

THE UNDERSTANDING OF REVERSIBLE SENTENCES IN PERSONS WITH APHASIA

RAZUMIJEVANJE REVERZIBILNIH REČENICA U OSOBA SA AFAZIJOM

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ABSTRACT

The main goal of this study was to examine and analyze the abilities of the understanding of reversible sentences in persons with aphasia caused by stroke. The study was conducted on a random sample of 25 patients/respondents who had a stroke and who were diagnosed by neurological examination and speech-language therapist examination of a speech and language disorder defined as aphasia. The control group consisted of the same number of respondent, but without aphasia. The assessment of reversible sentences comprehension in patients/respondents was performed using a Reversible Sentences Comprehension Test (Byng and Black, 1999). Analysis of the research results showed that there are significant differences in abilities of understanding reversible sentences between persons with aphasia and those without aphasia. Persons with aphasia have difficulties in understanding reversible sentences. These difficulties can be of varying shape and intensity, from severe to milder interference. Persons with Wernicke's aphasia suffer from the majority of difficulties and persons with anomic aphasia have the least difficulties.

Key words: aphasia, abilities of understanding, reversible sentences.

SAŽETAK

Glavni cilj istraživanja bio je da se ispituju i analiziraju sposobnosti razumijevanja reverzibilnih rečenica u osoba sa afazijom uzrokovanom moždanim udarom. Istraživanje je provedeno na slučajnom uzorku od 25 ispitanika kojima je nakon moždanog udara neurološkim i logopedskim pregledom dijagnosticiran govorno-jezičke poremećaj definiran kao afazija. Kontrolnu grupu činio je isti broj ispitanika bez afazije. Procjena sposobnosti razumijevanja reverzibilnih rečenica kod ispitanika obavljena je pomoću Testa razumijevanja reverzibilnih rečenica (Byng and Black, 1999).

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Analizom rezultata istraživanja utvrđeno je da postoje značajne razlike u sposobnostima razumijevanja reverzibilnih rečenica između osoba sa afazijom i osoba bez afazije. Osobe sa afazijom imaju teškoće u razumijevanju reverzibilnih rečenica. Te teškoće mogu biti različitog oblika i intenziteta, od težih do blažih. Najviše teškoća imaju osobe sa Wernicke-ovom afazijom, a najmanje sa anomičkom.

Ključne riječi: afazija, sposobnosti razumijevanja, reverzibilne rečenice.

INTRODUCTION

From the time of the origin of the original forms of speech and language to the present day, various disorders of speech and language, or communication, have occurred in a number of people and children. One of the most severe disorders is aphasia, which is a very complex disorder that disrupts what is most important in a person as a social being - the ability to communicate. Aphasia is a disorder that results from damage to the parts of the brain responsible for the language. For most people, these areas are located in the left hemisphere of the brain. Aphasia usually occurs suddenly, often after a stroke or head injury, but it can also develop slowly as a result of a brain tumour or progressive neurological disease (National Institute on Deafness and Other Communication Disorders, 2015). It affects the ability to communicate using language including speech, understanding the speech of others, reading, writing, gesturing, using numbers, but not affecting intelligence (National Aphasia Association, 2019). Today, in literature, numerous definitions of aphasia can be found, as a result of relatively different approaches to defining this speech and language disorder. One of the more modern definitions is the one stated by author Darley (1982), according to which aphasia is a "selective impairment of a cognitive system specialized in understanding and formulating language with relatively preserved other cognitive abilities" (according to Davis, 2007). Understanding reversible sentences in persons with aphasia is a modality on which, among other things, the possibilities of producing sentences depend. What if a person with aphasia really cannot understand with certainty that the phrase "Marko called a woman" has a something different meaning than "A woman called Marko"? There may be several reasons for the problem here. Only simple reversible sentences are covered in this paper. Reversible sentences are those sentences in which one person does something to another, or in which a subject changes the owner (reversible sentences). Some sentences are more difficult to process than others. Although the overall complexity of a sentence can be modulated in terms of its grammatical structure, there are additional features that can increase the complexity of a sentence. The prominent classes of such sentence types are semantically reversible sentences (e.g. "The leopard ran past a young lion"). These sentences have the interesting feature that when the subject (leopard) and object (lion) change places ("The lion ran past a young leopard"), the sentences remain meaningful, although the exact meaning of the sentence has changed. In contrast, in non-reversible sentences (e.g. "The dog is chewing on bones") the substitution of the subject (dog) and object (bones) gives a sentence with no true meaning ("The bones are chewing on a dog"). Accordingly, the subject and object of reversible sentences can change places and still produce a meaningful sentence, while non-reversible sentences become semantic anomalies when reversed (Richardson, Thomas and Price, 2010).

The main objective of this study was to examine the ability of reversible sentences understanding in persons/respondents with aphasia caused by a stroke, and to compare them with the same abilities in persons/respondents without aphasia. We were also interested in the impact of aphasic syndrome type on the ability to understand reversible sentences. However, this paper does not cover many aspects of sentence understanding, which opens up opportunities and the need for further research, discussion, and debate on this complex topic.

RESEARCH MATERIAL AND METHODS

Sample of respondents

In this study, the experimental group consisted of 25 respondents who were diagnosed with a communication disorder known as aphasia, after a neurological and speech therapy examination. There were 13 male and 12 female respondents in the experimental group. The age of the respondents suffering from aphasia ranged from 41 to 79 years with an average of 62.7 ± 9.7 years. In relation to the type of stroke, there were 22 respondents who had an ischemic stroke and 3 respondents who had an intracerebral hemorrhage. The control group consisted of the same number of respondents, but without aphasia. The groups of respondents were approximately equal in gender ($\chi^2 = 0.080$; $p = 0.777$) and age ($t = 0.014$; $p = 0.989$).

Method of conducting research

The study was conducted on a sample of respondents hospitalized at the University Clinical Centre Tuzla at the Clinic for Neurology - Department of Cerebrovascular Diseases, at the Clinic for Ear, Throat and Nose Diseases - Department of Audiology-Phoniatics and Public Health Institution Health Centre Tuzla - Department of Pathology of Hearing, Voice and Speech. The study had the characteristics of a prospective study, and was conducted using an examination method. The primary data obtained through the direct application of the test were used in accordance with the set research objectives. All respondents were individually examined. The criteria for selecting respondents were:

- persons diagnosed with aphasia caused by a stroke;
- persons who had a completely adopted and normal speech and language system prior to the disorder;
- persons who have relatively unimpaired abilities to derive semantic information based on the image of objects or people.

Measuring instruments

The criterion for selecting respondents who have relatively unimpaired abilities to derive semantic information based on the image of an object or people was determined based on The Pyramids and Palm Trees Test (Howatrd and Patterson, 1992). All respondents with aphasia had five or fewer errors/wrong answers on this test, which is close to the results of the control group respondents.

type of aphasic syndrome was determined using the Boston Diagnostic Aphasia Examination – BDAE, Short form (Goodglass, Kaplan and Barresi, 2001). Assessment of respondents' ability to understand reversible sentences was performed using the Reversible sentence comprehension test (Byng and Black, 1999). The purpose of this Test is to test whether the respondents understands reversible active sentences with a set of verbs, adjectives, and prepositions in the predicate composition. In order for the task to be done correctly, the respondent must choose the appropriate image after hearing or seeing the sentence. He/she has to form a representation of that sentence and memorize it until he/she finds the picture. When images are displayed, each one should be interpreted and the event or condition chosen to be presented. The representation of the picture is compared with the given sentences and the decision on the best pair is made. Thus, the task involves both linguistic and non-linguistic analysis, and requires the ability to memorize and compare linguistic and non-linguistic representations.

The test consists of 40 items. On each item there is a vertical series of three pictures of the same format: the target picture, the picture of the inverted roles, and the picture that is a lexical interference. After explaining the testing procedure, the examiner tells the target sentence, and then the item with three pictures is represented to the respondent, from which he / she should select the one that most closely matches the spoken sentence. Target sentences are divided into 4 groups:

- *sentences containing action verbs* that express the action and attribute the thematic role to the subject, and the topics to the object. There are 10 target sentences (e.g. *The clown scolds the astronaut; The astronaut photographs the clown; etc.*).
- *sentences containing non-action verbs* that express perceptual or psychological states. There are 10 target sentences (e.g. *The clown dreads the astronaut; The dancer surprises the cook; etc.*).
- *sentences containing adjectives* that express psychological states or moods. There are 10 target sentences (e.g. *The boxer is sad about the cowboy; The swimmer is cruel to the workman; etc.*).
- *sentences containing locative prepositions* such as: in, on, below, inside, above, after, on top, below, behind. There are 10 target sentences (e.g. *The bag is inside the shoe; The boy is behind the queen; etc.*).

One point is awarded for each correct answer, that is, the respondent is left with no points for incorrect answer or when there is no answer. Accordingly, the score range ranges from 0 to 40 points. The correct answers in the action verbs category (from 0 to 10 points), the correct answers in the non-action verbs category (from 0 to 10 points), the correct answers in the adjectives category (from 0 to 10 points), and the correct answers in the locative prepositions category (0 to 10 points) are particularly evaluated, which, in total, gives the total number of points in the Reversible Sentences Comprehension Test.

Data processing methods

After the research, the obtained data were processed by the computer statistical program SPSS 16.0 for the Microsoft Windows operating system. Univariate statistical methods were used in statistical data processing, and in accordance with the defined research objectives. For all variables observed, basic statistical parameters were calculated: range of results, minimum and maximum results, arithmetic mean and standard deviation. A t-test, univariate analysis of variance (ANOVA) with multiple comparisons using Tukey test was used to determine the significance of differences. The statistical significance and the nature of the correlation between the observed variables were established by using the Pearson coefficient.

RESULTS AND DISCUSSION

Distribution of respondents by type of aphasic syndrome

The sample respondents were diagnosed with 4 aphasic syndromes: Broca's aphasia, anomic aphasia, Wernicke's aphasia and conductive aphasia. The most common was Broca's aphasia, diagnosed in 9 respondents, followed by anomic aphasia, diagnosed in 7 respondents, Wernicke's aphasia, diagnosed in 5 respondents and, the least represented, conductive aphasia, diagnosed in 4 respondents. The distribution of respondents according to the type of aphasic syndrome is shown in Figure 1.

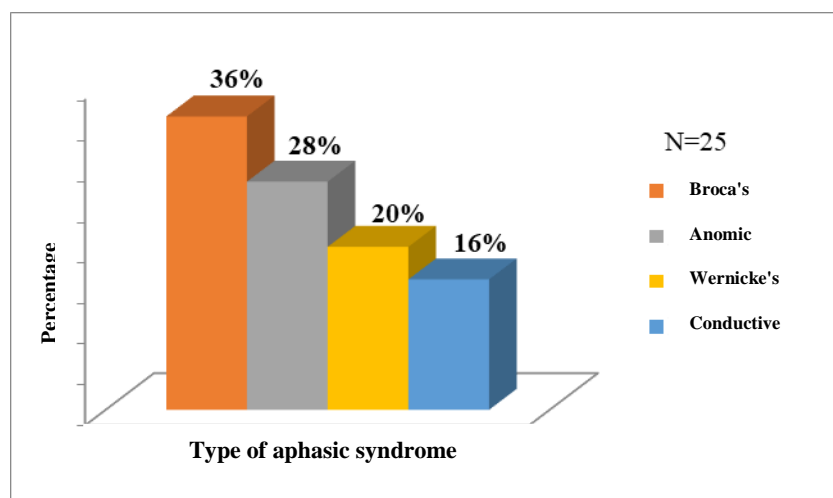


Figure 1. Distribution of respondents in relation to type of aphasic syndrome

Basic statistical parameters of the observed variables in the experimental group

The results of the descriptive statistics of the observed variables of the understanding of reversible sentences are presented in Table 1. The result of the Reversible Sentences Comprehension Test ranged from 6/40 to 33/40 points. Respondents with aphasia achieved a total of 536 out of a maximum of 1000 points, that is, they correctly completed more than 50% of the assigned tasks. The mean of the Reversible Sentences Comprehension Test was 21.44 points with a standard deviation of 7.159.

Most errors/wrong answers are noted on the tasks of understanding reversible sentences containing non-action verbs. Respondents had a total of 97 correct answers on this variable, that is, 153 errors. On the tasks of understanding reversible sentences containing action verbs, the respondents achieved an average of 6.56 points, with 164 correct answers, or 86 errors/wrong answers. The fewest errors/wrong answers were noted on the tasks of understanding reversible sentences containing locative prepositions, where the respondents had a total of 171 correct answers, that is, 79 errors/wrong answers. Respondents with aphasia also made a lot of mistakes on tasks of understanding reversible sentences containing adjectives, with 104 correct answers and 146 errors/wrong answers. Richardson, Thomas, and Price (2010) state that semantically reversible sentences are subject to misinterpretation and take more time for children and adults of typical development to understand. Reversible sentences are difficult especially for those with language difficulties such as aphasia or specific language impairment.

Table 1. Abilities to understand the reversible sentences of persons with aphasia

Variable	N	Range	Minimum	Maximum	Total	AM	SD
GLR	25	9	1	10	164	6.56	2.518
GLNR	25	4	2	6	97	3.88	1.333
PRI	25	5	2	7	104	4.16	1.344
LPRE	25	9	1	10	171	6.84	2.593
UKRRR	25	27	6	33	536	21.44	7.159

Legend:

- GLR - the number of correct answers to the tasks of understanding reversible sentences containing action verbs
- GLNR - the number of correct answers to the tasks of understanding reversible sentences containing non-action verbs
- PRI - the number of correct answers to the tasks of understanding reversible sentences containing adjectives
- LPRE - the number of correct answers to the tasks of understanding reversible sentences containing locative prepositions
- UKRRR - the total test result
- AM - arithmetic mean
- SD - standard deviation
- N - number of respondents

Differences in ability to understand reversible sentences between groups

Analyzing the results of understanding the reversible sentences, it was found that the respondents with aphasia performed poorly on all observed variables compared to the control group respondents. The relation of the results obtained is shown in Figure 2. Using the t-test, it was found that there were statistically significant differences between these groups of respondents in their ability to understand reversible sentences containing action verbs ($p = 0.017$), reversible sentences containing non-action verbs ($p = 0.000$), reversible sentences containing adjectives ($p = 0.000$), and on the overall result of the Reversible Sentences Comprehension Test ($p = 0.000$). Thus, aphasia significantly affects the ability to understand reversible sentences (Table 2). However, the differences did not prove statistically significant on the variable "number of correct answers to the task of understanding reversible sentences containing locative prepositions" ($p = 0.058$).

In cases where respondents with aphasia make significantly more reversible errors than the control group, and if those errors/wrong answers are most pronounced on the tasks of understanding reversible sentences containing non-action verbs and adjectives, Black, Nickels, and Byng (1991) state that this is a semantic / conceptual problem or the problem of transferring between a linguistic and pictorial representation.

Table 2. Significance of differences in the understanding of reversible sentences between groups

Variable	Group	N	AM	SD	t	p _{sig}
GLR	Experimental	25	6.56	2.518	2.481	0.017*
	Control	25	7.96	1.274		
GLNR	Experimental	25	3.88	1.333	6.389	0.000*
	Control	25	6.36	1.411		
PRI	Experimental	25	4.16	1.344	7.423	0.000*
	Control	25	7.04	1.399		
LPRE	Experimental	25	6.84	2.593	1.945	0.058
	Control	25	8.00	1.472		
UKRRR	Experimental	25	21.44	7.159	4.558	0.000*
	Control	25	29.36	4.923		

Respondents without aphasia scored a total of 734/1000 points, with a mean of 29.36 and a standard deviation of 4.923. Therefore, they scored 198 points more than the respondents with aphasia, with the standard deviation significantly lower. Most errors/ wrong answers were noted on the tasks of understanding reversible sentences containing non-action verbs and on the tasks of understanding reversible sentences containing adjectives. The least errors/wrong answers were noted on the tasks of understanding reversible sentences containing locative prepositions where the respondents had a total of 200 correct answers, that is, 50 errors/wrong answers. There were 51 errors/wrong answers on the tasks of understanding reversible sentences containing action verbs in respondents without aphasia. Byng and Black (1999) tested the ability to understand reversible sentences on a sample of 21 respondents without aphasia, three of whom were younger than 20, three in their fifties, nine in their sixties, five in their seventies, and one in their eighties. There were 19 females and 2 males in terms of gender. Based on the results of the research, it is concluded that respondents without aphasia could successfully complete this task, that is, they made much more correct than wrong answers. They made more reversible mistakes than mistakes with lexical interference. Black, Nickels and Byng (1991) state that the accuracy of responses when testing the ability to understand reversible sentences of respondents without aphasia is influenced by the semantic properties of the predicates in the sentences and / or their representation in the pictures. These respondents have made more errors/wrong answers in verbs and adjectives that express a psychological state than in sentences containing action verbs or locative prepositions. The same authors argue that the reversible errors of respondents without aphasia are not errors in sentence interpretation, but reflect the processes that take place after sentence interpretation, in transferring sentence interpretation to picture recognition.

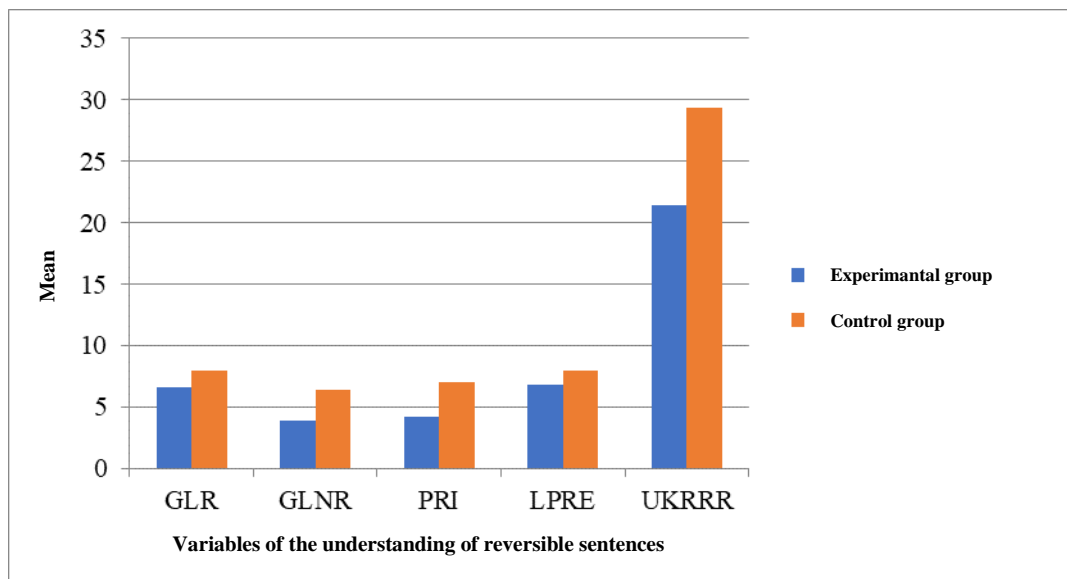


Figure 2. Abilities to understand the reversible sentences in persons with aphasia and persons without aphasia

Differences in the ability to understand reversible sentences in relation to the type of aphasic syndrome

The significance of differences in the ability to understand reversible sentences in relation to the type of aphasic syndrome was determined by analysis of variance, and the results are presented in Table 3.

Table 3. Differences in understanding reversible sentences in relation to the type of aphasia

Variables		Sum of Squares	df	Mean Square	F-ratio	p _{sig}
GLR	Between groups	74.293	3	24.764	6.679	0.002*
	Within groups	77.867	21	3.708		
	Total	152.160	24			
GLNR	Between groups	22.951	3	7.650	8.160	0.001*
	Within groups	19.689	21	0.938		
	Total	42.640	24			
PRI	Between groups	21.093	3	7.031	6.631	0.003*
	Within groups	22.267	21	1.060		
	Total	43.360	24			
LPRE	Between groups	79.473	3	26.491	6.794	0.002*
	Within groups	81.887	21	3.899		
	Total	161.360	24			
UKRRR	Between groups	661.988	3	220.663	8.156	0.001*
	Within groups	568.172	21	27.056		
	Total	1230.160	24			

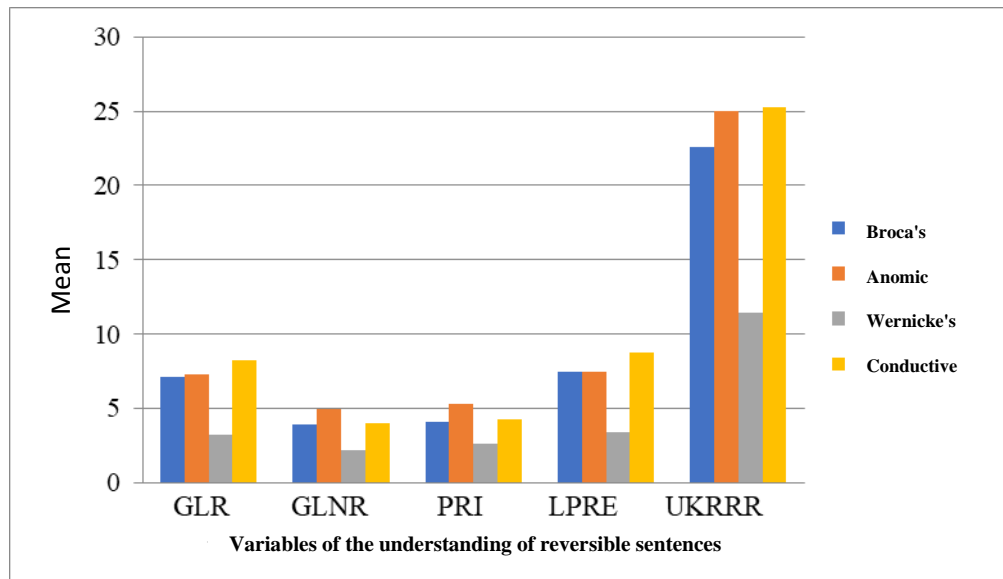


Figure 3. Understanding reversible sentences in relation to type of aphasic syndrome

It was found that there were statistically significant differences on all five observed variables between respondents with different aphasic syndromes. Figure 3 graphically shows the mean values of the reversible sentence comprehension variables for respondents with different aphasic syndromes. Respondents diagnosed with Wernicke's aphasia achieved the lowest scores on all observed variables. The best results were achieved by subjects with conductive and anomic aphasia. After applying multiple comparisons using the Tukey test, data were obtained indicating the following:

- the ability to understand reversible sentences on all observed variables in respondents with anomic aphasia was statistically significantly better only in relation to respondents with Wernicke's aphasia ($p = 0.001$), whereas in relation to respondents with Broca's aphasia and conductive aphasia the differences did not show to be statistically significant ($p < 0.05$);
- the ability to understand reversible sentences containing action verbs, non-action verbs, locative prepositions, and abilities related to the total score of the reversible sentence comprehension test in respondents with Broca's aphasia were statistically significantly better only in relation to respondents with Wernicke's aphasia, while on the tasks of understanding reversible sentences containing adjectives, the differences between these two aphasic syndromes did not prove statistically significant ($p = 0.069$);
- the ability to understand reversible sentences containing action verbs and locative prepositions, and the abilities related to the total score of the reversible sentence comprehension test in respondents with conductive aphasia are statistically significantly better in relation to respondents with Wernicke aphasia, while on the tasks of understanding reversible sentences containing adjectives and non-verbs, the differences between these two aphasic syndromes did not prove statistically significant.

The results of the study are expected given that the division of aphasia into different aphasic syndromes is based on the different phenomenology and symptomatology of speech and language disorders. Aphasia implies linguistic impediments in the first place, but there are also changes in personality behaviour and in its emotional and intellectual sphere (Vladislavjević, 1983). The basic signs of aphasia are: naming disorders, paraphasia production, speech fluency disorders, repetitive disorders, auditory comprehension disorders, grammatical processing disorders, reading and writing disorders and apraxia (Damasio, 1991a). The basic features of Broca's aphasia are non-fluent, hesitant spontaneous speech characterized by incomplete and syntactically simplified and agrammatic sentences, reduced phrase length, altered prosody, and difficult articulation (Vuković, 2002). In patients with Broca's aphasia, auditory comprehension is better than verbal production, but it is rarely preserved, and the comprehension of grammatically meaningful structures is particularly impaired (Benson and Ardila, 1996). The basic features of Wernicke's aphasia are fluent but paraphasic speech, impaired auditory comprehension, impaired repetition of words and sentences, and commonly impaired reading and writing abilities and rare hemiparesis (Graham, 1990).

Anomic aphasia is characterized by fluent speech, a relatively normal auditory comprehension of speech, preserved ability to repeat words, but with marked difficulty in finding words. Naming ability and reading and writing abilities are mostly impaired. In more severe cases, there is a hesitant speech, that is, the patients speak hesitantly, they barely speak the word spontaneously, answer with short questions only, with the inability to continue the conversation actively (Golubović, 1996). Damasio (1991b) identified specific areas in the left temporal lobe that are responsible for evoking/recalling words. Damage to areas 21, 20 and 38 reduces the ability to recall words without grammatical or phonemic difficulties. Damage to the area 38 alone causes deficits in the ability to remember names, but not common names, while damage to areas 21 and 20 causes deficits in both cases. The ability to recall other categories of words (verbs, articles, etc.) is not compromised. The basic features of conductive aphasia are fluent speech, but usually impecunious in relation to that of Wernicke's aphasia, minor impaired auditory comprehension with dominant impairments during repetition of words and sentences (Zečić, 2002). Benson et al. (1973), suggested three basic and five other characteristics of conductive aphasia. The basic characteristics are: 1. fluent, paraphasic conversational speech, paraphrases are usually literary; 2. approximately normal understanding; significantly impaired repetition of words. The five other characteristics that do not occur in all cases of conductive aphasia are: 1. impaired naming; 2. reading disorder, especially reading aloud; 3. writing disorder; 4. ideomotor apraxia; 5. basic neurological abnormalities, hemiparesis of the dominant side (according to Benson and Ardila, 1996). The ability to process sentences, to perceive occurrences and to produce verbs, and to understand reversible sentences are complex processes that depend on a number of factors. Understanding a sentence implies the meaning of all words and their relationships. How words relate to each other is also determined by factors such as the position in the sentence (word order), how their basic meaning changes with the addition of adverbs, auxiliaries and other elements, as well as aspects of the meaning of the words themselves (Black, Nickels, & Byng, 1991).

Agrammatism is characterized by comprehension deficits associated with the inability to understand sentences for which syntax comprehension is crucial to comprehending sentence meaning (e.g. in reversible sentences where the subject and object of the action are both animated (Edmonds, 2005).

Interrelationship between observed variables of the understanding of reversible sentences

To determine the relationship between the observed variables and the nature of this relationship in the experimental group, Pearson's correlation analysis was used. Table 4 shows the results of the correlation analysis between the variables of the understanding of reversible sentences. A correlation was found between all variables of the understanding of reversible sentences at a significance level of 1%. All realized correlations are of a positive sign, which indicates that by increasing the ability on one variable, the ability on the other variable increases and vice versa.

Table 4. Correlation of the observed variables in the sample of respondents with aphasia

Variables		GLR	GLNR	PRI	LPRE	UKRRR
GLR	r (Pearson)	1.000	0.679	0.723	0.978	0.968
	p _{sig}		0.000**	0.000**	0.000**	0.000**
	N	25	25	25	25	25
GLNR	r (Pearson)	0.679	1.000	0.941	0.633	0.831
	p _{sig}	0.000**		0.000**	0.001**	0.000**
	N	25	25	25	25	25
PRI	r (Pearson)	0.723	0.941	1.000	0.665	0.858
	p _{sig}	0.000**	0.000**		0.000**	0.000**
	N	25	25	25	25	25
LPRE	r (Pearson)	0.978	0.633	0.665	1.000	0.949
	p _{sig}	0.000**	0.001**	0.000**		0.000**
	N	25	25	25	25	25
UKRRR	r (Pearson)	0.968	0.831	0.858	0.949	1.000
	p _{sig}	0.000**	0.000**	0.000**	0.000**	
	N	25	25	25	25	25

The strongest correlation was found between the variables "number of correct answers to the task of understanding reversible sentences containing action verbs" and "number of correct answers to the task of understanding the reversible sentences containing locative prepositions", with a very high correlation coefficient $r = 0.988$. The lowest correlation coefficient was observed between the variables "number of correct answers to the task of understanding reversible sentences containing non-action verbs" and "number of correct answers to the task of understanding reversible sentences containing locative prepositions" ($r = 0.633$ - medium-strong correlation).

CONCLUSION

The study results conclude that respondents with aphasia had significantly lower ability to understand reversible sentences than respondents without aphasia. In the Reversible Sentences Comprehension Test, respondents with aphasia correctly solved 53.6% of assigned tasks, unlike respondents without aphasia who solved 73.4% of tasks in the same test. The most difficulties in respondents with aphasia occur in the tasks of understanding reversible sentences containing non-action verbs, and the least difficulties occur in understanding the reversible sentences containing locative prepositions. The type of aphasic syndrome significantly affects the ability to understand reversible sentences. Respondents with Wernicke's aphasia have the most difficulties, and respondents with anomic aphasia have the least difficulties. Correlation analysis revealed the relationship between all variables of the understanding of reversible sentences in persons with aphasia, and all realized correlations are of a positive sign.

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