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Misconceptions about neurodevelopmental disorders among Italian special education teachers: A mixed-methods study

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ABSTRACT

Limited research explores Neurodevelopmental Neuromyths' prevalence and educational implications. This study examined Neurodevelopmental Neuromyths among 241 Italian Special Educational Needs and Disabilities (SEND) teachers and their potential instructional implications. A mixed-methods triangulated approach was employed, combining findings from the Neurodevelopmental Neuromyths questionnaire with qualitative open-ended responses on instructional practices. The results indicated a prevalence of approximately 27.9 % for Neurodevelopmental Neuromyths among teachers. Prior attendance in a neuroscience course and reading of scientific magazines served as protective factors. Qualitative analysis revealed four predominant themes in instructional practices to support needs of SEND students: (1) simplifying teaching, (2) personalizing teaching and assessments, (3) empowering school inclusion, and (4) modifying the school/classroom environment. While certain instructional practices aligned with evidence-based approaches, others appeared to be influenced by prevailing neuromyths. The study highlights the importance of targeted interventions, including increased neuroscience training to enhance the overall support for SEND students.

1. Introduction

Neuromyths refer to commonly held misconceptions about the brain, often based on a misunderstanding of scientifically established facts (Bei et al., 2024; Gini et al., 2021). The prevalence of neuromyths can be traced to several factors, such as oversimplification of scientific results, sensationalistic reporting, and the omission of critical information (Gini et al., 2021) [1]. The Organization for Economic Cooperation and Development (OECD) has cautioned against the use of ineffective and non-evidence-based teaching practices resulting from the diffusion of neuromyths, which can have serious adverse effects on educational systems and learner outcomes worldwide (OECD, 2002).

Previous research has shown that educators have a greater ability to recognize neuromyths in comparison to the general population (Macdonald et al., 2017). Nonetheless, educators also continue to adhere to such misconceptions, as indicated by Gini et al.'s (2021)

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recent study, which reported no significant differences in the number of neuromyths held between individuals working in the education field and the general public. Furthermore, Bei et al. (2024) observed no differences in the number of neuromyths endorsed between Special Educational Needs and Disabilities (SEND) teachers and mainstream educators.

Previous studies conducted with educators have primarily focused on investigating the diffusion of neuromyths related to typical development (e.g., Dekker et al., 2012; Papadatou-Pastou et al., 2017; Tovazzi et al., 2020). Yet, limited attention has been given to educators' neuromyths about Neurodevelopmental Disorders in SEND children (Bei et al. (2024); Gini et al., 2021). Neurodevelopmental Disorders encompass a diverse range of conditions, such as 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, as defined by the diagnostic criteria in the DSM-5 (American Psychiatric Association, 2013).

Misconceptions about Neurodevelopmental Disorders can impede the inclusion of SEND children within the educational system. In addition to impacting the teaching and learning process, endorsing Neurodevelopmental Neuromyths can also have negative effects on the welfare of SEND children and contribute to their stigmatization within the educational environment (Gini et al., 2021; Tardif et al., 2015; Washburn et al., 2014). Yet, even with research investigating the factors influencing the endorsement and prevalence of Neurodevelopmental Neuromyths, there is a scarcity of studies exploring how these misconceptions can be applied within the educational context and classroom (Bei et al. (2024)). Gini et al. (2021), using the Neurodevelopmental Neuromyths Questionnaire, reported that British teachers - both mainstream and special educators - correctly answered approximately 75 % of items, implying a mean neuromyth endorsement rate of 25 %. In a more recent study conducted in Italy (Bei et al. (2024)), a similar rate of misconception (≈30 %) was found among both SEND and mainstream teachers, with no statistically significant differences between the two groups. These findings highlight the persistence of neuromyths in educational contexts, even among professionals with formal training. Previous studies on false beliefs about the typical development of the brain have also found that both prospective and practicing teachers tended to integrate certain misconceptions into their teaching approaches (e.g., Tardif et al., 2015).

Apart from the negative impact of these neuromyths on the teaching-learning process, misconceptions related to neurodevelopment can also adversely affect the well-being of SEND children (Corrigan & Watson, 2002; Gini et al., 2021). For example, despite the debunking of the notion that all children with Dyslexia see letters backward, a majority of teachers in the United Kingdom (91 %) still associate Dyslexia with visual perception difficulties, such as seeing letters backward or experiencing letter reversals (Washburn et al., 2014). Such misconceptions may hinder educators from referring SEND children for further assessment if the child does not display what is conventionally considered a "standard" symptom, such as letter reversals, or generally divert attention from evidence-based recommendations, treatments, and resources (Bei et al., 2024; Gini et al., 2021). This misalignment can delay diagnosis and the implementation of effective interventions, which in turn may exacerbate the child's academic difficulties, emotional distress, and sense of exclusion in the classroom (Bei et al., 2024; Gini et al., 2021). Finally, misconceptions in this domain can have adverse outcomes concerning the integration and inclusion of SEND children within mainstream educational systems. Previous studies have suggested that neurodevelopmental misconceptions may contribute to the stigmatization of SEND students within the educational environment, although this hypothesis needs further empirical testing in future studies (Gini et al., 2021; Schmitt et al., 2023; Washburn et al., 2014). For instance, the belief that students with Neurodevelopmental Disorders are inherently less capable can lead teachers to set lower expectations, avoid challenging them academically, or communicate condescension rather than support. These implicit attitudes may isolate students socially and reinforce harmful stereotypes, thereby contributing to their stigmatization within the school environment.

Informed by the existing literature, recent studies have emphasized the need to identify relevant factors that may serve as either protective or risk variables for the endorsement of neuromyths. Sociodemographic and educational variables such as years of teaching experience, prior participation in neuroscience-related training, and the frequency of engaging with scientific resources have been identified as potentially relevant in shaping teachers' susceptibility to neuromyths (Bei et al., 2024; Gini et al., 2021; Dekker et al., 2012; Papadatou-Pastou et al., 2017). Theoretical perspectives and reviews (e.g., Privitera, 2021) further suggest that targeted neuroscience training - both during initial teacher education and as part of ongoing professional development - could be particularly advantageous in reducing neuromyth endorsement, especially for teachers working with SEND populations. However, the impact of these factors among Italian SEND teachers remains largely unexplored.

2. The current study

In light of the potential adverse effects of neuromyths on SEND children, the present mixed-methods study focused on teachers' misconceptions about Neurodevelopmental Disorders, referred to as "Neurodevelopmental Neuromyths." The sample comprised Italian SEND teachers working in preschool, primary, or secondary education. The primary objectives of this study were:

1. To examine the prevalence (endorsement) of Neurodevelopmental Neuromyths; and b) which sociodemographic or other educational factors such as the educational content received can act as protective factors against their endorsement, through quantitative analysis.
2. To explore instructional practices related to the dissemination of common neuromyths via qualitative analysis.

To achieve these aims, we employed a mixed-methods cross-sectional survey design combining quantitative analysis of questionnaire responses with qualitative thematic analysis of open-ended items to better understand instructional practices.

3. Methods

3.1. Participants

A total of 241 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 using opportunity sampling by distributing a survey link within university postgraduate courses attended by SEND teachers working in preschool, primary, and secondary education.

3.2. Study design and procedure

A mixed-method triangulated approach was used to explore the prevalence and instructional practices related to Neurodevelopmental Neuromyths (Creswell, 2013). A cross-sectional online survey was conducted among SEND teachers of preschool, primary and secondary education in central Italy. Participants completed an online survey consisting of two components: a quantitative one including demographic questions and the Neurodevelopmental Neuromyths Questionnaire (Gini et al., 2021); and a qualitative one with free, not quantitative, open-ended questions addressed to teachers. The 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 original English version of both the quantitative and qualitative components was translated into Italian following a standard back-translation procedure to ensure linguistic and conceptual equivalence. The initial translation was performed by a bilingual researcher, and an independent back-translation was conducted by a second bilingual researcher blind to the original. Discrepancies were reviewed and resolved collaboratively by the research team, which included native Italian speakers familiar with both the content and cultural context.

3.3. Survey development

3.3.1. Quantitative survey

The online quantitative survey was developed in relation to the first research objective. The survey gathered sociodemographic characteristics of participants including their age and gender as well as additional questions on potential protective factors against neuromyths, including the frequency of accessing brain and neuroscience information, the attendance of a previous course related to brain or neuroscience and the regular reading (defined as weekly use) of diverse educational or career-related materials. Upon completing the sociodemographic questionnaire, the teachers were asked to complete the standardized Neurodevelopmental Neuromyths Questionnaire developed by Gini et al. (2021). This original version includes 30 statements related to Neurodevelopmental Disorders and was used without modification in the current study. These statements address neuromyths applicable across several conditions, as well as disorder-specific misconceptions pertaining to Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Down syndrome, and developmental dyslexia. Some of the items in the Gini et al. questionnaire were originally drawn from prior validated instruments and studies on specific Neurodevelopmental Disorders (e.g., Macdonald et al., 2017;], and were integrated by the original authors into a unified neuromyth assessment tool (Gini et al., 2021; Washburn et al., 2014).

The questionnaire includes a higher proportion of false statements ($n = 21$) as opposed to true statements ($n = 9$), in line with prior research which had mostly centered on incorrect beliefs regarding Neurodevelopmental Disorders (Gini et al., 2021). 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).

For the assessment of Neurodevelopmental Neuromyths participants were asked to rate each statement on a 4-point Likert scale ("True," "Probably True," "Probably False," and "False"). To facilitate comparison of scores across the various neuromyths, responses for all items were recoded using a scale of 1–4 as in the original study of Gini et al. (2021), 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.

3.3.2. Qualitative survey

The qualitative component of the study was designed to provide an in-depth understanding of teachers’ instructional practices and to uncover how misconceptions about Neurodevelopmental Disorders may influence real-world classroom adaptations. Aligned with mixed-methods approaches and qualitative theoretical frameworks, this component aimed to collect rich, open-ended textual data that would provide greater depth and contextual insight into the explored phenomena, particularly the ways in which neuromyths may be reflected in educational decisions. Such insights could not be captured through closed-form quantitative measures alone. (Braun et al., 2021).

Participants were provided with four open questions, developed to mirror the specific NDDs as assessed in the Neurodevelopmental Neuromyths Questionnaire of Gini et al. (2021), without word restrictions (free qualitative responses). The specific open-ended questions were:

1. Thinking about a child with ADHD, what adaptations and changes to your teaching would you make?
2. Thinking about a child with Down syndrome, what adaptations and changes to your teaching would you make?

3. Thinking about a child with ASD, what adaptations and changes to your teaching would you make?
4. Thinking about a child with language difficulties, what adaptations and changes to your teaching would you make?

3.4. Data analysis

3.4.1. Quantitative data analysis

Statistical analyses were conducted using IBM SPSS Statistics v25 software. Descriptive statistics were used to summarize participants' sociodemographic characteristics and to describe the overall prevalence of neurodevelopmental neuromyths among SEND teachers.

To explore whether neuromyth endorsement varied across different demographic and educational groups, we used the following comparison tests: Pearson's correlation analyses were applied to assess associations between continuous variables, such as age and years of teaching experience with SEND children, and neuromyth total scores. Independent-samples *t*-tests were conducted to compare neuromyth scores based on binary variables (gender; regular reading of newspapers, career-relevant blogs/websites, non-peer-reviewed magazines, popular science magazines). One-way ANOVAs were used to assess differences across multi-category variables (prior attendance to relevant university/training courses; frequency of access to relevant brain and neuroscience information).

Prior to conducting parametric analyses, assumption testing was performed. Normality of distribution was assessed using the Shapiro-Wilk test, and homogeneity of variances was verified using Levene's test. In all cases, assumptions for parametric testing were sufficiently met. Therefore, parametric tests were deemed appropriate for all analyses. Where ANOVAs yielded significant or marginally significant results, Tukey's post hoc tests were employed to identify specific between-group differences.

The use of correlation and difference testing served as a preliminary step to identify variables associated with neuromyth endorsement. This exploratory approach follows standard statistical practice for model building, where univariate analyses help guide the selection of variables to include in more robust multivariate models. Accordingly, a multiple linear regression analysis was conducted to examine the predictive influence of sociodemographic and educational factors on neuromyth endorsement, including those variables identified as significant in the univariate analyses.

3.4.2. Qualitative data analysis

Thematic analysis was conducted following the six-phase framework developed by Braun and Clarke, a widely used and well-established method in qualitative research [15–16]. This reflexive and interpretive approach emphasizes meaning-making and thematic development over code counting or interrater consistency. All participants responded to each of the four open-ended questions. However, since the responses were open-ended and unstructured, without any imposed word limit, it was not appropriate to quantify response frequencies. Instead, our aim was to capture the depth, variation, and complexity of participants' perspectives, in line with the interpretive framework of Braun and Clarke (Braun & Clarke, 2018; Braun et al., 2021).

The analytic stages involved becoming familiar with the data, initial coding, selective coding and identifying main themes, sorting the codes, writing memos, indexing themes, coding themes, and mapping and charting themes for interpretive purposes. Our approach to organizing and interpreting qualitative data involved the use of well-established open and selective coding methods, as previously described. This process included sorting codes by clustering smaller codes into larger categories, revisiting the data, and developing coherent themes for reporting. We ensured qualitative rigor by adhering to established quality criteria for qualitative research (Tracy, 2010). This included employing thick/rich descriptions, enhancing the credibility of the findings, and utilizing triangulation (Morse, 2015).

Table 1
Sociodemographic characteristics of the sample ($N = 241$).

	N (%)	***M(SD)***
Age		40.1 (8.5)
Gender		
Female	189 (78.4 %)	
Male	42 (17.4 %)	
Other	10 (4.2 %)	
Has a child with learning disability	17 (7.1 %)	
Prior attendance of relevant university/training course		
Yes, more than one	42 (17.4 %)	
Yes, only one	38 (15.8 %)	
No	161 (66.8 %)	
Years of teaching experience with SEND children		5.28 (4.12)
Frequency of access to relevant brain and neuroscience information		
Frequently	78 (32.4 %)	
Often	118 (49 %)	
Not often	45 (18.6 %)	
Reading regularly		
Newspaper (including online news websites)	202 (83.8 %)	
Career-relevant blogs and websites	155 (64.3 %)	
Career-relevant magazines and publications (non-peer-reviewed)	69 (28.6 %)	
Popular science magazines (e.g. Psychology Today)	36 (14.9 %)	

3.4.3. Integrated synthesis

To report and discuss the findings from both the quantitative and qualitative components of the study, we employed a well-established mixed-method approach. In this triangulated mixed-method design, both aspects of the study - quantitative and qualitative - were conducted concurrently (Creswell, 2013). The triangulation of results from each primary objective of the study allows for the convergence of different types of data, enhancing the robustness of the findings. The Results section below presents the outcomes from these distinct analytical approaches, while the Discussion section offers higher-order interpretations that integrate and link the two sets of results.

4. Results

4.1. Quantitative data analysis

4.1.1. Sociodemographic characteristics

The Sociodemographic characteristics of participants are presented in Table 1. Overall, 241 SEND teachers from Italy completed the online survey (quantitative and qualitative components). The majority of participants were female (78.4 %), with a mean age of 40.1 ± 8.5 years. Around 7.1 % of participants reported being a parent of a SEND child. Furthermore, the average teaching experience with SEND children was 5.28 ± 4.12 years. With regards to the content of education, more than half of the participants (66.8 %) reported that they had not received a university or training course related to brain or neuroscience. In addition, approximately one-third-of the sample reported to frequently access information relevant to the brain and neuroscience learning in their daily life. When asked which sources of information they usually access regularly, 83.8 % of participants answered that they read newspapers

Table 2a
Neurodevelopmental Neuromyths (False statements) ordered by prevalence of incorrect endorsement.

Item	Category	% Incorrect (Myth endorsement)	*M(SD)*
25. All children with hearing impairments benefit from visual information	Nonspecific neurodevelopmental neuromyth	72.7	1.46 (0.81)
14. Children with autism do not like to be touched	Autism	59.5	2.31 (0.98)
3. Reducing dietary intake of sugar or food additives is generally effective in reducing the symptoms of ADHD	ADHD	54.2	2.49 (0.87)
9. Prolonged use of stimulant medications for ADHD leads to increased addiction in adulthood	ADHD	51.5	2.51 (0.84)
28. Children with autism and ADHD and alike can be cured	Nonspecific neurodevelopmental neuromyth	47.1	2.6 (1.1)
2. Most ADHD children 'outgrow' their symptoms	ADHD	42.1	2.65 (0.81)
21. In some children dyslexia is caused by visual problems	Dyslexia	31.0	2.95 (0.99)
8. If a child responds to stimulant medications, then they probably have ADHD	ADHD	26.5	2.96 (0.81)
29. Disorders can be caused by adverse immune reactions to vaccinations	Nonspecific neurodevelopmental neuromyth	25.7	3.2 (0.93)
11. Children with autism do not have empathy	Autism	22.7	3.19 (0.92)
10. Children with autism are unable to notice social rejection	Autism	20.2	3.23 (0.88)
19. All children with dyslexia see letters backward	Dyslexia	16.1	3.28 (0.82)
20. Children who are dyslexic tend to have lower IQ scores	Dyslexia	14.5	3.4 (0.79)
23. Dyslexia can be helped by using colored lenses	Dyslexia	12.8	3.31 (0.77)
17. People with Down syndrome are always happy and affectionate	Down Syndrome	12.4	3.44 (0.75)
6. ADHD is largely the result of ineffective parenting	ADHD	11.2	3.39 (0.73)
24. Learning difficulties from brain function differences cannot be improved by education	Nonspecific neurodevelopmental neuromyth	11.2	3.46 (0.81)
13. Autism only occurs in boys	Autism	8.3	3.66 (0.68)
16. Children with Down syndrome cannot understand what they are reading	Down Syndrome	8.2	
18. Children with Down syndrome cannot learn anything complex	Down Syndrome	8.6	3.65 (0.59)
27. Understanding can be measured by what a child can say	Nonspecific neurodevelopmental neuromyth	6.2	3.58 (0.61)

Note: " % Incorrect" for myth-based items refers to participants who did not recognize a scientifically inaccurate (false) statement as incorrect.

(including online newspapers), 64.3 % career relevant websites and blogs, and 14.9 % popular science magazines.

4.1.2. Neurodevelopmental neuromyths prevalence

In linewith the approach used by Gini et al. (2021), incorrect answers were identified by participants endorsing false statements as "True" or "Probably True" and rejecting true statements as "False" or "Probably False". The prevalence of Neurodevelopmental Neuromyths - including incorrect responses to both false and true neurodevelopmental statements - was calculated as the mean percentage of incorrect answers across the 30-item questionnaire and was approximately 27.9 %. Regarding the false neurodevelopmental statements, the most endorsed neuromyth was that "All children with hearing impairments benefit from visual information" in which 72.7 % reported to be True or Probably True; the least endorsed neuromyth was "What a child with learning difficulties can understand can be measured by what that child can say" in which only 6.1 % 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 93 % of teachers responded that it is False or Probably False; the least prevalent neuromyths were that "Some children with autism have a special talent or savant skill" and "Children with dyslexia can often excel in other areas" in which only 5.8 % of participants answered that it is indeed False or probably False. The prevalence for each neurodevelopmental neuromyth is reported in Table 2a and Table 2b

4.1.3. Protective factors against Neurodevelopmental Neuromyths

Prior to running parametric tests, assumption testing was carried out. All test results were non-significant ($p > .05$), indicating that the assumptions for conducting parametric analyses, including correlation, t-tests, ANOVAs, and linear regression, were met.

4.1.3.1. Univariate analyses. Correlation analyses revealed a moderate relationship between age and neuromyths total score, $r = 0.51$, $p < .001$ with older age to be correlated with a better score on neurodevelopmental neuromyths which indicates fewer endorsement. In addition, a significant correlation was found between the years of teaching experience with SEND children and the total score of neurodevelopmental neuromyths, indicating that teachers with higher experience endorsed fewer neuromyths and scored higher on the questionnaire, $r = 0.74$, $p < .001$ Correlation analyses also revealed a weak to moderate relationship between age and years of teaching experience, indicating that older participants tended to have more experience teaching children with SEND, $r = 0.41$, $p < .001$.

Given the number of comparisons conducted, we applied a Bonferroni correction to adjust for potential inflation of Type I error. With seven independent tests (*t*-tests and ANOVAs), the adjusted significance threshold was set at $\alpha = 0.0071$ (0.05/7). The independent samples *t*-tests did not reveal any significant gender difference on neuromyths performance (see Table 3). However, a significant difference was found with SEND teachers who reported to read relevant scientific magazines, to report better performance scores on neuromyths questionnaire, $p = .004$.

ANOVA revealed a trend-level group difference in neuromyth scores based on prior attendance of relevant university/training courses, F (4.42), $p = .013$, which did not reach significance after Bonferroni correction (adjusted $\alpha = 0.0071$). Tukey post-hoc comparisons similarly indicated differences between those who had attended more than one course, $M = 3.16$, and those who had attended only one, $M = 2.98$, $p = .05$, or none, $M = 3.01$, $p = .014$). Frequency of access to relevant brain and neuroscience information (frequent; often; not often) did not show statistically significant differences in neuromyth scores.

Table 2b
Fact-Based (True) statements ordered by prevalence of incorrect endorsement.

Item	Category	% Incorrect (Fact Misunderstanding)	*M(SD)*
15. Children with Down syndrome have smaller brains	Down Syndrome	93.0	1.56 (0.63)
1. Stimulant drugs are the most common type of drug used to treat children with ADHD	ADHD	67.3	2.14 (1.08)
7. Symptoms of depression are found more frequently in children with ADHD than in children without ADHD	ADHD	61.1	2.24 (0.82)
30. Autism and ADHD are more common in first-degree biological relatives	Nonspecific neurodevelopmental neuromyth	42.1	2.6 (0.91)
26. The multisensory approach is always better for children with disorders	Nonspecific neurodevelopmental neuromyth	29.4	2.88 (1.03)
5. It is possible for an adult to be diagnosed with ADHD	ADHD	19.9	3.15 (0.87)
4. Children with ADHD have difficulties with focus and concentration	ADHD	9.2	3.77 (0.52)
12. Some children with autism have a special talent or savant skill	Autism	5.8	3.59 (0.63)
22. Children with dyslexia can often excel in other areas	Dyslexia	5.8	3.52 (0.65)

Note: " % Incorrect" for fact-based items refers to participants who did not recognize a correct scientific statement as true.
Note: Overall incorrect endorsement of both Neurodevelopmental Neuromyths (Table 2a) and Fact-based statements (Table 2a) was 27.9 %.

Table 3
Group differences in Neurodevelopmental Neuromyth scores by sociodemographic variables.

Variables	Neuromyths Scores *M* (*SD*)		*t* or F*	*P* value
Gender			.257	.411
	Female	3.01 (0.22)		
	Male	3.02 (0.27)		
Prior attendance of relevant university/training course			4.42	.013
	Yes, more than one	3.16 (0.26)		
	Yes, only one	3.01 (0.23)		
	No	2.98 (0.22)		
Frequency of access to relevant brain and neuroscience information			.108	.898
	Frequently	3.01 (0.26)		
	Often	3.02 (0.23)		
	Not often	2.99 (0.22)		
Reading regularly				
Newspaper (including online news websites)	Yes	3.01 (0.24)	1.68	.098
	No	3.07 (0.18)		
Career-relevant blogs and websites	Yes	3.02 (0.22)	.239	.811
	No	3.01 (0.25)		
Career-relevant magazines and publications (non-peer-reviewed)	Yes	3.04 (0.21)	1.36	.174
	No	3.01 (0.24)		
Popular science magazines (e.g. Psychology Today)	Yes	3.15 (0.23)	2.88	.004*
	No	3.00 (0.23		

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

4.1.3.1. Multivariate analyses. In the first block of the multiple regression analysis significant demographic variables from the univariate analyses, including participants' age and years of experience in teaching SEND children were entered (see Table 4). In the second block significant data related to the education content received, including prior attendance of relevant university or training courses, and reading regularly scientific magazines, were entered. Although the result for prior attendance of relevant university/training course did not survive Bonferroni correction in the univariate ANOVA, it was retained in the regression model based on both theoretical relevance and its borderline statistical significance.

The results of the regression analysis indicated that age and years of experience working with SEND children, entered in step 1, accounted for a non-significant 0.3 % of the variance in the average neuromyths score, and the model was not a significant predictor of neuromyths prevalence, $F(2, 195) = 0.317, p = .229$. Neither age nor years of experience were found to be significant predictors within this model.

In step 2 of the regression analysis, two additional variables, prior attendance of relevant university/training course and reading science magazines were included in the model. The increase in R^2 was significant, explaining an additional 5.3 % of the variance in the average neuromyths score, F change $(2, 193) = 5.100, p = .007$. Within this step, both prior attendance of relevant university/training course ($p = .036$), and reading science magazines ($p = .046$) were significantly associated with the neuromyths score. Age and years of experience remained non-significant in this extended model.

4.2. Qualitative data analysis

In exploring the responses to the first four questions regarding adaptations and changes to teaching based on Neurodevelopmental Disorder, using Braun and Clarke's (2006, 2018) thematic analysis, four predominant themes were identified: **(1)** simplifying teaching**, (2)** personalizing teaching and assessments**, (3)** empowering school inclusion**,** and **(4)** modifying the school/classroom environment. However, it should be noted that the key themes varied for each Neurodevelopmental Disorder, and not all themes emerged for every disorder or with equal frequency. A comprehensive overview of the main themes for each qualitative question related to adaptations

Table 4
Summary of multiple regression model for Neurodevelopmental Neuromyths.

Step 1				**Step2**		
	Unstandardized Coefficients		**Standardized coefficients**	**Unstandardized Coefficients**		**Standardized coefficients**
	B	***SE B***	***β***	***B***	***SE B***	***β***
Determinant Variables						
Age	−0.02	.003	−0.16	−0.04	.005	.03
Years of teaching experience with SEND children	.03	.004	.06	.05	.006	0.02
Prior attendance of relevant university/training course				−0.4	.14	−0.16
Reading popular science magazines				−0.1	.046	−0.14
R^2	.003			.053		

and changes in teaching is provided below.

4.3. Down syndrome

"Thinking about a child with Down Syndrome, what adaptations and changes to your teaching (e.g., delivery style, classroom environment, curriculum, assessment, marking etc.) would you make?

4.3.1. Simplification of teaching style and curriculum

One of the most frequently reported key themes that emerged from the analyses of responses regarding teaching children with Down Syndrome was the importance of simplifying teaching style, curriculum and educational materials. Many of the teachers indicated that in general the teaching style should be simplified to help a child with Down Syndrome, without however providing concrete examples, theory-based practices and teaching methods to implicate such adaptations within the classroom setting. Other participants provided more specific examples and ways to simplify teaching for a child with Down Syndrome, with the most common including simplification of teaching by breaking classroom activities into smaller parts, "I would simplify teaching, break it down into steps, we don't have to necessarily change the curriculum… " and incorporating more interactive and multisensory approaches, such as using visual and multimedia resources. Despite that, teachers rarely provided examples of how to simplify teaching style for specific subjects, with the most frequent area for applying simplification strategies to usually include reading and writing, "…simplifying lessons by using images and digital devices that can make reading for example easier".

4.3.2. Personalisation of teaching style and assessment

Majority of teachers indicated that they would apply adaptations to their teaching according to the personal and learning needs of the child with Down Syndrome. Teachers provided examples of key adaptations to promote a personalized style of teaching that mainly involves the design of individualized activities, "I would introduce and design tailored activities consistent to the child's strengths as emerged during observation", as well as flexible assessment methods according to the student's needs but also according to the goals set based on prior evaluation, "For example, if I knew that the child is good at art but in the assignment given he didn't put an effort that corresponds their potential, I wouldn't necessarily evaluate them positively…". Other participants focused on the importance of tailoring their teaching style and assessment methods with the aim of empowering self-autonomy in children with Down Syndrome: "Assessment would be more based on the milestones achieved with respect to the children's autonomy and not the learning milestones". Notably, some teachers supported that they are not able to provide any general examples on the changes they would apply as this depends on the particular learning and cognitive needs of each student that may vary significantly in each case.

4.3.3. Empowerment of school inclusion

Many teachers emphasized on the creation of an inclusive environment with the focus on promoting social skills and peer relationships, and empowering cooperative learning, "I would try to create an inclusive classroom environment, design inclusive activities in small groups and promote peer relationships through peer tutoring and exchange of information through workshop activities". Other teachers indicated that they would apply specific classroom modifications to encourage further peer relationships and ensure that the child with Down Syndrome is not excluded by their peers, "I would prioritize inclusion, providing for example soft corners within the classroom to encourage peer interaction".

4.4. Autism spectrum disorders

"Thinking about a child with autism, what adaptations and changes to your teaching would you make?"

4.4.1. Modifications of the classroom environment

One of the key themes that frequently emerged in relation to teaching children with ASD was the importance of modifying the classroom environment. Teachers recognized the potential for triggering stimuli in the classroom to cause discomfort for students with ASD, and emphasized the need for environmental modifications to mitigate these challenges. Participants identified various strategies for modifying the classroom environment, such as reducing excessive noise and lighting that could cause discomfort for the child. As one teacher stated, "I would try to modify the classroom so that I reduce excessive noise and lighting that could cause discomfort to the child." Others recommended creating a safe, quiet environment, "I would try to create a safe, quiet environment with soft corners and relaxation areas." Participants noted the importance of involving all students in understanding the need for a quieter environment, as well as avoiding too many stimuli at the same time, "I would modify the class environment to create a calm atmosphere, involving all students and explaining them that some of them may get easier bothered and agitated when there is confusion or a more chaotic environment."

4.4.2. Personalisation of teaching style and assessments

As in the case of Down Syndrome, teachers highlighted the importance of tailoring their teaching style according to the specific needs of a student with ASD. Yet, many teachers focused on the need of tailoring teaching by providing specific time schedules, daily routines and activities that facilitate stability and accommodate children's needs, "I would try to set up a clear routine or I would make it clear when we're having a break, when is time for activities etc.". Teachers also highlighted the need of designing more tailored activities to increase social and communication skills, "I would try to empower social skills and communication skills by introducing

more group and workshop activities". Yet, majority of teachers did not provide concrete examples of activities or other ways of personalizing teaching style to achieve the abovementioned objectives but rather focused on the outcome that was considered as critical: "I would focus mainly on the child's social skills and relationships with peers, on creating a sense of group within the classroom". Other teachers also indicated that teaching should be tailored by focusing more on emotional management and recognition "Primarily I would work on emotions, assisting the student to recognise the emotional reactions of their classmates and manage their own.. this is the most complex aspect…". Finally, as with Down Syndrome, teachers indicated that assessment methods should be more flexible corresponding to the cognitive and learning needs of the student with ASD and focusing to the achievement not only of learning outcomes but also outcomes related to social skills and self-autonomy.

4.4.3. Simplification of teaching style and curriculum

Although many teachers indicated that teaching style and content may need to be simplified to facilitate learning for children with ASD, this did not emerge as frequently as in children with Down Syndrome. Teachers mainly referred to simplifying the curriculum and lessons in the sense of providing a more structured environment, regular times and daily schedules as mentioned above. Consistent with this, some teachers also suggested simplifying teaching by adopting multisensory approaches and multimedia resources along with text or images in order that will assist learning and make the class organization simpler.

4.4.4. Empowerment of school inclusion

Similar to the case of Down Syndrome, a number of teachers recognized the importance of promoting school inclusion for students with ASD by establishing an accepting atmosphere that fosters a sense of belonging within the educational activities. Specifically, teachers emphasized the use of group activities and designated areas, such as soft corners, with the goal of enhancing peer relationships and social skills, which were recognized, as areas where children with ASD often struggle, "peer activities in pairs that gradually transition to a larger peer group to help with difficulties in communication and relationships."

4.5. Language difficulties

"Thinking about a child with language difficulties, what adaptations and changes to your teaching would you make?"

4.5.1. Simplification of teaching contents

In regards to teaching children with language difficulties, the majority of teachers focused on adaptations and simplifications of teaching materials to facilitate easier learning. Most teachers indicated the need to focus their teaching on more multisensory-oriented approaches including auditory and visual resources that can be used as "alternatives" to traditional teaching models that involve heavy reading text, providing thus a simpler method to facilitate reading and writing skills, "I would try to use all the necessary aids to reduce difficulties… e.g., use of images related to text, words in bold, videos to support lessons..". Other participants highlighted the need to simplify educational contents and foster learning by providing for example texts with a simpler vocabulary, simple words and short sentences, "simple texts, simple terms (nouns, verbs in the present tense)".

4.5.2. Personalisation of teaching activities

Many teachers indicated that aside from simplifying the educational materials, they would also make adaptations and changes on the teaching activities, according to the learning needs of the child with language difficulties. For example, some teachers provided examples of adaptations to promote a personalized style of teaching that mainly involved the design of tailored activities to enrich the lexicon of the children or facilitate reading: "I would include game activities in which the child has to find associations between different objects and sounds with words". Furthermore, many teachers reported that they would introduce specific peer and group activities such as peer tutoring to foster cooperative learning. Some teachers referred to activities they would eschew in order to promote the learning and well-being of children with language difficulties and avoid demotivating them during the learning process, "I would avoid reading aloud methods and such activities that can be considered as comparison with other children." Finally, some teachers reported adaptations they would make with regards to the assessment methodologies and processes, with the most common including prioritisation of flexible and focused learning - to the language difficulties - assessments.

4.6. Attention deficit hyperactivity disorder (ADHD)

"Thinking about a child with ADHD, what adaptations and changes to your teaching would you make?"

4.6.1. Personalisation of teaching style and assessment

Most teachers highlighted the importance of tailoring teaching lessons by providing increased time for breaks, incorporating motor activities that reduce fatigue and promote attention, and specific time schedules that cater to the needs of children. More specifically, teachers stressed the need for frequent interchanges between lessons and breaks as a critical adaptation to reduce fatigue and increase attention when in the classroom, "teaching style that includes often breaks, taking into account attention and fatigue". In addition to time breaks, teachers proposed a more flexible but structured time schedule that includes breaks, activities, and lesson times agreed upon and made aware among students.

Further, teachers reported the need of designing more tailored activities that will allow movement in the classroom, thereby facilitating difficulties of sitting still and increasing attention and interest of children with ADHD. To achieve this, they reported

examples of activities involving a more interactive style of teaching that will allow the child to move more freely during the learning process (e.g., motor activities), "activities such as theatre activities, motor activities where the child learns while moving around in the classroom…" Some of the participants also suggested individualized small activities "…assign tasks small tasks that allow them to move around (delivering papers, arranging desks and chairs)". In addition, many teachers indicated as beneficial the use of multi-sensory approaches such for example using multimedia support to empower child's attention and interest. In contrast to Down Syndrome where the multisensory approach was indicated as a way to simplify materials and replace for example heavy text, here it was mainly reported as an effort of engaging students with ADHD and increasing their interest during the learning process.

Tailored group activities, including organizing group workshops and small group tasks or assignments were also suggested as a way to empower peer relationships and involve the child with ADHD in a way that stimulates their interest and release excess energy. Finally, a more flexible, individualized assessment method was proposed. Similar to other Neurodevelopmental Disorders described above, teachers reported that assessment should be focused on the learning needs of children but also other aspects such as self-regulation, pertaining more to the nature of ADHD, "adapted assessment… evaluate and reward both knowledge and self-regulation…".

4.6.2. Modifications of the classroom environment

Several teachers reported their intention to alter the classroom setting in order to minimize external distractions and stimuli that could reduce focus and attention, "Modifications of the classroom should aim to reduce distracting noises and sensory stimuli". Frequently, teachers provided examples of specific classroom modifications to promote the movement and freedom of children with ADHD, addressing according to them one of the major challenges of this Neurodevelopmental Disorder, namely prolonged sitting, "I would arrange the classroom so that the child with ADHD sits in a location where he could easily get up and move to 'unload' his hyperactivity without distracting other students." Lastly, creating a calm and quiet environment was recommended for children in order to facilitate learning and keep attention. Teachers suggested modifying the classroom environment to promote awareness and cooperation among students, thereby creating a beneficial environment for children with ADHD.

4.6.3. Simplification of teaching content

Although simplification of the teaching processes and materials did not emerge as frequently as in other Neurodevelopmental Disorders (especially Down Syndrome), it was still reported by some teachers as a way to increase focus on learning for children with ADHD. In particular, some participants indicated that teachers should simplify the learning content by breaking it down into smaller steps that will enable the child to more easily maintain their attention and focus during the learning process, "…simplifying concepts and materials with focus on administering short tasks, one at a time to keep attention…".

5. Discussion

5.1. Neuromyths in educational practices

The current study makes a significant contribution by highlighting the prevalence and educational determinants of Neurodevelopmental Neuromyths, and by further exploring instructional practices that could be potentially influenced by these misconceptions among Italian SEND teachers. Considering the pivotal role of SEND teachers and the profound implications of their beliefs on the educational experiences and well-being of SEND students (Rosati & Lynch, 2023), the findings of the current study gain particular relevance. The results carry substantial value as they don't simply present the prevalence of neuromyths among SEND teachers but also explore specific determinants of neuromyths and instructional practices, some of them potentially influenced by the endorsement of these misconceptions. Although it should be noted that the endorsement of neuromyths cannot be directly associated with practice and educational outcomes, this exploratory mixed-methods study provides valuable insights for shaping informed educational policies and practices, highlighting the need to address and rectify these misconceptions in order to enhance the quality of support extended to SEND students.

In addressing our first research question (Research Question 1a) about the endorsement of Neurodevelopmental Neuromyths, the prevalence rates (mean acceptance was about 27.9 %) highlighted significant misconceptions among the teachers. Our findings align with the previous study by Gini et al. (2021), who initially introduced the Neurodevelopmental Neuromyths Questionnaire among British teachers. Italian SEND teachers, on average, answered correctly to 72 % of Neurodevelopmental Neuromyths, slightly lower than the 75 % observed among British teachers (majority were mainstream teachers). In addition, the study findings align with our recent study on Neurodevelopmental Neuromyths where SEND teachers were compared with mainstream teachers in Italy (Bei et al., 2024). The two groups, in total, presented with a mean acceptance of Neurodevelopmental Neuromyths of about 30 %, were found to be largely comparable across the majority of demographic and educational variables, and no significant differences between the number of neurodevelopmental myths endorsed where found between them. In addition, the finding that educational factors, such as previous attendance at a relevant course on neuroscience or regularly reading scientific magazines, can act as protective factors against neuromyths (Research Question 1b), aligns with previous studies in the field. These studies have indicated that teachers who display a strong interest in acquiring knowledge about the brain might be less affected by neuromyths (Authors et al., 2024; Gini et al., 2021; Privitera, 2021).

The prevalence of Neurodevelopmental Neuromyths among SEND teachers highlight the critical need for targeted interventions within the Italian educational context. While the exact impact of neuromyths on student learning and teacher performance lacks consistent evidence, previous research suggests that teachers who endorse such misconceptions often integrate them into their

teaching practices (Privitera, 2021). It is essential to recognize that Neurodevelopmental Neuromyths can potentially lead to mislabelling, stigmatization, or inadequate support when specific conditions are not fully understood (Braun & Clarke, 2006). For instance, highly endorsed neuromyths in our study such as "All children with hearing impairments benefit from visual information" (prevalence of 72.7 %) may result in the implementation of ineffective interventions for some SEND children, diverting teacher attention from evidence-based resources. These findings highlight the need of addressing and countering these critical misconceptions to enhance the overall educational landscape. Moreover, the finding that access to relevant information, such as attending courses or reading scientific magazines, can serve as a protective factor against endorsing neuromyths carries significant educational implications. This suggests that broadening access to accurate information could enhance understanding of Neurodevelopmental Disorders and reduce ineffective instructional practices among SEND teachers (Privitera, 2021). Implementing more neuroeducation programs and tailored training that ensure SEND teachers regularly access reliable resources may help reduce the prevalence of misconceptions about Neurodevelopmental Disorders in educational settings.

In addressing our second exploratory qualitative research question on the influence of neuromyths among SEND educational practices, certain patterns of qualitative analysis emerged, seemingly influenced by prevailing misconceptions. However, it is important to recognize that no direct associations can be made between specific neuromyths and instructional practices. The mixed-methodology employed in this study allows only for inferences to be made regarding the potential relationship between neuromyths endorsed in the questionnaire and practices reported in the qualitative findings.

A notable trend observed across the majority of responses and key themes, irrespective of the Neurodevelopmental Disorder category, was the absence of explicit references to neuroscientific principles in justifying educational decisions and instructional practices. While this could be attributed to the open-ended nature of the online questions, designed to elicit spontaneous responses without prescribing specific guidelines, the absence of scientific grounding in participants' educational choices suggests a general "disconnect" between pedagogical practices and the neurofunctional underpinnings of these disorders. Coupled with the quantitative data revealing the prevalence of Neurodevelopmental Neuromyths and the protective factors of educational content received, the insights further highlight the critical need for comprehensive training and a deeper understanding of the neurofunctional factors that shape educational decision-making.

Particularly notable was the recurring theme advocating for the simplification of teaching styles and curriculum **(Theme 1)**, predominantly associated with oversimplification approaches and in most cases with not concrete practices per learning subject, especially concerning students with Down Syndrome. This tendency may be linked to misconceptions suggesting that individuals with Neurodevelopmental Disorders, such as Down Syndrome, ASD, ADHD, or language difficulties, nearly always struggle with complex information processing, thus benefitting from a simplified approach (Gini et al., 2021; Cologon, 2013). Oversimplification strategies based on presumed cognitive deficits may hinder, rather than enhance, the learning experience. Individuals with Neurodevelopmental conditions exhibit a wide range of cognitive abilities, challenging the adoption of a one-size-fits-all approach suggested in some cases by participants. The endorsement of neurodevelopmental neuromyths in the questionnaire, such as "Children with Down syndrome cannot understand what they are reading,", "Children with Down syndrome cannot learn anything complex," and "Learning difficulties associated with developmental differences in brain function in children with disorders cannot be improved by education," also seem to align with the main theme of simplification found in the qualitative results. Altogether, these neuromyths imply a general notion that individuals with Neurodevelopmental Disorders always struggle with learning information and thus can benefit from a simplified approach. While these neuromyths were not highly endorsed by participants, their presence in addition to the qualitative findings on simplification without concrete – in most of the cases - practical examples per learning subject, highlight the need to critically examine and challenge misconceptions that may inform pedagogical approaches.

The prevalent suggestion to personalize teaching styles and assessments among all students depending on the Neurodevelopmental Disorder **(Theme 2)**, may reflect the common belief that these disorders lead to specific, uniform learning styles (Gini et al., 2021; Lethaby & Harries, 2016). While there remains no agreement on the degree to which neuromyths negatively impact students' learning, research indicates that educators who embrace these misconceptions tend to incorporate learning practices associated with them (Lethaby & Harries, 2016; Ruhaak & Cook, 2018). This might involve instructional approaches like evaluating students according to their preferred learning style or adapting learning activities to correspond with presumed specific learning styles associated with Neurodevelopmental Disorders (Gini et al., 2021). In their recent study, Ruhaak and Cook (2018) also found that pre-service special education teachers expressed confusion during interviews by the terminology surrounding educational neuromyths, such as preferred learning styles, and did not know how to identify pseudoscientific neuromyth-based practices. Notably, the researchers found that teachers who accurately identified neuromyths such as "Individuals learn better when they receive information in their preferred learning style" indicated they were more likely to implement effective instructional practices, compared to those who either did not identify these myths or responded with 'I do not know' (Ruhaak & Cook, 2018). According to the recent review of Privitera (2021), teachers' concurrent interest in and lack of training in neuroscience may partially contribute to the perpetuation of these neuromyths within the field of education. Indeed, evidence suggests that neuromyths such as the belief that students learn better when information is presented in their preferred learning style, persist among teachers across diverse cultures and experience levels (Deligiannidi & Howard-Jones, 2015; Pei et al., 2015). It is therefore important to recognize that every student is unique and assumptions about uniform learning needs or preferred styles based on diagnostic labels can perpetuate stereotypes (Ruhaak & Cook, 2018). Instead, tailoring approaches should stem from a comprehensive understanding of each student's unique strengths and challenges, rather than preconceived notions associated with neuromyths. Comprehensive training that emphasizes accurate neuroscience knowledge towards this direction, could be instrumental in combating such neuromyths, as access to reliable neuroscience information was identified as a protective factor against these misconceptions in our study.

However, it should be acknowledged that within this the key Theme 2, and in contrast to the theme of simplifying teaching

approaches (Theme 1), many SEND teachers provided useful examples of instructional practices grounded in factual understanding, rather than misinformation. For example, in the case of language difficulties, some of the participants suggested the design of tailored activities to enrich the lexicon of the children or facilitate reading, or other activities including peer tutoring. Also, for ADHD, teachers emphasized the necessity for adaptations to maintain attention in the classroom, such as incorporating frequent breaks, structured schedules, and movement-friendly activities. Multisensory approaches were also suggested to engage students and sustain their interest. The identification of such instructional practices aligns closely with the identification of accurate statements in the Neurodevelopmental Neuromyths questionnaire. For instance, true statements such as "Children with ADHD have difficulties with focus and concentration" was acknowledged as correct by the majority of participants (around 90 %), while approximately 70 % identified "The multisensory approach to learning is always better for children with disorders" as correct. In addition, this identification aligns with the fact that some of the teachers reported to have attended a relevant neuroscience course or reading scientific magazines which both emerged as protective factors against neuromyths.

In emphasizing the creation of inclusive environments **(Theme 3)**, teachers identified that students with ASD often encounter challenges in social interaction and communication, along with exhibiting restricted or repetitive stereotyped patterns of behaviors and interests. This theme emerged not only for students with ASD but also for those with Down syndrome. However, it is crucial to recognize that social difficulties can vary widely among individuals with Neurodevelopmental Disorders, in particularly ASD, challenging the neuromyth-driven assumption of uniform challenges in social interaction for all these students (John et al., 2018). These general assumptions on difficulties concerning social interactions, peer relationships and communication could align with the endorsement of neuromyths in our study such as "Children with autism are unable to notice social rejection" (prevalence of 20.2 %), “Children with autism do not like to be touched” (prevalence of 59.5 %), and "Children with autism do not have empathy" (prevalence of 22.7 %), perpetuating the misconception that these students *universally* struggle with social functioning aspects. However, it should be acknowledged that in the discussions surrounding the empowerment of school inclusion, majority of teachers provided practices grounded in factual understanding, potentially related to their training but also to protective factors against neuromyths that found in this study, related to having more access to neuroscience information. For instance, many teachers highlighted the importance of promoting social skills and peer relationships in general, as well as empowering cooperative learning within the classroom environment. Furthermore, specific classroom modifications were suggested to encourage peer relationships and ensure inclusion, such as implementing a horseshoe seating arrangement, creating spaces within the classroom for movement and interaction, and prioritizing inclusion by providing soft corners to encourage peer interaction.

Finally, in discussing modifications to the classroom environment (**Theme 4**), particularly for children with ASD and ADHD, teachers demonstrated a commitment to evidence-based practices aimed at supporting diverse learning needs. Rather than relying on neuromyths, teachers grounded their approaches in factual understandings of these Neurodevelopmental Disorders. For children with ASD, teachers emphasized the importance of creating a calm and comfortable atmosphere within the classroom. Strategies included reducing excessive noise and lighting, as well as providing safe, quiet spaces for students to retreat to when needed. These practices align with evidence-based approaches aimed at minimizing sensory overload and supporting students’ well-being without necessarily perpetuating neuromyths about sensory sensitivities (Jones et al., 2020). Similarly, modifications to the classroom environment for children with ADHD were based on the challenges often associated with the condition including difficulties with concentration (McDougal et al., 2023). Teachers expressed intentions to minimize external distractions and stimuli to enhance students’ focus and attention. Strategies included removing potentially distracting elements and providing spaces for movement to accommodate the needs of students with ADHD. These approaches align with the high prevalence (around 91 %) of the correct of the True statement in the Neurodevelopmental Neuromyths questionnaire that "Children with ADHD have difficulties with focus and concentration," highlighting the recognition among educators of the challenges faced by students with ADHD.

5.2. Limitations and future directions

The current study focused on neuromyths about Neurodevelopmental Disorders in a sample of Italian SEND teachers. An important strength of the study lies in its well-established mixed-methods triangulated approach, which facilitated rich data collection from a substantial cohort of SEND teachers (Creswell, 2013). In addition, employing a survey as a mixed-methods tool including free, open-ended qualitative questions, enabled the researchers to access a broader spectrum of participants, thereby amplifying the voices and perspectives represented in the study (Braun et al., 2021).

However, despite the strengths of this study, several limitations merit comment. First, a limitation of the study concerns the operationalization of neuromyths and brain knowledge in the Neurodevelopmental Neuromyths Questionnaire. 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 to assess adhesion to neuromyths in more realistic situations within the school setting (Bei et al., 2024). Another limitation is that only inferences could be drawn between the qualitative findings on neuromyths and instructional practices, and the responses to the Neurodevelopmental Neuromyths Questionnaire. In the mixed-method triangulated approach employed (Creswell, 2013), the results gathered from each of the two parts of the study offered an opportunity to converge the different types of results generated by each approach. However, this approach did not provide insights into direct associations between the quantitative and qualitative findings. Specifically, while the qualitative data provided valuable insights into teachers’ perceptions and practices, it was not possible to directly correlate these findings with the questionnaire responses due to the nature of the study. We did not impose any limitations on the length or structure of qualitative responses, allowing for a rich and nuanced exploration of their views. Given this approach, the data collected from these open-ended questions are inherently non-quantifiable which makes them unsuitable for numerical analysis.

Additionally, the use of the qualitative part of the survey may present limitations compared to conducting qualitative interviews. While surveys allow for data collection from a larger sample size, they may lack the depth and richness of information obtained through interviews ((Braun et al., 2021). Further, qualitative interviews offer the advantage of being interactive, allowing for unexpected topics to emerge and be explored by the researcher. This can help mitigate provider or researcher-centered biases while it may also explain why teachers in the current study sometimes did not provide concrete examples from their practice given the nature of the qualitative open-ended questions. Future studies could consider employing qualitative interviews alongside surveys to provide a more comprehensive understanding of teachers' beliefs and practices regarding neuromyths.

6. Conclusion

The present mixed-methods study provides novel insights into the prevalence of neurodevelopmental neuromyths among Italian SEND teachers and highlights the factors associated with reduced endorsement of such misconceptions. Quantitative findings revealed a moderate rate of neuromyth endorsement, with notable variation across different types of statements. Prior exposure to neuroscience-related education and engagement with popular science sources emerged as significant protective factors against neuromyths.

The qualitative analysis further demonstrated that instructional practices are shaped by both evidence-based understanding and persistent misconceptions. While some teachers described practices that align with neuroscientific principles, others revealed implicit reliance on inaccurate beliefs about neurodevelopmental disorders. This duality highlights the need for clearer integration of neuroscience into teacher training, particularly for those working with SEND populations.

Taken together, the mixed-methods findings emphasize the importance of targeted educational interventions to dispel neuromyths and promote scientifically informed pedagogical practices. Such interventions could include the integration of neuroscience components that are particularly pertinent to Special Educational Needs and Neurodevelopmental Disorders. These efforts are critical for ensuring that instructional approaches in inclusive education contexts are grounded in accurate, evidence-based knowledge.

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.

Data availability

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

CRediT authorship contribution statement

Eva Bei: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mikołaj Zarzycki:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation. **Oriana Incognito:** Writing – review & editing, Validation, Data curation. **Chiara Pecini:** Writing – review & editing, Supervision, Resources, Project administration, Conceptualization.

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@unibo.it)

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