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Neuromyths about brain development and learning among university students of primary education

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POVZETEK – V prispevku je prikazana razširjenost nevromitov o razvoju možganov in učenju v skupini 79 študentov prvega letnika (M = 19.55, SD = 0.84) in skupini 52 študentov zaključnega letnika (M = 19.55, SD = 0.84) študija razrednega pouka. Študentje so izpolnili vprašalnik, ki je temeljil na predhodnih raziskavah. Večina (več kot 50%) študentov obeh skupin je verjela v nevromite o hemisferni dominantnosti, učnih stilih in Brain Gym programu, večina študentov v obeh skupinah pa ni verjela nevromitom o ključni pomembnosti obdobja prvih treh let, dvojezičnosti kot pomanjkljivosti in uporabi 10% naših možganov. V nevromit o kritičnih obdobjih je verjela manjšina študentov prvega letnika, a večina študentov zadnjega letnika študija. Večina študentov obeh skupin je bila prepričana, da so znanstvena spoznanja o možganih (zelo) pomembna za razumevanje učenja in poučevanja, približno polovica študentov obeh skupin pa je odgovorila, da se seznanjajo z novimi informacijami o možganih.

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ABSTRACT – The article analyses and compares the degrees to which neuromyths about brain development and learning are spread among two groups of university students of primary education, namely 79 first-year students (M = 19.55, SD = 0.84) and 52 students in their final year of studies (M = 24.30, SD = 3.80). Both groups completed a questionnaire based on previous surveys. The majority (more than 50%) of students from both groups believed in neuromyths concerning hemispheric dominance, learning styles and the Brain Gym approach, but they did not believe in neuromyths about the crucial importance of the first three years, bilingualism as a disadvantage or the 10% use of the brain myth. The neuromyth about critical periods was only believed by a minority of first-year students but by the majority of students in their final year. Most students in both groups considered scientific knowledge about the brain as (very) important for understanding learning and teaching, and in both groups, about a half responded that they were acquainted with new information about the brain.

1 Introduction

Due to the complexity of neuroscience as a field, it is sometimes difficult to transfer its findings into educational work correctly. Consequently, teachers and students may develop some misconceptions about the brain and learning (Dekker, Lee, Howard-Jones & Jolles, 2012; Rato, Abreu & Castro-Caldas, 2013; Tardif, Doudin & Meylan, 2015) – called neuromyths (Dekker et al., 2012; Tardif et al., 2015). Neuromyths can be generated through the over- or misinterpretations of otherwise true scientific findings or through the persistence of scientific hypotheses that have been considered true for some time, but have now been rejected (Howard-Jones, 2014; Pasquinelli, 2012). They

are spread by popular media (Pasquinelli, 2012). Additionally, commercial brain-based educational programmes offered in schools may be the source of neuromyths among teachers (Goswami, 2004).

In the present article, the prevalence of neuromyths among future primary school teachers will be analysed, focusing specifically on seven of the most widespread as well as important in teaching (Howard-Jones, 2009, 2010, 2014; OECD, 2007). Below is a detailed description of each neuromyth included.

(1) "*We only use 10% of our brain*" – this neuromyth may stem from speculation on the untapped potential of the human brain (Pasquinelli, 2012). While it represents one of the most prevalent myths in neuroscience (OECD, 2007; Rato et al., 2013), "science has shown that although people can live with several brain traumas, this does not confirm [the] existence of useless areas" (Rato et al., 2013, p. 443). A large body of research about brain functioning has proven that healthy individuals use all parts of the brain (e.g. Ward, 2010). For the sake of clarity and conciseness, this neuromyth will be referred to as the *10% use of the brain* neuromyth throughout the article.

(2) The neuromyth that "*everything that is important for brain development occurs within the first three years*" is not scientifically proven; in fact, many studies have indicated that changes in the brain occur from birth to adulthood (Howard-Jones, 2010; Goswami, 2004). Immediately after birth, there is a massive increase in the number of neurons and in their interconnections (Bruerm, 1999a, 1999b, according to Alferink & Farmer-Dougan, 2010). With experience, a process of eliminating the neuronal connections also takes place; this is called pruning (Santos & Noggle, 2011). Although the changes are less intense compared to those in early life, the abovementioned processes also occur during subsequent developmental periods (Howard-Jones, 2010; Goswami, 2004). This neuromyth will be referred to as the *first three years are crucial for learning* in the article.

(3) "*There are critical periods in childhood after which certain things can no longer be learned*" – this neuromyth has been disproved by many studies which have indicated that changes in the brain occur from birth to adulthood (Goswami, 2004; Howard-Jones, 2010). Neuroscience supports the existence of sensitive periods in early development, especially for basic perceptual functions such as seeing and hearing (Howard-Jones, 2010). Nevertheless, certain deficits in perceptual functioning can partially be compensated for later in life (Sinha, 2009). That is why sensitive periods cannot be labelled as "*critical*" (Goswami, 2004; Howard-Jones, 2010). This neuromyth will be referred to as *critical* periods.

(4) The neuromyth that "*differences in hemispheric dominance (left brain, right brain) can help explain individual differences amongst learners*" emerged due to the misinterpretation of laterality studies that explored "left- and right-brain thinking"; according to this line of thought, "learners' dispositions arise from the extent to which they are left or right brain dominant" (Howard-Jones, 2010, p. 24). Neuroscience research indicates that in a healthy individual, the two hemispheres work together (Geake, 2008, p. 125). This neuromyth will be referred to as *hemispheric dominance*.

(5) The neuromyth that "*individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual or kinaesthetic)*" is based on the idea of so-called learning styles according to which learners can be classified (Dekker

et al, 2012; Rato et al., 2013). Accordingly, visual learners learn better through pictorial information, auditory learners through storing sounds and kinaesthetic learners through movement (Rato et al., 2013). While self-report studies indicate that individuals exhibit a preferred sense modality (Pasquinelli, 2012), scientific research has shown that individuals do not process information more effectively when they are educated in their preferred learning style (Howard-Jones, 2010). This neuromyth will be referred to as the *VAK approach*.

(6) The neuromyth that "*short bouts of co-ordination exercises can improve integration of left and right hemispheric brain function*" is based on the commercial programme called Brain Gym (Howard-Jones, 2009). The idea is that if the left and right parts of the brain do not work in co-ordination (due to the inefficient integration of visual, auditory and motor skills), we can use certain exercises to improve this. However, there is "a lack of published research in high quality journals to make claims about the practical effectiveness of programmes such as Brain Gym to raise achievement" (Hyatt, 2007, according to Howard-Jones, 2009, p. 28). This neuromyth will be referred to as *Brain Gym*.

(7) "*Children must acquire their native language before a second language is learned. If they do not do so, neither language will be fully acquired.*" This neuromyth concerns bilingualism, the ability to understand and speak two languages. First and second language acquisitions do not interfere with each other (Papalia, Wendkos Olds & Duskin Feldman, 2009). The neuromyth sprung from older studies on bilingualism (Lük Nećak, 1995, according to Marjanovič Umek, 2004), which indicated that children from a bilingual environment achieved lower scores on intelligence tests than children who spoke only one language. However, this research did not take into account that the testing was performed in the children's second language (Marjanovič Umek, 2004). This neuromyth will be referred to as *bilingualism as a disadvantage*.

In Slovenia, the transfer of neuroscientific insights into education has only recently begun to develop (Tancig, 2014). However, research results on teachers and students from other countries indicate that belief in neuromyths about brain development and learning is quite often found among this population. Dekker et al. (2012) included 242 primary and secondary school teachers from the United Kingdom and the Netherlands in their study. Among the 15 neuromyths explored, teachers believed in almost a half. The most prevalent ones were neuromyths about the VAK approach (more than 90 % of the teachers), hemispheric dominance (more than 85 % of the teachers) and the Brain Gym approach (more than 80 % of the teachers). Between 33 % (in the United Kingdom) and 52 % of the teachers (in the Netherlands) believed the neuromyth about critical periods in early childhood. Furthermore, Dekker et al. (2012) showed that some (7 % from the United Kingdom and 36 % from the Netherlands) believed the bilingualism myth.

In their study of neuromyths prevalent among Swiss (student) teachers, Tardif et al. (2015) explored the VAK approach, hemispheric dominance and Brain Gym. Their results showed that the majority of participants (around 80 %) strongly agreed with the VAK approach and with the idea of hemispheric dominance (around 85 %). Results concerning the Brain Gym approach were rather surprising: less than 20 % of the participants had at least some information about this method and half of those wrongly believed in its effectiveness (Tardif et al., 2015). A similar analysis encompassing 583

Portuguese teachers from different fields of expertise (Rato et al., 2013) found that the most prevalent neuromyths among them were about the VAK and the Brain Gym approach (approximately 50 % in each case).

It is our aim here to analyse the prevalence of neuromyths in two groups of university students enrolled in a primary teacher programme, one group in the first and the other in the last year of study. Related questions about whether the students consider having information about the brain important, their level of interest in such new information and its sources were also included in the study. As potential future educators, it is important that the participants have certain information about brain development and learning which they can utilise in their work with children.

2 Method

Sample

There were 131 students enrolled in the Primary Teacher Education programme in Ljubljana who participated in the study: 79 first-year students (60 %; M = 19.5 years, SD = 1.2 years) and 52 fifth-year students (40 %; M = 24.3 years, SD = 3.8 years).

Instruments

Neuromyths about brain development and learning in students were assessed using a questionnaire, which was formulated on the basis of previous surveys (Herculano-Houzel, 2002; Dekker et al., 2012). The seven neuromyths included in the questionnaire were:

- *We only use 10 % of our brain.*
- *Everything that is important for brain development occurs within the first three years.*
- *There are critical periods in childhood after which certain things can no longer be learned.*
- *Differences in hemispheric dominance (left brain, right brain) can help explain individual differences amongst learners.*
- *Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual or kinaesthetic).*
- *Short bouts of co-ordination exercises can improve integration of left and right hemispheric brain function.*
- *Children must acquire their native language before a second language is learned.*

If they do not do so, neither language will be fully acquired. Each statement or neuromyth was graded on a 5-point Likert scale (from "1 – Don't agree at all" to "5 – Totally agree", with 3 denoting "I don't know"). The students also answered two additional questions: firstly, whether they think that scientific knowledge about the brain is important for understanding teaching and learning, where the students responded using a Likert scale (from "1 – Not important" to "5 – Very important"); secondly, they were asked whether they were familiar with recent developments concerning knowledge about the

brain (either by way of scholarly and popular articles, the Internet and other sources) and given the option of answering either "Yes" or "No". In the case of the affirmative answer, they also marked the relevant sources of their knowledge among those listed: popular articles and books, scientific articles and books, TV and radio programmes, university, secondary school, specific training programmes and/or other sources.

Procedure and data Analysis

The students completed the questionnaire during one of their lectures at the beginning of the academic year. Their participation was anonymous and voluntary. For each neuromyth statement, the answers 1 and 2 on the Likert scale were combined into one category (Correct), answers 4 and 5 into another (Incorrect), while 3 remained a "Do not know" category. Then, the frequency and the percentage of correct, I do not know and incorrect answers was calculated for individual neuromyths in each group of students. The possible differences between the first-year and last-year groups of students according to the percentage of incorrect answers were analysed using a series of χ^2 square tests. Additionally, the percentages of each source of knowledge about the brain were calculated for each group. After that, a series of χ^2 square tests or Likelihood ratio χ^2 (when cell frequencies were less than five) were used for each pair of the six listed sources of knowledge for each group of students.

3 Results and discussion

We begin the results and discussion section by analysing and comparing the neuromyths about brain development and learning in first-year and last-year students of primary teacher education and establishing any differences between the groups. The frequencies and percentages of incorrect, I do not know and correct students' answers are presented in Table 1 for each neuromyth as well as any differences between the two groups calculated according to the percentage of incorrect answers (χ^2 square tests).

The results show that three neuromyths are accepted by the majority (more than 50 %) of the students in both groups with no significant differences between them. These are the neuromyths about the VAK approach, Brain Gym and hemispheric dominance. The most prevalent among these three is the VAK approach neuromyth, with 98 % of first-year and 100 % of last-year students responding that they believed in it. This means the students believe that learning is more efficient when the information is presented in the individual's preferred sense modality (Dekker et al, 2012; Rato et al., 2013) although scientific research does not support such a conclusion (e.g., Howard-Jones, 2010). These results are comparable to studies conducted in other countries. In their study including teachers from the United Kingdom and the Netherlands, Dekker et al. (2012) reported that more than 90 % of them believe this neuromyth. Similarly, Swiss teachers and student teachers (Tardif et al., 2015) agreed with it in approximately 80 % of cases, and Portuguese teachers in about a half (Rato et al., 2013). It is probable that teachers or professors in schools or universities believe in the VAK approach

because they have not had access to more recent information about its ineffectiveness. Correcting this misinterpretation should be addressed in university study programmes so that it may directly influence the teaching methods of future educators.

Table 1: Neuromyths in first-year and last-year students of primary teacher education and differences between the groups regarding the percentages of incorrect answers

Neuromyth	*Study year*	*Incorrect*	*%*	*Do not know*	*%*	*Correct*	*%*	*p*
VAK approach	first	77	98	1	1	1	1	0.31
	last	52	100	0	0	0	0	
Brain Gym	first	58	73	21	27	0	0	0.23
	last	43	83	13	13	4	4	
Hemispheric dominance	first	54	69	19	24	6	8	0.83
	last	35	67	9	17	7	13	
Critical periods	first	29	37	13	16	37	47	0.00
	last	36	69	3	6	13	25	
10% use of the brain	first	33	42	14	18	32	40	0.84
	last	21	40	15	29	21	40	
First three years are crucial for learning	first	6	8	20	25	53	67	0.73
	last	5	10	12	23	35	67	
Bilingualism as disadvantage	first	23	29	8	10	48	61	1.00
	last	15	29	1	2	36	69	

As for the Brain Gym neuromyth, 73% of the first-year and 83% of last-year students believe in it. This means the majority of students believe in the idea that using specific exercises leads to better coordination between the left and right hemispheres. Similarly, teachers from the United Kingdom and the Netherlands (Dekker et al., 2012) believed the Brain Gym neuromyth in more than 80% of cases, while Portuguese teachers (Rato et al., 2013) in about 50% of cases. However, Swiss teachers and student teachers (Tardif et al., 2015) believed in the effectiveness of Brain Gym in only 10% of the cases (what is more, they had information about it in only 20% of cases). As research (Hyatt, 2007, according to Howard-Jones, 2009) does not support this idea, it should not only be challenged during the education process of future teachers, but – as the percentage of incorrect answers is even higher in last-year students – perhaps in some cases even prevented from being promoted.

When it comes to the hemispheric dominance neuromyth, 69% and 67% of first-year and last-year students respectively responded that they believe the assumption that each brain hemisphere may operate in isolation or is specialised only for certain types of learning (Howard-Jones, 2008). This is somewhat less than approximately 85% of teachers from the United Kingdom, the Netherlands and Switzerland (Dekker et al., 2012; Tardif et al., 2015) who believed in hemispheric dominance. As both hemispheres work together in the performance of most everyday tasks (Howard-Jones, 2008), the re-

sults show how necessary it is that the idea of neural functional interconnectivity should be presented to future primary school teachers.

Surprisingly, the majority of the students in their final year of study (69 %) also believe in the neuromyth of critical periods, while only 37 % of their younger colleagues do. There is thus a significant difference between the groups. Other studies have found that between 33 % and 52 % of teachers in the United Kingdom and the Netherlands believed in this neuromyth (Dekker et al., 2012). Because the neuromyth about critical periods in the present study was found to be substantially more prevalent among students in their final year, it should be specifically addressed. The reason why so many of these students believe in critical periods may stem from a lack of distinction between the terms "sensitive" and "critical" periods of development. "Sensitive" periods cannot be termed "critical" as certain deficits in early development can be partially compensated for later in life (e.g. Howard-Jones, 2010).

There are three neuromyths which the majority of students in both groups do not believe: 10 % use of the brain, bilingualism as a disadvantage and the crucial importance of the first three years. There were also no significant differences between the results of both groups. 42 % of first-year and 40 % of last-year students believe the 10 % use of the brain neuromyth. Even though these percentages do not reach 50 %, they are still rather high. Because of this and also because the percentage of correct answers only amounted to 40 % in each group, it may be concluded that many students are quite uncertain about the untapped potential of the human brain (Pasquinelli, 2012). The students should in future be informed that science has not confirmed the existence of "useless areas" in the brain (Rato et al., 2013).

Finally, the neuromyth about bilingualism as a disadvantage – that first and second language acquisition interfere with each other in childhood – is believed by 29 % of the students from both groups. Similar studies have found that even fewer teachers from the United Kingdom (7 %) and somewhat more teachers from the Netherlands (36 %) (Dekker et al., 2012) believe that this occurs. This is another area of brain development that should be emphasised during primary teacher education, as a second language is included in Slovene primary school curricula from the very beginning.

Only 8 % of first-year and 10 % of last-year students accept the neuromyth about the crucial importance of the first three years. As it is scientifically confirmed that changes in the brain occur in all developmental periods, although they are less intense in adulthood compared to earlier periods (Howard-Jones, 2010; Goswami, 2004), it is encouraging that the vast majority of primary education students are aware of this fact. Knowledge that brain development may be influenced by one's social environment beyond the age of three may support them in their endeavours as future educators.

Students were also asked about their opinion regarding the importance of scientific knowledge about the brain for understanding teaching and learning. Their answers indicate that they regard scientific knowledge about the brain as (very) important for these processes, with 94 % of first-year and 90 % of last-year students giving an affirmative reply. In the majority of cases, students also stated that they were acquainted with recent or new knowledge about the brain: 61 % of the first-year and 60 % of the last-year students replied in this way. Again, these results are encouraging. The students were also asked to identify the sources of their knowledge (Table 2).

Table 2: Frequencies and percentages of sources of knowledge about the brain for first--year and last-year students

Sources of knowledge	*First year of study*		*Last year of study*	
	F	*%*	*f*	*%*
TV or radio	23	29	12	23
Secondary school	17	22	3	6
Popular literature	16	20	15	29
University	3	4	12	23
Scientific literature	12	15	6	12
Other educational programmes	4	5	3	6
Other	4	5	0	0

First-year students most often selected the following important sources of their knowledge about the brain: TV or radio (29%), secondary school (22%), popular (20%) and scientific literature (15%). The most influential sources of knowledge for last-year students were: popular literature (29%), TV or radio (23%), lectures at the university (23%) and scientific literature (12%).

For both groups of students, possible differences between each pair of these sources were calculated (χ^2 square tests or Likelihood ratio χ^2) and are presented in Table 3.

Table 3: Comparisons of the knowledge sources' importance in first-year and last-year students

	First year of study	*Last year of study*
1	TV or radio = Secondary school	TV or radio > Secondary school**
2	TV or radio = Popular literature	TV or radio = Popular Literature
3	TV or radio > University**	TV or radio = University
4	TV or radio > Scientific literature*	TV or radio = Scientific literature
5	TV or radio > Educ. programme**	TV or radio > Educ. programme**
6	Secondary school = Popular literature	Secondary school < Popular literature**
7	Secondary school > University**	Secondary school < University**
8	Secondary school = Scientific literature	Secondary school = Scientific literature
9	Secondary school > Educ. programme**	Secondary school = Educ. programme
10	Popular literature > University**	Popular literature = University
11	Popular literature = Scientific literature	Popular literature > Scientific literature*
12	Popular literature > Educ. programme**	Popular literature > Educ. programme**
13	University < Scientific literature	University = Scientific literature
14	University = Educ. Programme	University > Educ. programme*
15	Scientific literature = Educ. programme	Scientific literature = Educ. programme

Note: Educ. programme – Other educational programmes; * – $p < 0.01$; ** – $p < 0.05$

These comparisons show that TV, radio and popular literature are the most important sources of the students' knowledge about the brain for both student groups. As expected, secondary school also represents an important source of knowledge for first-year students and the university study programme for last-year students. However, it is rather surprising that popular literature becomes a more important source of knowledge than scientific literature for last-year students. Since neuromyths may be generated by the oversimplification or over-interpretation of scientific facts that are often found in popular media and literature (Pasquinelli, 2012), the information that these types of media represent the most important sources of brain knowledge for the students is a cause for concern. Perhaps discussion regarding the information they hear/read in popular media/literature could be included in the study programme, thus enabling an on-going process of preventing neuromyth emergence.

4 Conclusions

These results suggest that during their studies, students do not get enough scientific information about the functioning of the brain which would enable them to overcome the neuromyths they had formed even before entering university. Consequently, the results have certain implications for all the professionals working with them. Knowledge about the brain could be included and/or refreshed within specific study courses. Special attention should be given to neuroeducational themes, such as the importance of including different types of sensory input while learning. Information and support in finding reliable scientific sources should be provided to the students.

Further research could include some open questions about the students' understanding of specific statements or expressions used in the questionnaire, such as "critical periods". Their explanations could lead to a deeper understanding of their needs regarding future lectures. The study could perhaps be designed as a longitudinal one by assessing the same – now first-year – students when they finish their studies. Alternatively, students attending other (pedagogy) study programmes may be included in a prevalence of neuromyths study.

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Nevromiti o razvoju možganov in učenju pri študentih razrednega pouka

Nevroznanost je kompleksno področje, ki ga ni enostavno "pravilno" prenesti na področje vzgoje in izobraževanja. Zaradi tega (bodoči) učitelji pogosto oblikujejo napačna prepričanja o delovanju možganov in njegovi povezanosti z učenjem, ki jih imenujemo nevromiti (npr. Howard-Jones, 2009, 2010, 2014; OECD, 2007; Tardif, Doudin & Meylan, 2015). Nevromite razširjajo popularni mediji in tržno naravnani izobraževalni programi (Goswami, 2004; Pasquinelli, 2012), k razlikovanju med znanstvenimi

spoznanji in napačnimi prepričanji o delovanju možganov pa lahko pomembno prispeva branje ustrezne strokovne literature (Dekker idr., 2012).

V prispevku smo se usmerili predvsem na ugotavljanje zastopanosti sedmih nevromitov pri študentih razrednega pouka, saj so le-ti zelo pomembni za učiteljevo delo in med najbolj razširjenimi pri učiteljih drugih držav (Howard-Jones, 2009, 2010, 2014; OECD, 2007). V nadaljevanju bomo vsakega od njih tudi opisali. Nevromit "Uporabljamo le 10% naših možganov" je eden od najbolj razširjenih na področju nevroznanosti (OECD, 2007; Rato idr., 2013), čeprav številne raziskave dokazujejo, da zdravi ljudje pri reševanju različnih nalog uporabljajo večino svojih možganov (npr. Ward, 2010). Prav tako znanstvene raziskave zavračajo nevromit "Vse, kar je pomembno za razvoj možganov, se zgodi do tretjega leta starosti", saj dokazujejo, da se bistvene spremembe v razvoju možganov dogajajo v vseh razvojnih obdobjih in ne le v najzgodnejšem (npr. Howard-Jones, 2010; Goswami, 2004). Ne velja tudi nevromit, da "Obstajajo kritična obdobja v otroštvu, po katerih se določenih stvari ne moremo več naučiti", saj je večino primanjkljajev na različnih področjih učenja možno (vsaj do neke mere) kompenzirati tudi v kasnejših obdobjih življenja (Sinha, 2009). Nevromit "Z razlikami v dominantnosti hemisfer lahko razložimo individualne razlike med učenci" izhaja iz napačnih razlag raziskav o t.i. "levo- in desnohemisfernem učenju". Nevroznanstvene raziskave kažejo, da pri zdravih osebah pri opravljanju večine vsakodnevnih nalog in pri učenju obe možganski polobli delujeta skupaj (npr. Howard-Jones, 2008). Nevromit "Posamezniki se bolje učijo, če sprejemajo informacije v preferenčnem učnem stilu (npr. slušnem, vidnem ali gibalnem)" temelji na ideji o t.i. učnih stilih, s katerimi lahko opišemo učence kot pretežno slušne, vidne ali gibalne tipe (npr. Dekker idr., 2012). Raziskave, ki temeljijo na samoporočanju posameznikov, sicer kažejo njihovo naklonjenost sprejemanju informacij preko enega od čutnih kanalov (Pasquinelli, 2012), a ni dokazov, da se posamezniki tudi bolje (na)učijo, če poučevanje poteka le preko tega kanala (npr. Howard-Jones, 2010). Nevromit "S kratkimi vajami za koordinacijo lahko izboljšamo integracijo delovanja leve in desne polovice možganov" temelji na t.i. Brain Gym tržnem programu (Howard-Jones, 2009), katerega osnovna ideja je, da leva in desna polovica možganov ne delujeta koordinirano, kar lahko izboljšamo z različnimi vajami. Znanstvene raziskave ne podpirajo učinkovitosti teh specifičnih vaj za izboljšanje koordinacije leve in desne polovice možganov (Hyatt, 2007, v Howard-Jones, 2009). Nevromit "Otroci se morajo najprej naučiti maternega jezika, da se lahko učijo drugega. Če ne, se nobenega od jezikov ne bodo dobro naučili" izhaja iz napačnih zaključkov starejših raziskav o dvojezičnosti, pri katerih so dvojezični otroci dosegali nižje rezultate na preizkusih inteligentnosti v primerjavi z otroki, ki so se učili le enega jezika. Omenjeni zaključki izhajajo iz napak pri merjenju inteligentnosti, saj preizkusi pri dvojezičnih otrocih niso bili izvedeni v otrokovem maternem jeziku, kar je bilo ključno za nižje otrokove dosežke (Lük Nećak, 1995, v Marjanovič Umek, 2004).

Pri nas se je prenos nevroznanstvenih spoznanj v izobraževanje šele začel (npr. Tancig, 2013, 2014), rezultati nekaterih raziskav iz drugih držav pa kažejo, da učitelji pogosto verjamejo v nevromite o razvoju možganov in učenju (npr. Dekker idr., 2012; Pasquinelli, 2012; Rato idr., 2014; Tardif idr., 2015). Nevromiti, v katere je v tujini verjela večina učiteljev, so: sprejemanje informacij v preferenčnem učnem stilu izboljša učinkovitost učenja, z razlikami v hemisferni dominantnosti lahko razložimo razlike med učenci, z Brain Gym programom lahko izboljšamo integracijo leve in desne polo-

vice možganov (npr. Tardif idr., 2015). Manj pogosto so učitelji iz drugih držav verjeli v nevromit o obstoju kritičnih obdobij v zgodnjem otroštvu, le manjšina učiteljev iz drugih držav pa je bila prepričana v nevromit o tem, da je učenje dveh jezikov lahko škodljivo (npr. Dekker idr., 2012).

Kot smo že omenili, je bila raziskava namenjena prikazu razširjenosti sedmih nevromitov pri študentih prvega in zadnjega letnika študija razrednega pouka. Zanimala so nas tudi prepričanja študentov o pomenu informacij o možganih za delo učitelja in o tem, ali se študentje zanimajo za nove informacije o delovanju možganov in kje pridobivajo tovrstne informacije. Študentje so izpolnili vprašalnik, ki je temeljil na ugotovitvah predhodnih raziskav (Herculano-Houzel, 2002; Dekker idr., 2012). V raziskavo je bilo vključenih 131 študentov razrednega pouka iz Ljubljane: 79 študentov (60 %) je obiskovalo prvi letnik študija (M = 19,5 let, SD = 1,2 leti), 52 študentov (40 %) pa je obiskovalo zadnji letnik študija (M = 24,3 leta, SD = 3,8 let). Študentje so izpolnili vprašalnike na začetku študijskega leta, udeležba v raziskavi pa je bila anonimna in prostovoljna.

Večina (več kot 50 %) študentov obeh skupin je verjela v nevromite, da z razlikami v hemisferni dominantnosti lahko razložimo razlike med učenci, da sprejemanje informacij v preferenčnem učnem stilu izboljša učinkovitost učenja in da z Brain Gym programom lahko izboljšamo integracijo leve in desne polovice možganov – razlike med obema skupinama študentov niso bile statistično pomembne. Tudi rezultati raziskav z učitelji iz drugih držav kažejo, da večina učiteljev verjame v omenjene nevromite o delovanju možganov in učenju (npr. Tardif idr., 2015).

Prav tako večina študentov v obeh skupinah ni verjela v nevromit, da se vse, kar je pomembno za razvoj možganov, zgodi do tretjega leta starosti, v nevromit o tem, da ljudje uporabljamo le 10 % možganov, in o tem, da ima učenje dveh jezikov pri otrocih škodljive učinke – obe skupini študentov se med seboj nista statistično pomembno razlikovali. Primerljiva raziskava z učitelji iz drugih držav (Združenega kraljestva in Nizozemske), ki je vključevala nevromit o škodljivosti učenja dveh jezikov, je pokazala, da je bila le manjšina učiteljev prepričana, da je učenje dveh jezikov škodljivo (Dekker idr., 2012).

V naši raziskavi je nevromitu o kritičnih obdobjih za učenje verjela manjšina študentov prvega letnika, a večina študentov zadnjega letnika študija – razlike med skupinama študentov so bile statistično pomembne. Rezultati nakazujejo, da se omenjeni nevromit v času študija lahko še utrdi. V primerljivi raziskavi z učitelji iz Združenega kraljestva oz. Nizozemske je približno 33 % oz. 55 % učiteljev verjelo v omenjeni nevromit o obstoju kritičnih obdobij v otroštvu (Dekker idr., 2012).

S trditvijo, ki smo jo vključili v raziskavo, da so znanstvena spoznanja o možganih (zelo) pomembna za razumevanje učenja in poučevanja, se je strinjala večina študentov obeh skupin, približno polovica študentov obeh skupin pa je odgovorila, da se seznanjajo z novimi informacijami o možganih. Kot najpomembnejše izvore znanja o možganih so študentje izbrali poslušanje televizije in radia, branje poljudne literature in znanje, pridobljeno v srednji šoli (študenti prvega letnika) in na fakulteti (študenti zadnjega letnika).

Glede na to, da je raziskava pokazala, da študentje razrednega pouka tako na začetku kot ob koncu študija verjamejo v nekatere nevromite o delovanju možganov

in njegovi povezanosti z učenjem, bi bilo pomembno, da temeljno znanje o možganih vključimo v različne študijske predmete (npr. psihologijo, didaktiko). Posebno pozornost bil lahko namenili konkretnim znanstvenim spoznanjem o delovanju možganov, npr. celostnemu delovanju možganov pri reševanju različnih nalog, pomenu podajanja informacij preko različnih čutnih kanalov (npr. sluh, vid in gibanje) za učinkovitejše učenje, kritičnemu pogledu na učinke Brain Gym programa itn. Študente bi bilo smiselno usmeriti k prebiranju tistih virov znanja o možganih, ki temeljijo na znanstveno utemeljenih ugotovitvah.

V nadaljnje raziskovanje nevromitov bi lahko dodali nekatera odprta vprašanja (npr. o razumevanju izraza "kritična obdobja"). Odgovori nanje bi lahko nudili boljši vpogled v razumevanje nevromitov pri študentih ter omogočili lažje načrtovanje vsebin, ki bi jih ponudili študentom v času njihovega študija. Raziskavo bi lahko izvedli tudi vzdolžno in tako spremljali iste študente od začetka do zaključka njihovega študija, vanjo pa bi lahko vključili še študente drugih (pedagoških) študijskih programov.

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