ASSESSMENT OF THE INTELLIGIBILITY OF SPEECH IN PERSON WITH DYSARTHRIA

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Abstract: Dysarthria is a speech disorder that belongs to the group of neurologically based communication disorders. It can occur at any age – at birth or after an injury or even after an illness. Dysarthria may range in severity from minimal impairment to that which make the speech practically unintelligible. Excessive nasalization, disordered speech prosody, imprecise articulation, and variable speech rate are often associated with damage to neuromuscular systems regulating speech. Disorders in speech physiology may result in distortion of the acoustic signal and reduced speech intelligibility. Reduced speech intelligibility affects all aspects of life. Individuals with intelligibility deficits experience difficulties with social interaction, academic performance, and vocational placement. The purpose of this article is to present some of the results obtained after conducting a study to assess the Intelligibility of speech in persons with dysarthria. The methodology that was used is Frenchay Dysarthria Assessment Second edition (FDA-2). The test is translated and adapted into Bulgarian language according to its phonetic rules. The test is also used to determine the form of dysarthria. The participant of the study are total of 80 people aged between 20-90 years old with acquired dysarthria. All of them have a confirmed neurological diagnosis such as stroke, Parkinson's, multiple sclerosis, myasthenia gravis, epilepsy, etc. The participants are divided into five groups according to the form of dysarthria – flaccid, spastic, ataxic, extrapyramidal and mixed dysarthria. The assessment of intelligibility of speech is carried out at three levels - words, sentences and conversation. Each person is required to read 10 words, 10 sentences and to have a 5-minute conversation on the topic of favorite activities and hobbies. The results obtained of all five groups of dysarthria are analyzed by statistical methods. They show that there is a statistically significant difference in terms of intelligibility of speech in the different forms of dysarthria. The most difficult to understand for the listener is the speech of the mixed type of dysarthria. This group of people have unintelligible speech at all three levels – words, sentences and conversation. The first part of the FDA-2 requires reading of ten words. The persons demonstrate similar results in reading words. The listener can understand more than six words from the participants' utterances with ataxic, flaccid and extrapyramidal type of dysarthria. The second task of the test evaluates intelligibility at sentence level. The highest scores show persons with the ataxic dysarthria. This means that their speech is understandable at the sentence level. The most difficult task for all participants is the conversation. The speech of persons with dysarthria when having a conversation is most difficult to understand by the listener. The results confirm the hypothesis that the severity of dysarthria has a negative influence on the degree of intelligibility of speech according to the different forms of dysarthria.
Keywords: dysarthria, assessment, intelligibility, speech.

1. INTRUDUCTION

Dysarthria is a speech disorder that results from the disturbance of neuromus- cular control. Impairments can be due to damage to the central or peripheral nervous system resulting in weakness, slowing, incoordination, altered muscle tone, and inaccuracy of oral and vocal movements that in turn lead to abnormal characteristics of the speech produced. The pattern of speech can indicate the level and type of neurological dysfunction, assisting in the diagnosis of the dis- order and its appropriate management. However, diagnosing the type of dysar- thria is difficult, particularly for less experienced ears. Distinguishing between flaccid, spastic, hypokinetic, and cerebellar dysarthria requires not only good listening skills and a familiarity with the nature of the speech, but also the observational skills needed to identify movements that are abnormal as well as those that are retained. The interdependence of the speech systems is such that an abnormality in one will cause an abnormality in another. For example, poor respiratory con- trol will, in itself, cause poor laryngeal function and possibly a weak plosion of some consonants. Identifying the primary deficits is important for the specificity of treatment. It is obvious that treating one function is not going to be effective if the related functions are not targeted as well. Dysarthria, therefore, has become inclusive term that covers motor disorders of respiration, phonation, articulation, resonance, and prosody. It also includes isolated, single-process motor speech disorders such as those associated with the seventh cranial nerve. The term anarthria is sometimes used to de- scribe the total inability to speak, associated with severe neuromuscular disor- der that prevents vocalization and articulation, While it is semantically correct, the term is tarely used now; the term dysarthria is generally used to encompass all levels of severity (Симонска,2013; Aronson,1993; Daffy,2004; Daffy, 2013; Yorkston,1999).

The neuromuscular cardition dvsarthria can exist in conjunction with other types of communication disouder, such as dyspraxia or dysphasia. While usually a person with cysartbria will have normal language functian, it itas hern noted that many will simplity thrir langna ge in the aisence ol aphasia In oriler to onserve energy: however. the liaguistic structure will be correct. In the absence of dyspraxia, the abaarnmallly of dysartheia will be predictable with the ororiocor end speech tasks shawing similar levels af difficulty (Nicolosi,2004; Daffy,2004, Daffy,2013).

Dysarthria is present in approximately one third of all patients with trau- matic brain injuries. It also affects a bigh percentage oi those with pre- and perinatal neurological damage; the prevalence of dysarthria among those with degenerative diseases such as multiple sclerosis, Parkinson's disease, and motor neuron disease varies from 19% to 100%. It is the most common of the acquired communication disorders and yet it has attracted relatively little research and frequently is overlooked in patient management. A seminal work by Darley, Aronson, and Brown (1975) provides a co- gent structure of organization and classification of speech symptoms. The Mayo Clinic study (Aronson, 1993) was validated and extended by the Frenchay study (Enderby, 1980). Both studies classify dysarthria type and characteristics ac- cording to the underlying pathology. Table 1.

The main objective of this article is to present the results of a scientific research aimed at assessing the speech intelligibility in individuals with acquired dysarthria. The main reason for conducting this research was the lack of such studies to determine the degree of speech intelligibility in people with this pathology in Bulgaria.

A total of 80 people at the age between 20 and 90 years took part in this study. The study itself took place in centers for disabled people, hospices, nursing homes and medical facilities. The selection of the study subjects was based on their medical diagnoses, which were provided to us by the medical staff or confirmed by medical commission expert decisions.

Dysarthria type	Features (Enderby,1983)	Features (Aronson,1993)
Flaccid dysarthria	Normal respiration and rate	e.g., recurrent laryngeal nerve breathy, hoarse, reduced loudness, short phrases, stridor, diplophonia (normal resonance and articulation)
	Intelligibility less affected than in other groups	Can affect multiple cranial nerves → breathy, reduced loudness, short phrases, stridor, imprecise consonants
	Isolated areas of involvement depending on lower motor neuron affected	
Spastic dysarthria	More difficulty with swallowing, drooling than in other groups	Strained hoarseness
	Nonspeech oral-motor tasks performed better than those involving motor movements in speech	Hypernasality
		Slow, imprecise articulation
Cerebelar (ataxic) dysarthria	Good performance on laryngeal tasks except for intonation	Unsteady, excess loudness, tremor, normal resonance, irregular articulatory breakdowns
	Able to control pitch and volume but not appropriately in conversation	
	Lips, jaw, tongue, and palate appear normal at rest	
	Most difficulty with alternating tongue movements	
Mixed dysarthria	Larynx and tongue movements poorest	Strained, wet, hoarse voice with rapid tremor
	Lip seal and speech tasks poorer than for other groups	Hypernasality
	Good palatal movement in swallowing but not so good in speech hypernasality	Slow, imprecise articulation
Extrapiramidal dysarthria	Rapid rate	Hypokinetic
		Hyperkinetic

Table 1 Features of Dysarthria Types

2. MATERIALS AND METHODS

To achieve the objectives of this study, a scientific-based literature on speech therapy was studied in ISI Web of Knowledge – WEB OF SCIENSE and EBSCO Hots Academic Search, regarding the methods used to assess speech intelligibility in people with dysarthria. The studied literature is from the period between 1996 and 2018.

By studying these two databases, we were able to get an idea of what the main tests were used in speech therapy practice to assess speech intelligibility. Interestingly, there was not much data on their application. Another thing that impressed us is that there was no data on larger studies in this area. Unfortunately, we did not find any tests to be used in Bulgaria or to assess the speech intelligibility of persons with such a disorder.

The methods we were able to find may be divided into two main groups: "formal" and "informal". The first group includes all the standardized tests that we were able to find. These are tests with clear and consistent procedures

regarding information collection and evaluation. Also, those that may be standardized may be considered "official". There is a total of five "official" tests:

1. Assessment of Intelligibility of Dysartric Speech (AIDS) – Yorkston &   Beukelman, 1984
2. Speech Intelligibility Test (SIT) – Yorkston, Beukelman & Hakel, 1996
3. Frenchay Dysarthria Assessment (FDA) and second edition (FDA-2) – Enderby & Palmer, 2008
4. Dysarthria Examination Battery (DEB) – Drummond, 1993
5. Dysarthria Profile – Robertson, 1987

The first two tests are designed mainly to assess speech intelligibility, and the other three tests are designed to assess dysarthria in a broader sense, but also have sections dedicated to speech intelligibility

Of these five tests, data on the reliability of the tests has not been published for only two test, namely the Speech Intelligibility Test and Dysarthria Profile. For the other tests, there is information on how many patients and how the test was applied and whether it is reliable and valid. These five tests are the most widely used in speech therapy practice in the United States. We were able to reach this conclusion thanks to what was described by Gurevich (2017), who conducted a large-scale study on what methods of assessing speech intelligibility in people with dysarthria are used by speech therapists. The results of his study show that about 35% of speech therapists do not use standardized tests.

There are also several "informal" methods for assessing speech intelligibility that are used in speech therapy practice. These are preferred by many speech therapists because they take much less time. Patients are required to read a text, a list of words, sentences or phrases and thus the diagnostician may subjectively assess the extent to which the subject's speech is intelligible.

Based on our research, we were able to select the test that we will use for our study. The most suitable one, as it may also be used to determine the form of dysarthria, proved to be FDA-2.

Speech intelligibility is assessed by FDA-2 test at three levels: words, sentences, and conversation. The subject is required to read a total of 12 words, of which only ten are assessed. The first two words are taken as examples. The total number of words for intelligibility assessment is 116 and all of them are printed on cards. The person randomly chooses which ones to read. The researcher is required to make an audio recording of the speech in order to be able to more easily note afterwards how many of the words have been read intelligibly, i.e. it is not the articulation that is evaluated but the intelligibility of the words. When assessing sentences, the person is again required to read 12 sentences, choosing them at random.

As the test is in English, it had to be translated and adapted to the Bulgarian language. All words and sentences of the test were replaced with words in Bulgarian. The principle of word selection was exactly the same as in the original test – all words had to be phonetically balanced. Another very important criterion that we had to comply with was the "frequency" of the words, i.e. all words had to be used with great frequency in colloquial speech. For this purpose we found two dictionaries: (1) Frequency Dictionary in Bulgarian by the Bulgarian National Corpus (BNC) at the Institute of Bulgarian Language; (2) Frequency Dictionary of the Bulgarian Colloquial Speech with author Tsvetanka Nikolova. Based on these two criteria, the required number of words and sentences were selected to meet the requirements of the test.

3. RESULTS

Statistical analysis of the results was performed by the use of SPSS software and more specifically by the non parametric Kruskal-Wallis test to detect a statistically significant difference between more than two groups.

Figure 1 shows the average ranks obtained for each form of dysarthria regarding the use of FDA-2 for intelligibility assessment. The lowest values in terms of intelligibility were reported in mixed dysarthria at all three levels: (1) word level – (21.78); (2) sentence level – (20.55); (3) conversation level – (20.68). This means that all 20 people with this form of dysarthria presented the lowest values of the tasks assigned. Figure 2 also shows their mean values presented through descriptive statistics. The third task in individuals with mixed form had the lowest average value was recorded (1.35). This low score means that the speech is almost completely unintelligible and only individual words may be deciphered. The values obtained in the other two groups, i.e. word level and sentence level show that there is an impossibility to recognize 50% of the spoken words. In general, we may summarize that the higher values were reported at the word level, and what makes an impression is the higher value reported in ataxic dysarthria at the sentence level (3.53). This is also the highest average. In two of the forms, i.e. extrapyramidal and flaccid forms, the same mean values were reported for all three tasks (see Figure 2). Their results show that they were able to pronounce intelligibly between 7 and 9 words out of 10. Individuals with spastic dysarthria also showed lower

values than those with flaccid, extrapyramidal, and ataxic dysarthria. They managed to pronounce only about 5 words out of a total of 10 and the speech during the conversation task was half understandable.
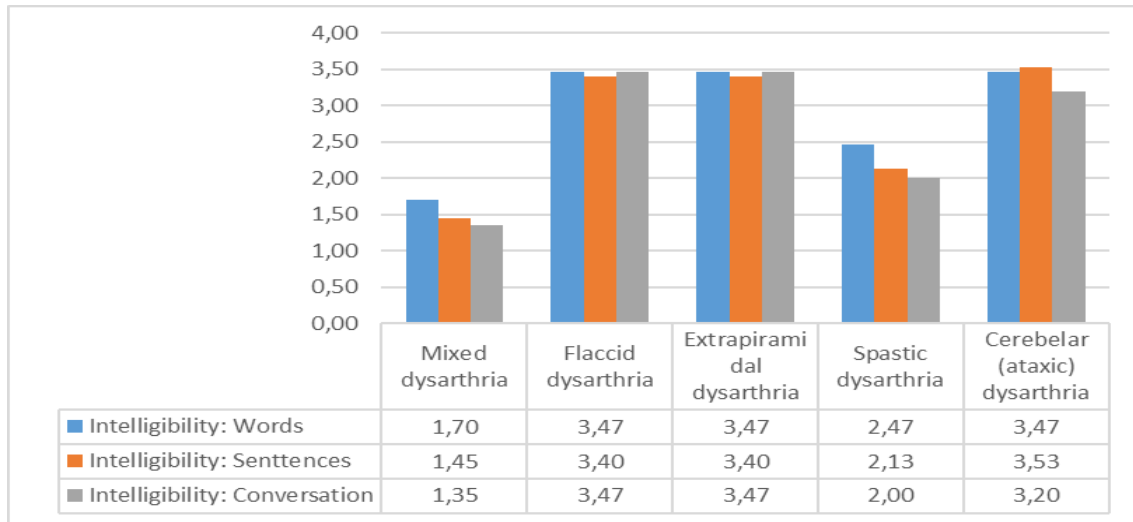

	Mixed dysarthria	Flaccid dysarthria	Extrapiramidal dysarthria	Spastic dysarthria	Cerebelar (ataxic) dysarthria
■ Intelligibility: Words	1,70	3,47	3,47	2,47	3,47
■ Intelligibility: Senttences	1,45	3,40	3,40	2,13	3,53
■ Intelligibility: Conversation	1,35	3,47	3,47	2,00	3,20

Figure 1. Average rank by individual tasks for assessing intelligibility in individual forms of dysarthria.
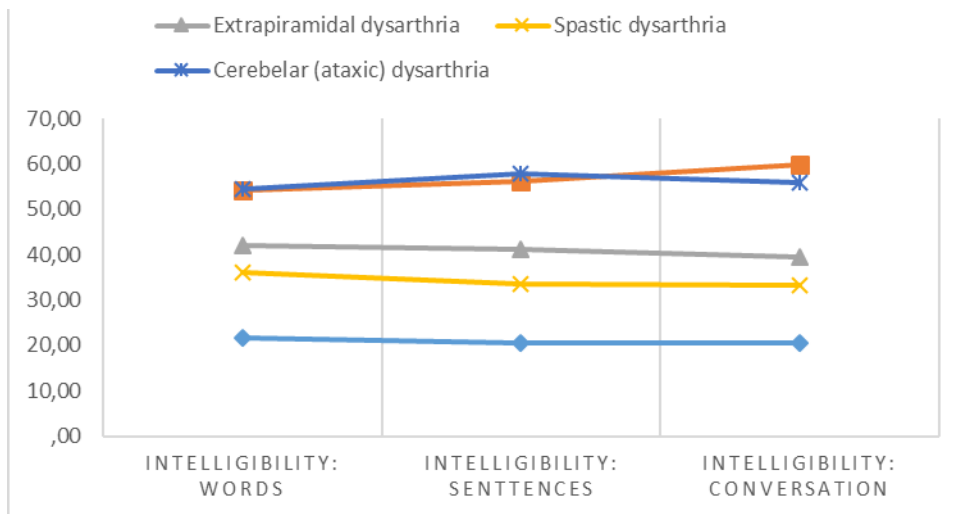

Figure 2 Averages for all forms of dysarthria after the application of the intelligibility assessment tasks.

Based on Kruskal-Wallis test, we were able to find out that there is a statistically significant difference in speech intelligibility in the 5 forms of dysarthria. For all three tasks, the value obtained by us was (0.000) at p ≤ 0.05 (see Fugure 3).

	Chi-Square	df	Asymp. Sig.
Intelligibility: Words	25,876	4	,000
Intelligibility: Senttences	33,297	4	,000
Intelligibility: Conversation	35,443	4	,000

Table 2 Crucal-Wallis results to detect a statistically significant difference in intelligibility assessment.

4. CONCLUSIONS

The FDA-2 test is a test for the diagnosis of dysarthria, which is easily applicable and effective for making a speech therapy diagnosis. Its adaptation in Bulgarian and its implementation in 80 adults with dysarthria gave us the opportunity to assess the various functions that are affected in people with dysarthria. It also helped us determine their degree of speech intelligibility, and we were able to determine whether there was a statistically significant difference in their speech intelligibility. It is these results that aroused our interest in this direction and provoked us to deepen our research in this area and to further develop the methodology.

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