that suggests "Disorders can be caused by adverse immune reactions to vaccinations." This neurodevelopmental neuromyth bears particular relevance to SEND children, a demographic who often requires additional and tailored educational support due to various cognitive, emotional, or physical challenges that can impede their learning and development [5,14]. Given that SEND children's educational needs and support requirements are unique, such neuromyths specifically targeting the neurological aspects of their development demand more focused attention. Therefore, addressing these distinct neuromyths within the educational context is pivotal not only to dispel misinformation but also to ensure that SEND children receive the appropriate educational support and an inclusive learning environment.

Educators and policymakers must be vigilant about countering these misconceptions, considering the unique needs of SEND children. A previous study on neuromyths about the typically developing brain found that both pre-service and in-service teachers were inclined to incorporate specific neuromyths into their teaching methods [9]. For instance, 96% of the participants endorsed the idea that "some individuals are visual learners while others are auditory learners." Notably, 87% of them agreed that implementing this belief in teaching would enhance the learning process, with 80% indicating that they either currently use or intend to use this approach in their teaching [9]. Aside from the negative impact neuromyths can have on the teaching-learning process, neurodevelopmental neuromyths can also have a negative impact to the welfare of SEND children [17,5]. For example, a previous study showed that whilst the hypothesis that all children with Dyslexia see letters backwards has been dismissed, the majority of teachers in the United Kingdom (91%) still believe Dyslexia to include visual perceptions difficulties such as seeing letters backward or letter reversals [15]. Such misconceptions can prevent educators from referring SEND children for further assessment, if the child does not present with what is considered to be a "standard" symptom, such as in this case letter-reversals [18]. Another example includes the popular misconceptions about ADHD pertaining to the treatment and characteristics of the disorder. A previous study conducted by West et al. [19] revealed that teachers erroneously believed that special diets could effectively treat ADHD. Such misconceptions can potentially impede children's proper treatment and divert attention from evidence-based recommendations, treatments and resources. Finally, misconceptions in this domain can have negative outcomes in relation to the integration and inclusion of SEND children within the mainstream educational system and environment. Previous studies have suggested that neurodevelopmental neuromyths can form the basis of stigma against SEND students within the education environment [5,15,20], yet this is a hypothesis that needs to be further tested empirically by future studies.

The prevalence of neuromyths about typical development among teachers has been investigated among various cultures, educational systems and countries including Italy [21], Spain [22], Portugal [23], Greece [7], the UK and the Netherlands [1], Turkey [24] and China [25]. In Italy, the mean level of acceptance of neuromyths about the typically developing brain among Italian teachers was investigated using the traditional questionnaire of Deligiannidi & Howard-Jones [26] (DHJ); the authors found a prevalence of approximately 40% of neuromyths, with the neuromyth regarding learning styles being endorsed by 92.5% of the sample [21]. Yet, research on neurodevelopmental neuromyths remains limited, with few studies to have addressed the prevalence of these types of neuromyths, underscoring the need for further investigation [5].

Considering the pivotal role of teachers and the profound implications of their beliefs on the educational experiences and well-being of all children, including SEND children [27], it is imperative to examine which specific neurodevelopmental neuromyths are commonly endorsed by teachers and what factors contribute to the perpetuation of these misconceptions. This can offer valuable insights to inform future initiatives aimed at rectifying and addressing these misconceptions, particularly in the context of educational practices. Furthermore, conducting a comparative analysis between general neuromyths and neurodevelopmental neuromyths will not only deepen our understanding of the prevalence of misconceptions concerning typical development versus neurodevelopmental disorders among educators, but also provide robust evidence for the development and implementation of tailored interventions where necessary. This endeavor can contribute to the identification of critical training requirements in the field of neuroscience for educators, which could play a critical role in reducing the prevalence of common neuromyths and addressing specific misconceptions within the educational context. Ultimately, this process can foster a more precise and accurate knowledge base among educators, particularly in the areas that require attention.

1.2. Factors associated with the endorsement of neuromyths

Prior research has shown that individuals working in the field of education tend to exhibit a higher ability to identify neuromyths when compared to the general population [18]. Yet, adherence to misconceptions still persists even among teachers, with the recent study of Gini et al. [5] showing no significant differences in the number of beliefs held in those working in education compared with the general population. In addition to this, it has been suggested that differences in terms of the neuromyths prevalence may also exist between SEND and mainstream teachers, with SEND teachers potentially holding fewer incorrect beliefs given perhaps to a higher level of exposure to educational training or interest related to neuroscience, and experience with SEND children [5,7]. Yet, research on differences in neuromyths accuracy between the two groups remains scarce with the majority of studies to have focused on differences between other teaching groups including pre-service and in-service teachers [7,28]. For instance, in the study conducted by Papadatou and colleagues [7], a significant difference was found among preservice teachers from two different Greek universities. The ones who were part of a university with a Special Education Department performed better in identifying neuromyths related to special education. The difference may be attributed to the comprehensive training they received in matters concerning neurodevelopmental issues and learning disabilities or, perhaps to a higher interest for the field of special education. Future studies could benefit from a more in-depth examination of the potential disparities in the accuracy of neuromyth endorsement between SEND and mainstream teachers, informing the designing and development of more tailored training recommendations aimed at enhancing knowledge and reducing neuromyths prevalence.

Furthermore, prior research suggested that the accuracy of identifying neuromyths appears to be associated with teaching experience and professional development received [2]. For example, teachers who have previously attended a neuroscience course perform better and report lower endorsement of neuromyths [18,28]. Additionally, in the study of Gini et al. [5] the frequency of access to brain information emerged as a protective factor against endorsing neuromyths among the general public but also teachers. The above finding is in line with previous studies including the study of Papadatou-Pastou et al. [7] who found that general knowledge about the brain acts as a safeguard against neuromyths, and that of Herculano-Houzel [10] who found that reading popular science magazines and newspapers significantly contributed to enhancing one's knowledge of neuroscience. Nonetheless, there has been limited exploration of the specific influence of these factors in different countries. As outlined in the recent scoping review of Privitera [2], while previous research provide some evidence that introducing teachers to neuroscience concepts is, at the very least, not harmful and may even have beneficial effects on teacher beliefs and instructional methods, the scarcity of research available make it challenging to draw definitive conclusions regarding the precise impact of neuroscience training on teachers. Therefore, in the context of Italy, an examination of the educational variables that serve as protective factors against neuromyths could yield valuable insights for shaping educational strategies and improving training initiatives.

Finally, need for cognition, defined as the tendency of an individual to enjoy thinking [29], might also be a protective factor against neuromyths beliefs. In the context of education, research has shown that need of cognition strongly predicts the tendency to seek educational programs fostering deep learning [30]. Higher levels of need of cognition also predict higher effort for completing a complex task [31]. Therefore, it is possible that higher need for cognition may be associated with higher interest in accessing brain information which, in turn, may lead to less endorsement of neurodevelopmental neuromyths. Yet, to date, at least to our knowledge, no study has investigated neither the direct nor indirect effect of need for cognition in neuromyths prevalence. Recognizing the potential importance of this aspect, the exploration of the need for cognition could inform future educational strategies and programs. These initiatives may incorporate more active learning methods aimed at enhancing future educators' need for cognition, contributing to the reduction of neuromyths.

1.3. The current study

The current study focused on misconceptions about neurodevelopmental disorders (called "Neurodevelopmental Neuromyths") among teachers. The sample consisted of Italian teachers working in preschool, primary, or secondary education. The study was designed to explore the following four hypotheses, with the aim to provide a comprehensive understanding of neuromyths prevalence and factors influencing their endorsement among teachers in Italy, ultimately contributing to more accurate knowledge in the field of educational neuroscience:

1. Based on the existing literature, it was predicted that as in other country samples, teachers would endorse both general and neurodevelopmental disorders' neuromyths and that neurodevelopmental neuromyths will be spread across different neurodevelopmental disorders.
2. Given the exposure to educational training and/or direct experience, it was predicted that mainstream class teachers would hold more incorrect beliefs than SEND teachers.
3. Based on the recent evidence-based literature [5,28] it was hypothesised that the educational content received and the access to relevant neuroscience information will be significant factors of better performances (fewer incorrect beliefs) in neuromyths total score.
4. Finally, it was predicted that the indirect effect of need for cognition on neurodevelopmental neuromyths will be mediated by the frequency of accessing relevant information.

2. Method

2.1. Participants

A total of 820 Italian teachers gave their consent to participate in the online survey and completed the relevant demographics and outcome measures used for the current study. Participants were recruited through opportunity sampling by sharing a link in university postgraduate courses attended by mainstream and SEND teachers who work in preschool, primary and secondary education.

2.2. Study design and procedure

The study received ethical approval by the Ethical Committee of the Univeristy of Florence (n. 241, 02/20/2023). To address the research objectives, a cross-sectional online survey was distributed via the survey platform Qualtrics. Participation in the study was voluntary. Individuals interested in participating had to click on the survey link and provide informed written consent before taking part in the survey. Participants had the right to withdraw from the study at any time. The duration of the survey was approximately 15 to 30 min.

2.3. Survey development

A self-report questionnaire was used to gather sociodemographic characteristics of participants including their age and gender as well as additional questions about the experience working with SEND children and their familiarity with neurodevelopmental disorders (e.g., having a child with learning disability; frequency of accessing brain and neuroscience information; attendance of a previous course related to brain or neuroscience; relevance of training course). Upon completing the sociodemographic questionnaire, participants were asked to complete a need for cognition survey and a questionnaire on general and neurodevelopmental neuromyths. In the neurodevelopmental neuromyths questionnaire, items of different neurodevelopmental disorders were presented in a mixed order. All materials of the survey were prepared in Italian, and the measures were translated through a back-translation process conducted by native Italian speakers who are also fluent in English. A short description of the survey items used for this study is presented in the following section.

3. Measures

3.1. Need for cognition

The level of need for cognition among teachers was assessed using the Need for Cognition Scale [29], a well-validated instrument comprising 18 items. Sample items include the following: "I would prefer complex to simple problems' or 'Thinking is not my idea of fun' (reverse scored). Items are rated on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scale has previously shown high reliability in several studies (e.g., [32–34]. In the present study reliability (Chronbach's alpha) was 0.81.

3.2. General neuromyths

To assess general neuromyths about the typical brain development among teachers we employed the "General Brain Knowledge Statements Survey", derived from the Ruhaak & Cook questionnaire [28]. The questionnaire consists of 15 general statements, 10 of which are correct and 5 of which are incorrect. Sample items of correct and incorrect statements include the following: "The right and left hemisphere of the brain always work together" (Correct statement); "We only use 10% of our brain" (Incorrect statement).

3.3. Neurodevelopmental neuromyths

To assess neurodevelopmental neuromyths among teachers, the "Neurodevelopmental Neuromyths" questionnaire as developed by Gini et al. [5] was used. The questionnaire consisted of 30 statements regarding neurodevelopmental disorders, which included both neuromyths applicable to several neurodevelopmental disorders as well as specific statements pertaining to the following individual neurodevelopmental disorders: ASD, ADHD, Down syndrome, and developmental dyslexia. The statements were sourced from a number of prior studies that primarily focused on neuromyths related to individual neurodevelopmental disorders [e.g., 18, 15]. In comparison to general neuromyths questionnaire, as described above, the questionnaire includes a higher proportion of false statements ($n = 21$) as opposed to true statements ($n = 10$), in line with prior research which had mostly centered on incorrect beliefs regarding neurodevelopmental disorders [5]. Sample items of correct and incorrect statements include the following: "Stimulant drugs are the most common type of drug used to treat children with Attention Deficit Hyperactivity Disorder (ADHD)" (Correct statement); "Children with autism are unable to notice social rejection" (Incorrect statement).

3.4. Scoring of general neuromyths and neurodevelopmental neuromyths

For the assessment of both neuromyth scales (General Neuromyths and Neurodevelopmental Neuromyths), participants were asked to rate each statement on a 4-point Likert scale ("True," "Probably True," "Probably False," and "False"), rather than a 2-point (True/False) scale. The reason for this decision, as previously reported by Gini et al. [5], was due to the possibility that participants might be reluctant to provide definite answers for all statements. To facilitate comparison of scores across the various neuromyths, responses for all items were recoded using a scale of 1–4 as in Gini et al. study [5], from least to most correct answer, thereby generating a total score that reflects the overall accuracy of the participants' beliefs about neuromyths. Lower scores are indicative of a higher endorsement of neuromyths.

3.5. Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics v25 software. Descriptive statistics were used for summarizing participants' sociodemographic characteristics. An independent samples *t*-test and Chi-square tests were used to examine whether mainstream and SEND teachers were comparable in terms of relevant demographic and education variables. Then, a mixed 2 × 2 ANOVA was used to test differences between mainstream and SEND between general and neurodevelopmental neuromyths. Correlation analyses, independent-samples *t*-tests and one-way ANOVA were performed for examining the association of sociodemographic characteristics and general questions presented in the first section of the survey, with the total score on neurodevelopmental neuromyths. For significant ANOVAs, Tukey post hoc analyses were performed to determine which group was significantly different from the others. A multiple linear regression was performed to test the direct effect of sociodemographic characteristics and additional factors that were found to be significant during univariate analyses, on neurodevelopmental neuromyths.

Finally, following Preacher and Hayes' guidelines [35], we conducted a mediation analysis through the SPSS PROCESS macro with a bootstrapping procedure. Mediation analysis was conducted to examine whether frequent access to relevant information mediates the relationship between our independent variable (need for cognition) and neurodevelopment neuromyths prevalence (outcome variable).

4. Results

4.1. Sociodemographic characteristics

Sociodemographic characteristics of participants are presented in Table 1. Overall, 820 teachers from Italy completed the online survey. Among them, 485 participants were mainstream teachers whereas the remaining 335 were SEND teachers. Based on the Italian educational system, participants were asked to indicate the educational level in which they were teaching: 7% worked in preschool education, 22.2% in primary education, and 29.3% and 39.5% in lower and upper secondary education, respectively. The majority of participants were female (83%), with a mean age of 44.5 ± 9.9 years. Around 13% of participants reported being a parent of a SEND child. Furthermore, most of the participants indicated that they had previously worked with SEND children (93%), with the average teaching experience being 8.5 ± 7.6 years. With regards to the content of education, more than half of the participants (58%) reported that they had not received a university or training course related to brain or neuroscience. Attendance to these courses was defined as participating in educational programs covering topics directly linked to the brain, its functions, or broader neuroscience concepts. The participation in such courses by teachers could include various educational levels, such as undergraduate or graduate programs, workshops, seminars, or professional development courses. In addition, 53% of the participants indicated that their training or professional course covered only little the development of children with neurodevelopmental disabilities. Finally, approximately one third of the sample reported to frequently access information relevant to the brain and neuroscience learning in their daily life.

4.2. Descriptive analyses

To calculate the prevalence of neuromyths the percentage of incorrect responses was used. For the rest of the statistical analyses including comparisons of general versus neurodevelopmental neuromyths in teachers the total mean scores of the questionnaires were used as described in the methods section.

Overall, the prevalence of general neuromyths corresponding to the incorrect responses given was about 27.2% whereas that of neurodevelopmental neuromyths about 30%. In line with hypothesis 1, teachers endorsed both general and neurodevelopmental neuromyths, with a higher mean total score - which is indicative of better performances and less endorsement - in the general statements, $t(819) = 10.33$, $p < .001$.

In the general neuromyths questionnaire, the most endorsed false

Table 1
Sociodemographic characteristics of the sample.

	Total Sample		Mainstream Teachers		SEND Teachers	
	N (%)	*M(SD)*	*N (%)*	*M(SD)*	*N (%)*	*M(SD)*
Age		44.5 (9.9)		47.8 (9.64)		40.73 (8.92)
Gender						
Female	681 (83%)		408 (84.1%)		273 (81.5%)	
Male	99 (12.1%)		59 (12.2%)		40 (11.9%)	
Other	40 (4.9%)		18 (3.7%)		22(6.6%)	
School type workplace						
Preschool education	57 (7%)		28 (5.8%)		29 (8.7%)	
Primary education	180 (22.2%)		103 (21.2%)		77 (23%)	
Lower secondary education	237 (29.3%)		142 (29.3%)		95 (28.4%)	
Upper secondary education	320 (39.5%)		203 (41.9%)		117 (34.9%)	
Has a child with learning disability	106 (12.9%)		68 (14%)		38 (11.4%)	
Prior attendance of relevant university/training course						
Yes, more than one	193 (23.5%)		131 (27%)		62 (18.5%)	
Yes, only one	152 (18.5%)		97 (20%)		55 (16.4%)	
No	475 (57.9%)		257 (53%)		218 (65.1%)	
Teaching experience with SEND children						
Yes	761 (92.8%)		467 (96.3%)		294 (87.8%)	
No	59 (7.2%)		18% (3.7%)		41 (12.2%)	
Years of teaching experience with SEND children		8.49 (7.59)		10.85 (8.42)		5.05 (4.29)
My training course covered the development of children with developmental disabilities						
Yes	256 (31.2%)		160 (33%)		96 (28.7%)	
No	107 (13%)		69 (14.2%)		38 (11.3%)	
A little	430 (52.4%)		240 (49.5%)		190 (56.7%)	
Cannot remember	27 (3.3%)		16 (3.3%)		11 (3.3%)	
Frequency of access to relevant brain and neuroscience information						
Frequently	271 (33%)		175 (36.1%)		96 (28.7%)	
Often	433 (52.8%)		257 (52.9%)		176 (52.6%)	
Not often	116 (14.1%)		53 (10.9%)		63 (18.6%)	

statement was that “We only use 10% of our brain” in which 60.1% of teachers reported that it is true or probably true; the least endorsed false statement was that “Mental capacity is hereditary and cannot be changed by the environment or experience” which was answered as true or most probably true by 3.8% of the participants. With regards to the true statements the most prevalent was that “The left and right hemispheres of the brain always work together” in which 63.6% responded that it is false or probably false; the least endorsed true statement was that “There are sensitive periods in childhood when it is easier to learn things in which only 4.3% answered that it is false or probably false.

Regarding the false neurodevelopmental statements, the most endorsed neuromyth was that “All children with hearing impairments benefit from visual information” in which 78.4% reported to be true or probably true; the least endorsed neuromyth was “Some children with autism have a special talent or savant skill” in which only 5.1% reported that it is true or probably true. For the correct neurodevelopmental statements, the most endorsed was that “Children with Down syndrome have smaller brains” in which 92.4% of teachers responded that it is false or probably false; the least prevalent neuromyth was that “Children with ADHD have difficulties with focus and concentration” in which only 2.6% of participants answered that it is indeed false or probably False. A significant yet weak correlation was evident between accuracy on general and neurodevelopmental neuromyths, $r = 0.2$, $p < .001$. The prevalence for each general and neurodevelopmental neuromyth is reported in Table 2 and Table 3.

To test hypothesis 2, that SEND teachers would hold fewer incorrect beliefs than mainstream teachers, we initially examined whether the two groups were comparable in terms of relevant demographic variables. This comparison was conducted through an independent samples *t*-test and Chi-square tests. The analysis revealed the following: Age ($p >$ .05) and gender did not exhibit statistically significant differences between the two groups ($p > .05$). In addition, the Chi-square tests demonstrated no significant differences between mainstream and SEND teachers in the various educational variables. This included whether their training or professional course provided limited coverage of child development in the context of neurodevelopmental disabilities ($p > .05$) and whether they had previously attended a university or training course related to brain or neuroscience ($p > .05$). Likewise, there were no significant differences between the two groups in terms of their teaching experience with SEND children ($p > .05$). The Chi-square tests only revealed significant differences between the two groups in the access of information pertinent to the brain and neuroscience, particularly in the category of frequent information access ($X^2 = 12.45$, $p < .002$). In summary, the results suggest that, except for the frequency of accessing relevant, the two groups of teachers were largely comparable across the examined demographic and educational variables.

Table 2
Prevalence of General Neuromyths (incorrect responses).

Item	True/False	Neuromyth Prevalence
1. The left and right hemispheres of the brain always work together	T	**63.6%**
2. When a brain region is damaged other parts of the brain can take up its function.	T	**30.7%**
3. We only use 10% of our brain.	F	**60.1%**
4.Learning is due to the addition of new cells in the brain.	F	13.8%
5. Normal development of the human brain involves the birth and death of brain cells.	T	**36.9%**
6. Circadian rhythms ("body-clock") shift during adolescence, causing students to be tired during the first lessons of the school day.	T	**47.1%**
7. Brain development has finished by the time children reach secondary school.	F	16.1%
8. The brains of boys and girls develop at the same rate.	F	**36.1%**
9. Mental capacity is hereditary and cannot be changed by the environment or experience.	F	3.8%
10. Learning occurs through modification of the brain's neural connections.	T	16.4%
11. Information is stored in the brain in a network of cells distributed throughout the brain.	T	**31.7%**
12. Production of new connections in the brain can continue into old age.	T	14.1%
13. Vigorous exercise can improve mental function.	T	21.2%
14. There are sensitive periods in childhood when it is easier to learn things.	T	4.3%
15. We use our brains 24 hr a day.	T	11.8%

Note. To calculate the prevalence of General Neuromyths the percentage of incorrect responses was used.

Using a mixed 2 × 2 ANOVA we compared beliefs about general and neurodevelopmental neuromyths for SEND versus mainstream teachers. Adhering to ANOVA assumptions, we examined the data for potential outliers and found no significant outliers that could influence the findings. Secondly, we assessed the normality of the dependent variables, and given also our sufficiently large sample size, the data approximated a normal distribution. Finally, the assumption of homogeneity of variances was met, indicating that variances among the groups were not significantly different. The results indicated a non significant main effect of the group (SEND vs mainstream teachers), $F(1, 818) = 0.67$, $p > 0.05$, but a significant factor interaction between the teacher group and general neuromyths $F(1, 818) = 4.76$, $p < 0.05$, (see Table 4). Post hoc tests were subsequently conducted to explore this interaction, and Bonferroni corrections were applied to control the familywise error rate. The post hoc results, however, did not reveal statistically significant differences, indicating that SEND teachers did not achieve significantly better scores than mainstream teachers in the domain of general neuromyths.

To explore potential determinants of neurodevelopmental myths' endorsement, as described in hypothesis 3, univariate analyses including correlation analyses, independent samples *t*-test, and ANOVAs were performed.

Correlational analyses showed weak associations between age and years of teaching experience, with older participants reporting higher levels of teaching experience with SEND children, $r = 0.56$, $p < .001$. Need for cognition was also weakly correlated to neuromyths scores, with those reporting a higher level of need for cognition performing better in neuromyths questionnaire, $r = 0.19$, $p < .001$.

In the ANOVAS, three variables were found to be associated with neurodevelopmental neuromyths performance: prior attendance to relevant university/training course related to neuroscience or brain; training/professional course that covered the development of children with developmental disabilities; frequency of accessing relevant

Table 3
Prevalence of Neurodevelopmental Neuromyths (incorrect responses) presented according to the neurodevelopmental disorders category.

Item	True/False	Category	Neuromyth Prevalence
1. Stimulant drugs are the most common type of drug used to treat children with Attention Deficit Hyperactivity Disorder (ADHD)	**T**	**ADHD**	**68.6%**
2. Most ADHD children "outgrow" their symptoms and subsequently function normally in adulthood	**F**	**ADHD**	**50.3%**
3. Reducing dietary intake of sugar or food additives is generally effective in reducing the symptoms of ADHD	**F**	**ADHD**	**43.9%**
4. Children with ADHD have difficulties with focus and concentration	T	ADHD	2.6%
5. It is possible for an adult to be diagnosed with ADHD	T	ADHD	20.7%
6. Current research suggests that ADHD is largely the result of ineffective parenting skills	F	ADHD	12.2%
7. Symptoms of depression are found more frequently in children with ADHD than in children without ADHD	**T**	**ADHD**	**53.2%**
8. If a child responds to stimulant medications (e.g. Ritalin), then they probably have ADHD	F	ADHD	23.2%
9. Research has shown that prolonged use of stimulant medications for ADHD leads to increased addiction (i.e. drug, alcohol) in adulthood	**F**	**ADHD**	**50.7%**
10. Children with autism are unable to notice social rejection	F	Autism	23.4%
11. Children with autism do not have empathy	F	Autism	27.5%
12. Some children with autism have a special talent or savant skill	T	Autism	5.1%
13. Autism only occurs in boys	F	Autism	7%
14. Children with autism do not like to be touched	**F**	**Autism**	**61.4%**
15. Children with Down syndrome have smaller brains	**T**	**Down Syndrome**	**92.4%**
16. Children with Down syndrome cannot understand what they are reading	F	Down Syndrome	5.9%
17. People with Down syndrome are always happy and affectionate	F	Down Syndrome	20.8%
18. Children with Down syndrome cannot learn anything complex	F	Down Syndrome	8.3%

(*continued on next page*)

Table 3 (*continued*)

Item	True/ False	Category	Neuromyth Prevalence
19. All children with dyslexia see letters backward	F	Dyslexia	16.9%
20. Children who are dyslexic tend to have lower IQ scores than children who are not dyslexic	F	Dyslexia	13.4%
21. In some children dyslexia is caused by visual problems	**F**	**Dyslexia**	**35.3%**
22. Children with dyslexia can often excel in other areas	T	Dyslexia	5.7%
23. Dyslexia can be helped by using colored lenses and/or colored overlays	F	Dyslexia	16%
24. Learning difficulties associated with developmental differences in brain function in children with disorders cannot be improved by education	F	Nonspecific neurodevelopmental neuromyth	14.5%
25. All children with hearing impairments benefit from visual information	**F**	**Nonspecific neurodevelopmental neuromyth**	**78.4%**
26. The multisensory approach (e.g., supporting oral information with visual information) to learning is always better for children with disorders	T	Nonspecific neurodevelopmental neuromyth	17.4%
27. What a child with learning difficulties can understand can be measured by what that child can say	F	Nonspecific neurodevelopmental neuromyth	10.8%
28. Children with autism and ADHD and alike can be cured	**F**	**Nonspecific neurodevelopmental neuromyth**	**53.3%**
29. Disorders can be caused by adverse immune reactions to vaccinations	F	Nonspecific neurodevelopmental neuromyth	21%
30. Autism and ADHD are more common in the 1st degree biological relatives (i.e. mother, father, siblings) of children with autism or ADHD, respectively, than in the general population	**T**	**Nonspecific neurodevelopmental neuromyth**	**46.4%**

Note. To calculate the prevalence of Neurodevelopmental Neuromyths the percentage of incorrect responses was used.

information; and the level of need for cognition. Tukey post-hoc analyses revealed that teachers who reported to have attended more than one course relevant to brain and neuroscience scored better and endorsed less neuromyths compared to those who either attended only one course ($p = .032$) or those who didn't attend any ($p = .011$), (see Table 5). Additionally, teachers whose training or professional course covered the development of children with developmental disabilities reported better neuromyths scores compared to those who reported that they cannot remember ($p = .009$) but not for those who reported that they did not have such a course. Frequent access to information about brain and neuroscience in daily life was also significantly associated with lower neuromyths prevalence, with teachers who reported to access "frequently" relevant information to score better in neuromyths than those who reported to access relevant information "often" ($p = .006$) or not "often" ($p = .001$).

Table 4
Summary of responses to General Neuromyths and Neurodevelopmental Neuromyths for Mainstream and SEND teachers.

		N	*Mean*	*SD*	*Min*	*Max*
General Neuromyths						
	Mainstream teachers	485	3.03	.31	1.73	3.90
	SEND teachers	335	3.07	.29	2.00	3.93
	Total	820	3.05	.30	1.73	3.93
Neurodevelopmental Neuromyths						
	Mainstream teachers	485	2.93	4.6	2.00	3.57
	SEND teachers	335	2.91	4.4	2.23	3.50
	Total	820	2.92	4.55	2.00	3.57

Table 5
Neurodevelopmental Neuromyths associations with selected sociodemographic study variables.

Variables		Neuromyths Scores *M* (*SD*)	*t* or F*	*P* value
Gender			.822	.411
	Female	2.93 (0.24)		
	Male	2.9 (0.27)		
Prior attendance of relevant university/training course			4.6	.010*
	Yes, more than one	2.97 (0.26)		
	Yes, only one	2.91 (0.26)		
	No	2.91 (0.22)		
My training course covered the development of children with developmental disabilities			4.15	.006*
	Yes	2.95 (0.25)		
	No	2.92 (0.23)		
	A little	2.89 (0.25)		
	Cannot remember	2.79 (0.24)		
Frequency of access to relevant brain and neuroscience information			11.24	<0.001**
	Frequently	2.97 (0.25)		
	Often	2.91 (0.23)		
	Not often	2.85 (0.24)		

Note.
* $p < 0.05$.
** $p < .001$.

4.3. Multivariate analyses

Multivariate analyses were performed to test hypothesis 3 that the educational content received and the access to relevant neuroscience information will be significant factors of better performances on neurodevelopmental neuromyths scores.

4.4. Predictors of neurodevelopmental neuromyths

Table 6 shows the results of the multiple regression analysis, conducted to determine factors of neurodevelopmental myths endorsement among teachers. In the first block demographic variables including

Table 6
Summary of multiple regression model for neurodevelopmental neuromyths.

Step 1				Step2			Step 3		
	Unstandardized Coefficients		Standardized coefficients	Unstandardized Coefficients		Standardized coefficients	Unstandardized Coefficients		Standardized coefficients
	B	SE B	β	B	SE B	β	B	SE B	β
Determinant Variables									
Age	−0.12	.03	−0.16	−0.12	.03	−0.16	−0.11	.03	−0.15
Teaching category	−0.3	.2	−0.06	−0.2	.2	−0.04	−0.2	.2	−0.04
Years of teaching experience with SEND children	.12	.04	.12	.11	.04	0.11	.11	.04	.11
My training course covered the development of children with developmental disabilities				−0.21	.3	−0.03	−0.28	.3	−0.04
Prior attendance of relevant university/ training course				−0.3	.34	−0.04	−0.21	.34	−0.02
Frequency of access to relevant brain and neuroscience information				−1.97	4.12	−0.18	−1.75	.42	−1.56
Need for cognition							1.21	.03	.14
R^2	.023			.058			.078		

participants' age, teaching category (mainstream versus SEND teachers), and years of experience in teaching SEND children were entered. In the second block significant data from the univariate analyses related to the education content received, including prior attendance of relevant university or training courses, training course that covered the development of children with neurodevelopmental disorders, and frequency of access to relevant information, were entered. Finally, in the third block, the need for cognition was entered.

The results of the regression model indicated that age, teaching group and years of experience in teaching SEND children, added in step 1, accounted for a significant 2.3% of the total variance and that the model was a significant predictor of neuromyths prevalence, $F\,(2718) = 5.59$, $p < .001$. Yet, only the age and years of teaching experience were found to be significant whereas teachers' group was not.

In step 2 of the regression analysis, the three variables related to educational content received and access to information were factored in the model. The increase in R^2 was significant and explained an additional 3.6% of variance in neurodevelopmental myths score, F change $(3, 715) = 9.013$, $p < .001$. Within step 2, however, only higher frequency of accessing relevant neuroscience information was significantly associated with better performance in neuromyths. Yet, prior attendance of relevant courses and of a training course that covered children with neurodevelopmental disorders were not.

Finally, in step 3, the need for cognition was entered in the equation. The increase in R^2 was significant and explained an additional 2% of variance, F change $(1, 714) = 15.14$, $p < .001$, with higher levels of need for cognition to be associated with a better performance in neurodevelopmental myths.

Table 7
Results of mediating effects of access to information in the link between the need for cognition and performance in neurodevelopmental neuromyths.

Regression paths	Unstandardized coefficients		*t*	*p*		
	B	*SE*			95% CI	
					Lower	*Upper*
Mediation *a* path (Need for cognition on access to information)[a]	−0.01	.01	−4.36	.001	−0.02	−0.01
Mediation *b* path (Access to information on neurodevelopmental neuromyths)[b]	−0.05	0.01	−4.02	0.001	−0.08	−0.03
Direct effect *c'* path (Need for cognition on neurodevelopmental neuromyths)	.01	0.01	4.85	0.001	0.01	0.01
Total effect *c* path (Need for cognition on neurodevelopmental neuromyths; direct + total indirect effect)[c]	0.01	0.01	5.47	0.001	0.01	0.01
Indirect effect bootstrapped (a * b) with bootstrapped 95% CI (Access to information as a mediator)	0.01	.01			0.01	0.01

[a] Model summary: R^2=0.05, F(1818)=19.03, p <0.001.
[b] Model summary: R^2=0.06, F(2817)=23.81, p <0.001.
[c] Model summary: R^2= 0.07, F(1818)=29.92, p <0.001.

4.5. Mediation analysis

A mediation analysis was conducted to test hypothesis 4 about the mediating effect of access to relevant information between the relationship of need for cognition with neurodevelopmental neuromyths endorsement. Table 7 presents the results of the mediation analysis with need for cognition as an independent variable, access to relevant information as a mediating variable and neuromyths prevalence as an outcome variable. The mediation analysis indicated that higher levels of need for cognition were significantly associated with higher frequency in accessing relevant information (path *a*). Higher frequency of accessing relevant information was associated with better performance in neurodevelopmental neuromyths (path *b*). The total effect of the need for cognition on neuromyths was significant (path *c*) as was the direct effect (path *c*′). The results of the bootstrap test for accessing relevant information as a mediator were significant, indicating that the latter partially mediated the link between the need for cognition and neuromyths performance.

5. Discussion

The current study investigated the prevalence of neuromyths in a sample of 820 teachers in Italy. The study makes a substantial contribution by shedding light on the prevalence of both general and neurodevelopmental neuromyths among Italian teachers, emphasizing the need for targeted efforts to counter both types of misconceptions within the educational context. Noteworthy, within an environment where accurate scientific knowledge is pivotal for effective teaching and learning processes [2,12], and where neurodevelopmental misconceptions can potentially hinder the support provided to SEND children [5,15,20], our findings hold substantial value. They identify specific determinants that mitigate the endorsement of these critical - yet compared to general neuromyths - understudied neurodevelopmental misconceptions, offering valuable insights for educational policy and practice.

Consistent with Hypothesis 1, Italian teachers endorsed at least some general and neurodevelopmental neuromyths with the mean acceptance for general neuromyths reaching approximately 27.2% and that for neurodevelopmental neuromyths about 30%. The findings about general neuromyths indicate a relatively better performance of the Italian teachers who participated in this study compared to the Italian teachers ($N = 174$) in the recent study of Tovazzi and colleagues [21]. In that study [21], the mean level of acceptance of neuromyths using the traditional questionnaire of Deligiannidi & Howard-Jones [26] (DHJ) in typical developing brain, was found to be approximately 40%. Yet, in the same study the authors also proposed another multiple-choice questionnaire that presents realistic scenarios occurring in school, in which the beliefs of neuromyths were significantly lower compared to DJH scale. Further, the current results about general neuromyths align with other previous studies conducted in Europe [26,36-37].

The study findings are also consistent with those reported in the study of Gini et al. [5], in which the neurodevelopmental neuromyths questionnaire was initially introduced, with Italian teachers reporting only slightly lower performances than British teachers. Italian teachers on average answered correctly to 73% of the general neuromyths and 70% of neurodevelopmental neuromyths compared to 81 % and 75 %, respectively, of the teachers in the British sample. Although small, the difference between general and neurodevelopmental neuromyths was significant with overall fewer general neuromyths to be endorsed by teachers, suggesting that more targeted efforts are needed to counter this critical type of misinformation within the educational context. As previously highlighted in our introduction and in line with the recent review by Privitera [2], while the impact of neuromyths on student learning and teacher performance lacks consistent evidence, previous studies indicate that teachers who endorse such misconceptions tend to often adopt teaching practices linked to these incorrect beliefs. Furthermore, it is important to acknowledge that neuromyths related to neurodevelopmental conditions could potentially lead to mislabeling, stigmatization, or inadequate support when specific conditions are not fully understood [15]. For example, a widespread belief that "prolonged use of stimulant medications for ADHD leads to increased addiction (i.e., drug, alcohol) in adulthood," as observed in our study (prevalence of 50.7 %), can make it challenging for teachers to identify children in need of assessment and formal diagnosis. Similarly, the misconception that "all children with hearing impairments benefit from visual information" (prevalence of 78.4%) might result in the development and implementation of ineffective interventions for some SEND children in the school context, diverting teacher attention from evidence-based resources.

As a general note, the higher accuracy in identifying neuromyths reported both in the current study and that of Gini et al. [5] who used the same questionnaire on general neuromyths and introduced the neurodevelopmental neuromyths questionnaire, as compared to similar studies presenting conducted more than 10 years ago [1] may reflect an increased awareness around popular misconceptions and neuromyths. Yet, to explore and compare the diffusion of neuromyths across different countries and contexts, it may be necessary to account for cross-country variations, particularly in relation to existing neuroeducation initiatives designed to disseminate accurate scientific knowledge and decrease misconceptions.

According to hypothesis 2, the study compared responses between mainstream versus SEND teachers. The two groups were found to be largely comparable across the majority of demographic and educational variables. Consistent with prior recommendations [5,7] and considering our expectations of a potentially higher level of exposure to educational training or interest in neuroscience, as well as experience with SEND children, we hypothesized that SEND teachers would exhibit a greater number of accurate beliefs in the neurodevelopmental neuromyths questionnaire compared to mainstream teachers. Yet, there was no significant difference between the number of general and neurodevelopmental myths endorsed when compared with mainstream teachers. Contrary to this finding, in their previous study Papadatou-Pastou and colleagues [7] found a significant difference between preservice teachers in two different universities in Greece, with those who attended a university including a department of special education scoring better in the neuromyth items focused on special education. In contrast, the current study included teachers from across different schools and thus may have experienced a range of training related to special education. The absence of significant differences between mainstream and SEND teachers coupled with the prevalence of neurodevelopmental neuromyths in both groups of our study suggests that dissemination efforts necessitate a more comprehensive educational approach applicable in all school settings and among all teachers.

In accordance with previous research regarding neuromyths concerning both the typical and atypical developing brain [2,5,7,18], the regression analysis conducted to assess hypothesis 3, demonstrated that increased access to information regarding the brain was a mitigating factor against the endorsement of neurodevelopmental neuromyth beliefs by Italian teachers. Prior studies have indicated that teachers, display a strong interest in acquiring knowledge about the brain and how it relates to educational and instructional practices, [2,38]. Despite this however, our study also supports the notion that these misconceptions endure in the field of education and are prevalent among various types of teachers, including mainstream and SEND teachers. As noted by Privitera [2], teachers' interest in neuroscience when accompanied by limited or insufficient training in this area may not be enough to eliminate the continued prevalence of these neuromyths within the field of education.

In the univariate analyses, prior attendance to courses about the brain and neuroscience was also associated with decreased endorsement in neuromyths. Additionally, teachers whose training or professional course covered the development of children with developmental disabilities reported better neuromyths. Previous studies have suggested that improved performance on assessments of neuroscience content knowledge [39,40] and increased confidence in comprehending and teaching neuroscience concepts [41] have been reported after participating in neuroscience teacher training programs. Privitera's review [2] supported that engaging in neuroscience training can impact the instructional approaches chosen by teachers, with research examining the effects of such training on teaching practices to indicate a rise in the self-reported utilization of hands-on, inquiry-based, and student-centered teaching methods after completing the training. Yet, in our study, both these educational variables did not significantly account for the variation in neurodevelopmental neuromyths performance when entered in the regression analysis, and thus did not fully replicate previous findings supporting that familiarity with neurodevelopmental disorders is directly associated with higher knowledge [1]. However, as suggested in the review of Privitera [2], enhancing neuroscience knowledge does not automatically lead to a reduction in the prevalence of neuromyths among participating teachers. For example, Im et al. [39] found that participating in an educational psychology course, which included neuroscience topics, reduced but did not entirely eliminate belief in neuromyths among pre-service teachers. In line with this, it is plausible that while neuroscience training, especially when limited to a single neuroscience course or training, may not offer a comprehensive solution against neuromyths, it still holds the potential to decrease the prevalence of these misconceptions among teachers while simultaneously enhancing their understanding of neuroscience content.

Furthermore, need for cognition was a significant predictor of decreased endorsement in neuromyths for neurodevelopmental disorders confirming our hypothesis that the level of cognitive investment by teachers plays a role in the identification of popular misconceptions in education. Considering that high levels of need for cognition have been found to be related with the effectiveness of continuous education in adults [42] and engagement in deep learning strategies and critical thinking skills [43], the indirect effect of need for cognition on neurodevelopmental neuromyths was also tested, as mediated by the frequency of accessing relevant information. The mediation analysis showed that need for cognition was significantly associated with a higher frequency of accessing relevant information about the brain which in turn led to lower endorsement of neuromyths. Although small effect sizes were reported, the results from the model indicated that higher levels of need for cognition result in higher interest and efforts on behalf of teachers to receive relevant education content which may in turn increase their ability to identify better neuromyths. This finding is consistent with prior research supporting that the need for cognition predicts the tendency to seek optional education programs which allow for enriched deep learning [30].

5.1. Implications for teacher education

The current study provides important implications for teacher education and professional development. Despite the relatively good performance for teachers related to neuromyths overall, the persisting presence of both general and neurodevelopmental neuromyths suggest the need for further initiatives within the Italian education context aimed at increasing awareness about prevalent misconceptions in education and including neuroscience concepts in teacher training. Based on our findings, it is particularly important to emphasize the importance of initiatives focused specifically on dispelling neurodevelopmental neuromyths. This emphasis arises not only from the observed small yet significant difference between general and neurodevelopmental neuromyths, with teachers endorsing fewer general neuromyths overall, but also due to the fact that these misconceptions are directly linked to the population of SEND children, holding the potential to impact both teaching-learning processes but also the support and resources provided.

In addition, the insignificant differences between mainstream and SEND teachers indicate that current training initiatives aimed at decreasing misconceptions in relation to neurodevelopmental disorders may have been insufficient, regardless of the teaching group and the differences among the educational curriculum of teachers. This further points to the importance of considering the introduction of more targeted neuroscience concepts, as recommended by our findings, among all teachers. These could include the integration of neuroscience components that are particularly pertinent to special educational needs and neurodevelopmental disorders. Although, as stated in Privitera's review [2], the effectiveness of such specific initiatives have not been previously investigated, there is a belief that neuroscience training could offer significant advantages, particularly for teachers who work with SEND children and diverse educational needs.

Furthermore, the outcome that access to information may act as a protective factor against neuromyths endorsement bears also important implications for education as it implies the potential to enhance knowledge about neurodevelopmental disorders through the wider dissemination of accurate information. Neuroeducation initiatives aimed to provide regular access to relevant resources among all teachers could be beneficial to decrease the endorsement of misconceptions on neurodevelopmental disorders in education. A number of potentially beneficial practices to promote brain knowledge have been recommended, including a regular, interactive email to receive an accurate summary of the latest findings in relation to educational neuroscience as well as the introduction to websites with valid information on the brain and educational neuroscience [7]. As also previously suggested [23], the establishment of neuroschools aimed at providing a global platform to promote social awareness and encourage interdisciplinary collaborations in the field of neuroscience and education, including special education, and the existence of relevant for educators conferences can also have a positive impact in advancing the international discourse surrounding the domain of educational neuroscience. Yet, future studies should examine in practice the effectiveness of these educational recommendations for teachers. Finally, our study is the first, at least to our knowledge, to indicate a significant contribution of teachers' need for cognition in the identification of neurodevelopmental neuromyths, pointing to the importance of designing and implementing effective educational training programs that integrate critical thinking and active learning methods to improve need for cognition levels.

5.2. Limitations and future directions

The current study focused on neuromyths about neurodevelopmental disorders in a large sample of Italian teachers. The study explored various determinants that account for neuromyths variations, providing important evidence for their nature and prevalence among Italian teachers. Despite the strengths of this study, several limitations merit comment. First, a limitation for all research in this area considers the operationalisation of neuromyths and brain knowledge. Brain facts may not be easily distinguished from neuromyths via the item-statements and the response format of the questionnaires, whereas the phrasing of certain items may increase response bias. Future studies could benefit from a more fine-grained investigation of neuromyths including mixed-methodologies to assess adhesion to neuromyths in more realistic situations within the school setting. Second, in line with Privitera [2], significant efforts are required to draw definitive conclusions regarding the effectiveness of educational variables such as neuroscience training or information for teachers. Utilizing more robust research designs, such as comparing the impact of training between teachers and using appropriate control groups, will provide a deeper understanding of the value of these educational factors and how they can be optimized. Further, expanding the evaluation of training outcomes to encompass student achievement would address a substantial gap in the existing body of literature. Third, it should be mentioned despite the significant determinants proposed in the regression analysis and the mediation model, only small effect sizes were reported. Future research should further examine the associations reported exploring more potential predictors and models accounting for the prevalence of neuromyths among teachers. Finally, our study used a cross-sectional design which precludes forming clear cause-and-effect inferences, whereas teaching experience and educational content received were assessed simply through self-reported single item questions. Future research might benefit from using longitudinal study designs that will allow a more in-depth investigation on the impact of continuous professional development in identifying neuromyths in education.

6. Conclusion

In conclusion, the current study showed that, similarly to teachers from other countries, Italian teachers adopt both general and neurodevelopmental neuromyths, with the latter to be more prevalent. However, they also seem to have basic neuroscience knowledge about the brain. Findings further showed that SEND teachers did not hold fewer incorrect beliefs about neuromyths as compared to mainstream teachers, highlighting the need for comprehensive neuroeducation initiatives to increase awareness among all teachers. The present results also showed that higher levels of need for cognition and frequency of accessing relevant brain information may act as protective factors against neuromyths. In light of the current findings, and with the aim to debunk popular misconceptions on neurodevelopmental disorders that proliferate within educational settings, there is a need for future research to delve deeper into the impact of specific neuroscience initiatives. These initiatives should serve as a means to bolster precise scientific knowledge and eliminate misconceptions through the integration of active learning methods. Such efforts should extend to both initial teacher education and the ongoing professional development of teachers.

Ethical statement

We confirm that this study received ethical approval by the Ethical Committee of the Univeristy of Florence n. 241, 02/20/2023.

Financial statement

We confirm that we have no relevant financial interests in relation to this publication.

Declaration of Competing Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

We understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office). She is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs. We confirm that we have provided a current, correct email address which is accessible by the Corresponding Author and which has been configured to accept email from (eva.bei.0209@gmail.com)

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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