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1.01 Original scientific paper

Bilingualism in connection with executive functions and cognition in children in Slovenian bilingual area

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Abstract:
The purpose of this study was to research the assumptions about the connection between bilingualism and results in the field of cognitive functioning. Research showing the advantage of bilingual individuals in comparison with monolinguals in cognitive functioning is often explained by the mechanisms that allow bilingual individuals to control and represent the two languages in the brain. Our study included children aged 9 to 11 years: a group of bilingual children who speak Slovene and Hungarian and a control group of monolingual, Slovene speaking children. We tested them with the following cognitive abilities tests: executive functions with TMT and Stroop test, working memory with digit span task forward and backward, verbal abilities with verbal fluency test and vocabulary. The data showed that, although verbal fluency was lower in bilingual group, bilingual children performed better on versions of Stroop task, which could indicate advantage in speed of processing and to lesser extent also in ability of handling conflicting information.

Key words:
bilingualism, cognition, executive functions, working memory, verbal abilities

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Bilingualism and cognitive functions[1]

Life experiences such as education, leisure activities, and work experiences can shape the structure and functioning of the brain as well as affect cognitive abilities. Bilingualism is recognized as one of the key factors in shaping an individual's cognitive abilities. The use of language is one of the most permanent and intense experiences in an individual's life. Speech and language processing are not limited to a set number of hours in a day or a set period of life, therefore, they greatly affect the formation of cognitive abilities during all periods of life.[2]

It is important to distinguish between bilingualism and occasional use of the second language when studying the effects of bilingualism on cognitive abilities. The level of language proficiency in both languages is also important. Grosjean[3] defines bilingualism as "regular use of two languages", as well as describes bilingualism as the ability to function in any of the two languages according to current needs. In their study, Bialystok, Craik, Klein, and Viswanathan[4] defined those participants who speak two languages every day at least since they were ten as bilingual. Consequently, the results of their study cannot be applied to individuals who have more limited knowledge or use of another language. Bialystok, Craik, and Freedman[5] find that bilingualism only has positive effects on cognitive abilities if the individual speaks both languages fluently. If the individual has attained a certain level of language proficiency but does not use the language often, positive effects on cognitive abilities do not occur.

Per some estimates, more than half of the global population regularly speaks two or more languages[6]. Due to ever more frequent migrations, the

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[2] Ellen Bialystok, "The bilingual adaptation: How minds accommodate experience", *Psychological Bulletin* 143 (2017), 233–262 (hereinafter: Bialystok, "The bilingual adaptation: How minds accommodate experience").

[3] François Grosjean, "Neurolinguists, beware! The bilingual is not two monolinguals in one person", *Brain and Language* 36 (1989), 3–15.

[4] Ellen Bialystok, Fergus I. M. Craik, Raymond Klein and Mythili Viswanathan, "Bilingualism, aging, and cognitive control: Evidence from the Simon task", *Psychology and Aging* 19 (2004), 290–303 (hereinafter: Bialystok, Craik, Klein and Viswanathan, "Bilingualism, aging, and cognitive control: Evidence from the Simon task").

[5] Ellen Bialystok, Fergus I. M. Craik and Morris Freedman, "Bilingualism as a protection against the onset of symptoms of dementia", *Neuropsychologia* 45 (2007), 459–464 (hereinafter: Bialystok, Craik and Freedman, "Bilingualism as a protection against the onset of symptoms of dementia").

[6] Edmarie Guzman-Vélez and Daniel Tranel, "Does bilingualism contribute to cognitive reserve? Cognitive and neural perspectives", *Neuropsychology,* 29 (2015), 139–150 (hereinafter: Guzman-Vélez and Tranel, "Does bilingualism contribute to cognitive reserve? Cognitive and neural perspectives").

number of bilingual individuals is most likely rising. This is also affected by the fact that individuals are learning a second language in early childhood.

Research shows that bilingualism affects cognitive abilities, especially the efficiency of executive functions[7]. Individuals who speak two languages perform better on tasks that require recognizing conflicting information, task switching, and retaining rules in working memory[8]. Because executive function is recognized as a critical component of cognitive and social development, research on bilingualism has implications for our understanding of the development of executive function as well as practical issues with respect to second-language instruction.

Psycholinguistic research also showed that both languages are active during linguistic processing in people who actively speak two languages, which means that they do not "switch off" one language while using the other[9]. This leads to potential competition between the two languages and causes linguistic processing to require more effort[10]. Bilingual individuals use control mechanisms that allow the use of one language in a particular situation to a greater extent than monolingual individuals[11]. Such control mechanisms are present whenever bilingual individuals use the language; there is an assumption that the control mechanisms are also activated in situations not related to language use[12].

Language processing in bilingual individuals

It is hypothesized that bilingual individuals are constantly choosing the language they intend to use. Both languages are always active during the use of one language in bilingual individuals, and the process that enables the use of the desired language requires the activation of mechanisms needed for the selection process. Such selection mechanisms are a part of the executive control

7 Ellen Bialystok, Gregory Poarch, Lin Luo and Fergus I. M. Craik, "Effects of bilingualism and aging on executive function and working memory", *Psychology and Aging* 29 (2014), 696–705 (hereinafter: Bialystok, Poarch, Luo and Craik, "Effects of bilingualism and aging on executive function and working memory").

8 Bialystok, Poarch, Luo and Craik, "Effects of bilingualism and aging on executive function and working memory", 696–705.

9 Jill P. Morford, Erin Wilkinson, Agnes Villwock, Pilar Piñar and Judith F. Kroll, "When deaf signers read english: Do written words activate their sign translation?", *Cognition* 118 (2011), 286–292 (hereinafter: Morford, Wilkinson, Villwock, Piñar and Kroll, "When deaf signers read english: Do written words activate their sign translation?").

10 Bialystok, Poarch, Luo and Craik, "Effects of bilingualism and aging on executive function and working memory", 696–705.

11 Ibidem.

12 Ibidem.

system; therefore, language selection has a generalized effect on cognition[13].

Switching between tasks as well as switching between two languages requires two specific tasks: 1) An individual needs to retain the primary answer to a specific task (e.g. activation of the first language); 2) the individual needs to activate the right answer for the specific task (e.g. activation of the second language). Morford et al.[14] studied the hypothesis that bilingual individuals when using the first language do not "switch off" language processing in the second language on the population of deaf bilingual individuals, wherein they presumed that their first language is the American Sign Language (hereinafter: ASL), and English is their second. They were interested if deaf individuals activate ASL when they read an English text. This was tested using a selection of English words, where the corresponding ASL translation has specific common structural parameters (e.g. placement of hands, gesture, and orientation), and English words which have no common parameters with the corresponding word in the ASL. Participants had to decide as quickly as possible if the listed word pair has a similar meaning in English or not. They found that participants have a statistically significant quicker response to semantically similar word pairs than word pairs that have no semantic similarity, which indicates that participants, when reading words in English, also process their meaning in ASL.

Neurophysiological aspects of bilingualism

The possibility that bilingualism affects changes in the cognitive system and the brain relates to research findings which indicate that structural changes occur in the brain when learning a foreign language[15]. Functional imaging of brains is an important tool for gaining accurate understanding and representation of the second language in bilingual individuals. Such studies complement the findings of behavioural studies. It provides an opportunity to determine representation and use of language based on the brain activation pattern that occurs in bilingual individuals[16].

Based on data acquired through neurological imaging, Abutalebi and

[13] Ellen Bialystok, Jubin Abutalebi, Thomas H. Bak, Deborah M. Burke and Judith F. Kroll, "Aging in two languages: Implications for public health", *Ageing research reviews* 27 (2016), 56–60 (hereinafter: Bialystok, Abutalebi, Bak, Burke and Kroll, "Aging in two languages: Implications for public health").

[14] Morford, Wilkinson, Villwock, Piñar and Kroll, "When deaf signers read english: Do written words activate their sign translation?", 286–292.

[15] Bialystok, "The bilingual adaptation: How minds accommodate experience", 233–262.

[16] Jubin Abutalebi and David Green, "Bilingual language production: The nurocognition of language representation and control", *Journal of neurolinguistics* 20 (2007), 242–275 (hereinafter: Abutalebi and Green, "Bilingual language production: The nurocognition of language representation and control").

Green[17] find that neural representations of the second language in bilingual individuals are combined with the representations of the language that the individual learned first. The use of language in bilingual individuals is a dynamic process that requires the activation of cortical and subcortical structures that participate in the resolution of inhibition and competition regarding the selection of the desired language[18]. The study showed that individuals who speak only one language activate the following brain regions when they are tasked with distinguishing contradictory or conflicting information: cingulate cortex, left prefrontal cortex, left inferior parietal lobule and caudate. The same regions activate during language use (linguistic processing) in individuals who speak two languages.

The main brain structure responsible for performing cognitive control is the prefrontal cortex. However, other brain regions are also involved. Complex functions, such as cognitive control, are performed by a network of various brain structures, each contributing its specific control function. The prefrontal cortex is linked with the parietal cortex, which is thought to be responsible for the selection between two impulses or to have an important role in switching between tasks[19]. Badre and Wagner[20] find that the selection process is also associated with the anterior cingulate cortex. The left prefrontal cortex and anterior cingulate cortex activate simultaneously when completing different working memory tasks, specifically with tasks that require switching between trials, such as the Stroop task.

In their review paper, Pliatsikas and Luk[21] analysed recent studies conducted with fMRI. They found that brain regions which are activated by executive control coincide with regions that are activated in bilingual individuals when controlling and processing language.

Performance of bilingual individuals in different cognitive processing tasks

Linguistic processing demands more effort from bilingual individuals than monolingual individuals, due to the combination of a smaller vocabulary size

[17] Abutalebi and Green, "Bilingual language production: The nurocognition of language representation and control", 242–275.

[18] Ibidem.

[19] Ibidem.

[20] David Badre and Anthony D. Wagner, "Selection, integration, and conflict monitoring: Assessing the nature and generality of prefrontal cognitive control mechanisms", *Neuron* 41 (2004), 473–487.

[21] Christos Pliatsikas and Gigi Luk, "Executive control in bilinguals: A concise review on fMRI studies", *Bilingualism: Language and Cognition* 19 (2016), 699–705.

and the need to activate executive functions to resolve the "competition" between both languages. Therefore, bilingual individuals perform worse on tasks that involve lexical proficiency than monolingual individuals[22]. Studies that compare language skills of monolingual and bilingual individuals show that bilingual individuals have smaller vocabulary size at all ages[23], are slower when naming pictures in comparison to monolingual individuals[24], and experience "the tip-of-the-tongue" state more frequently[25].

Luo, Craik, Moreno, and Bialystok[26] researched the performance of a sample of older and younger, monolingual and bilingual adults in verbal and spatial working memory tasks. The decline in memory associated with ageing was more significant in relation to spatial memory tasks than verbal memory tasks. The age-related working memory decline was the same for both language groups (bilingual and monolingual individuals). Bilingual individuals performed better in spatial working memory tasks and were less successful in verbal working memory tasks compared to monolingual individuals. This result was observed in both younger and older adults.

Bialystok, Craik, and Ryan[27] find that the complexity of the task is also a factor that affects the bilingual individuals' advantage over monolingual individuals. The results showed that bilingual individuals more quickly complete more complex tasks in which they are tasked with deciding on different types of conflicting stimuli, compared to monolingual individuals. They also found that the advantage of bilingual individuals over monolingual individuals increases with age. The authors conclude that the advantage of bilingual individuals can best be observed in complex tasks that require the use of higher-level executive functions.

Warmington, Kandru-Pothineni, and Hitch[28] examined the advantage of

[22] Bialystok, Poarch, Luo and Craik, "Effects of bilingualism and aging on executive function and working memory", 696–705.

[23] Jose S. Portocarrero, Richard G. Burright and Peter J. Donovick, "Vocabulary and verbal fluency of bilingual and monolingual college students", *Archives of Clinical Neuropsychology* 22 (2007), 415–422 (hereinafter: Portocarrero, Burright and Donovick, "Vocabulary and verbal fluency of bilingual and monolingual college students").

[24] Tamar H. Gollan, Rosa I. Montoya, Christine Fennema-Notestine and Shaunna K. Morris, "Bilingualism affects picture naming but not picture classification", *Memory & Cognition* 33 (2005), 1220–1234.

[25] Tamar H. Gollan, Rosa I. Montoya and Grace A. Werner, "Semantic and letter fluency in Spanish–English bilinguals", *Neuropsychology* 16 (2002), 562–576.

[26] Lin Luo, Fergus I. M. Craik, Sylvain Moreno and Ellen Bialystok, "Bilingualism interacts with domain in a working memory task: Evidence from aging", *Psychology and Agin* 28 (2013), 28–34.

[27] Ellen Bialystok, Fergus I. M. Craik and Jennifer Ryan, "Executive control in a modified antisaccade task: Effects of aging and bilingualism", *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 32 (2006), 1341–1354.

[28] Meesha A. Warmington, Swathi Kandru-Pothineni and Graham J. Hitch, "Novel-word learning, executive control and working memory: A bilingual advantage" *Bilingualism: Language and Cognition* (2018), 1–20 (hereinafter: Warmington, Kandru-Pothineni and Hitch, "Novel-word learning, executive control and working memory: A bilingual advantage").

bilingual individuals over monolingual individuals with regard to attention span, working memory, and novel-word learning. Compared to monolingual individuals, bilingual individuals always performed better in tasks that required novel-word learning and almost always in tasks that involve working memory. Both groups performed comparably in selective attention tasks. The results of this research indicate specific advantages of bilingualism; however, they are not transferred to all aspects of cognition.

Bilingualism in different developmental stages

Research show that bilingualism increases attention span and cognitive control in children[29,30], middle-aged adults[31], and older adults[32,33,34].

Choosing between two languages leads to a constant exercising of attention control and affects faster development of children, improved functioning of adults, and later decline in older adults[35].

Cognitive development in children is marked by the development of attention control and the complexity of representations. Cognitive functions that develop the fastest during childhood are those that decline most significantly in older adults[36].

Bialystok et al.[37] examined the difference between bilingual and monolingual children, young adults, middle-aged adults and older adults. Results

[29] Ellen Bialystok, *Bilingualism in Development: Language, Literacy and Cognition* (Cambridge, 2001) (hereinafter: Bialystok, *Bilingualism in Development: Language, Literacy and Cognition*).

[30] Ellen Bialystok, Catherine McBride-Chang and Gigi Luk, "Bilingualism, Language Proficiency, and Learning to Read in Two Writing Systems", *Journal of Educational Psychology* 97 (2005), 580–590 (hereinafter: Bialystok, McBride-Chang and Luk, "Bilingualism, Language Proficiency, and Learning to Read in Two Writing Systems").

[31] Deanna C. Friesen, Vered Latman, Alejandra Calvo and Ellen Bialystok, "Attention during visual search: The benefit of bilingualism", *International Journal of Bilingualism* 19 (2015), 693–702 (hereinafter: Friesen, Latman, Calvo and Bialystok, "Attention during visual search: The benefit of bilingualism").

[32] Bialystok, Craik, Klein and Viswanathan, "Bilingualism, aging, and cognitive control: Evidence from the Simon task", 290–303.

[33] Ellen Bialystok, Fergus Craik and Gigi Luk, "Cognitive control and lexical access in younger and older bilinguals", *Journal of Experimental Psychology: Learning, Memory, and Cognition* 34 (2008), 859–873 (hereinafter: Bialystok, Craik and Luk, "Cognitive control and lexical access in younger and older bilinguals").

[34] Guzman-Vélez and Tranel, "Does bilingualism contribute to cognitive reserve? Cognitive and neural perspectives", 139–150.

[35] Bialystok, Craik and Freedman, "Bilingualism as a protection against the onset of symptoms of dementia", 459–464.

[36] Bialystok, Craik, Klein and Viswanathan, "Bilingualism, aging, and cognitive control: Evidence from the Simon task", 290–303.

[37] Bialystok, McBride-Chang and Luk, "Bilingualism, Language Proficiency, and Learning to Read in Two Writing Systems", 580–590.

of the research did not show any differences between the group of bilingual and monolingual young adults; however, statistically significant differences between monolingual and bilingual children were observed, as well as between monolingual and bilingual middle-aged adults and older adults when given the same task.

Friesen et al.[38] studied the impact of selective attention as one of the core abilities that affect the advantage of bilingual individuals in executive function tasks. They measured reaction time and the correctness of responses in younger adults, wherein bilingual individuals outperformed monolingual individuals, especially in solving complex executive functions tasks.

Older bilingual individuals with multiple years of experience in switching between two languages have usually better developed different aspects of executive control that tend to decline the fastest with ageing. The higher the number of years that individuals speak the two languages, the more significant the protective effect against the onset of first signs of cognitive decline is[39].

Bialystok et al.[40] used the Simon task in their first research of the effect of bilingualism on cognitive abilities of older adults. They found that the decline of executive control abilities is lesser in older bilingual participants than in the monolingual participants of the same age. Bilingual participants in this study regularly used two languages since they were 6 years old.

Research shows that the age of participants is an important factor that affects the results of the comparison between bilingual and monolingual individuals' performance in completing tasks. They indicate that the advantages of bilingual individuals are more frequently observed in older than in younger participants[41,42].

Bialystok et al.[43] tried to examine the conditions, under which the advantage of bilingual individuals over monolingual individuals occurs. In their study, they used the Stroop task to examine the effect of ageing and bilingualism on the task performance. They presumed that bilingual participants will display a better ability to resolve interference (measured as the difference in time that the participants need to name the colour if the colour of

[38] Friesen, Latman, Calvo and Bialystok, "Attention during visual search: The benefit of bilingualism", 693–702.

[39] Bialystok, Abutalebi, Bak, Burke and Kroll, "Aging in two languages: Implications for public health", 56–60.

[40] Bialystok, Craik, Klein and Viswanathan, "Bilingualism, aging, and cognitive control: Evidence from the Simon task", 290–303.

[41] Ibidem.

[42] Bialystok, Craik and Luk, "Cognitive control and lexical access in younger and older bilinguals", 859–873.

[43] Bialystok, Poarch, Luo and Craik, "Effects of bilingualism and aging on executive function and working memory", 696–705.

the displayed word does not match and the time that they need to name the colour that matches the displayed word), which will be more significantly pronounced in older adults. If monolingual and bilingual individuals read the simple version of the task (where both stimuli match) at the same speed, then the same level of automatism in reading words is observed for both groups. Therefore, they presumed that the differences in resolving interference can be attributed to differences in executive control. Results of the first research indicated that older participants, in general, needed more time to complete the task than younger adults; however, a statistically significant difference was observed between the two language groups, wherein the monolingual individuals were statistically significantly slower than the bilingual. There were no differences between the language groups in younger adults. Bilingual individuals in both age groups displayed better interference resolution than monolingual participants.

Bilingualism and cognitive reserve

Environmental factors, usually associated with maintaining cognitive functioning in older adults and later first signs of dementia, are education, career or work experience, socio-economic status, physical activity, intellectual activities, and social engagement. These factors are usually associated with the cognitive reserve concept. Bialystok et al.[44] found, on the basis of previous research, that bilingualism is one of the factors of cognitive reserve. The general finding from previous research is that bilingual individuals attain better results in tasks that require executive control or selective attention.

The cognitive reserve hypothesis states that the brain has the ability to reorganize and substitute individual deficits in functioning with the purpose of optimizing the performance[45]. Brains have the ability to adjust to the environment on a structural and organizational level during all stages of life[46]. More and more research points towards the conclusion that bilingualism is one of the factors that affect cognitive reserve and the subsequent onset of visible symptoms of dementia. Research show that individuals who speak two languages their entire life use brain resources more efficiently than individuals that speak

[44] Bialystok, Abutalebi, Bak, Burke and Kroll, "Aging in two languages: Implications for public health", 56–60.

[45] Silvia Morbelli and Flavio Nobili, "Cognitive reserve and clinical expression of Alzheimer's disease: Evidence and implications for brain PET imaging", *American Journal of Nuclear Medicine and Molecular Imaging* 4 (2014), 239–247.

[46] Adriana Galván, "Neural plasticity of development and learning" *Human Brain Mapping* 31 (2010), 879–890.

only mother tongue, which allows them to maintain cognitive function in case of neuropathology[47].

Research problem

Research of cognitive development in bilingual and multilingual children and adolescents, more specifically of the effect of bilingualism/multilingualism on the cognitive development of children, particularly on the development and functioning of executive functions, has been the focal point of language and cognition research for the last few years. What are the executive functions? The most established is the three-part model of executive functions (hereinafter: EF), which consists of three processes: inhibition, updating (which includes working memory) and shifting[48]. Multiple previous studies (Canada, USA) found that bilingual children have an advantage or perform better in EF tasks, especially in the field of mental flexibility. Higher mental flexibility in bilingual children is presumably affected by the shifting or refocusing of attention between "target" languages. However, the results of existing research are not unambiguous, which can be attributed to diverse approaches, tests or tasks, and studied populations used[49]. Yet numerous studies undoubtedly confirm that the language environment affects the cognitive development of children[50].

The constant switching between languages "exercises" the individual's EF, as the focus is alternately switched to the suitable language. EF are a very important area of cognition and largely predict school or academic performance. It should be determined which components of EF are included in the linguistic processing of bilingual/multilingual children the most. Based on several previous studies[51], we presume that these are shifting (mental flexibility) and inhibition (retention of a certain answer/language to avoid interference). It seems that especially shifting (flexibility) and efficient “monitoring” are the most important elements[52].

47 Guzman-Vélez and Tranel, "Does bilingualism contribute to cognitive reserve? Cognitive and neural perspectives", 139–150.

48 Akira Miyake and Naomi P. Friedman, "The nature and organization of indvidual differences in executive functions: Four general conclusions", *Current Directions in Psychological Science* 21 (2012), 8–14.

49 Bialystok, Poarch, Luo and Craik, "Effects of bilingualism and aging on executive function and working memory", 696–705.

50 Susan Goldin-Meadow, Susan C. Levine, Larry V. Hedges, Janellen Huttenlocher, Stephen W. Raudenbush and Steven L. Small, "New evidence about language and cognitive development based on a longitudinal study: Hypotheses for intervention", *American Psychologist* 69 (2014), 588–599.

51 Ellen Bialystok, "Global-local and trail-making tasks by monolingual and bilingual children: Beyond inhibiton", *Developmental Psychology* 46 (2010), 93–105.

52 Philip D. Zelazo, Douglas Frye and Tanja Rapus, "An age-related dissociation between knowing rules and using them", *Cognitive Development* 11 (1996), 37–63.

Some studies also indicated that bilingual/multilingual individuals are more efficient when it comes to processing conflicting information. Certain results are characteristic for not only childhood but also adulthood and old age.

Of course, other questions also remain open; e.g. does the length or duration of learning and the start of learning the second language affect the extent of bilingualism's effect on EF? Therefore, is there a ratio between the level and type of bilingual experience and its effect on cognition? Does the time period in which we started to learn the second language have an impact on the effect? Does this happen immediately in our first years of life – namely, in parallel with the development of speech or later during schooling? Does the level of language proficiency also impact the cognitive effect?

It would be sensible to compare different groups of bilingual or multilingual children – groups that were exposed to different types of bilingualism (bilingualism in the family; learning of the second language in kindergarten or school, etc.) as well as to research the effect of contextual factors (family, education of parents, SES, etc.) – and thus examine the impact of these variables on the cognitive development, especially in the field of EF and processing of conflicting information. With its specific features, the Slovene environment can be considered a "natural language laboratory" (e.g. bilingual area in the Pannonian region next to the Hungarian border, Slovene Littoral next to the Italian border), where we can study different types of bilingualism in relation to the cognitive development of children.

In this research, we examined if differences can be observed between bilingual children from the Pannonian region next to the Hungarian border and monolingual children from the Styrian region of the same age, in different aspects of cognitive functioning, and especially in EF (inhibition, shifting), including working memory, and verbal abilities.

Method

Participants

35 children, between the ages of 9 and 11, participated in the study (M = 10.03, *SD* = 0.71), of which 14 were boys (40%) and 21 were girls (60%). Study participants attended the 4th and 5th grade of primary school. 15 participants, namely 4 boys and 11 girls, with an average age of 9.93 (*SD* = 0.46) came from a monolingual environment and attended monolingual primary school, while 20 participants, namely 10 girls and 10 boys, with an average age of 10.10 (*SD* = 0.85) came from a bilingual environment and attended bilingual primary school. Of the 20 bilingual participants, 6 reported that they speak Slovene at home, 3 of them speak Hungarian at home, 6 stated that they speak both langu-

ages at home, and no information regarding the language spoken at home was obtained from 4 bilingual participants.

Measures

Vocabulary (Wechsler Intelligence Scale for Children – WISC)[53] is a task used to measure verbal comprehension. We used the abbreviated version of the Wechsler subscale. Participants were tasked with describing or indicating the meaning of fifteen words. Bilingual participants explained the meaning of the words in both Slovenian and Hungarian language.

Verbal fluency test FAS[54] is a verbal fluency task that requires the participants to orally produce as many words as possible beginning with F, A or S in one minute. Participants must recall the requested content from memory, wherein executive control over the cognitive process, such as selective attention, information switching, and self-monitoring, is required.

Stroop task[55] is common used measure of interference and processing speed. A paper and pencil Stroop task was used. The task includes color naming and word reading with congruent and incongruent trials. Each condition included 50 items. In congruent condition the items were words of colors, in first condition printed in black. Children were asked to read the words. In the second condition there was the same number of XXXX simbols in different colors as there were names of colors in the previous condition. Participants were asked to name the colors. The incongruent condition also had 50 items per sheet, but they were written in different colors (e.g. the word green was written in yellow ink). In first incongruent condition children were asked to read the words and in second incongruent condition they were asked to name the colors regardless of the actual written words. The testators recorded the response time in seconds for each condition.

Trail making test (TMT)[56] is one of the most frequently used tests for examining EF. It consists of two parts. In the first part of the test (TMT A), participants need to connect digits from 1 to 25 in the correct order. In the second part

[53] David Wechsler, *Wechsler intelligence scale for children – Third edition UK – WISC III* (ZDA, 1949) (hereinafter: Wechsler, *Wechsler intelligence scale for children – Third edition UK – WISC III*).

[54] Tom N. Tombaugh, Jean Kozak and Laura Rees, "Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming", *Archives of Clinical Neuropsychology* 14 (1999), 167–177.

[55] Colin M. MacLeond, "Half a century of research on the stroop effect: An integrative review", *Psychological Bulletin* 109 (1991), 163–203.

[56] John E. Partington and Russell G. Leiter, "Partington's Pathways Test", *Psychological Service Center Journal,* 1 (1949), 11–20; as cited in Cynthia A. Riccio, Alane Blakely, Myeungsun Yoon, and Cecil R. Reynolds, "Two-Factor Structure of the Comprehensive Trail-Making Test in Adults", *Applied Neuropsychology: Adult* 20 (2013), 155–158.

of the test (TMT B), participants are required to alternately connect numbers from 1 to 12, and letters from A to L. The test is used to assess mental flexibility, task switching, the speed of psychomotor responses, complex attention and the speed of visual scanning.

Digit span test (Wechsler Intelligence Scale for Children – WISC)[57] is one of the most commonly used neuropsychological tests of short-term auditory memory and numeric memory, and working memory[58]. Participants were asked to recall a series of digits in the order in which they were presented (forward digit span) or in the reverse order (backward digit span). The length of the series increases from 2 to 9 in the forward digit span test and from 2 to 8 in the backward digit span test. The test ends when the participant makes two mistakes in a row or when they successfully repeat the maximum number of digits.

Procedure

Upon prior agreement with the schools in both language areas, we handed out informed consents, containing information regarding the course and the purpose of the test, to potential participants to be signed by their parents. In agreement with the schools' management, the testing was conducted at school, with individual participants completing the tests in an empty office or classroom, where peaceful conditions were provided. The tests were carried out during or after class. Participants were first asked to complete the Vocabulary task, wherein multiple words were read out loud to participants, who in turn provided oral definitions of individual words. Next was the Verbal fluency task, where participants had one minute to list as many words as possible that start on a given letter. This task was followed by Stroop test in four conditions. The task includes color naming and word reading with congruent and incongruent trials. The second to last task was the Trail making test A and B, which they completed using the paper-and-pencil method, while testers measured the time that participants needed to complete each part of the test. The last task was the Digit span task (forward and backward), wherein testers read the digits out loud and the participants had to repeat them in the same order and then again in the reverse order. The task ended when the participant made two consecutive mistakes or when they successfully repeated the maximum number of digits. The whole testing process took approximately 20 minutes.

[57] Wechsler, *Wechsler intelligence scale for children – Third edition UK – WISC III.*

[58] Sven Hilbert, Tristan T. Nakagawa, Patricia Puci, Alexandra Zech and Markus Bühner, "The digit span backwards task. Verbal and visual cognitive strategies in working memory assessment", *European Journal of Psychological Assessment* 31 (2015), 174–180.

Analysis

Statistical analyses were conducted using the IBM Statistics SPSS 21 software. Basic descriptive statistic for the sample description and test results was prepared first. We used the Kolmogorov–Smirnov test to analyse the normality of distribution. In order to examine the differences between the two groups, we used a t-test for independent samples and the Mann-Whitney test for distributions that deviated from normality.

Results

Table 1 presents basic descriptive statistics for the results of all tasks of both the monolingual and the bilingual group, and the t-test results for the independent samples, and of the Mann-Whitney test.

Table 1: Basic descriptive statistics for all tests for both groups, t-tests for independent samples, and Mann-Whitney test

	Monolingual	**Bilingual**					
	M (*SD*)	*M* (*SD*)	*t*	*U*	*df*	*p*	*d*
Vocabulary	19.40 (4.19)	19.00 (4.83)	0.26		33	.75	0.08
Verbal fluency	20.07 (5.31)	15.75 (5.27)		82.50		.02	0.82
Stroop1	37.07 (6.69)	31.80 (7.63)	2.13		33	.04	0.69
Stroop2	43.47 (6.05)	45.40 (9.12)	-0.71		33	.48	-0.21
Stroop3	35.60 (4.67)	32.05 (7.97)	1.54		33	.13	0.45
Stroop4	58.00 (11.31)	69.12 (22.13)	-0.69		17	.50	-0.50
TMT A	31.13 (7.28)	33.25 (12.95)	-0.57		33	.57	-0.16
TMT B	85.20 (28.37)	93.45 (40.10)		162.50		.68	-0.21
Digit span (forward)	5.27 (0.80)	5.35 (1.09)	-0.25		33	.80	-0.07
Digit span (backwards)	4.00 (0.93)	4.10 (0.97)	-0.31		33	.76	-0.10

Note: d = Cohen`s *d*; Stroop task 1 = reading the colours (without word-colour conflict); Stroop task 2 = naming the colours (without word-colour conflict); Stroop task 3 = reading the colours (with word-colour conflict); Stroop task 4 = naming the colours (with word – colour conflict); *M* (Stroop tasks and TMT tasks) = average time participants needed to complete the task

On average, monolingual participants achieved better results in the Vocabulary task (*M* = 19.40, *SD* = 4.19) than bilingual participants (*M* = 19.00, *SD* = 4.83); however, the difference between the groups was not statistically signifi-

cant, $t(33) = 0.26, p = .75$. The results have shown a statistically significant difference between the two groups on the Verbal fluency test, $U = 82.50, z = -2.26, p = .02, d = 0.82$. Monolingual participants produced more words beginning with a specific letter ($M = 20.07, SD = 5.31$), compared to bilingual participants ($M = 15.75, SD = 5.27$). There was also a statistically significant difference between groups in first condition of Stroop task, where participants had to read the colours without word-colour conflict. Bilingual participants were faster ($M_{time} = 31.80, SD = 7.63$) than monolingual participants ($M_{time} = 37.07, SD = 6.69$); the result is statistically significant, $t(33) = 2.13, p = .04$ and it represents a medium-sized effect ($d = 0.69$). Difference between bilingual and monolingual participants in other Stroop task conditions was not statistically significant, although, in Stroop task 3, where participants had to read the colours with word-colour conflict, monolingual participants needed somewhat more time to read the colours ($M_{time} = 35.60, SD = 4.67$) in comparison to bilingual participant ($M_{time} = 32.05, SD = 7.97$). On the other hand, monolingual participants completed the Trail making test A somewhat faster ($M_{time} = 31.13, SD = 7.28$), compared to bilingual participants ($M_{time} = 33.25, SD = 12.95$); however, the difference between the two groups was not statistically significant, $t(33) = -0.57, p = .57$. Similar results were also observed for the Trail making test B, as monolingual participants on average completed the task in shorter time ($M_{time} = 85.20, SD = 28.37$) than bilingual participants ($M_{time} = 93.45, SD = 40.10$); however, the difference between the two groups was not statistically significant, $U = 162.50, z = 0.42, p = .68, r = - .07$. In the Digit span test forward, bilingual participants achieved somewhat higher result ($M = 5.35, SD = 1.09$), compared to monolingual participants ($M = 5.27, SD = 0.80$); however, the difference between the results was also not statistically significant, $t(33) = 0.25, p = .80$, and a small effect size was observed, $r = .04$. Similarly, bilingual participants achieved slightly better results on the Digit span test backwards (M = 4.10, SD = 0.97), compared to monolingual participants (M = 4.00, SD = 0.93); however, the difference was not statistically significant, $t(33) = 0.31, p = .76, r = .05$.

Discussion

In this study, we examined if differences can be observed between bilingual children from the Pannonian region next to the Hungarian border and monolingual children from the Styrian region of the same age in certain aspects of cognitive functioning: in EF, working memory, and verbal abilities. Differences in verbal abilities between the two groups included were observed in this study. The results showed that there is a statistically significant difference between the two groups in the performance on verbal fluency task. Monolingual par-

ticipants were able to produce a higher number of different words beginning on the given letter in the set time than bilingual participants. In the Vocabulary task, the difference between the groups was not statistically significant. When comparing the comprehension of the Hungarian language in bilingual participants, approximately the same level of comprehension was observed than in the Vocabulary task in the Slovenian language, which indicates that on average bilingual participants successfully comprehended the Hungarian language. Children were awarded one point when they provided the corresponding word in the Slovenian language, and another if they also described the meaning of the word in the Hungarian language. There was no statistically significant difference in the Trail making test (TMT A and TMT B) nor in the Digit span forward and backwards. Monolingual participants needed slightly less time to complete both TMT tasks than bilingual participants and bilingual participants were slightly more successful in recalling digits in both versions of Digit span task than monolingual participants, which could indicate that short-term and working memory is functioning slightly better in bilingual than monolingual pupils. More obvious was the difference in Stroop tasks, especially in condition 1 and partially condition 3, where bilinguals needed shorter time to complete the task, which includes reading, processing speed and in condition 3 also ability of handling with conflicting information.

Compared results of monolingual and bilingual participants regarding vocabulary did not differ significantly, which indicates that verbal comprehension between monolingual and bilingual children does not differ significantly; however, a difference was observed in the field of verbal fluency. The result of this study that indicates higher verbal fluency abilities in monolingual participants when compared to bilingual participants, coincide with the study performed by Portocarrero et al.[59] which showed that when comparing linguistic abilities of monolingual and bilingual individuals, bilingual individuals exhibit smaller vocabulary size. In our study, bilingual participants displayed good comprehension of both languages. Despite the results regarding cognitive abilities, bilingualism leads to a richer language experience of a child, as it allows them to compare various linguistic structures and semantic domains of both languages, which can also contribute to learning new words and relations between them[60]. Children from the bilingual area on average displayed a good comprehension of the Hungarian language, which may indicate that their use of both languages is more or less balanced. A study in the context of the ELDIA

[59] Portocarrero, Burright and Donovick, "Vocabulary and verbal fluency of bilingual and monolingual college students", 415–422.

[60] Livija Knaflič, "Pismenost in dvojezičnost", *Sodobna pedagogika* 2 (2010), 280–294 (hereinafter: Knaflič, "Pismenost in dvojezičnost").

(European Language Diversity for All) international project, which is based on self-assessment of adult participants living in a bilingual area, found that language comprehension in the area of the Hungarian minority indicates balanced bilingualism[61]. In our study, 6 (40%) children reported that they speak Slovene at home, 3 (20%) reported that the language spoken at home is Hungarian, and 6 (40%) reported that they speak both Slovene and Hungarian at home.

Bialystok et al.[62] find that the effect of bilingualism on cognitive abilities may be limited. They note that a significant effect of bilingualism on cognitive abilities occurs only when an individual is fluent in both languages and frequently uses both. As previously stated, our group was quite heterogeneous regarding the use of both languages in all environments. Even though they speak both languages and learn in both languages at school, there can be a significant difference in proficiency between both languages, depending on what language they speak in their spare time, with their family and friends.

The study showed that the performance of monolingual and bilingual children did differ significantly on tasks used to test speed of processing and processing of conflicting information (Stroop task), but not so on tasks which test task switching, selective/ complex attention, and the speed of visual scanning (TMT A and TMT B). Likewise, there was no statistically significant difference between the groups in the task used to test short-term memory and working memory (Digit span test). Monolingual participants performed somewhat better on TMT A and B than bilingual participants, while bilingual participants performed slightly better on the Digit span tasks. Most important difference was evident in versions of Stroop task. Warmington et al.[63] found that the advantage of bilingualism does not transfer to all aspects of cognition. In their research, bilingual participants outperformed monolingual participants in novel-word learning, as well as in certain working memory tasks. The later was somehow indicated also in our study, where there was a tendency of better performance on working memory tasks for bilingual group. Somehow bigger was the advantage of bilinguals on two versions of Stroop task. A reason why the presumed statistically significant differences between the groups regarding mental flexibility/ shifting were not observed, is possibly the fact that bilingual primary school learners have a firm grasp on both Slovenian and Hungarian syllabary which differ to an extent but also include numerous similarities; therefore, an

[61] Anna Kolláth "Jezikovne spretnosti madžarske manjšine v Sloveniji", *Jezik in slovstvo* 57 (2012), 83–99.

[62] Bialystok, Craik and Freedman, "Bilingualism as a protection against the onset of symptoms of dementia", 459–464.

[63] Warmington, Kandru-Pothineni and Hitch, "Novel-word learning, executive control and working memory: A bilingual advantage", 1–12.

interference could occur when completing the TMT B task, which resulted in bilingual participants completing the task somewhat slower.

It should be considered in future research of bilingualism that exposure to a bilingual environment or learning of the second language are not the only factors that affect gaining language proficiency in the second language, but also that individuals who either live in bilingual areas or speak two or more languages could differ in other significant characteristics that have an impact on learning and the use of the second language, namely the age of the child when they are exposed to the foreign language or when they start to learn the foreign language; and also intelligence, certain personal characteristics, and motivation[64].

One of the shortcomings of this study is the small sample size, as well as the way of testing the level of proficiency in both languages of bilingual participants. As Knaflič[65] points out, the Slovenian environment lacks the tools to measure proficiency in both languages. Tests used to test mother tongue proficiency are available; however, the use of such tests on the bilingual population may be questionable[66].

One of the drawbacks of researching the bilingual population, in general, is the fact that comparing monolingual and bilingual population can be very challenging in some respects. Children that are acquiring proficiency in one language most probably differ in several ways from those that are acquiring proficiency in two or more languages[67]. Bilingual individuals also gain different experiences in different language environments[68].

Bialystok[69] also emphasizes the issue of defining bilingualism. She points out that we can consider bilingualism as a scale from the point at which the child has no knowledge of the second language to the point at which they speak both languages fluently. Bialystok questions at what point on this scale can we say that the child is bilingual.

The effect of bilingualism on cognitive abilities in all developmental periods was described in the introduction. It would be sensible to include different age groups in future research and test if differences which are not as pronounced in childhood become more profound in later periods of life or if they perhaps serve as a protective factor against the decline of cognitive functions in late adulthood. Studies indicate that the age of participants is an important fac-

64 Knaflič, "Pismenost in dvojezičnost", 280–294.
65 Ibidem.
66 Ibidem.
67 Ibidem.
68 Bialystok, *Bilingualism in Development: Language, Literacy and Cognition.*
69 Ibidem.

tor that affects performance in different tasks and related differences between monolingual and bilingual participants[70,71].

In addition to including a larger study sample, it would also perhaps be good to divide participants into groups based on the frequency of use of the second language or their second language proficiency. In this manner, we could test to what extent second language proficiency and frequency of its use affect their performance in tasks that test different cognitive functions. It would also be sensible to include more versatile tasks, with which we would test a wider spectrum of different abilities, as there is a possibility that the difference between the groups shows only in certain areas of functioning[72].

As we mentioned in relation to the Trail making test (TMT B), it is possible that smaller differences between the groups in testing the performance of monolingual and bilingual individuals in different areas of cognitive function also occur due to smaller differences in language proficiency, which can occur in both groups, according to certain studies. In order for us to state with confidence that the difference between the groups does not relate to participants' vocabulary size, we should also include cognitive tests in the second language (e.g. TMT B in the alphabet of the second language if it differs from the alphabet of the mother tongue).

According to some estimates, as much as half of the primary school children across the world speak two or more languages and bilingualism is an increasingly common occurrence in Slovenian primary schools; not only in bilingual areas but also in monolingual schools, primarily due to increasing migration. We can generally say that bilingual children attending Slovenian primary schools are children from the Italian or Hungarian national minority, as well as immigrant children. Schooling of children from the Italian and Hungarian national minorities has a long-standing tradition in Slovenia, as it has been performed in this area throughout history and is linked in an economic and cultural sense with the majority national group[73]. It is somewhat more challenging to integrate bilingual immigrant children into monolingual primary schools, as these children most commonly encounter a second language only when they enter kindergarten or school and are confronted with learning a new language while also having to learn the subject matter in a language in which they are not

[70] Bialystok, Craik, Klein and Viswanathan, "Bilingualism, aging, and cognitive control: Evidence from the Simon task", 290–303.

[71] Bialystok, Craik and Luk, "Cognitive control and lexical access in younger and older bilinguals", 859–873.

[72] Warmington, Kandru-Pothineni and Hitch, "Novel-word learning, executive control and working memory: A bilingual advantage", 1–12.

[73] Knaflič, "Pismenost in dvojezičnost", 280–294.

proficient yet. To conclude – research on bilingualism may contribute to better understanding of the advantages of bilingualism, not only in the linguistic field but also in other areas of cognitive functioning for individuals of all ages.

Sara Mičič in Karin Bakračevič

DVOJEZIČNOST V POVEZAVI Z IZVRŠILNIMI FUNKCIJAMI IN KOGNICIJO PRI OTROCIH NA SLOVENSKEM DVOJEZIČNEM OBMOČJU

POVZETEK

Dvojezičnost je v mnogih študijah prepoznana kot pomemben dejavnik pri oblikovanju kognitivnih sposobnosti posameznika. Raba jezika je ena izmed najbolj trajnih in intenzivnih izkušenj v posameznikovem življenju. Govor in procesiranje jezika namreč ni omejeno na določeno število ur v dnevu ali na določeno življenjsko obdobje, zato v veliki meri vpliva na oblikovanje kognitivnih sposobnosti v vseh življenjskih obdobjih. Po nekaterih podatkih se število dvojezičnih posameznikov povečuje, prav tako se zaradi številnih migracij povečuje število posameznikov, ki se drugega jezika učijo že v zgodnjem življenjskem obdobju.

Raziskave kažejo, da dvojezičnost vpliva na kognitivne sposobnosti, pri čemer se kaže še posebej viden učinek na delovanje izvršilnih funkcij. Posamezniki, ki govorijo dva jezika dosegajo boljše rezultate na nalogah, ki zahtevajo prepoznavanje konfliktnih informacij, na nalogah preklapljanja med zahtevami in nalogah vzdrževanja pravil v delovnem spominu. Razlog za večjo uspešnost kognitivnega funkcioniranja pri dvojezičnih posameznikih se najpogosteje povezuje s hipotezo na področju nevrolingvističnega procesiranja dvojezičnih posameznikov, ki pravi da sta pri uporabi jezika pri dvojezičnih posameznikih zmeraj aktivna oba jezika, proces ki omogoča uporabo želenega jezika pa zahteva uporabo mehanizmov, ki so potrebni za proces izbire nasploh. Tovrstni mehanizmi so del izvršilnega kontrolnega sistema, zato ima proces izbiranja jezika generaliziran učinek na kognicijo. Izvršilne funkcije pa so izjemno pomembno področje kognicije in v veliki meri napovedujejo tudi šolsko oz. akademsko uspešnost. Raziskave na področju vpliva dvojezičnosti na kognitiv-

ne funkcije tako temeljijo na ugotavljanju komponent izvršilnih funkcij, ki so v največji meri vključene v jezikovno procesiranje dvojezičnih posameznikov. Dosedanje raziskave so pokazale, da so to predvsem preklapljanje oz. mentalna fleksibilnost in inhibicija oz. zadržanje določenega odziva (ali jezika) v izogib interferenci. Prav tako naj bi bili dvojezični posamezniki uspešnejši v procesiranju konfliktnih informacij. Izbiranje med dvema jezikoma tako predstavlja nenehno treniranje kontrole pozornosti in vpliva na hitrejši razvoj pri otrocih, izboljšanje funkcioniranja pri odraslih in kasnejši upad pri starejših odraslih.

Pri preučevanju vpliva dvojezičnosti na kognitivne sposobnosti pa je zelo pomembno razmejiti med dvojezičnostjo in občasno rabo drugega jezika. Prav tako je pomemben nivo znanja obeh jezikov. Raziskave namreč kažejo, da ima dvojezičnost pozitivne učinke na kognitivne sposobnosti samo v primeru, da posameznik tekoče govori oba jezika. V primeru, da ima posameznik določeno znanje jezika, vendar ga ne uporablja pogosto, se pozitivni učinki na kognitivne sposobnosti ne pojavijo.

Slovensko okolje je zaradi obstoječih specifik eden "naravnih jezikovnih laboratorijev" (npr. dvojezično območje v Prekmurju ob meji z Madžarsko ter na Primorskem ob meji z Italijo), kjer lahko preučujemo različne vrste dvojezičnosti v povezavi s kognitivnim razvojem otrok. V slovenske osnovne šole se kot dvojezični vključujejo otroci, ki pripadajo italijanski in madžarski narodnostni manjšini, prav tako pa tudi otroci priseljencev. Šolanje otrok iz italijanskih in madžarskih narodnostnih manjšin ima v Sloveniji dolgo tradicijo, saj na tem področju živita ti dve manjšini že daljše zgodovinsko obdobje in sta gospodarsko in kulturno povezani z večinskim narodom. Nekoliko težje je pri vključevanju dvojezičnih otrok priseljencev v enojezične osnovne šole, saj se ti otroci največkrat srečajo z drugim jezikom šele ob vstopu v vrtec ali šolo in imajo pred seboj nalogo, da usvojijo nov jezik, hkrati pa morajo obvladovati tudi učno snov v jeziku, ki ga še ne poznajo.

V pričujoči raziskavi smo želeli ugotoviti, ali se bodo med dvojezičnimi otroki oz. učenci z območij v Prekmurju ob meji z Madžarsko in enako starimi enojezičnimi otroki oz. učenci iz Štajerske regije pokazale razlike v nekaterih vidikih kognitivnega delovanja, predvsem v izvršilnih funkcijah (inhibicija, preklapljanje, ravnanje s konfliktnimi informacijami) vključno z delovnim spominom ter v verbalnih sposobnostih. V raziskavo smo vključili otroke, stare od 9 do 11 let, in sicer: skupino dvojezičnih otrok, ki govorijo slovenski in madžarski jezik (učenci dvojezične šole na območju Prekmurja), ter kontrolno skupino enojezičnih otrok (učenci enojezične šole v Podravski regiji). Testirali smo jih z naslednjimi testi kognitivnih sposobnosti: verbalne sposobnosti, besedno fluentnost (FAS test verbalne fluentnosti), izvršilne funkcije (TMT test in Stroop test) in delovni spomin (test obsega števil). Rezultati so pokazali, da dvojezični otroci dosegajo boljše rezultate na nekaterih področjih izvršilnega funkcio-

niranja, kar se sklada z ugotovitvami nekaterih predhodnih raziskav, ki ugotavljajo, da je (pozitiven) vpliv dvojezičnosti na kognitivne funkcije lahko omejen in se navadno ne prenese na vse aspekte kognicije, večinoma pa se odraža v izvršilnih funkcijah. Prav tako se s predhodnimi raziskavami sklada ugotovitev, da se pri enojezičnih udeležencih kaže nekoliko večji besedni zaklad in besedna fluentnost v primerjavi z dvojezičnimi udeleženci.

V prihodnjih raziskavah bi bilo smiselno primerjati različne skupine dvojezičnih oz. večjezičnih otrok – skupine, ki so bile na različne načine deležne dvojezičnosti (dvojezičnost v družini; učenje drugega jezika v vrtcu ali šoli...) ter raziskati vpliv kontekstualnih faktorjev (družina, izobrazba staršev, SES...) – in tako preučiti vpliv vseh teh spremenljivk na kognitivni razvoj, predvsem na področju izvršilnih funkcij in procesiranja konfliktnih informacij. Prav tako bi bilo smiselno vključiti različne starostne skupine in preveriti ali se morda razlike, ki v otroštvu niso izrazite, v kasnejših obdobjih poglobijo in ali morda delujejo kot varovalni dejavnik pred starostnim upadom na področju kognitivnih funkcij.

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Title: **DVOJEZIČNOST V POVEZAVI Z IZVRŠILNIMI FUNKCIJAMI IN KOGNICIJO PRI OTROCIH NA SLOVENSKEM DVOJEZIČNEM OBMOČJU**

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Jezik: angleški (izvleček angleški in slovenski, povzetek slovenski)

Ključne besede: dvojezičnost, kognicija, izvršilne funkcije, delovni spomin, verbalne sposobnosti

Izvleček: Namen pričujoče raziskave je preveriti predpostavke o povezanosti med dvojezičnostjo in boljšimi rezultati na področju kognitivnega funkcioniranja. Raziskave, ki kažejo na prednost dvojezičnih posameznikov pred enojezičnimi na področju kognitivnih funkcij, rezultate razlagajo s pomočjo mehanizmov, ki dvojezičnim posameznikom omogočajo kontrolo in reprezentacijo obeh jezikov v možganih. V raziskavo smo vključili otroke, stare od 9 do 11 let, in sicer: skupino dvojezičnih otrok, ki govorijo slovenski in madžarski jezik, ter kontrolno skupino enojezičnih otrok. Testirali smo jih z naslednjimi testi kognitivnih sposobnosti: izvršilne funkcije s TMT testom in Stroopovo nalogo, verbalne sposobnosti z nalogo besedne fluentnosti in preizkusom besednjaka, ter obseg delovnega spomina. Rezultati so pokazali, da enojezični otroci dosegajo boljše rezultate na nalogi verbalne fluentnosti, dvojezični otroci pa so bili boljši v hitrosti procesiranja ter obdelavi konfliktnih informacij.