



# Neuromyths in Education: Prevalence Among South Indian School Teachers

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This study aimed to find out the existence of neuromyths among school teachers in the South Indian states. An online survey was carried out to assess the school teachers' general understanding of the brain and their belief on selected seven neuromyths statements. A total of 503 high school and higher secondary school teachers from South India participated in this study. On average, 65.5% of teachers have shown their belief toward more than two of the neuromyths; 84% of the participants have believed the learning style myths. This points out the difficulty of teachers in distinguishing factual information from non-scientific facts or myths. Therefore, there is an important need for involving interdisciplinary conversation that can reduce misunderstandings among teachers in the future.

**Keywords:** scientific facts, misbeliefs, non-factual information, gray regions, misunderstanding

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## INTRODUCTION

Modern-day technological advancements revolutionize brain research at all levels, such as molecular, cellular, systematic, and behavioral levels. The debilitating and costly effects of neurological and psychiatric diseases add a sense of urgency to the quest to understand the brain and its functioning. The invention of brain imaging techniques has fastened this process and made the researcher to find out reliable evidence based on scientific facts. These facts could guide the common person to make informed decisions and solve problems in a sophisticated manner. Understanding of the individuals and the neurological issues will be manipulated due to the new scientific exploration. Due to countless whys and wherefores, people stick to their widely accepted way of looking into information, beliefs, and ideas, which ends in appealing myths. An analogous misconception that exists for the brain and its functioning is known as “neuromyths.” It is customary for the common person to believe in myths. When a learned person, especially a person dealing with the molding of students during their schooling is influenced by “myths,” it would be more detrimental to the upcoming generations and their understandings about mind, brain, and related concepts. In this context, understanding the teacher's belief about neuromyths sounds to be an essential need of the hour to initiate remedial strategies.

## NEUROMYTHS

The term “neuromyths” was coined by Alan Crockard, a British neurosurgeon, in the 1980s and was referred to as “unscientific understanding of the brain in medical culture” (Howard-Jones, 2009). The Organization for Economic Cooperation and Development (OECD) defines it as “misconceptions generated by a misunderstanding, a misleading or a misquoting of facts

scientifically established to make a case for the use of brain research in education and other contexts.”

Overgeneralization of scientific information would be the most important cause for neuromyths (Macdonald et al., 2017). The scientific facts endorsed by the research results are disproportionately generalized instead of the particular conditions in which the results apply. Neuromyths about “right-brained” and “left-brained” exist from ancient times. They had also strengthened due to the initial evidence of neuroimaging and neuropsychological studies that demonstrate the lateralization of some cognitive functions. In addition to this, few other factors, such as variation in the training background (Howard-Jones, 2014), inaccessibility of empirical research (Ansari and Coch, 2006), levels of inquiry, and lack of professional training (Goswami, 2006), also contribute to the formation of neuromyths. Our neuroscientific understanding has implications for memory, learning and emotion, vicarious learning, learning about the brain, mathematics, reading, music, creativity, and brain care (Howard-Jones, 2010).

## In Education

Teachers are the role model for the younger generations to follow, particularly in a collective culture like India. The educational standards of a nation partially lie in the educational pragmatism of the teachers. Responsive teachers may bring a miraculous change in the students’ life. Students could develop as responsible citizens with the consecutive effort of different teachers in their life. The teaching profession has been considered as a noble profession among many professions. This profession also requires to be updated with the knowledge of contemporary science and other advancements in the field. Since teachers are an integral part of our socialization process, they need to be clear in their vision, so that they can direct their students to a better future. “How do they believe in neuromyths?” is an important question that has high relevance for their students’ belief in neuromyths. The existence of neuromyths among primary and secondary school teachers from different countries has been revealed in many studies. In the past, studies from Netherlands, England (Dekker et al., 2012), Latin America (Bartoszeck, 2012), Portugal (Rato et al., 2013), Australia (Bellert and Graham, 2013), Greece (Deligiannidi and Howard-Jones, 2015), China (Pei et al., 2015; Zhang et al., 2019), Turkey (Karakus et al., 2015), Switzerland (Tardif et al., 2015), Spain (Ferrero et al., 2016), the United States (Lethaby and Harries, 2016), and Canada (Macdonald et al., 2017) have identified the possibilities and existence of neuromyths among primary and secondary teachers. Teachers teaching 1st–5th standard of schooling are considered as primary teachers, and teachers teaching 6th–10th standard of schooling are considered as secondary teachers. Among the diverse neuromyths, the “preferred learning style” has been believed by almost all the teachers (96%) of the United Kingdom (UK), Netherlands, Turkey, Greece, and China. “Hemispheric dominance” comes next in the order of myths. Howard-Jones (2014) has highlighted the seven important dominant neuromyths that have been found in these five different countries. Finally, “developmental difference in brain function cannot be remediated by education” has been believed by 22% of teachers. We do not have any evidence from the literature of existence

of neuromyths among Indian teachers. Idrissi et al. (2020) have insisted the dearth of data on the prevalence of neuromyths in low and middle-income countries. Teacher’s pedagogical choices and practice will have significant impact by their belief in neuromyths. In the changing educational scenario, understanding of the existence of “neuromyths” among teachers will help us to design or tailor the remedial course of actions. Hence, this study attempts to reveal the existence and intensity of influence of these neuromyths among the South Indian teachers at primary, secondary, and tertiary levels.

## MATERIALS AND METHODS

This study attempted to seek answers to the following questions.

- (1) What are the school teachers’ misconceptions of scientific concepts related to brain and behavior in south Indian states?
- (2) How is it comparable with the misconceptions of scientific concepts of other developed and developing countries?

## Participants

This study was conducted among the primary and secondary school teachers in two different states of India, namely, Kerala and Tamil Nadu. Kerala is the state with a high literacy rate in India, and Tamil Nadu is the top in gross enrollment ratio during 2019 (AISHE, 2019). The sample consists of 503 school teachers teaching in various schools in two different states of India; 60 schools from Tamil Nadu and 28 schools from Kerala have been selected randomly and requested permission for including their teachers through a “willingness form.” Registered willing participants were approached through an online survey. Fifty-four teacher educators have registered to their willingness to participate in this study. They were involved in the academic supervision of their students in the abovementioned schools. All the participants were informed about the study purpose, and consent was taken. They have been assured of the confidentiality and privacy of the data. All the participants who have registered their concerns, meeting the purpose and objective of the study, had been allowed to participate in this study.

Descriptions of the participants are highlighted in **Table 1**. There were 44.9% male participants and 55.1% female participants aged between 24 and 65 years ( $M = 36.32$ ;  $SD = 10.2$ ); 29.6% of the participants were of undergraduate education, 55.5% of the participants were of postgraduate education, 6% of the participants had MPhil degree in different subjects, and 8.9% of the participants were Ph.D holders; 63.2% of teachers were teaching in primary schools, 24.7% of teachers were teaching in secondary schools, and 10.7% were assistant professors working in different colleges.

They have been requested for the personal details and agreeableness on the different statements, which are “neuromyths.” The responses were submitted and analyzed.

## RESULTS

The teachers’ beliefs on different neuromyths statements have been presented in **Table 2**, given the overall representation of

**TABLE 1** | Descriptions of the participants.

Descriptions		n	Percentage
Gender	Male	226	44.9%
	Female	277	55.1%
Educational qualification	Graduates	149	29.6%
	Postgraduates	279	55.5%
	MPhil	30	6%
	Ph.D	45	8.9%
Occupation	Primary teachers	318	63.2%
	High school teachers	131	26.1%
	Assistant professors	54	10.7%

the preference of neuromyths statements among the sample of school teachers from Kerala and Tamil Nadu. More than 60% of teachers have believed in four neuromyths statements among the seven. Among the different myths, information processing style, namely, visual, auditory, and kinesthetic (VAK), has been agreed by 84% of the teachers, which is the highest among all neuromyths in this sample. “Shrinking of brain due to lack of water” was found to be agreed by less number of teachers. The study further pointed out from the responses that the highest number of teachers did not believe the “developmental differences cannot be remediated by education.” The lowest in this category is “integration of left and right hemisphere.” “Hemispheric dominance” has been the highest among the “undecided” category. The lowest in the “undecided” category is the neuromyths on “Learning Style.”

In **Table 3**, an attempt is made to compare the prevalence of neuromyths among teachers of different countries, such as the UK, New Zealand (NL), Turkey, Greece, and China. In this study, the author has compared the data collected from South India with the data published by Howard-Jones (2014).

As observed in other countries in **Table 3**, “preferred learning style”—the belief that students could learn in any visual, auditory, or kinesthetic (VAK) dominant style is also highly prevalent in the participant teachers of this study. The least prevalent neuromyth is “brain shrinking due to lack of water.” Similar results could be found in New Zealand, Greece, and China (Howard-Jones, 2014). In China and Turkey, only lesser than 50% of the teachers agreed with this statement. Few UK teachers and Turkey teachers have reported believing in the myth “Learning problems associated with developmental differences in brain function cannot be remediated by education.” The myth about “hemispheric dominance” has been found comparatively less in Indian teachers than in UK and New Zealand teachers. There is a good variation among the countries in the prevalence of the myth “brain shrinking due to lack of water.” China, Greece, New Zealand, and the UK teachers were shown less prevalence than Indian teachers in this myth. A higher proportion of Turkey teachers believed this myth as true than the Indian teachers.

Among the countries in the myth about the usage of the brain, Indian teachers’ prevalence is relatively higher than other countries of the comparison pool. Overall, a very less

**TABLE 2** | Prevalence of neuromyths in South India.

S. No.	Neuromyths	Agree		Not agree		Undecided	
1	We mostly use only 10% of our brain	323	64%	134	26.6%	46	9.0%
2	“Individuals learn better when they receive information in their preferred learning style” (for example, visual, auditory, or kinesthetic)	421	84%	57	11.3%	25	5%
3	“Short bouts of coordination exercises can improve integration of left and right hemispheric brain function”	305	61%	43	8.5%	155	31%
4	“Differences in hemispheric dominance (left brain or right brain) can help to explain individual differences amongst learners”	272	54%	69	13.7%	162	32%
5	“Children are less attentive after sugary drinks and snacks”	301	60%	136	27.0%	66	13%
6	“Drinking less than 6 to 8 glasses of water a day can cause the brain to shrink”	198	39%	176	35.0%	129	26%
7	“Learning problems associated with developmental differences in brain function cannot be remediated by education”	206	41%	196	39.0%	101	20%

portion of Chinese teachers expressed their belief in these neuromyths statements. The countries such as the UK and New Zealand have more proportion of teachers to believe in neuromyths than India. In New Zealand, hemispheric dominance myths were found to be significantly higher than in other countries.

An attempt has been made to find the difference in neuromyths belief among the teachers based on their gender, educational levels, and the different students’ levels they teach. The results table has been attached in the Appendix as an additional document. Gender appears to have no difference, since neuromyths are associated with the information and knowledge toward the subject and discipline. Also, the literature did not give any importance and differences based on gender. Moreover, a similar percentage of teachers has “agreed” all six neuromyths statements except the second one. In “preferred learning style,” 90% of female teachers have displayed their agreement with the statement in comparison with 74.8% of male teachers. While comparing teachers on their educational background, the “preferred learning style” myth has been found to be preferred by the majority of the participants with the educational background of undergraduation, post-graduation, M.Phil, and Ph.D. “Drinking 6 to 8 glasses of water” myth has been found to be the least preferred by the teachers among all four educational levels. Based on the students’ level and teaching, we attempted to compare the primary, secondary, and tertiary teachers. Similar finding discussed for educational level is applicable here also.

**TABLE 3** | Prevalence of neuromyths in South India in comparison with other countries.

S. No.	Neuromyths	South India		UK	NL	Turkey	Greece	China
		n = 504		n = 137	n = 105	n = 278	n = 174	n = 238
1	We mostly only use 10% of our brain	323	64%	35%	44%	18%	25%	25%
2	“Individuals learn better when they receive information in their preferred learning style” (e.g., visual, auditory, or kinesthetic)	421	84%	68%	91%	35%	55%	41%
3	“Short bouts of co-ordination exercises can improve integration of left and right hemispheric brain function”	305	61%	64%	78%	26%	34%	35%
4	“Differences in hemispheric dominance (left brain or right brain) can help to explain individual differences among learners”	272	54%	66%	82%	28%	43%	30%
5	Children are less attentive after sugary drinks and snacks	301	60%	42%	52%	16%	26%	26%
6	“Drinking less than 6 to 8 glasses of water a day can cause the brain to shrink”	198	39%	21%	15%	16%	6%	2%
7	“Learning problems associated with developmental differences in brain function cannot be remediated by education”	206	41%	12%	18%	8%	19%	21%

Source: Through the secondary source research paper authored by Howard-Jones (2014).

## DISCUSSION

Worldwide researches on “Neuromyths” have been robust in this decade. Educational advancements and technological revolutions have drastically changed teachers’ skills in teaching and other deliverables. Parallely, advancement in screening and diagnostic procedures has revealed new visions about human behavior and the brain’s influence on it. At this juncture, it becomes essential to elucidate the myths that teachers carry with them and their remedial measures. This may influence their daily teaching and the guidance they extend to students in their academics.

In the South Indian context, it is apparent that most of the teachers have believed in more than 4 neuromyths. VAK learning style has been found as the dominant neuromyths of these teachers (higher than the UK teachers), which is influential in our pattern of the educational system and teacher training program. A minimal number of teachers (11.3%) believe that it does not exist. Learning style has been a topic of debate over the years. Even though it originated around the 1970s, its existence was plagued by the issue of full clarification and empirical validity (Fallace, 2019). Gardner’s theory of multiple intelligence also provided considerable momentum for the idea of individual student’s learning strengths, preferences, and styles (Gardner, 1983). Teachers who rely on learning styles will enforce students to use various teaching aids, students’ participation, and activities based on motor skills (Papadatou-Pastou et al., 2020). Adey and Dillon (2012) have also pointed out the heavy cost involved in adopting learning style-based teaching. The Educational Endowment Foundation (Education Endowment Foundation, 2017) has also emphasized that the idea of “learning style” could be a misconception and may lead to a harmful decision of categorizing students based on it. This will make students’ learning styles fixed or rigid

rather than motivating them for the challenging tasks. In a systematic review from 18 countries with more than 15,000 participants in 37 different studies, Newton and Salvi (2020) have concluded that there is a lack of evidence that matches the learning styles. Not only teachers but also the mental health professionals such as those who serve individuals with learning difficulty have various modes of teaching-learning methods based on it. It is high time to look into the revision of the practices we have at par with the research evidence available.

The least preferred myth is “drinking less than 6 to 8 glasses of water a day can cause the brain to shrink.” Six out of ten teachers have an idea that the brain may not shrink if we have less water intake. This idea is more prevalent among Indian teachers than the teachers in other countries.

It is found that teachers in India have shown many myths and misconceptions about the brain as similar as it has been recorded in other countries (Howard-Jones, 2014). The neuromyth of using 10% of the brain is found to be higher in the present sample in comparison with other countries. Indian teachers’ understanding of the brain and its different location-specific functioning in normal healthy individuals is misleading. “Why don’t you use your brain” is a quite common usage found in Indian culture. The brain’s higher functional capability to do more wonder might have been misunderstood as less usage of the brain by the teachers. The evidence from the functional localization studies also provides more chance to believe in lesser functioning of the brain area when an individual do not have certain capabilities (Imaezue, 2017).

Likewise, more teachers have been found to believe that drinking less than 6–8 glasses of water/day can cause the brain to shrink than in other countries. During the summer, it could be noticed from all media encouraging people to drink more water to avoid dehydration. Teachers probably may have a chance

of generalizing it to the brain also, even though it has its own mechanism to manage its water content and avoid shrinking. A notable decline in cognitive tasks performance during dehydration has been reported in many studies (Cheuvront and Kenefick, 2014; Imaezue, 2017; Stachenfeld et al., 2018; Bethancourt et al., 2020) but these studies do not indicate shrinking of brain cells in particular. This variety of information about the impact/effect of dehydration might have been foreseen mistakenly by the teachers for brain shrinking.

In this study, teachers hold higher neuromyths related to remedial education's ability to rectify the learning problems associated with developmental differences than in other countries. In the Indian context, the remedies available for developmental problems are yet in infancy. Even though developmental disorders like intellectual disability (1.7%) and autism (1.6%) are of prevalence, the need for comprehensive child and adolescents' mental health has been a mirage (Gururaj, 2016). This indicates the lack of confirming evidence for teachers to believe that these could be altered. More practice-oriented applications of neurological testing may have a chance of scientifically changing the teachers' beliefs.

Even though there are similar results among different countries regarding neuromyths, it cannot underestimate the teachers' thirst for knowledge, which has led to higher indulgence in neuromyths. Knowledge has been found as a predictor of myths in Morocco, the UK, and Netherlands (Dekker et al., 2012; Karakus et al., 2015; Idrissi et al., 2020). Teachers' thirst for knowledge leads them to read on the important brain research information both right and wrong. As Beck suggests, teachers need to translate the information very carefully (Beck, 2010). They also need to get heightened clarity about what can be concluded and what cannot be concluded from their reading.

Descriptive analysis of the data based on the gender, educational level, and different levels of students teachers engage in has revealed some important findings. This study could not find any gender difference in teachers' belief in neuromyths except "preferred learning style," which may require further deeper exploration to identify the reason for the same. Furthermore, the educational level comparison has resulted in the existence of "neuromyths" in the different groups in a uniform manner including Ph.D holders. According to the studies by Dekker et al. (2012), Karakus et al. (2015), and Idrissi et al. (2020), while engaging more in knowing, the parallel chance of engaging more in neuromyths' belief also increases. Similar results give us to question the level of inquiry we have at different levels of educational background. Further, it also implies us to consider all the educational background teachers together while looking for the remedy. Primary, secondary, and tertiary teachers also found to have the same proportion of "agree" with the neuromyths statements. This confirms the invariable nature of the existence of neuromyths among teachers of various levels in the Indian context.

As the neuromyths exist with teachers globally and in all levels of teaching, remedies for them to reduce are also very

much essential at this time. Most importantly, a collaboration between teachers and neuroscientists could be entertained. Comprehensive training modules for educators to target their misconceptions could also be put into effect. There is a need to accept the existence of confirmatory bias and familiarity bias, the basic nature of humankind that needs to be tackled with care. Beyond familiarity, teachers need to be skillful to minimize the neuromyths. It is necessary that neuroscience also breach the boundary and reach laypeople through popular media so that a larger group of people would get the right information.

The other side of the argument also has its validity, which tries to dismiss the unjust claim of the existence of neuromyths itself. These ideas have been appearing in media because of some truth in it, but not a fully acceptable one, and require further research on that line to confirm the evidence (Gardner, 2020). Ideally, researchers, educators, and popularizers have to unanimously discuss and debate across the borders on matters that require more intense research evidence to lead to strong and valid conclusions on these neuromyths.

## CONCLUSION

This study has attempted to explore the neuromyths among school teachers in South India, especially Kerala and Tamil Nadu. We could conclude from the results that South Indian teachers do believe in neuromyths like other country teachers. On average, 65.5% of teachers have believed more than two of the neuromyths. Misbelief about the learning styles was the highest among the other neuromyths. Very few teachers have agreed on the myth of "shrinking of brain cells if we drink lesser than 7–8 glasses of water per day."

In comparison with other developed countries, the existence of neuromyths among South Indian teachers is less. Still, it is high time to encourage or implore the efforts to minimize it. Collaboration among researchers, practitioners, and teachers is essential to mitigate the neuromyths and deliver the scientifically proven facts to the budding students in the classroom. Parallely, neuroscientists and government agencies could also invest more in the research area, which is still in gray to confirm the truth and bring out the more persistent knowledge source. Teacher training program/course structure needs to initiate teachers to look into the valid evidence before confirming their ideas about the brain and related ideas.

This study's results could be inferred with the caution of its limitations. Even though data from a large sample has been collected, the purposive sample did not ensure randomization among the teachers. Only two states in South India have been focused in this study. Further studies could give more emphasis on the other states to confirm the findings. Future studies could see the difference among various stream teachers such as CBSE, ICSE, Matriculation, and State Board to find the extent of

neuromyths prevalence among the teaching community. Deeper exploration with qualitative and quantitative methodology could be used to explore the reason behind the neuromyths belief to mitigate the remedial step more preciously.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Departmental Research Ethics Board, Central University of Karnataka. The patients/participants provided their written informed consent to participate in this study.

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## AUTHOR CONTRIBUTIONS

All authors contributed equally to the conception and execution of the research work and preparation of the manuscript.

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## SUPPLEMENTARY MATERIAL

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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