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Performance of bilingual individuals in psychodiagnostic testing of cognitive abilities using their first and second languages

Výkon bilingválnych jednotlivcov pri psychodiagnostickom vyšetrení kognitívnych funkcií v ich prvom a druhom jazyku

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Abstrakt

Cieľom práce bolo porovnať výkon bilingválnych jednotlivcov pri testovaní pozornosti, pamäti a inteligencie v ich prvom a druhom jazyku. Výskumný súbor tvorilo 126 bilingválnych respondentov s priemerným vekom 17.87 (SD = 7.77), 66 žien a 60 mužov. Súbor bol rozdelený na štyri vekové skupiny – mladší školský vek, obdobie pubescencie, adolescencie a dospelosti. Vybrané kognitívne funkcie boli merané slovenskými a maďarskými jazykovými formami nasledovných psychologických testov: Číselný štvorec, Pamäťový test učenia, Wechslerov inteligenčný test pre dospelých a Wechslerova inteligenčná škála pre deti. Z výsledkov vyplýva zhoršenie výkonu pri psychodiagnostickom vyšetrení pozornosti, pamäti a inteligencie v druhom jazyku bilingvistov a to bez ohľadu na ich vek.

Klíčová slova: bilingvizmus, druhý jazyk, inteligencia, pamäť, pozornosť.

Abstract

The aim of the study was to compare the performance of bilingual individuals in testing attention, memory and intelligence using their first (L1) and second (L2) languages. These abilities were selected by us based on the fact that they are the diagnostic criteria of many diagnostic units, e.g. ADHD, ADD etc., so if they are not correctly determined, there is a chance of issuing inadequate psychological report.

The issue of psychological testing of bilingual individuals is also topical problem in other European countries, such as the Czech Republic, Romania, Serbia, Croatia etc., where there is also a large percentage of ethnic minorities, but also countries outside of Europe, such as the USA are no exception.

Our intention was to test the implicit assumption that the performance of bilingual individuals deteriorates during psychodiagnostic testing, if the test is not performed in their first language. The sample consisted of 126 bilingual respondents with an average age of 17.87 (SD = 7.77), of which 66 were female and 60 male. The sample was divided into four age related groups - young school age children, preadolescent, adolescencents and adults.

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The selected cognitive abilities were measured by using Slovak and Hungarian language forms of the following psychological tests: Number Square, Learning Memory Test; Wechsler Intelligence Test for Adults (WAIS-R) and Wechsler Intelligence Scale for Children (WISC III). The results indicate a deterioration of performance at psychodiagnostic test of attention, memory and intelligence using L2 of bilinguals regardless of their age. The conclusion of the study shows the importance of choosing appropriate language for psychological testing for bilingual clients in order to eliminate adverse conditions compared to monolingual clients.

Keywords: attention, bilingualism, intelligence, memory, second language

Bilingualis

Bilingualism is not clearly defined. According to Mackey (2000) this ambiguity stems from the fact that it is not possible to determine when, how, at what stage the individual becomes bilingual. In this study, we are inclined to accept the notion of Štefánik (2000a), according to which the individual has alternative abilities of using two languages when interacting with other people depending on the situation and environment in which the communication is happening. The level of proficiency is not important; the main thing is a meaningful communication using both languages.

Research in bilingualism mostly focuses on the differences between monolinguals and bilinguals. Complete turnaround in negative understanding of bilingualism was brought by Peal and Lambert (1962), who found higher intelligence in bilingual group than in the control one, the monolingual.

These findings were followed by numerous studies pointing out the positive impact of bilingualism on the psyche of the individual (Adi-Japha, Berberich-Artzi, Libnawi, 2010; Bassetti, 2007; Bialystok, 2011; Bialystok, Craik, Klein & Viswanathan, 2004; Bialystok, Craik & Luk, 2008; Bialystok & Feng, 2009; Kaushanskaya, Blumenfeld & Marian, 2011; Kaushanskaya & Marian, 2009; Kessler & Quinn, 1980, 1987; Torrance, Wu, Gowan & Aliotti, 1970), most of which was undertaken in L1 of bilinguals.

It is questionable whether the cognitive benefits of bilingualism would have been also shown in the case of testing using L2 of simultaneous bilinguals. It is important to indicate what factors change the outcome of the examination. The result depends primarily on the characteristics of the client and of the specialist, also on the test conditions and physical characteristics of the test environment (Rosenthal, Rosnow, 2009; Halama, 2011). We would also include the test language selection to the situational factors, which if not selected properly for bilingual individuals, can cause negative changes on an emotional level, and in turn increase the anxiety of testing and consequently lead to a decline in performance (Chappell et al., 2005; Putwain, Connors, & Symes, 2010).

The test language as one of the situational factors may cause negative changes on the cognitive level, as the communication of bilingual individuals, unlike monolinguals, two typical processes

are taking place, code-switching and code-mixing, and that can lead to a slowdown of thought processes and consequently decline in performance in the test.

Code-switching is an alternation of codes, a phenomenon when two bilingual people fluently switch from one language to another and back again during their conversation (Pallay, 2009).

When mixing languages [code-mixing] bilingualists use both their languages in the same communication, creating mixed language. The basic language remains when transferring; only some words are replaced by the words from another language (Lanstyák, 2002).

The issue of the L1 and L2 in bilingualism is being researched from linguistic and psycholinguistic point of view (Assche, Duyck, Hartsuiker & Diependaele 2009; Kroll, Michael, Tokowicz & Dufour, 2002 Montri 2005; Schlemminger, 2011) rather than from psychological.

We try to approach the topic of bilingualism from the practical side of the psychodiagnostic examination findings. The aim of our research is not to compare the performance of monolingual and bilingual individuals but to examine the cognitive performance of a bilingual individual in their L1and L2.

We are trying to find links between the language used in examinations and performance of attention, memory and intelligence of bilingual respondents. We look at whether code switching leaves any marks on the speed and level of cognitive abilities of the bilingual individual, while we test each respondent in their L1 and then their L2. We also look at the age aspect of a possible change of the mentioned cognitive performance of bilingual individuals, as we are interested, whether the natural cognitive development also goes in parallel with the changes in performance in the first and the second language of the individual.

Methods

Participants

The respondents of our research were exposed to two languages (Slovak and Hungarian) from birth (simultaneous bilingualism). Two languages were used simultaneously at home and in the community by 57% of our respondents while in the community up to 92.8%. Others used the languages alternately (one at home, the other in the community). One group of our research respondents came from a type of language education, where they were exposed to the language of the community only while away from home as the non-dominant language of the community was the only language spoken at.

Another group of our research sample came from a type of language education in which the surroundings as well as the parents were bilingual, the parents communicated with the child alternately in both languages. Such methods of bilingual education appear rather in families of linguistic minorities, as well as in our research group (Štefánik, 2000b). The group consisted of 126 respondents, 66 females (52.4%) and 60 males (47.6%), aged 7-39 years (M = 17.87, SD = 7.77); 50.0% had a L1 Slovak and 50.0% Hungarian (see Table no. 1 in Appendix).

We have selected a cross-sectional research plan to find out whether conditional adaptation to the bilingual environment due to the ageing is reflected on cognitive ability of bilinguals in psychodiagnostic examination in two languages.

The condition of acceptance in the research group was good command of the Slovak and Hungarian languages, by which we eliminated from findings distorting factor of misunderstanding of the test instructions or cues.

We have not tested the command of languages, it was determined from self statement questionnaire and active communication with respondents. Language skills of the respondents are presented in Table no. 2 (see in Appendix), the vast majority has the ability of speaking in Slovak and Hungarian language at a good level and/or as the mother tongue.

Materials

Demographic Data and Language Skills Questionnaire

When drawing up the questionnaire, we were inspired by Scirdon's and Kantor's questionnaires of bilingualism (2013) as well as Harding-Esch and Riley (2008). The questionnaire also contained our own questions, detecting the linguistic characteristics of the bilingual respondent (e.g. What level are your language skills? Do you speak at home only one language or two languages? If you use more than one language at home, please indicate on the scale how often there is communication in two languages at your home) which indicated the first language of the bilingual individual.

We tried to define the mother tongue according to Göncz's criteria (2005), under which the mother tongue of the bilingual individual is the first acquired, better managed and most often used language. This indicates that the mother tongue is the first language (L1) of the respondent.

Number Square

This method is used for testing attention. On the test sheet there is printed square in which numbers from one to twenty-five are arranged randomly and not systematically. The task for the tested person is to find the numbers in the correct order as quickly as possible, to point at them with a finger and pronounce their verbal form aloud.

The respondent pointed out the order of numbers 10 times repeatedly while the time of searching for the numbers was measured. . This method examines the level of concentration and distribution of attention, the reliability of the test is 0.76 - 0.86. Indicative numeric values of reliability of this diagnostic tool (Number Square) should be critically assessed in regard to the ways of their calculation by the test authors. Repeated testing using this test was allowed to perform again after 10 days, which was strictly adhered to (Jirásek, 1992).

Given the objective of the research, in one instance the testing language was Slovak, in the other, Hungarian. The performance was evaluated based on average time of ten consecutive attempts of searching the numbers and especially, the average time of the first five and the second five experiments.

Learning Memory test

This diagnostic tool is used to test the memory with 15 stimuli words from different topic areas. Words are of four-syllable maximum, but mostly two syllables (Preiss, 1999). The testing was divided into three stages. The first stage focused on an immediate recall of the words five

times in succession, while the administrator had read the words to the respondent before each attempt. It was followed by a set of words used as interference, which the respondent also had to remember. Immediately after the interference set followed a delayed recall, in which the respondent had to recall the first set of words without reading them.

After 30 minutes, we asked the respondent to remember the first set of words once again.

Bilingual participants of our research took part in testing in Slovak language (the language of instruction, stimulus words and response was Slovak) and Hungarian (the language of instruction, stimulus words and response was Hungarian). As the Learning Memory Test includes a set of words for repeated examination, participants of the research were not faced with the same vocabulary during the two testing sessions. Particular attention was given to the translation accuracy of words from the original Slovak language to Hungarian.

Cronbach's alpha of the translated words is 0.81, Split-half is 0.76. Split-half reliability of the original test is 0.77 - 0.86 (Preiss, 1999). In the evaluation, we looked at the number of immediately recalled words, the number of words after interference and also after 30 minutes, the number of repetitions and confabulations.

Wechsler adult intelligence scale (WAIS-R) and Wechsler intelligence scale for children (WISC-III)

From available multidimensional intelligence tests for the purposes of our research we've used only verbal subtests: Information, Digit Span, Vocabulary, Arithmetic, Similarities and Comprehension. Bilingual participants of the research were tested in both Slovak and Hungarian version of the diagnostic tool, retesting was performed after a minimum of two months in accordance with the instructions in the manual. Reliability of the Slovak version of WISC-III is between the values of 0.73-0.91, these values correspond with split-half correlations of verbal subtests.

Reliability of the Slovak version of Wechsler intelligence scale for children is between the values of 0.69 and 0.96, reliability of the Hungarian translation of the test is 0.55 - 0.95. Reliability of the Slovak translation of Wechsler intelligence test for adults is between the values of 0.89 - 0.97 and the reliability of Hungarian translation falls between values of 0.76 - 0.93 (Kun & Szegedi, 1996; Říčan, Sebek & Vágnerová 1983; Wechsler, 1996).

Procedure

Testing for the purposes of our research was conducted on individual basis, in a sensory reduced environment. We applied the whithin subject design; each respondent was tested twice, once in their L1 and L2.

The time scale for individual tests was determined by the information contained in the manuals for diagnostic tools used. The average time interval between the two tests was 64.33 days (min = 61, max = 69). Once the informed consent about the research was signed, in order to determine the mother tongue, in early testing we used a questionnaire to obtain demographic data and language skills. Then we have engaged respondents to a free conversation by which we tried to find out

as much information as possible about the language environment of the individual in the past and the present. Summarizing the information gained from the questionnaire and an interview we determined, which one of the two daily used languages is their L1. The conversation was followed by the test phase of our research (Number Square, Learning Memory test, WAIS-R or WISC-III). We consider it important to note that we alternated the language of the first test. In 50.0% of respondents the first test took place in their L1 and in 50.0% of the respondents in their L2. We have tried to prevent the fact, that any deterioration or improvement in the results of the tests of cognitive functions could be affected by a stable order of languages in testing.

Results

The data was analyzed by using the statistical software SPSS 14.0. For the analysis we have used Wilcoxon test or t-test based on the normality test.

First, we analyzed data collected from young school age children respondents. Tab. no. 3 (see in Appendix) indicates that bilingual children showed worse performance in the test of attention, memory and intelligence in their L2. In the test of attention, the respondents underperformed using their L2 during the full test and in particular, in the first five attempts of the test. In the memory test, respondents achieved significantly worse results in the entire test and in each part thereof, except confabulation. Intelligence test showed that the respondents scored lower using their L2 particularly in verbal intelligence, and subtest parts concerning Comprehension and Similarities.

Table no. 4 (see in Appendix) summarizes the results of the data analysis for preadolescent group. Respondents showed poorer performance in their L2 for each mental function measured by us. Worse performance was shown in the test of attention in the L2 for the full test and also for its two parts. In analyzing the results of the memory tests, we found a lower number of reproduced words in the L2 throughout the test, and both immediate and delayed recall of words. Respondents achieved worse performance in the L2 throughout the intelligence test and in subtests concerning Information, Digit Span, Arithmetic and Similarities.

In the next part of our study, we focused on the age category of adolescence. The results are summarized in Tab. no. 5 (see in Appendix), which shows that respondents provided worse performance in their L2 in the test of attention, memory and intelligence. In the complete test of attention and its individual parts, we found worse performance while using L2 of respondents.

Adolescents of our research group showed worse performance while using their L2 for the entire memory test and delayed recalls. During the intelligence test and subtests Comprehension, Digit Span and Similarities respondents performed worse while using their L2.

In the final step of data analysis, we focused on the adult age group, in which respondents achieved worse scores while using their L2, which is summarized in Tab. no. 6 (see in Appendix) In the test of attention they showed significantly worse performance while using their L2 in the final and partial results. The memory tests show a weaker performance while using their L2 in the complete test and in the immediate recall too. In the entire intelligence test and in each of its subtests adult respondents showed worse performance while using their L2.

Results collected for the whole research unit and each of the tests were analyzed further according to respondents' mother tongue, the teaching language of their current school and the level of speaking in both of the languages (see Table 7 in Appendix).

Discussion

The subject of this research study was to confirm a correlation of the language used for administering the psychological testing of a bilingual client and their cognitive performance. Our aim was to examine the performance of attention, memory and intelligence while using the L1 and L2 of a simultaneous bilingualist.

The language used in testing, as one of the presumed situational factors, as a language of instruction, stimulus and response to stimulus remained the same in each test i.e., in Slovak testing using the Slovak language, in Hungarian testing using the Hungarian language.

We did not analyse the tendency to code switching in our respondents. We are aware, that the Number Square as a psychodiagnostic tool does not offer psychometric characteristics for adolescent and adult population. Each tool we used just to judge the performance of the individual in L1 (first language) and L2 (second language). This performance was not compared with the performance of the population.

In the Attention test respondents in the young school age children group reached worse performance using their L2. At a more detailed analysis of the results, we have noted that the time difference in the time required to complete the tasks appeared only in the first five test attempts. In the preadolescent, adolescencent and adult groups the respondents succeeded to solve the test of attention also in a longer time while using their L2. However, respondents in young school age children group appeared to have the longer reaction time in both parts of the test. We believe that the equalization of testing time during the tests among young school age children was a result of adaptation to the test situation, which they perceived as a game. We believe that the adaptation in higher age groups did not happen because the respondents perceived the testing as a situation requiring performance, which in turn generated a stress response, even anxiety, and impeded the optimal performance of attention (Fernández-Castillo & Caurcel, 2014).

From the description of the results of the attention test, is clear that in all age groups the total time became longer in using L2 of respondents, which means that even with simple tasks (enumeration of numbers) the language of the test plays an important role.

In the memory test respondents in younger school age group and in preadolescence reproduced fewer words in their L2 throughout the test and its various parts (immediate and delayed recall). In the adolescence group, the individuals thought of fewer words using their L2 during the test. We believe that in the overall result of the memory test of a bilingual pupil, the teaching language of currently attended school also plays a role as it is the language which the individual uses for learning every day. The memory is used more actively in this language, which makes it the mother tongue language as the individual uses this language most of the time (Göncz, 2005). We anticipate that as a result of everyday learning and education in their L1, their memory performance would also be better in that language. At a detailed analysis of the results of memory test in adolescence group we found, that the difference in the number of thought of words appeared only in delayed recall (long term memory). Even in the adult group, the participants of

our research reproduced fewer words throughout the test while using their L2; this is in contrast with our adolescents research group, during the immediate recall test. In this age group were also included employed individuals, so their performance could not be affected by the language currently used in their education. Detailed analysis shows that worse performance while using L2 appeared in adolescence, for the delayed recall tasks, while in adulthood in immediate recall tasks. This finding would require examination in view of L2 and other factors of memory, such as personality traits, gender, education, learning strategy, target orientation etc. (Carr, Castel, Knowlton, & 2015; Hülür, Hertzog, Pearman, & Gerštorf, 2015, Lee Ning & Goh, 2014; Ozańska-Ponikwia, Dewaele, 2012)

In summary, the respondents achieved in each age group worse results while using L2. Our findings contradict the findings of Kormi-Nouri et al. (2008), which highlighted the improved memory of bilingual individuals compared with monolingual individuals, whereby this advantage was shown in both languages of bilinguals.

The results of the attention test used for this study are interplay of five mental functions, perception, readiness, attention, imagination and memory. Thus bilingual memory performance is supported by the results of the Number Square confirming the worse performance of the memory while using the L2 of the respondent.

In the verbal intelligence test, bilingual children in our young school age children group presented worse performance using their L2. Respondents showed worse performance while using their L2 in subtests concerning Comprehension and Similarities which focus on solving everyday situations and ability to generalise. The preadolescent bilingual individuals scored lower in the intelligence tests while using their L2 too. Respondents presented worse performance while using their L2 in subtests concerning Information, Similarities, Arithmetic and Digit Span, which focus on general knowledge, generalization, arithmetic tasks and short-term verbal memory. Poorer performance in the subtests concerning Digit Span also points to the worse performance of the memory while using L2 of the bilingual adolescents. We assume that the result may reflect the language that was used in teaching of the respondent, similarly to memory test. The adolescent respondents presented poorer performance in the intelligence test while using their L2, while the differences in similar subtests of the research such as Comprehension, Digit Span and Similarities were found. The adult respondents also scored lower while using their L2, poorer performance while using L2 was present in all subtests of the intelligence test. These results may correlate with the flexibility of thinking which is part of intelligence. This flexibility of thinking is also applied at the time of manipulation with already acquired knowledge (Ruisel, 1992). During our research, bilingual respondents were tasked to switch fluently between both of their spoken languages. We have examined the switching between the languages in the context of psychological testing. Our results prove that switching between daily used languages leaves traces on the performance of each cognitive function that we examined.

Romaine (1995) tried to develop definitions of bilingualism by adding level of competence in spoken languages of an individual. She coined the term “balanced” and “unbalanced” bilingualist. We have examined the cognitive performance in each test according to the level of spoken languages and different performance had shown only in the intelligence subtest concerning Vocabulary. In this subtest worse performance while using the second language was given by the respondents who speak one of their languages at good level but not as good as the mother tongue. The dominant language that respondents have good command of, is usually their L2,

which they use less frequently than their L1, therefore the conceptualizing processes are not at the same level as the L1. We have examined differences in the bilingual performance of attention, memory and intelligence according to the L1 and the teaching language of the current school. Poorer performance while using L2 appeared among the respondents with Hungarian L1 and those, attending schools with Hungarian as teaching language. The notable subtests of intelligence test were those concerning: Information, Comprehension and Digit Span. These findings suggest the seriousness of testing of bilingual individuals where their L1 does not match the dominant language of the society and as a result they are then usually tested in their L2, which in turn can lead to unrealistic results of diagnostic tests.

Suggestion to consider the testing methodology for bilingual individuals is considered the major benefit of this study. Harding-Esch and Riley (2008) highlight the fact that we have yet not created any psychological methods of testing that would be specific to testing of bilingual individuals.

For the bilingual individual we would suggest the following order of examination:

1) Thorough examination of language skills of an individual
2) Determination of their L1
3) Provision of tests in the L1 of the client (as practicable)
4) The battery of tests
5) Evaluation

Benefits of this study could also include a selection of psychological aspect topics little explored in Slovakia so far which would highlight their importance. We would include agency of the test administrator as a limitation of our study. Other drawbacks of our study are small size sample in one of the age groups, parental presence during the test of minor respondents and the long research procedure.

For further study of this type it would be appropriate to use a more complex test of attention and test measuring the anxiety. It would be interesting to examine the cognitive performance in using of L1 and L2 on biological basis as well. There were a number of studies already that examined the brain activity of bilinguals, only from a different perspective. When determining the localization of language functions of bilinguals Peng and Wang (2011) found a stronger activity in the left brain hemisphere, while Proverbio and Adorni (2011) with their research point to a reduced hemispherical asymmetry of bilinguals.

In the study of neural correlates in the context of cognitive control, experts found different brain activation in monolingual and bilingual respondents (Luk, Anderson, Craik, Grady, Bialystok, 2010). Hernandez, Dapretto, Mazziotta and Bookheimer (2001) examined the enumeration of objects and movements presented in the picture in both languages of individuals on the biological basis. With the help of fMRI they found very little neurological deviation in brain processes dependent on the language. Based on these neuropsychological findings and our own results, we recommend reviewing bilingual cognitive performance that was examined by us, in relation to brain processes in the cross-sectional design.

Our results however, need further verification due to mentioned limitations; nonetheless, they still emphasize the importance of obtaining detailed picture of language skills of bilingual individuals of all ages prior to psychological testing.

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Appendix

Table 1. Descriptive analysis by age groups (N = 126)

	Gender		Age				School/Employed			L1	
	Women	Men	M	SD	Min	Max	STL	HTL	Employed	Slovak language	Hungarian language
Younger school age (N = 31)	N = 17 54.8%	N = 14 45.2%	9.42	1.65	7	12	N = 18 58.1%	N = 13 41.9%	N = 0	N = 17 54.8%	N = 14 45.2%
Pubescence (N = 31)	N = 15 48.4%	N = 16 51.6%	13.87	0.85	13	15	N = 16 51.6%	N = 15 48.4%	N = 0	N = 16 51.6%	N = 15 48.4%
Adolescence (N = 32)	N = 18 56.3%	N = 14 43.7%	19.28	1.99	16	22	N = 19 59.4%	N = 13 40.6%	N = 0	N = 14 43.7%	N = 18 56.3%
Adulthood (N = 32)	N = 16 50.0%	N = 16 50.0%	28.53	5.41	23	39	N = 6 18.8%	N = 3 9.4%	N = 23 71.8%	N = 16 50.0%	N = 16 50.0%

M – Mean; SD - Standard Deviation
STL - school with Slovak teaching language
HTL - school with Hungarian teaching language

Table 2. Language skills of the respondents in their daily-used languages (N=126)

	Slovak language - reading	Slovak language - writing	Slovak language - speaking	Hungarian language - reading	Hungarian language - writing	Hungarian language - speaking
Weak	N = 0	N = 0	N = 0	N = 3 2.40%	N = 5 4.0%	N = 0
Medium	N = 13 10.30%	N = 18 14.30 %	N = 0	N = 14 11.10%	N = 17 13.40%	N = 2 1.60%
Good	N = 45 35.70 %	N = 44 34.90%	N = 47 37.30%	N = 36 28.60%	N = 34 27.0%	N = 25 19.80%
At a level of the mother tongue	N = 68 54.0%	N = 64 50.80%	N = 79 62.70%	N = 73 57.90%	N = 70 55.60%	N = 99 78.6%

Table 3. Results of the test of attention, memory and WISC III in young school age children (N = 31)

Numeric square												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn	Range	MR	Mdn	Range	MR	Z	p	r	t	p	d
Full test	44.40	8.30	15.46	47.80	7.40	17.86	-2.411	**.016***	**-.43**			
1st part of the test	48.50	7.60	14.38	50.40	7.10	22.75	-2.185	**.029***	**-.39**			
2nd part of the test	43.10	10.70	15.32	45.60	7.20	17.67	-1.744	.081	-.31			
Memory test of learning												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Full test	78.47	8.81		73.68	8.70					4.165	**<.001***	**.55**
Immediate reproduction	52.00	7.00	14.60	50.00	9.00	14.48	-2.966	**.003***	**-.53**			
Delayed recall	28.39	3.90		25.94	3.42					4.276	**<.001***	**.67**
Repetition	2.00	2.00	13.08	3.00	3.00	24.20	-2.139	**.032***	**-.38**			
Confabulations	0.00	2.00	9.57	1.00	3.00	10.25	-1.197	.231	-.21			
WISC III												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Verbal intelligence	91.00	11.00	16.76	84.00	19.00	5.00	-4.668	**<.001***	**-.84**			
Information	7.61	2.68		6.64	2.11					2.244	.032*	.40
Comprehension	7.26	2.65		5.97	2.79					2.325	**.027***	**.47**
Digit Span	8.19	1.82		7.58	2.32					1.509	.142	.29
Arithmetic	8.48	2.59		7.45	2.14					2.302	.028*	.43
Similarities	7.35	2.12		5.39	2.42					5.362	**<.001***	**.86**
Vocabulary	7.32	3.25		6.74	3.61					0.688	.496	.17

** The difference is statistically significant at the significance level p = 0.05. Highlighted differences with a medium or large effect.*

Mdn – Median; M – Mean; SD - Standard Deviation; MR – Mean Rank; Full test – 10 attempts of number searching; 1st part of the test – first 5 attempts of number searching; 2nd part of the test – second 5 attempts of number searching; Full test – all attempts of repetition words; Immediate reproductions – after reading the words; Delayed recall – after interference and without reading the words; Repetition – repeating one word during one repetition attempt of 15 words; Confabulations – placing a word outside the original set of words; Verbal intelligence – Verbal IQ derived from scaled scores

Table 4. Results of the test of attention, memory and WISC III for preadolescent group (N = 31)

Numeric square												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn	Range	MR	Mdn	Range	MR	Z	p	r	t	p	d
Full test	25.50	4.50	13.81	28.10	5.70	16.76	-2.696	.007*	-.48			
1st part of the test	26.90	4.50	15.88	29.40	5.00	16.04	-2.372	.018*	-.43			
2nd part of the test	24.50	4.70	11.83	27.30	6.30	17.70	-2.744	.006*	-.49			
Memory test of learning												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Full test	82.00	7.00	17.23	77.00	9.00	9.60	-3.924	<.001*	-.70			
Immediate reproduction	53.00	7.00	15.88	50.00	7.00	14.00	-3.059	.002*	-.55			
Delayed recall	30.00	3.00	16.08	26.00	3.00	5.67	-4.349	<.001*	-.78			
Repetition	2.58	2.75		3.13	3.07					1.058	.298	-.19
Confabulations	1.48	1.36		1.65	1.72					.487	.630	-.11
WISC III												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Verbal intelligence	92.64	8.28		84.13	11.88					5.468	<.001*	.83
Information	9.45	1.57		7.65	2.60					3.674	.001*	.84
Comprehension	6.90	1.90		6.35	2.44					0.986	.332	.25
Digit Span	9.00	3.00	15.40	7.00	2.00	13.05	-2.514	.012*	-.45			
Arithmetic	7.71	2.10		6.68	2.23					2.380	.024*	.48
Similarities	8.39	1.93		6.87	3.05					2.398	.023*	.60
Vocabulary	6.00	2.54		6.58	3.01					-.815	.421	-.21

** The difference is statistically significant at the significance level p = 0.05. Difference with a medium or large effect.*

Mdn – Median; M – Mean; SD - Standard Deviation; MR – Mean Rank; Full test – 10 attempts of number searching; 1st part of the test – first 5 attempts of number searching; 2nd part of the test – second 5 attempts of number searching; Full test – all attempts of repetition words; Immediate reproductions – after reading the words; Delayed recall – after interference and without reading the words; Repetition – repeating one word during one repetition attempt of 15 words; Confabulations – placing a word outside the original set of words; Verbal intelligence – Verbal IQ derived from scaled scores

Table 5. Results of the test of attention, memory and WAIS-R for adolescent group (N = 32)

Numeric square												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn	Range	MR	Mdn	Range	MR	Z	p	r	t	p	d
Full test	24.70	3.67	15.30	26.95	4.47	23.00	-2.787	**.005***	**-.49**			
1st part of the test	26.15	3.75	15.09	28.30	5.30	24.10	-2.684	**.007***	**-.47**			
2nd part of the test	22.90	3.43	15.27	25.00	3.58	19.80	-2.920	**.003***	**-.52**			
Memory test of learning												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Full test	86.00	8.00	16.81	80.00	14.25	14.80	-3.563	**<.001***	**-.63**			
Immediate reproduction	55.06	5.34		53.53	6.03					2.131	.041*	.27
Delayed recall	30.00	3.75	16.54	26.00	7.75	13.75	-3.257	**<.001***	-.58			
Repetition	2.47	2.18		3.06	1.88					-1.358	.184	-.29
Confabulations	1.00	3.00	15.19	1.00	2.00	10.63	-.956	.339	-.17			
WAIS-R												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Verbal intelligence	90.50	16.25	16.50	80.00	21.50	15.80	-4.019	**<.001***	**-.71**			
Information	7.56	2.46		6.97	2.39					.947	.351	.24
Comprehension	9.09	3.06		6.88	2.86					3.289	**.003***	**.75**
Digit Span	10.00	2.75	14.92	8.00	2.75	9.64	-2.757	**.006***	**-.49**			
Arithmetic	7.44	2.35		6.97	2.21					1.024	.314	.21
Similarities	9.00	4.00	17.04	7.50	4.00	14.57	-3.040	**.002***	**-.54**			
Vocabulary	11.00	16.00	19.88	8.50	12.00	11.29	-1.766	.077	-.31			

** The difference is statistically significant at the significance level p = 0.05. Highlighted differences with a medium or large effect.*

Mdn – Median; M – Mean; SD - Standard Deviation; MR – Mean Rank; Full test – 10 attempts of number searching; 1st part of the test – first 5 attempts of number searching; 2nd part of the test – second 5 attempts of number searching; Full test – all attempts of repetition words; Immediate reproductions – after reading the words; Delayed recall – after interference and without reading the words; Repetition – repeating one word during one repetition attempt of 15 words; Confabulations – placing a word outside the original set of words; Verbal intelligence – Verbal IQ derived from scaled scores

Table 6. Results of the test of attention, memory and WAIS-R in the adult group (N = 32)

Numeric square												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn	Range	MR	Mdn	Range	MR	Z	p	r	t	p	d
Full test	22.55	7.60	9.56	24.00	6.63	18.81	-3.508	**<.001***	**-.62**			
1st part of the test	23.80	7.00	14.30	25.20	4.50	16.91	-3.602	**<.001***	**-.64**			
2nd part of the test	20.70	8.07	12.78	22.80	7.95	16.67	-2.418	**.016***	**-.43**			
Memory test of learning												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Full test	87.50	18.50	18.02	83.50	16.75	12.61	-2.819	**.005***	**-.50**			
Immediate reproduction	58.00	10.50	15.63	56.00	12.50	12.58	-3.078	**.002***	**-.54**			
Delayed recall	29.59	5.24		28.47	7.28					2.177	.037*	.33
Repetition	3.41	3.16		3.78	3.85					-.480	.635	-.11
Confabulations	0.00	1.75	10.25	1.00	1.75	13.35	-1.099	.272	-.19			
WAIS-R												
	L1			L2			Wilcoxon test			t test		
Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Verbal intelligence	102.56	11.07		89.47	11.21					5.819	**<.001***	**1.18**
Information	10.06	2.11		8.09	2.23					4.190	**<.001***	**.91**
Comprehension	11.00	3.00	14.65	9.50	3.00	14.13	-2.067	**.039***	**-.37**			
Digit Span	13.00	3.75	17.30	9.00	2.75	10.56	-3.054	**.002***	**-.54**			
Arithmetic	9.66	2.44		8.44	2.55					3.512	**.001***	**.49**
Similarities	11.91	2.20		7.97	2.24					7.210	**<.001***	**1.77**
Vocabulary	29.00	16.00	15.47	19.00	17.25	10.11	-2.293	**.022***	**-.41**			

** The difference is statistically significant at the significance level p = 0.05. Highlighted difference with a medium or large effect.*

Mdn – Median; M – Mean; SD - Standard Deviation; MR – Mean Rank; Full test – 10 attempts of number searching; 1st part of the test – first 5 attempts of number searching; 2nd part of the test – second 5 attempts of number searching; Full test – all attempts of repetition words; Immediate reproductions – after reading the words; Delayed recall – after interference and without reading the words; Repetition – repeating one word during one repetition attempt of 15 words; Confabulations – placing a word outside the original set of words; Verbal intelligence – Verbal IQ derived from scaled scores

Table 7. Performance analysis of some subtests of the intelligence test according to the selected criteria – significant results only

		L1			L2			Wilcoxon test			t test		
	Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
Slovak L1 (N = 63)		8.00	2.85	32.23	8.00	2.20	28.47	-.849	.396	.11			
	Subtest Information												
Hungarian L1 (N = 63)		9.00	1.90	31.67	7.00	2.50	19.38	-5.537	<.001*	.70			
School with Slovak teaching language (N = 59)		9.00	2.85	29.80	8.00	2.45	28.50	-1.367	.172	.18			
	Subtest Information												
School with Hungarian teaching language (N = 44)		8.66	1.90		6.41	2.16					6.114	<.001*	1.11
Slovak L1 (N = 63)		7.86	2.84		7.60	2.83					.720	.474	.09
	Subtest Comprehension												
Hungarian L1 (N = 63)		9.00	2.80	30.2	7.00	3.20	23.35	-4.728	<.001*	.60			
School with Slovak teaching language (N = 59)		7.49	2.94		7.03	2.33					1.162	.250	.17
	Subtest Comprehension												
School with Hungarian teaching language (N = 44)		8.79	2.52		5.98	3.12					5.663	<.001*	.99
Slovak L1 (N = 63)		8.00	2.90	27.84	8.00	2.70	22.26	-1.653	.098	.21			

Continue the Table 7. Performance analysis of some subtests of the intelligence test according to the selected criteria – significant results only

		L1			L2			Wilcoxon test			t test		
	Variables	Mdn/M	Range/SD	MR	Mdn/M	Range/SD	MR	Z	p	r	t	p	d
	Subtest Digit Span												
Hungarian L1 (N = 63)		10.00	3.90	31.26	8.00	2.40	21.05	-5.010	<.001*	.63			
Good level of speaking in languages (N = 70)		9.00	11.50	36.83	6.00	9.20	30.50	-2.510	.012*	.30			
	Subtest Vocabulary												
At the level of the mother tongue (N = 123)		8.00	12.15	67.75	7.00	10.20	58.66	-1.496	.135	.13			

** The difference is statistically significant at the significance level p = 0.05. Difference with a medium or large effect.*

Mdn – Median; M – Mean; SD - Standard Deviation; MR – Mean Rank