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Suprasegmentals in dysarthric speech in cases of cerebral palsy. The research project

SUMMARY

The article presents the research project "Suprasegmentals in Dysarthric Speech in Cases of Cerebral Palsy. Acoustic Analyses in Experimental Logopedic Studies on Polish-Speaking Children Aged 6 to 15 Years". The objective of these planned studies is to describe and compare the acoustic parameters of suprasegmentals in the speech of dysarthric children with CP – in the experimental group (30 persons) and in the control group (30 children in whom no speech disorders and CP have been diagnosed). The analysis of the suprasegmental level of the phonetic sequence will include intonation, word and sentence stress, rhythm of utterances, rate of speech, length of phrases, and respiratory, phonatory and articulatory synchronization, nasal resonance, and voice quality. Statistical analyses of the results of acoustic experiments will also enable an evaluation of the relationships holding between selected suprasegmental phenomena in dysarthric speech. Moreover, we are planning to conduct studies with the participation of speech therapists as competent raters, whose task will be to conduct an auditory evaluation of particular phenomena manifesting themselves at the suprasegmental level of utterances of children with CP-related dysarthria, as well as an evaluation of the degree of intelligibility of their pronunciation. A comparison of the results of an acoustic analysis with the results of a perceptual analysis will make it possible to indicate the relationship between the individual suprasegmentals and between the realization of suprasegmentals and the intelligibility of CP-related dysarthric speech.

Keywords: dysarthria, cerebral palsy, suprasegmentals, acoustic analysis, perceptual analysis

INTRODUCTION

Linguistic communication disorders understood as problems with communicating in one's ethnic language in its primary (spoken) and secondary (written)

modes affect the majority of persons with *cerebral palsy* (CP),[1] this being a significant aspect of psychosocial problems associated with this syndrome. Dysarthria is one of more frequent speech disorders in CP: it is diagnosed in ca. 30% of patients (Obrębowski and Woźnica 1997; Mirecka and Gustaw 2005). Since the clinical picture of infantile cerebral palsy shows motor disorders as dominant, connected with the dysfunction of the central nervous system, I regard dysarthria, defined as performance disorders of the motor speech mechanism, as a speech impediment specific to CP (Mirecka 2013a). Neurological impairments – the cause of dysarthria – are manifested in the dysfunctions in the respiratory, phonatory and articulatory apparatus that result in distortions of the phonic substance of utterances at the segmental and suprasegmental levels. Dysarthric disorders have a different range and intensity (in extreme cases they are manifested as an inability to produce speech sounds) and a large group of patients have to cope with a serious problem – limited intelligibility of their pronunciation that makes it difficult or impossible to impart information through the articulatory-auditory channel (Mirecka 2008; 2015).

The survey of English and Polish literature of the subject published in the recent thirty years indicates several main areas of research into CP-related dysarthria:

1. The most established and clinically preferred studies based on the procedures of perceptual analysis of dysarthric speech;

The diagnostician's auditory and visual systems allow him to make observations in two aspects: vocal and motor ones, enabling the identification and differentiation of symptoms, as well as the assessment of the intensity of vocal abnormalities produced by a patient (mainly at the phonic level of utterances), and of motor dysfunctions (especially the motor activities of the speech apparatus). In experimental studies, perceptual analysis is used first of all to determine the symptomatology of dysarthria in CP (Love 2000) and to differentiate its clinical types (Moore et al. 1991). The established indicators essential for diagnosing dysarthria are used in techniques applied in examining dysarthric patients – rating scales (Bunton et al. 2007; Murdoch 1998). The methods of the perceptual analysis are classified as subjective (Keintz et al. 2007; Kent 1996) and – although the subjectivity factor is minimized by the criteria defined in the scales – the evaluation

[1] The term *cerebral palsy* refers to the etiologically and clinically diverse syndrome of symptoms, in which, the symptoms of motor dysfunctions (permanent disorders in the development of movement and posture, they are attributed to non-progressive disturbances that occur in the development of the brain of the fetus or infant) are often accompanied by disorders in communication and behavior, sensation, perception, cognition, epilepsy and secondary musculoskeletal problems; the most essential in the pathomechanism of this neurodevelopmental disorder are symptoms regarded as dominant ones: limb pareses indicating the central motor neuron injury, involuntary movements showing an injury to the subcortical nuclei, ataxic motor and balance disorders indicating the cerebellum injury (Gajewska 2009; Kułak and Sobaniec 2006; Michałowicz 2001).

of disorders depends to a certain extent on the diagnostician's clinical experience. Examples of such studies conducted in Poland are those oriented towards finding relationships between dysarthric speech disorders and the clinical picture of CP (Sobaniec et al. 2008) and those studying the intelligibility of utterances in CP (Mirecka 2010/2011; 2013a).

2. Examinations using instrumental methods to assess the condition of the speech organs and their functioning, such as computer tomography (CT), magnetic resonance (MRI), electromyography (EMG), electroglottography (EGG), ultrasonography (USG), laryngophotokimography, videofluoroscopy, pneumography, etc.;

Such objective examinations inter alia enable establishing correlations between the symptomatology of dysarthric speech and pathophysiological indicators, e.g. the EMG examination of muscles of the articulatory apparatus is conducted to verify theories concerning the pathophysiology of dysarthria in CP cases (Neilson and O'Dwyer 1981), examination of relationships between the range of morphological changes reveal in CT and MRI, and the degree of motor dysfunctions and the intensity of dysarthric difficulties in CP children (Otapowicz et al. 2007), or examination of movements of the speech organs (kinematics) in the contexts of articulatory dysarthric difficulties (Chen et al. 2010).

3. Examinations based on the analysis of the acoustic aspects of speech, conducted first of all to assist medical diagnosis and support rehabilitation;

The analysis of acoustic parameters (formant frequency distribution, nasality coefficient, changes in amplitude, etc.) allows one to determine the degree of pathological changes, or their impact on utterance intelligibility (Kent et al. 1999), e.g. in studying relationships between vowel contrasts and intelligibility of dysarthric speech in CP cases (Kim et al. 2011), in assessing the efficacy of therapeutic methods (Marchant et al. 2008), as well as comparison of normative and disturbed emotional prosody (Waryszak 2013).

4. Application studies oriented toward analyzing the influence of various therapeutic measures;

Examples include the examination of the influence of the art therapy (Pąchalska et al. 2001) and gesture support (Hustad and Lee 2008) on the level of intelligibility of utterances by dysarthric patients, studies on the role of early treatment, based on multi-specialist diagnosis, in faster improvement of speech, in preventing negative psychological effects, and in better social adjustment (Nawal et al. 2008).

5. Examination of different aspects of communication of persons with dysarthria in the course of CP;

Examples include the examination of relationships between cognitive, pragmatic and motor aspects of utterances by persons with dysarthric disorders (Falkman et al. 2005; Pirila et al. 2007; Sigurdardottir and Vik 2011; Svraka 2008),

and also of linguistic competencies (in the oral and written subcodes of language) in children diagnosed with dysarthria in the course of CP (Michalik 2012; Dahlgren Sandberg 2006).

To transfer into the Polish context the results of examinations whose subject are utterances in a foreign language is possible only to some extent; they have to be complemented with the data resulting from the analysis of utterances by persons who use Polish or try to learn it: this applies in a special way to speech disorders in children. This transfer in the direction of Polish constitutes not an easy task difficult because the comparatively great complexity of Polish consonantal phonology understood syntagmatically (e.g. long consonantal clusters) or paradigmatically as a complex place-of-articulation contrast makes all comparisons with other languages very difficult. Thus even a simple pronunciation test can constitute a much more difficult challenge for a Polish child than for a child whose native language is phonologically simpler.

THE SCIENTIFIC GOAL OF THE PROJECT

The scientific goal of the project "Suprasegmentals in dysarthric speech in cases of cerebral palsy. Acoustic analyses in experimental logopedic studies on polish-speaking children aged 6 to 15 years" is to widen the existing knowledge about the suprasegmental features in the speech of dysarthric Polish-speaking patients with CP. As part of the project, experimental logopedic investigations will be conducted, whose results will enable finding out acoustic parameters of suprasegmental phenomena in dysarthric speech in CP cases. The analysis of the suprasegmental level of the phonetic sequence will include intonation, word and sentence stress, rhythm of utterances, rate of speech, length of phrases, and respiratory, phonatory and articulatory synchronization, nasal resonance, and voice quality. The objective of these planned studies is to describe and compare suprasegmentals in the speech of children aged 6–15 – in the group of dysarthric children in CP and in the group of children in whom no speech disorders and CP have been diagnosed. Statistical analyses of the results of acoustic experiments will also enable an evaluation of the relationships holding between selected suprasegmental phenomena in dysarthric speech. Moreover, we are planning to conduct studies with the participation of speech therapists as competent raters, whose task will be to conduct an auditory evaluation of particular phenomena manifesting themselves at the suprasegmental level of utterances of children with CP-related dysarthria, as well as an evaluation of the degree of intelligibility of their pronunciation. A comparison of the results of an acoustic analysis with the results of a perceptual analysis will make it possible to define the predictors determining the level of utterance intelligibility in dysarthric children with CP (cf. De Bodt et al. 2002).

The concept of the studies arose from a methodological reflection in the course of analyzing the present author's own research conducted from 2010 to 2012 as part of the post-doctoral research project "Segmental and suprasegmental specificity of the phonic sequence and intelligibility of utterances in dysarthric cases in infantile cerebral palsy" (38th research project contest of the Ministry of Science and Higher Education, project no. NN 106 268538), carried out at the Department of Logopedics and Applied Linguistics, Maria Curie-Skłodowska University, Lublin (Mirecka 2013a). One of the research objectives of the project involved analysis of the phonic sequence at the suprasegmental level, thereby enabling detection of disturbances in the prosodic organization; the evaluation of phenomena manifesting at the suprasegmental level was qualitative and quantitative (on the five-degree scale determining the level of intensity of abnormalities). The empirical material prepared at that time in accordance with the perceptual (auditory and visual) analysis procedure (audiovisual recordings of utterances of children with CP-related dysarthria) would be acoustically analyzed in the future.

RESEARCH PLAN

This project becomes an attempt at fulfilling the plan that arose 3 years ago – it is planned to make use of archive utterances recordings of children with CP-related dysarthria, who were diagnosed by the author in the studies that were a part of the post-doctoral research project. Language material intended to acoustic analyses will be chosen from previously collected audiovisual recordings (the language material are 20 words and 9 sentences repeated by the children after the researcher, from tests contained in the *Dysarthria Scale. Children's Version* (Mirecka and Gustaw 2006) – the main diagnostic technique of the post-doctoral research project). The type of the language material subjected to analysis (constituted by words and sentences) and the type of the task the speaker is to perform (a repetition of language material first pronounced by the researcher), is widely used in numerous experimental studies (cf. Kim et al. 2011). The decision to select the linguistic material to be analyzed (it consists of words and sentences) and the type of the speaker's task (which consists in repeating what the researcher says) is influenced by the following factors:

a) The necessity of collecting the empirical material of both (experimental and control) groups, comparable in terms of language and the type of task;

The character of disorders in intellectually disabled children in ICP exerts an impact on their linguistic functioning (problems with competence and linguistic skills) – their spontaneous utterances are usually limited, both in terms of length (prevalence of one-word utterances) and type (they are declarative utterances).

b) The necessity of proper identification of the linguistic material (decoding of utterances);

In the case of a significant intensity of dysarthric disorders, decoding a spontaneous utterance may be impossible, which makes it difficult -or even impossible- to interpret acoustic analysis (e.g. regarding realizations of sentence stress, intonation, or text phrasing). In the case of realization disorders (dysarthria is a disorder at the executive level of the motor speech mechanism) the use of word/sentence repetition tests provides an opportunity to assess the capability of using the speech apparatus, which certainly does not mean that the results obtained in the studies so constructed can be fully extrapolated to spontaneous speech. The planned language material has been regarded as sufficient for the purposes of experimental comparative studies of the suprasegmental aspect of performance efficiency.

Work plan:

1. Definition of the groups of the studied children aged 6–15.

Experimental group: 30 children with CP-related dysarthria; the experimental group divided into two 15-child subgroups: intellectually normal children (average and below-average intelligence) and mentally retarded children (mild and moderate retardation); Control group: 30 children without CP and speech disorders, intellectually normal.

2. Preparation of the empirical material of the experimental group for analysis (choice of the linguistic material from archive recordings of children with CP-related dysarthria).

3. Logopedic and psychological assessment of children from the control group (field studies in educational institutions).

4. Collecting the empirical material of the control group – repeating words and sentences from the *Dysarthria Scale* by the children – digital audiovisual recordings (field studies).

5. Acoustic analysis of phenomena manifesting themselves at the suprasegmental level of utterances in the collected language material (the language material are twenty words and nine sentences repeated by the children after the researcher, from tests contained in the *Dysarthria Scale*).

Polish words

monosyllabic: *pies, dom, stół*

disyllabic: *lampka, wąsy, bałwan, noże, zima, dziadzio, małpka, ogień*

trisyllabic: *zabawki, gazeta, widelec, mamusia, kapelusz*

quadrasyllbic: *filiżanka, telewizor, helikopter*

Polish sentences

Dziewczynki i chłopcy to dzieci.

Jabłuszka i banany są bardzo smaczne.

Pan Hilary zgubił swoje okulary.

Drzwi są zamknięte.

Czy możesz zamknąć te drzwi?
Zamknij te drzwi!
Dzisiaj idę ***na spacer****.*
Dzisiaj ***idę*** *na spacer.*
Dzisiaj *idę na spacer.*

In the analysis of the language material of the experimental groups special attention will be focused on disorders of suprasegmental level typical of dysarthric speech (Mirecka 2013b) – here given in brackets:

• intonation (monotonous, unstable intonation);
• sentence stress (reduced stress);
• rhythm of utterances (weakening/ suppression of consonance isochronism, incorrect word stress, vowel prolongation, "chanting", "staccato" – lack of fluency in articulation transitions, stronger sounding of some phones);
• rate of speech: duration of particular segments of the phonic sequence – speech sounds and acoustic pauses, number of respiratory pauses (too slow, unstable rate);
• phrase length: duration and number of syllables within a phrase (too short phrases);
• respiratory-phonatory-articulatory synchronization (speech on residual air and on inhalation);
• nasal resonance (hypernasality, unstable resonances);
• voice quality (hoarse, weakened voicing, intermittent phonation, loss of voice);
• voice volume (too soft voice, unstable in volume);
• voice pitch (unstable, unintentionally variable pitch, too high/too low voice);
• vocal attack (hard/breathy).

The graphs of the following relationships between:

• amplitude of the signal acoustic pressure and time = oscillogram: A(t)
• frequency and time (+ amplitude) = spectrogram: F(t); A
• pitch and time = intonogram: F0 (t)
• sound intensity level and time: I(t)

The analysis of particular variables of acoustic contours: speech signal intensity, frequency and time will enable indicating acoustic parameters of suprasegmentals, which are subjected to the assessment (Demenko 1999; Dukiewicz and Sawicka 1995).

6. Examinations with the participation of 30 speech therapists as competent raters: the auditory assessment of particular phenomena manifesting at the suprasegmental level of utterances of children with CP-related dysarthria, and the assessment of the degree of intelligibility of their pronunciation. The sentences repeated by children (mentioned in point 5) are the language material which is auditorily assessed.

7. Statistical analysis of the data – results of acoustic analyses and assessments given by competent raters.

8. Interpretation of the data.

RESEARCH METHODOLOGY

The plans of solving the posed problem involve carrying out empirical examinations using linguistic, especially in the fields of acoustic phonetics and phonology, speech-therapy, audiological, psychological, and engineering competencies (technical physics, medical specialty) as well as those in biocybernetics and speech acoustics represented by persons to be employed on the project.

The methodology of the acoustic examination was created and consulted by experts from the Maria Curie-Skłodowska University (UMCS) in Lublin: Prof. Wiesława Kuniszyk-Jóźkowiak (the UMCS Faculty of Mathematics, Physics and Computer Sciences, Division of Biocybernetics), Wiktor Gonet, PhD (the UMCS Faculty of Humanities, Institute of English Studies, Division of Phonetics and Phonology) and Małgorzata Waryszak, MA (the UMCS Faculty of Humanities, doctoral studies).

The methodology of statistical surveys was created by Beata Daniluk, PhD (the UMCS Faculty of Education and Psychology, Institute of Psychology, Division of Clinical Psychology and Neuropsychology).

The experimental method:

Two groups of children aged 6–15 will participate in the experimental examinations: they were qualified for the examinations based on the established selection procedure: the criterion group will comprise dysarthric children with CP (30 persons), half of whom will be characterized by intellectual disability (children with a mild degree of mental retardation, and children with a moderate degree); for the control group (30 persons), children of the same age and sex and without CP, dysarthria and mental retardation (intellectually normal children). Moreover, we are planning to conduct studies with the participation of speech therapists as competent raters (30 persons), whose task will be to conduct an auditory evaluation of particular phenomena manifesting themselves at the suprasegmental level of utterances of children with CP-related dysarthria, as well as an evaluation of the degree of intelligibility of their pronunciation.

The method of logopedic diagnosis:

Logopedic diagnosing language and communication skills; the main technique used in investigations will be *Dysarthria Scale. Children's Version* (Mirecka and Gustaw 2006). *The Dysarthria Scale* consists of 70 tasks in nine consecutive

spheres, whose arrangement is based on transition from more complex acts and functions to simpler ones:

I. Self-Assessment

Sphere I pertains to such aspects as intelligibility of the patient's own utterances, his fatigability during speech, respiration problems and vocal difficulties, which we get to know from the perspective of the subject tested.

II. Intelligibility

Sphere II assesses the intelligibility of words (62) and sentences (9) which the patient repeats after the testing person, and intelligibility of the patient's free utterances.

III. Articulation

Tasks in Sphere III serve to identify difficulties in the pronunciation of vowels, consonants and consonant clusters in words repeated by the subject, and possible problems with realization of the phonetic structure of polysyllabic words. Phonetic abnormalities at the segmental level are also recorded in tests consisting in repetition of sentences and in the patient's free utterances.

IV. Resonance

Sphere IV covers abnormalities in nasal resonance in words and sentences repeated by the patient and in his free utterances.

V. Prosody

In the tasks of Sphere V we assess the ability to imitate intonation in sentences and intonation in free utterances, the ability to imitate various stress patterns, realization of the rhythmic aspects of speech and the ability to maintain the appropriate rate of speech in repeated sentences and in free utterances. We also assess the ability to accelerate and slow down the speech rate and length of phrases in sentences and free utterances as well as synchronization of respiration, phonation and articulation.

VI. Phonation

Sphere VI comprises tasks that test vocal attack, maximum phonation time, voice volume during speech, the ability to raise and lower voice volume, voice pitch and the ability to raise and lower it, and the quality of voice.

VII. Respiration

Sphere VII defines the type and rhythm of respiration at rest and during speech; it also assesses the length of exhalation phase.

VIII. Alternating movements

Sphere VIII permits assessment of diadochokinesis in the articulatory apparatus. Tests of alternating movements cover lip and tongue movements at the horizontal and vertical levels performed as motor exercises and as movements during articulation of contrasting sounds and syllables in respect of pronunciation.

IX. Functional condition of musculature of the articulatory apparatus

Sphere IX tasks provide information about the work of muscles of the lips, tongue, soft palate and throat, the level of lip and tongue tone, and symmetry of facial muscles; we also note the occurrence of involuntary movements.

Tasks are graded on the 5-point scale (0 to 4): 0 – absence of disorders, 1 – slight degree of disorder, 2 – moderate degree of disorder, 3 – significant degree of disorder, 4 – profound degree of disorder. Apart from the grade point assessment, the testing person also gives descriptive information concerning the way of performance of particular tests by the subject.

The method of psychological diagnosis:

Measuring the level of general intelligence in the control group (The Raven's Standard Progressive Matrices). The information about the level of intellectual development of the children from the experimental group was contained in the psychological documentation which was shared with the author by the authorities of the establishments where the examination was conducted from 2010 to 2012 in the post-doctoral research project (Mirecka 2013a).

The methodology of speech acoustics:

The following computer programs will be used to carry out acoustic analyses: Adobe Audition, Praat, WaveSurfer and WaveBlaster (WaveBlaster – software developed by Dr. Ireneusz Codello of Maria Curie-Skłodowska University for automatic detection of speech disfluencies. It produces oscillograms, spectrograms and scalograms with the use of the Fast Fourier Transform, the wavelet transform and Kohonen neural networks, which enables it to reduce noise. The software can be used to control the correctness of speech signal segmentation).

The language material are twenty words and nine sentences repeated by the children after the researcher.

Suprasegmental phenomena (with the parameters analyzed):

1. Intonation – research in this point aims at defining the quality of intonation and possible finding of the presence of monotonous or unstable intonation. The study will be based upon studying the frequency of F0 (fundamental frequency, laryngeal tone), specifically its frequency at peaks of the accented syllables relative to the mean values for phrases.

2. Sentence stress – the study aims at the assessment of the placement of the sentence stress in accordance with the sentence's logic. It will be studied by:

   2.1. an F0 reading and observing its shape, as well as reading its values at syllable peaks;

   2.2. studying the relative changes in sound intensity (reading it at peaks of accented syllables and at the neighbouring syllables; comparison of their values;

2.3. duration study: comparison of the duration of accented syllables relative to the other syllables within the phrase.

3. Utterance rhythm - encompasses the study of five suprasegmentals vectors that make up the rhythm of an utterance:

3.1. Correct vs. incorrect word stress studied by reading F0 course and value and comparing the relative intensity and syllable duration;

3.2. Weakening/elimination of isochrony studied by measuring the duration of stress groups;

3.3. Prolonging sounds – studied by measurement of duration of the prolonged speech sounds;

3.4. Chanting – studied by marking and measuring inter-syllable pause durations;

3.5. Staccato – studied by measuring the durations of speech sounds and pauses (if they exist between them).

4. Speech pace – the study will aim at identifying too slow or unstable speech pace. Studied by taking measurements of the durations of the successive segments of the phonetic sequence of speech sounds and acoustic pauses. Defining the number of breath pauses.

5. Phrase duration and syllable number within phrases – studied by counting syllables within a phrase on the basis of a segmented acoustic speech signal; measuring phrase duration.

6. Breath – phonation and articulatory synchronization – assessed on the basis of the presence of ingressive speech or speaking with last reserves of air. Studied by observing the occurrence of voiced and voiceless sounds on the basis of F0 and voice bar presence. Evaluation of synchronisation will also be done by resorting to video recordings.

7. Nasal resonance – disturbances in nasal resonance, that are most often revealed as hypernasalization of unstable resonance, will be evaluated on the basis of vowel formant analysis.

8. Voice quality:

8.1. Hoarse voice – its presence will be determined by observing the oscillographic and spectrographic images, as well as determining the value of jitter that describes the variability in the periodicity of the acoustic speech signal;

8.2. Voicing weakening– understood as VOT and VIC variability;

8.3. Voice breaks – studying the presence vs. absence of quasi-periodic vibrations in the oscillogram and of voice bars in the spectrogram;

8.4. Aphonia – as above;

8.5. Incorrect voice intensity: instability of voice intensity – studied by measuring the values of the relative intensity and shimmer, with the

aid of z viewing video recordings that allow to observe the occurrence of voiceless articulation and changing distance between the microphone and the person being recorded;

8.6. Pitch abnormalities (unstable unintentional excessive pitch variability, too high/low voice – studied by analyzing the shape of the F0 curve and measuring F0 in the successive syllables; comparing the local readings with the mean;

8.7. Abnormal voice attack – hard attack vs. soft attack- studied on oscillographic and spectrographic visualizations.

The methodology of auditory analysis:

Competent raters (30 persons – speech therapists) will conduct auditory evaluation of the suprasegmental phenomena and the level of utterance intelligibility in dysarthric children with CP (the assessment on the five-degree scale determining the level of intensity of abnormalities: 0 – absence of disorders, 1 – slight degree of disorder, 2 – moderate degree of disorder, 3 – significant degree of disorder, 4 – profound degree of disorder). The language material are nine sentences repeated by the children after the researcher, from tests contained in the *Dysarthria Scale*.

The statistic methods:

Descriptive statistics (the mean, the measure of dispersion), analysis of variance, correlation analyses, regression models; statistical package SPSS 22 for Windows will be used to conduct these analyses.

The use of descriptive statistics (the mean, the measure of dispersion) at the first stage of analysis of results will enable a detailed description of suprasegmental phenomena in the two groups of children. Analysis of variance will make it possible to compare the acoustic parameters of the children's utterances, and to determine the characteristic features of the subjects in the individual groups, taking the level of intellectual capacity into consideration. To determine to what extent the acoustic characteristics of the children's speech can be accounted for by their neurological condition (presence/absence of CP and dysarthria) will be possible based on the measures of effect sizes (Cohen's coefficient and omega-squared coefficient). For comparisons between the two independent groups the t test and the Mann–Whitney U test will be used, depending on the distribution of variables.

At the second stage, correlation analyses will be carried out to assess relationships between selected phenomena of dysarthric speech (Pearson's r or Spearman's r).

The last stage will use regression models (inter alia multiple regression and logistic regression models), which will make it possible to establish predictors

determining the level of intelligibility of verbal utterances by CP children, and to assess the risk of occurrence of pathological phenomena.

SIGNIFICANCE OF THE PROJECT

The present project entails conducting primary research on Polish linguistic material: the studies concerned with the acoustic parameters of suprasegmental phenomena in dysarthric speech in CP (suprasegmentals in the utterances by Polish-speaking patients diagnosed with dysarthria in the course of CP). The planned studies are experimental, they enable intergroup comparisons: suprasegmentals in the speech of children aged 6–15 in the group of subjects with CP-related dysarthria and in the group of subjects in whom speech disorders and CP were not found. The planned research procedure should also provide information on the acoustic aspect of relationships between phenomena at the suprasegmental level and intelligibility of dysarthric speech. The foregoing problems have not yet been the subject of research using the Polish linguistic material, this fact justifying the investigation of the research problem.

The original contribution of the project will be to develop, based on the conducted studies, the list of acoustic parameters that characterize disorders of the phonic sequence at the suprasegmental level in cases of CP-related dysarthria, and to indicate the degree of their impact on the level of intelligibility of utterances by dysarthric persons (it is essential to include in speech-therapy diagnosis the evaluation of utterance intelligibility because of its communication aspect). These data can be used in comparative studies on speech disorders, in particular those neurologically related.

The investigation of the research problem means, the applicant assumes, progress in the methodology of speech therapy research conducted in Poland: it can therefore contribute to the development of Polish linguistics, in particular, acoustic phonetics and phonology, and neurologopedics.

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