Neuromyths are prevalent in all spheres of life and can be found in all professions. The teaching profession is especially susceptible to neuromyths as teachers want to provide the most effective, science-based instruction to their students. Sometimes these instructions are not based on scientific studies but on a misinterpretation of scientific findings or neuromyths. The goal of the present paper was to examine the prevalence of seven popular neuromyths in teachers in Bosnia and Herzegovina (BIH).

The research study comprised 300 teachers from all parts of BIH. The research material comprised 300 teachers (232 females and 62 males) from all parts of BIH. Participants were either personally invited to the study or recruited through an online survey sent to schools throughout BIH and teacher organizations. As a method we used the Questionnaire consisting of basic demographic information on the participants (gender, working experience, type of teacher) and 7 neuromyths statements on which participants were asked to answer whether they think the statement is true, not true, or they do not know.

The results of this study indicate a wide prevalence of neuromyths in BIH teachers. The prevalence ranged from 17% to 82%. The most prevalent myth is about learning styles, while the least prevalent was that drinking less than 8 glasses of water causes a brain to shrink. There were statistically significant differences in the prevalence of neuromyths in relation to the teachers’ gender for every statement. However, the trend is not uniform. Although, overall the neuromyths were more prevalent in female teachers (for 5 items), for two neuromyth statements, male teachers had a higher prevalence. Additionally, the prevalence of neuromyths was more frequent in early-grade teachers. It should be noted that there are also differences in the results obtained for the different types of neuromyths.

Neuroscience is important for education and for the teachers. Thus, more attention should be given to the process of translating neuroscientific findings into useful facts for teachers. One way to improve this process is through the continual professional development of teachers in the field of neuroscience.

Key words: neuromyths, neuroscience, educational myths, teachers, science-based practice, Bosnia and Herzegovina

1 The study was approved by the University of Sarajevo, Faculty of Educational Studies.
INTRODUCTION

These quotes above best reflect the importance of teachers and the teaching profession in general. The desire to shape the future of children and adolescents and an interest in teaching are the main motivational sources to become a teacher (Nesje et al., 2018). Much has been written on the qualities a good teacher needs to possess in order to contribute to her student's success. Two major categories that comprise an ideal teacher are personal qualities and subject knowledge (Arnon & Reichel, 2007). Similarly, good teachers are characterized by three p’s: passion, personality, and pedagogy (Benekos, 2016). Good teachers are also expected to quickly adapt to changing roles they have in educational reforms. Role expectations of teachers have increased and intensified in four areas: instructional, institutional, collaborative, and learning (Valli & Buese, 2007). Educational reforms also require teachers to be accountable for their student’s success. This is not surprising given that students’ achievement depends heavily on the quality of teachers and teaching (Hochberg & Desimone, 2010). Accountability also involves using evidence-based practices to produce better outcomes for children. Evidence-based practices are the ones that are supported by the findings of high-quality, experimental research studies (Cook et al., 2008). Thus, there is a great emphasis on teachers’ knowledge of practices, and instructional methods in their work with students. Ideally, these practices and methods should be firmly based on scientific findings and are thus called: scientific-based or evidence-based methods in education.

Neuroscience is one of the fields that has a lot to offer to education. The value of neuroscience research in improving education is promising (Stern, 2005). Neuroscience and education have been seen as an ideal partnership to guide 21st-century learning (Carew & Magsamen, 2010). Teachers are fascinated by the notions of brain-based curricula and learning (Bruer, 1997), so they could offer the best instruction possible for their students. There are many ways in which neuroscience can inform education. For example, neuroscience has a great potential to enhance education through interventions that might alter the neural mechanisms of learning (Schrag, 2011). In addition, neuroscience offers an outstanding source of knowledge regarding learning processes (Tommerdahl, 2010). Although it might sound as an effortless endeavor, the translation of neuroscientific research into practice is quite a challenging task. Neuroscience research pertaining to education has often been misinterpreted, leading to the creation of the so-called neuromyths. Neuromyths were first referring to unscientific ideas about the brain in the medical field but have quickly spread to other fields as well, including education (Howard-Jones, 2014).
The gap between neuroscience findings and education practice is still very wide (Morris & Sah, 2016). Unfortunately, many times this gap is filled with programs and strategies claiming to be “brain-based” or “evidence-based” (Goswami, 2006). These programs quickly become widespread and are offered commercially to teachers. This in turn makes teachers want to incorporate these “up to date” programs into their daily teaching routines in the classrooms. Many teachers around the world, regardless of culture and country’s GDP, are susceptible to neuromyths (Gleichgerrcht et al., 2015; Hughes et al., 2020; van Dijk & Lane, 2020). It is difficult to determine what makes teachers believe in neuromyths given the growing sources of available information and courses (Simoes et al., 2022). As for the within-teacher factors that contribute to neuromyths, research has shown that age, years of teaching, in-service training do not have a significant impact on neuromyths (Dekker et al., 2012). Of these within-teacher factors, only gender appears to have an impact on the prevalence of neuromyths (Ferrero et al., 2016).

Although, the studies examining prevalence of neuromyths were conducted in many countries, there are no studies regarding the prevalence of neuromyths conducted with teachers in Bosnia and Herzegovina (BIH). Although the teacher surveys in BIH were conducted on different topics, mostly regarding the attitudes towards educational inclusion (Biscevic et al., 2017; Memisevic et al., 2021) or attitudes towards educational technologies (Delibegović Džanić & Hasanspahić, 2020; Demirli, 2013), no such survey exists regarding the neuromyths. Thus, in this study, we wanted to examine the prevalence of neuromyths in a sample of teachers from BIH and to see if BIH teachers differ from their colleagues in other countries. An additional goal was to examine whether there are difference in the prevalence of neuromyths in relation to the gender and type of teacher (early grades teachers who teach children from Grades 1-5 and subject teachers, who teach children one subject from Grades 5-9).

**MATERIAL AND METHODS**

The research study comprised 300 teachers (232 females and 62 males) from all parts of BIH. Participants were either personally invited to the study or recruited through an online survey sent to schools throughout BIH and teacher organizations. Basic demographic information for the teachers are presented in Table 1.

As a method we used in our research the Questionnaire consisting of basic demographic information on the participants (gender, working experience, type of teacher) and 7 neuromyths statements on which participants were asked to answer whether they think the statement is true, not true, or they do not know. These neuromyth statements were previously examined in population of teachers in other countries (Howard-Jones, 2014). The total number of collected questionnaires was 316, and 16 questionnaires were dismissed due to missing or incomplete data. Teachers who completed the survey provided their consent that the data will be anonymously used for the purposes of this study. This study was approved by the Ethics Committee of Faculty of Educational Sciences.
Statistical analysis

Data were presented descriptively, through counts and percentages. We also calculated Chi square tests in relation to the demographic variables (gender, and type of teacher) to examine if any of these factors had a significant impact on the results. An alpha level of .05 was set for all statistical tests. The statistical analysis was performed with the computer program SPSS v.27 for Windows (IBM, 2020).

RESULTS

We first present descriptive data on each of the neuromyths statements in Table 2. As can be seen the most prevalent neuromyth in teachers in BIH was the one related to the learning styles (82%), while the least prevalent was for the myth of relationship between water drinking and brain shrinkage (17%). The remaining myths had a prevalence between 23% and 63%.

To examine whether the male teachers or female teachers were more likely to believe in neuromyths we performed a Chi square test for the gender distribution of each statement. These results are presented in Table 3.

As can be seen from Table 3, there were statistically significant differences in the prevalence of neuromyths in relation to the teachers’ gender for every statement.

Table 2. Prevalence of neuromyths in teachers in Bosnia and Herzegovina

<table>
<thead>
<tr>
<th>Neuromyth statement</th>
<th>Yes</th>
<th>No</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We use only 10% of our brains</td>
<td>125</td>
<td>73</td>
<td>102</td>
</tr>
<tr>
<td>2. Children learn better if they receive information according to their learning style</td>
<td>246</td>
<td>41</td>
<td>13</td>
</tr>
<tr>
<td>3. Coordination exercises can improve integration of left and right brain hemisphere</td>
<td>190</td>
<td>42</td>
<td>68</td>
</tr>
<tr>
<td>4. Differences in hemispheric dominance can explain individual differences among children</td>
<td>130</td>
<td>54</td>
<td>116</td>
</tr>
<tr>
<td>5. Children have more attention problems after sugary drinks and cookies</td>
<td>151</td>
<td>68</td>
<td>81</td>
</tr>
<tr>
<td>6. Drinking less than 8 glasses of water a day can cause a brain shrinkage</td>
<td>51</td>
<td>110</td>
<td>36</td>
</tr>
<tr>
<td>7. Learning problems associated with developmental differences in brain function cannot be remediated by education</td>
<td>68</td>
<td>113</td>
<td>119</td>
</tr>
</tbody>
</table>

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ment. However, the trend is not uniform. Although, overall the neuromyths were more prevalent in female teachers (for 5 items), for two neuromyth statements, male teachers had a higher prevalence.

In Table 4, we present the prevalence of neuromyths in relation to the type of teacher. Although the prevalence of neuromyths was more frequent in early-grade teachers, there were two items for which the prevalence of believing in neuromyth was higher in subject teachers. For one neuromyth statement (7th), the distribution of believing in the statement was almost the same, however, statistically significant differences stemmed from the different distributions of “do not know” and “no” answers.

Table 3. Prevalence of female and male teachers who agree with the neuromyth statement

<table>
<thead>
<tr>
<th>Neuromyth statement</th>
<th>Yes/ Males</th>
<th>Yes/ Females</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We use only 10% of our brains</td>
<td>46</td>
<td>79</td>
<td>24.5</td>
</tr>
<tr>
<td>2. Children learn better if they receive information according to their learning style</td>
<td>26</td>
<td>220</td>
<td>137.9</td>
</tr>
<tr>
<td>3. Coordination exercises can improve integration of left and right brain hemisphere</td>
<td>19</td>
<td>71</td>
<td>109.7</td>
</tr>
<tr>
<td>4. Differences in hemispheric dominance can explain individual differences among children</td>
<td>11</td>
<td>119</td>
<td>90.1</td>
</tr>
<tr>
<td>5. Children have more attention problems after sugary drinks and cookies</td>
<td>17</td>
<td>134</td>
<td>72.4</td>
</tr>
<tr>
<td>6. Drinking less than 8 glasses of water a day can cause a brain shrinkage</td>
<td>14</td>
<td>37</td>
<td>19.3</td>
</tr>
<tr>
<td>7. Learning problems associated with developmental differences in brain function cannot be remediated by education</td>
<td>9</td>
<td>59</td>
<td>19.9</td>
</tr>
</tbody>
</table>

Note. * all \( p \) values are <.001.

Table 4. Prevalence of neuromyths in relation to the type of teacher

<table>
<thead>
<tr>
<th>Neuromyth statement</th>
<th>Early-grade teachers</th>
<th>Subject teachers</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. We use only 10% of our brains</td>
<td>59</td>
<td>66</td>
<td>15.2*</td>
</tr>
<tr>
<td>2. Children learn better if they receive information according to their learning style</td>
<td>172</td>
<td>74</td>
<td>66.5*</td>
</tr>
<tr>
<td>3. Coordination exercises can improve integration of left and right brain hemisphere</td>
<td>136</td>
<td>54</td>
<td>50.5*</td>
</tr>
<tr>
<td>4. Differences in hemispheric dominance can explain individual differences among children</td>
<td>97</td>
<td>33</td>
<td>42.3*</td>
</tr>
<tr>
<td>5. Children have more attention problems after sugary drinks and cookies</td>
<td>108</td>
<td>43</td>
<td>38.1*</td>
</tr>
<tr>
<td>6. Drinking less than 8 glasses of water a day can cause a brain shrinkage</td>
<td>28</td>
<td>23</td>
<td>10.7**</td>
</tr>
<tr>
<td>7. Learning problems associated with developmental differences in brain function cannot be remediated by education</td>
<td>42</td>
<td>26</td>
<td>8.7**</td>
</tr>
</tbody>
</table>

Note. *\( p < .001 \); **\( p < .05 \)
DISCUSSION

The goal of the present paper was to examine the prevalence of neuromyths in teachers in BIH. Results of this study indicate a wide prevalence of neuromyths in BIH teachers, which ranged from 17% for the myth: *Drinking less than 8 glasses of water a day can cause a brain shrinkage* to 82% for the myth *Children learn better if they receive information according to their learning style*. The prevalence of neuromyths observed in this study is similar to those reported in other countries as well. For example, in one study, 44% of Spanish teachers believed that we use only 10% of our brains (Ferrero et al., 2016). In other studies, there were 47.4% of Greek teachers who agreed with the statement that we use only 10% of our brains (Papadatou-Pastou et al., 2017) and 28.8% of the Moroccan teachers (Janati Idrissi et al., 2020). Although in our study the differences between female and male teachers were significant for all neuromyth statements, the trend was inconclusive. Females believed in more neuromyths than males, however some myths were more believed by males. The consistent pattern of the gender effect on neuromyths did not emerge. A study conducted in Spain revealed that gender was a significant predictor of neuromyths (Ferrero et al., 2016). In that study, female teachers were significantly more likely to believe in neuromyths than male teachers. However, no explanation was given on why the differences in relation to gender might exist. As for the type of teacher, whether it is early-grades teacher or subject teacher, there were statistically significant differences in the myth prevalence, but as in the case of gender, no consistent trend was observed. Although early-grade teachers were more likely to believe in neuromyths, there were some neuromyths where the higher prevalence was among the subject-teachers.

The prevalence of a certain myth depends upon several factors. For example, we believe if we conducted the same study 20 or even 10 years ago, the prevalence of the myth regarding how much brain we use would be much higher among teachers. Media coverage of a certain topic most likely contributes to better knowledge of that topic. The myth that we use about 10% of our brains has been present in the literature for a long time (Arora, 2020). Consequently, there was plenty of time to present scientific evidence regarding this myth and to present the fact to the general public. However, some myths appear to be harder to dispel than the others. One of the most persistent myths is the myth regarding learning styles. The results of our study have shown that it is by far the most prevalent myths which was the most prevalent myth in our study. In our study, 95% of teachers believe that myth was true. That is in accordance with the prevalence reported in teachers from United Kingdom, The Netherlands, Turkey, Greece, and China (Howard-Jones, 2014). So, what makes this myth so resistant to debunking? Learning styles- the belief that people learn better when presented with an instruction that is in accordance with their dominant way of learning is one of the most pervasive myths about cognition (Nancekivell et al., 2020). There are couple of issues with the notion of learning styles (Kirschner, 2017): a) there is
a difference between how someone prefers to learn and what leads to effective learning; b) preference for how someone is studying is not a learning style, and c) empirical evidence for learning styles is almost non-existing. Despite these issues, there is a massive industry still supporting learning styles and making profit from selling books and programs related to learning styles. Commercial interests are a powerful force supporting the notion of learning styles and teachers are often targeted as customers for these products. Thus, it should be teachers’ responsibility to use instructions that are scientifically-supported and to understand what is and what is not scientifically-supported instruction (Cuevas, 2015).

Identification of neuromyths prevalence in teachers is important as it might lead to corrective strategies (Sullivan et al., 2021). There are various strategies that can help bridge the gap between neuroscience findings and their application in educational practice. First of all, teachers need to be more familiar with neuroscience research. This can be achieved through the pre-service training of teachers in the field of neuroscience. Teacher education institutions need to be more proactive in changing the existing curricula for teachers (Livingston, 2016). Currently, no teacher education institution in BIH offers courses in neuroscience. A one-semester course in neuroscience would immensely help teachers in learning more about neuroscience. A word of caution is warranted here as some research has suggested that the origins of neuromyths might be in university training (Blanchette Sarrasin et al., 2019). As these authors have suggested it is possible that teachers who reported university training as a source of neuromyths misinterpreted information presented in those courses. Thus, learning objectives for such courses must be precise and straightforward. Another avenue to increase teachers’ knowledge in neuroscience is through the professional development of in-service teachers. Some of the courses offered to them should be aimed at neuroscience research and its findings. These professional development courses need to be supportive, job-embedded, instructionally focused, and collaborative and as such they would result in teacher learning and improved practice (Hunzicker, 2011). One such professional development program aimed at increasing teachers’ competencies in neuroscience is the BrainU program (Dubinsky et al., 2013). BrainU program has two major ideas to convey to teachers: 1. Neuroscience is relevant for teachers; and 2. Neuroscience provides neurobiological basis for learning, that is discussions about student learning occur within a scientific, psychological, and pedagogical context. To conclude, neuroscience courses for teachers, provided as collaborations between scientists and teachers, can be very beneficial in understanding of neuroscience (Dubinsky et al., 2019), and therefore development of cognitive and creative self, which might be important for their further professional work (Pachalska, 2022).

Let us mention several limitations of the present study. First of all we do not know whether the sample was representative of the teachers in BIH. It might be the case that only teachers interested in the topic of neuroscience decided to participate in this study and complete questionnaires. Next, we did not assess other within-teachers variables that might have impacted the results, such as
CONCLUSION

Neuromyths are quite prevalent in teachers in Bosnia and Herzegovina. The prevalence of myths ranged from 17% to 82%, depending on the myth. The most prevalent and persistent myth was the one about learning styles. We could not unequivocally determine the gender effect on neuromyths. Although female teachers were more likely to believe in myths, some of the myths were more prevalent in male teachers. The same is true for the type of teachers. Early-grade teachers believed in more myths, but some myths were more prevalent in subject teachers. This study stresses the necessity of bridging the gap between neuroscience findings and teachers' practice. Narrowing this gap can be achieved through professional development of teachers and their joint collaboration with neuroscientists.

REFERENCES


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