SOFIA UNIVERSITY “ST. KLIMENT OHRIDSKI”
FACULTY OF EDUCATIONAL STUDIES
AND
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DEPARTMENT OF LOGOPEDICS

INFLUNCE OF PHONOLOGICAL PROCESSING ON SPOKEN AND WRITTEN LANGUAGE IN APHASIA

DISSERTATION ABSTRACT

FOR AWARD OF THE EDUCATIONAL AND SCIENTIFIC DEGREE OF "DOCTOR" IN THE PROFESSIONAL FIELD 1.2. PEDAGOGY, DOCTORAL PROGRAM IN "LOGOPEDICS" AT THE DEPARTMENT OF "LOGOPEDICS"

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The dissertation contains 231 standard typewritten pages of text, of which 175 represent the substantive part of the development. The dissertation's structure includes a table of contents, introduction, three chapters, summary and conclusions, recommendations, limitations, conclusion, and contributions. It incorporates 16 tables, 28 figures, and 78 appendices. The bibliography comprises 116 titles (26 in Cyrillic, 90 in Latin script).

The dissertation is submitted for discussion and defense in the Department of Logopedics at the Faculty of Educational Studies and the Arts, Sofia University "St. Kliment Ohridski."

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INTRODUCTION TO THE PROBLEM

Aphasia is a profound disruption in the heart of human communication. It transcends the suffering of the individual affected by it, altering their perspectives on relationships with others and their participation in society.

Aphasia is a symptom, not a standalone condition, often associated with other medical conditions, primarily following a stroke. According to Veleva-Goranova, Vasileva, and Nedev (2011:55), in about 50% of cases of stroke or other brain pathologies, speech disorders are observed in the form of aphasia and/or dysarthria. The risks associated with aphasia increase with age, with Engelter et al. (2006) noting that for each year after the age of 65 in a stroke patient, the risk of developing aphasia increases from 1% to 7%. Stroke, one of the leading causes of death and disability in Europe (Norrving et al., 2018), is associated with high morbidity, mortality, and costs, with aphasia occurring in 21–38% of patients with acute stroke (Berthier, 2005). Although many make progress in recovery, the process can be prolonged, and often patients do not receive the necessary ongoing therapy and care.

The aim of this dissertation is to examine the influence of phonological processing on spoken and written language in aphasia. *The subject* of the research is the condition of phonological processing, as well as the qualities of spoken and written language in patients with aphasia. The experimental study focuses on adult patients with this acquired communication disorder. Within this dissertation, the theoretical foundations of aphasia and phonological processing are analyzed, exploring the relationship between them and investigating practical applications, including aphasia examination.

For the purpose of this research, data from 60 adult patients with native Bulgarian language were analyzed, divided into two groups – Experimental and Control group, each consisting of 30 individuals with a male-to-female ratio of 2:1. The main characteristic of individuals in the Experimental group was the presence of aphasia.

In this research context, a foreign diagnostic toolkit for examining phonology in aphasia is adapted to the characteristics of the Bulgarian language. The Boston Diagnostic Aphasia Examination is used to examine the language ability and its domains. The results indicate that both diagnostic tools provide reliable data. The study emphasizes that the quality of phonological processing is affected in aphasia patients and is a key predictor for the

condition of spoken and written language, with a stronger impact compared to various demographic factors. Its correlation with the severity of language difficulties is highlighted, emphasizing the need for a comprehensive approach in examining the language function.

The insufficient amount of scientific research in this area in the Bulgarian language, along with the trend of increasing number of aphasia patients and decrease in their age, determines the scientific significance of the dissertation. The data from the study is necessary for improving the examination and therapy of spoken and written language in aphasia, which would enhance the possibility of restoring the patients' work capacity, their social realization, emotional satisfaction, and overall quality of life.

CHAPTER ONE. THEORETICAL OVERVIEW

1.Theoretical Foundations of Aphasia

1.1. Definition and Etiology of Aphasia

Aphasia is a term denoting a complex of disorders affecting an already established linguistic system for the realization of language abilities in its various aspects (speaking, understanding, reading, and writing). This term determines acquired language impairments resulting from localized brain damage in the dominant hemisphere, i.e., the processes of linguistic encoding and decoding. Depending on the location and extent of brain damage, the severity and type of aphasia may vary. This disorder is often accompanied by other impairments such as dysarthria, apraxia, and/or agnosia. Recovery typically involves speech and language therapy, as well as other forms of medical and physical rehabilitation (Lesser, 1989:1; Asenova, 2009:170; Simonska, 2009; Veleva-Goranova, Vasileva & Nedev, 2011:54; Tsenova, 2012:138). In addition to spoken language disorders, post-stroke language problems can lead to impairments in written language, such as alexia and agraphia, which often coexist with aphasia. Alexia and agraphia are terms indicating brain-induced disruptions of written language in adult individuals (Asenova, 2009:225).

1.2. Historical Aspects of Aphasia

The interest in aphasias, following the establishment of aphasiology as a separate medical specialty in the 1860s, led to numerous studies related to their characteristics, symptoms, and therapy. The classification by Lichtheim-Wernicke, known as the "classic" or "traditional" model of aphasia, provides a fundamental framework for understanding the relationship between different brain areas and corresponding language functions. This model, based on the associationist approach, categorizes aphasias into motor (subcortical, cortical, transcortical, and conductive) and sensory (subcortical, cortical, and transcortical). In comparison, Luria's classification offers six types of aphasias based on a neuroanatomical, psychological, and linguistic approach. This model takes into account the structure of language and includes aphasias such as efferent motor, dynamic, sensorimotor-acoustic, acoustic-mnestic, semantic, and others. Finally, Mavlov's hierarchical structural-functional model (1997) explains the occurrence of aphasias as a result of impairments at the linguistic level (Raychev et al., 2012:32; Caplan, 2004:262; Asenova, 2009:171).

1.3. Modern Classifications of Aphasia

The International Classification of Diseases (ICD) is a system for classifying and coding various diseases, health conditions, medical procedures, and causes of death. In ICD-10, aphasias are presented in the context of various diseases, while in ICD-11, they are separated with their own code (MA80.0 Aphasia).

The International Classification of Functioning, Disability, and Health (ICF) is a recognized and significant classifier, presented in its final version in May 2001 by the WHO. This classification illustrates the classical division of aphasias into expressive and receptive, presenting possible symptomatology (Simonska, 2009).

1.4. Description of the Types and Symptoms of Aphasia

Broca's aphasia is the most common type of aphasia. The process of generating verbal messages is predominantly affected, with the Broca's area being implicated. Both high-level stages involving the selection and planning of linguistic units and lower-level stages related to articulatory planning and realization are affected. There are two components of impairment – apraxic and aphasic. The primary clinical characteristic is a qualitative and quantitative reduction in verbal expression in both spoken and written forms. In *transcortical motor aphasia*, only linguistic encoding is affected. Key characteristics of this type of aphasia include a pronounced lack of speech initiative, limited expressive means, and concise responses to questions, with no disruption of grammatical structure and comprehension of foreign speech. The same is observed in written speech. *Wernicke's sensory aphasia* combines a linguistic aphasic deficit and a verbal agnosic deficit. It involves a universal language impairment in both decoding and encoding verbal messages. The linguistic deficit consists of a severe disruption of the linguistic symbolic system affecting all levels. *Global aphasia* affects language function in all its dimensions. It is characterized by a severe impairment in generating and understanding verbal messages, due to the simultaneous involvement of all linguistic and speech functions. Individuals with conduction aphasia have difficulties in accurately repeating words or phrases, but their language comprehension and generation may be relatively preserved. The phonemic language level is affected. The most characteristic clinical manifestation is phonemic defects in spontaneous spoken production, with all forms of spoken speech accompanied by phonemic paraphasias. *Transcortical sensory aphasia*

disrupts both linguistic encoding and decoding. The impairment is at the linguistic level, while speech gnosis and praxis are preserved. Deficits encompass understanding and generating verbal messages. The semantic component of language is severely impaired. *Anomic aphasia* affects expressive speech, characterized solely by difficulties in retrieving a specific word during spontaneous spoken and written speech, which are the most noticeable difficulties (Raychev et al., 2012:56; Asenova, 2009:179-194; Veleva-Goranova, Vassileva & Nedev, 2011:57-85; Tsenova, 2012:142-146; Raychev & Raychev, 2013:149). *Progressive aphasia* is a manifestation of several neurodegenerative diseases and is associated with the progressive loss of specific language functions while relatively preserving other cognitive abilities (Bonner, Ash & Grossman, 2010).

1.5. Predictors in Aphasia

Studying the impact of predictors in aphasia is crucial for personalizing therapy, predicting its success, understanding the cause-and-effect relationships of symptoms, and recovery in aphasia. Kalpachka (2023:9) categorizes significant factors, predictors for aphasia, into four main groups:

1. *Brain lesions:* size and location of brain damage, severity of hypoperfusion, realization of the stroke area;
2. *Patient characteristics:* age, gender, education, cognitive skills, handedness, paresis/paralysis, accompanying diseases, socio-economic status;
3. *Applied therapies:* pharmacological/non-pharmacological therapy, time since the onset of stroke, intensity, duration, choice of therapy/combinations of therapeutic approaches;
4. *Severity of aphasia.*

For the Bulgarian population, a scientific study by Kalpachka (2023:28) focusing on significant predictors in aphasia shows that higher educational level is a positive factor for improving language skills, while advanced age is associated with a negative effect on overall improvement (Kalpachka, 2023:41). Additionally, the patient's gender does not show a statistically significant correlation with the severity of aphasia and the results of different language tests. Due to limitations in the statistical analysis conducted by Kalpachka

(2023:49), there is no data on the degree of correlation between the severity of aphasia and the extent of language recovery in the chronic phase of ischemic stroke. It is important to emphasize that recovery after aphasia requires an individualized approach that takes into account the multitude of interconnected variables representing the unique clinical profile of each patient.

1.6. Description of Types and Symptoms of Acquired Reading and Writing Disorders

Alexias are reading disorders in adults observed after focal brain damage. Peripheral and central alexias are distinguished. In *peripheral alexias*, spontaneous writing and writing under dictation are preserved, but the visual processing of written signals is affected. *Central alexias* are characterized by impaired ability to operate with linguistic symbols, as well as impaired writing ability. They involve disturbances at the lexical level. *Lexical alexia* is a selective inability to read nonstandardly spelled words aloud, while reading those with standard orthography is preserved or significantly better. *Semantic alexia* preserves linguistic activities related to the phonological and lexical processing of letters and words, making reading possible, but understanding of the read text is absent. *Phonological alexia* is the inability to read new, unfamiliar words, or pseudowords. The deficit is concentrated at the level of grapheme-phoneme conversion. *Deep alexia* is defined as a pronounced inability to read familiar and unfamiliar words. It presents symptoms of phonological alexia combined with semantic disturbances. Spontaneous writing and writing under dictation are affected (Tsenova, 2012:192-193; Asenova, 2009:237-246; Raychev et al., 2012:179-182; Mavlov, 2005:32-40).

Agraphias are disorders of the ability to write, distinguishing between central and peripheral agraphias. *Peripheral agraphias* are non-linguistic agraphias where there is no linguistic deficit with preserved symbolic value of the letter, word, message. They are divided into motor and apraxic agraphias. *Central agraphias* are linguistic and are associated with disruptions in the language processes through which the selection and generation of appropriate linguistic units for the written generation of the verbal message are performed. Agraphias are encountered in different aphasic syndromes. When combined with *Broca's aphasia*, it combines a linguistic disorder of grammatical encoding with apraxic disturbance.

When the linguistic deficit predominates in written speech, agrammatical sentences are observed, but with well-formed letters. When apraxia predominates, agraphia manifests with poorly formed, large, and mainly printed letters, as well as literal paragraphs, identical to substitutions in spoken speech. In *transcortical motor aphasia*, the central disturbance falls on monologic speech in its spoken and written forms, making spontaneous writing impossible, while writing under dictation is preserved. In *transcortical sensory aphasia*, the ability to write under dictation is preserved, although spontaneous writing is incomprehensible. Written production is light and smooth, with well-formed letters, but lacks content similar to spoken speech. When combined with *Wernicke's aphasia*, there is a combination of severe linguistic deficit in decoding with disturbances in encoding with phonemic-gnostic disorders. Graphic disturbances are expressed in unintelligible letter combinations resembling the phonemic and semantic features of spoken speech. When combined with *conduction aphasia*, patients make literal paragraphs but write smoothly, with well-formed letters, managing to write isolated words (Mavlov, 2005:67-68; Raychev et al., 2012:172-175; Tsenova, 2012:195-196).

2. Phonology and Aphasia

Phonological processing in aphasia has its specifics due to the impairment of linguistic ability. The phonological system of a language includes the description of sounds and their characteristics, as well as the rules that determine how the sounds interact. This system involves modeling the sounds of the language and is a means through which sound information is mapped onto higher levels of language (Kendall et al., 2010; Tsenova, 2012:44).

2.1. Definition and Components of Phonological Processing. Features of the Bulgarian Phonological System

Wagner and Torgesen define phonological processing as responsible for using phonological information in analyzing spoken and written language. It consists of three components: phonological awareness, encoding phonological information in working memory, storing phonological information in long-term memory (according to Shtereva, 2012:19). Phonological processing is carried out through cognitive abilities such as

recognizing speech sounds, segmenting speech into individual units like syllables and phonemes, storing and retrieving phonological representations from memory, and manipulating phonological information for language generation and comprehension (according to Asenova, 2009:198; Tsenova, 2012:168).

According to the theory of the nonlinear phonological structure of a word, all syllables are divided into the so-called onset, consisting of a consonant or a consonant cluster, and the rhyme component, including the vowel and the subsequent consonants in the syllable. The peak or nucleus of the syllable in the Bulgarian language is always the vowel phoneme, and the code is called the final consonant or consonant cluster (Stoel-Gammon and Stemberger, 1994).

Bulgarian words are characterized by a prevalence of three-syllable stress units and various syllabic structures. Syllables, as the smallest independent pronounceable units, contain vowels and consonants grouped in contrast. Combinations of vowels and consonants at the beginning of a word are mainly characterized by pairs of two consonants - hard and hard or hard and palatal. In the medial position, combinations of consonants are numerous and diverse. A characteristic feature of the Bulgarian language is the absence of words ending in sonorant and palatal consonants. In the final position of Bulgarian words, only combinations of fricative consonants, sonorant consonants, as well as combinations /st, sht, kht, ssh/ are possible (Tilkov and Boyadzhiev, 1999:168).

2.2. Theoretical Approaches and Models Related to Spoken, Written Language, and Phonological Processing

The Connectionist Model of Phonological Processing (Connectionist Model) is applicable for examining phonology and phonological processing in spoken and written language in aphasia. It reflects the theory of information processing as a parallel distributed process containing a system of four processors: context, meaning, orthography, and phonology. In this model, the focus is on the connections between elements rather than individual elements themselves (Shtereva, 2012:53). The use of the Parallel Distributed Processing (PDP) model helps to understand that linguistic activity is a process of interaction between parallel and interconnected elements. PDP supports the idea that the processing of spoken and written language involves synchronized activation of semantic, phonological, and

orthographic units. Word knowledge exists as a learned pattern of neural activity located in the connections between these distributed language units. The connectionist model includes three directions: semantics and phonology, phonology and orthography, and orthography and semantics (Plaut, 1996; Plaut, 1999; Seidenberg & McClelland, 1989; Nadeau, 2001).

The Primary Systems Hypothesis (PSH; Lambon Ralph, Moriarty & Sage, 2002; Woollams, Halai & Ralph, 2018; Patterson & Lambon Ralph, 1999) is based on the PDP theory, advocating the idea that written language abilities develop and rely on the same primary brain systems that support spoken language. PSH postulates that all language activities, including naming, reading, and spelling, are supported by an interconnected language system. The theory emphasizes the importance of phonological processing as a fundamental component linked to higher levels of language skills, including writing and understanding written speech. PSH focuses on shared brain systems regarding spoken and written language abilities and challenges the "classical" perspective on adult written language disorders, stating that reading is part of a more global language system, and disorders in it indicate issues with one or more primary brain systems used for all types of communication.

2.3. Relationship between Phonological Processing and the Condition of Spoken and Written Language in Aphasia

In aphasia resulting from a stroke, the most common comorbid alexia is acquired sublexical reading impairment (impaired ability to read pronounceable pseudowords, as opposed to reading real words). The existing link between phonological alexia and the overall phonological impairment motivates researchers to propose the Primary Systems Hypothesis, suggesting that it is just one manifestation of a general phonological impairment. The contemporary understanding of primary systems acknowledges that sublexical reading depends on the functionally unified phonological system. According to this hypothesis, the impairment in reading pseudowords is associated with lesions in the left perisylvian regions, considered to represent the so-called phonological network (Dickens et al., 2021).

2.4. Phonological Disorders in Aphasia

The presence of phonological disorders in aphasia is a phenomenon described by Denes (1999:195) as a difficulty or inability to convey and/or perceive information using spoken words, as well as to produce and/or perceive words correctly. An important characteristic of phonological disorders is the absence of impairment in articulatory production and peripheral mechanisms of perception.

2.4.1. Phonological Deficits in Speech production in Aphasia

Phonological deficits in individuals with frontal and those with more posterior lesions differ. The first group primarily exhibits deficits in articulatory execution, with lesser impairments in phonological selection and planning. In contrast, the second group experiences deficits in lexical selection and phonological planning, with minor impairments in articulatory execution (Blumstein, 2004:366).

2.4.2. Phonological Deficits in Speech Perception in Aphasia

Almost all individuals with aphasia exhibit perceptual deficits in phonological processing. These deficits become apparent in tasks requiring the patient to distinguish words or syllables differing in one or more phonetic characteristics (e.g., dime-time, da-ta). Individuals with aphasia experience more difficulty in naming or pointing tasks compared to discrimination tasks. They also make more errors in perceiving nonsense syllables compared to real words. Phonetic and phonological deficits may contribute to disruptions in listening comprehension in aphasia, but they do not appear to be the primary cause of these impairments (Blumstein, 2004:367).

2.4.3. Disorders and the Phonetic and Phonological Level in Aphasia – Data from Bulgarian Studies

Based on their own studies, Ovcharova and Raychev (1980:34) present conclusions about the characteristics of speech substitutions in patients with motor and sensory aphasia. Phonemic substitutions are the most common phonetic impairments in patients with these types of aphasia, and more severe impairments are reported in written versus spoken speech.

In motor aphasia, omissions and substitutions account for a significant proportion, while assimilatory effects are of great importance in sensory aphasia. Specific substitutions based on articulatory similarity, primarily involving spoken and palatal consonants with alveolar ones, predominate in motor aphasia. Vowels and alveolar consonants prove to be more stable in patients with aphasia. In the case of sensory aphasia, substitutions frequently occur between acoustically close consonants and between voiced and voiceless phonemes. In motor aphasia, substitutions mainly occur based on manner and place of articulation. Studies note deformations in the overall statistical structure of the phonological system in patients with aphasia compared to the normal population, leading to a decrease in the informativeness of phonemes and serving as an indicator of the degree of phonetic disintegration.

2.5. Disorders of Phonological Processing and their Relationship with Impaired Lexical Retrieval in Aphasia

Friedman, Biran, & Dotan (2013) identify and distinguish the components of lexical retrieval. The lexical access model begins with the formation of the representation in the conceptual system. This non-lexical representation activates the lexical-semantic counterpart in the semantic lexicon, containing words and information about their meanings, which in turn activates the lexical-phonological representation in the phonological production lexicon. The activation is transmitted from the phonological output lexicon to the phonological output buffer, responsible for the phonological effects in combining words and affected by the effects of the length of the phonemic chain it contains. It is specifically related to the process of generating pseudowords, which are not pre-stored in the orthographic and phonological lexicons and are read through the sublexical route. The phonological output lexicon stores the product of transforming graphemes into their corresponding phonemes and links the phonemes into a chain. The same principle applies to the repetition of pseudowords. The phonological representation of the word is sent from the phonological output buffer for phonetic encoding, preparing the phonemic chain for articulation, and from there to the motor system. For the next stage related to the semantic lexicon, the syntactic lexicon is crucial, storing syntactic information about the interaction between words and the idiosyncratic qualities of lexical elements. In case of involvement of the phonological output lexicon and buffer, phonological paraphasias are possible, with the involvement of the phonological output lexicon reflecting the word frequency effect, while buffer impairments affect reading and repeating pseudowords, as well as affecting phonological short-term memory.

3. Assessment of Phonological Processing in Aphasia

3.1. Approaches in the Assessment of Aphasia

In the examination of aphasia, various approaches are used: clinical-neuroanatomical, functional, linguistic, and psycholinguistic (cognitive-neuropsychological) approaches. In Bulgaria, the assessment of aphasias is carried out using a specialized protocol created by the Aphasia Laboratory in 1963: "Protocol for neuro-psychological examination of patients with aphasia," based on A. R. Luria's clinical-psychological qualitative method for assessing speech disorders. Additionally, the Boston Diagnostic Aphasia Examination (BDAE) and the Western Aphasia Battery (WAB), adapted for the Bulgarian language, are utilized for a comprehensive assessment of language functioning in individuals with aphasia (Raychev et al., 2012:259). Specifically for the Bulgarian language, there is the "Methodological Guide for Working with Individuals with Speech Disorders (Aphasia)" (Boyanova et al., 2006), which includes a form and practical guidelines for examining patients with aphasia.

3.2. Assessment of Phonology in Aphasia

Kendall et al. (2010) describe the development of a diagnostic tool in English called the Standardized Assessment of Phonology in Aphasia (SAPA), aiming to diagnose various phonological parameters in patients with aphasia. This test battery is based on the Parallel Distributed Processing Model by Stephen E. Nadeau, presented earlier in this exposition. For the Bulgarian language, there are no specialized diagnostic tools available that investigate specific language areas and domains, particularly those directed at the phonological aspects in aphasia.

Conclusions and prerequisites for the realization of the dissertation work based on the conducted theoretical overview:

1. Aphasia is a socially significant communicative disorder with deep historical roots, but there is a need for updating modern diagnostic and therapeutic approaches in the field of speech therapy.
2. Recovery from aphasia requires an individualized approach that takes into account multiple interconnected variables (and predictors) representing the unique clinical profile of each patient.
3. Aphasia shows involvement of the phonological level with a substantial contribution to language production and perception.
4. Phonological processing in aphasia plays a crucial role in the communication process in both spoken and written forms, and understanding its characteristics contributes to effective speech therapy intervention.
5. Significant theories and studies (e.g., Parallel Distributed Processing and Primary Systems Hypothesis) demonstrate the influence of phonological processing on the condition of spoken and written language in aphasia.
6. There is an available test examining phonology in aphasia, specifically based on the connectionist Parallel Distributed Processing model for English language characteristics.
7. In Bulgarian research literature, there is no created or adapted diagnostic tool assessing the condition of phonology in aphasia applicable to the characteristics of the Bulgarian phonological system, limiting the possibilities for comprehensive therapy of spoken and written language for patients with this disorder.

CHAPTER TWO. RESEARCH METHODOLOGY

1. Aim

The provided theoretical foundation leads to the main aim of this experimental study: to create a tool that can assess the condition of phonological processing in individuals with aphasia and demonstrate its impact on both spoken and written language in these Bulgarian-speaking patients.

2. Tasks of the Research

2.1. To review literature sources providing information on the condition of phonological processing and its assessment in individuals with aphasia.

2.2. To adapt an existing foreign language diagnostic methodology for assessing phonological processing in aphasia to the characteristics of the Bulgarian language, following approval and guidance from the original test author.

2.3. To select a suitable diagnostic battery evaluating the severity and extent of language function impairment in both spoken and written forms, ensuring a comprehensive language assessment in individuals with aphasia.

2.4. To establish criteria for selecting the study participants.

2.5. To obtain approval for the research from the Ethics Committee of Sofia University "St. Kliment Ohridski" regarding the chosen instruments and procedures.

2.6. To conduct a study of the medical documentation for each potential participant, along with consultation with speech therapists and medical personnel regarding the involvement of specific patients in the current study.

2.7. To obtain consent from the relatives/caregivers of each participant.

2.8. To administer the structured experimental batteries to each participant, adhering to both general and specific ethical norms.

2.9. To input, analyze, and process the obtained data using appropriate statistical methods.

3. Stages of the Research

3.1. Study of the theoretical foundations related to the researched issues.

3.2. Identification and selection of the study sample for the scientific research.

3.3. Development of a methodology, selection, and adaptation of diagnostic tools for the scientific research.

3.4. Implementation of the experimental procedures.

3.5. Processing and analysis of the results.

3.6. Derivation of contributions from both a scientific and applied-practical perspective in relation to the dissertation work.

3.7. Formulation of conclusions and recommendations based on the obtained results.

4. Hypotheses

Main Hypothesis I: *It is assumed that the quality of phonological processing in aphasia is affected*.

Sub-hypothesis 1: Efficiency in phonological processes is reduced in individuals with aphasia. It is expected that patients will demonstrate reduced efficiency in phonological processes, manifested as difficulties in recognizing and processing phonemes and phonological structures.

Sub-hypothesis 2: Other factors influence the condition of phonological processing. Demographic factors (age, educational level, gender, residence, and birthplace), as well as the duration of aphasia, significantly influence the condition of phonological processing in individuals with aphasia.

Main Hypothesis II: *The condition of phonological processing in individuals with aphasia is related to the qualities of spoken and written language.*

Sub-hypothesis 1: The performance of individuals in spoken and written language tasks varies depending on the degree of impairment of phonological processing. Individuals with greater impairment of phonological processing experience more pronounced difficulties in generating and understanding spoken and written language.

Sub-hypothesis 2: The relationship between the condition and degree of impairment of phonological processing has prognostic value for the early stages of the disorder and the condition of spoken and written language in aphasia.

Sub-hypothesis 3: There is a significant correlation between the condition of phonological processing and the degree of aphasia. It is believed that the degree of impairment of phonological processing is directly related to the degree and severity of language impairment. This may be due to the compromise of the phonological system, leading to difficulties in recognizing and processing phonological units.

5. Object of the Research

The object of the current study is adult patients with motor or sensorimotor aphasia.

6. Subject of the Scientific Research

The subject of the current study is the condition of phonological processing, as well as the qualities of spoken and written language in patients with aphasia.

7. Research Sample

The total number of participants included in the results analysis is sixty (60), ranging in age from twenty-three (23) to eighty-nine (89) years. Among them, 40 are males and 20 are females. The male-to-female ratio is 2:1. In the Experimental Group (EG), the average age is 65.7 years, with a male-to-female ratio of 2:1. In the EG, the youngest male participant is 23 years old, and the oldest is 86 years old. In the group, only one person is bilingual; two individuals are ambidextrous, while all others are right-handed. In the Control Group (CG), the average age is 64 years, with a male-to-female ratio of 2:1. In this group, the youngest male participant is 27 years old, and the oldest is 89 years old. In the group, one person is bilingual, and one is ambidextrous, while all other participants are right-handed.

Criteria for Selecting Study Participants

All participants in the study are literate and native speakers of the Bulgarian language. All individuals have no history of previous intellectual, sensory (visual or auditory), communicative, psychiatric, or emotional-behavispoken disorders.

The *Experimental group* includes individuals with diagnosed aphasia (motor or sensorimotor) based on medical records and diagnosed by speech therapists. Individuals with severe dysarthria and apraxia, as well as those with severe language comprehension difficulties (sensory aphasia), are excluded due to the specific requirements of the research, which necessitate understanding tasks and instructions with more complexity. Individuals with overall physical discomfort are not included.

The *Control group* includes individuals selected based on demographic data matching those of the Experimental group, i.e., their characteristics correspond in parameters such as gender, age, education, place of birth, place of residence, monolingualism/bilingualism, profession, dominant hand.

The examination was conducted between March 2022 and October 2023 in the following institutions in Sofia: the Rehabilitation Hospital and Hospice "Serdika," Hospice "Marinela," and the Speech Therapy Center "Govori s Men."

8. Procedure for Conducting the Scientific Research

Each of the participants admitted to the study was examined in a calm and quiet environment. For individuals in the Experimental group (EG), examination in a hospital room was necessary due to the specificity of their physical condition. The examination was tailored to their current condition, needs, and the schedule of accompanying medical and rehabilitation procedures. For this reason, the examination of this group was conducted in stages on different days during morning hours when individuals were in optimal physical shape.

8.1. Description of the Instrument for the Assessment of the Overall Language Status

The first diagnostic test, the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan - Boston Test, 1983), is a neuropsychological battery created by Harold Goodglass and Edith Kaplan. It was adapted for the Bulgarian language in 1995 by a team for neuropsychological research under the scientific research project "Cognitive Processing of the Bulgarian Language in Norm and Pathology," consisting of Bogdana Aleksandrova, Margarita Terzieva, Ivaylo Turnev, and Lyudmil Mavlov. The test provides a detailed assessment of various aspects of language functioning in individuals with aphasia and helps determine the type and severity of the disorder. In the present study, this instrumental battery was applied only to individuals in the EG, as it provides comprehensive information about the current condition and the impact on language function in both spoken and written forms due to aphasia symptoms. The test is divided into five subtests, including evaluation of conversational and narrative speech, comprehension of heard speech (at the word level, understanding the meaning of complex relationships, understanding spokenly presented text), spoken speech (articulatory mobility, automated speech, recitation, singing, rhythm reproduction, word and phrase repetition, naming in visual presentation of pictures, naming animals, responding to questions), reading (recognizing symbols and words, recognizing phoneme-grapheme correspondences, recognizing words among other distractor words, understanding words spoken sound by sound, pronouncing words sound by sound, composing words from images, reading sentences and paragraphs with understanding, reading aloud words and sentences), and writing (writing name and address, copying, recalling written symbols, dictation of letters, numbers, words, sentences, written naming in visual presentation, composing a written narrative). The score range is from 0 to 5 points, following precise and clear criteria for marking results. A scale for assessing the severity of aphasia is presented, ranging from 0 to 5, and a profile of the scale for assessing speech characteristics (range from 1 to 7) is compiled, reflecting indicators such as melody, phrase length, articulatory mobility, grammatical form, paraphasia, phrase repetition, finding necessary words, and understanding of heard speech.

8.2. Description of the Instrument for the Assessment of Phonological Processing

The second diagnostic test was administered to all patients from both groups - a tool for assessing phonology and phonological abilities in aphasia. For the purposes of this study, it was adapted to the characteristics of the Bulgarian language and population from the Standardized Assessment of Phonology in Aphasia (SAPA) (Kendall et al., 2010) after approval from the original test author, Diane L. Kendall, and the Ethics Committee of Sofia University "St. Kliment Ohridski," with the working translated title Стандартизирана оценка на фонология при афазия (СОФА).

Selection of Linguistic Material

The chosen linguistic material is adapted based on the criteria of word frequency, utilizing data from the Bulgarian National Corpus (version of BNC: December 2011) in a combined style and words with diverse frequencies. Each sample contains high-frequency and low-frequency words with varied structures. The entire linguistic material consists of nouns, following the principle of the original test. For generating pseudowords in Bulgarian, the computer program and method Wuggy (Shtereva et al. 2020) have been employed. The ratio of real words to pseudowords is 1:1.

Creation of Design for Each Subtest and Research Process

During adaptation, the original structure of the test is preserved. The design of each subtest includes a preliminary description of the evaluation specifics of the responses, as well as the recommended instructions before each task.

Improvement of Conditions for Collection, Storage, and Processing of Results for Each Patient

Each subtest is presented in a separate MS PowerPoint presentation. The instructions and verbal stimuli from subtests 2 and 3 are provided through high-quality audio recordings, created in a sound recording studio and processed by a professional to achieve maximum quality. Each instruction for the patient is presented both in audio and written form.

Scoring of the results from the administered diagnostic tasks is point-based: 1 point for a correct and 0 points for an incorrect answer (presence of a phonological or semantic error, or a missing response). The result is not influenced by distortions, unclear articulation, or dialectal pronunciation. Before each section, there are instructions and practice items with feedback for the examined individual, but once the test has started, this is not allowed.

The first subtest for assessing reading consists of 65 items in 4 categories: real words, pseudowords, words with non-standard spelling, and pseudohomophones. The first two tasks, "Real Words" and "Pseudowords," require reading aloud words with a direct sound-letter correspondence. "Pseudohomophones" includes written words with incorrect spelling that sound like real words when pronounced. "Non-standard Words" involves reading aloud words containing elements without correspondence between grapheme and phoneme.

Subtest 2 assesses auditory phonological processing. It consists of 55 items in 4 sections: rhyming of real and pseudowords, lexical decision, minimal pairs. The first two tasks are related to recognizing rhyming pairs of heard real and pseudowords, using rhyming pairs that differ by only one sound. The "Lexical Decision" task requires judging whether a given word is real in the Bulgarian language. "Minimal Pairs" assesses whether the two heard syllables are identical or different.

Subtest 3 assesses skills in repetition, blending, and parsing. It consists of 70 items distributed across 6 sections: repetition of real and pseudo-words, blending of real and pseudowords, parsing of real and pseudowords. The repetition tasks for real and pseudowords require the patient to repeat the heard word accurately and clearly. Tasks related to blending and parsing focus on the syllable and phoneme. Blending real and pseudo-words includes linguistic material for blending phonemes, syllables, onset, and rhyme. Parsing tasks for real and pseudowords have a different structure, divided into three subparts, requiring the patient to parse the word phoneme by phoneme, remove a syllable, or remove a phoneme.

9. Used Quantitative and Statistical Methods

In this study, we utilize the statistical package SPSS 20 (Statistical Package for Social Sciences), which is a computer program designed for the organization,

processing, and analysis of statistical information. The following statistical procedures are employed for the purposes of this study:

1. Descriptive Statistics.

2. Testing measurement reliability with Cronbach's Alpha.

3. Correlation Analysis – Pearson and Spearman's rho correlation coefficients.

4. Analysis of Variance.

5. Factor Analysis.

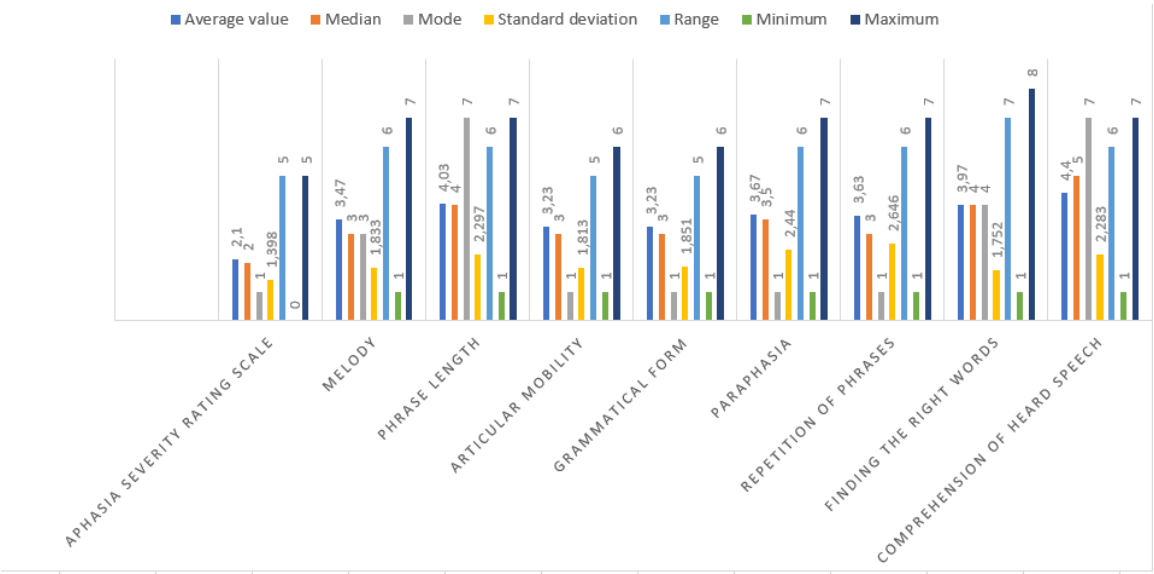
6. Regression Analysis.

CHAPTER THREE. RESEARCH RESULTS AND DISCUSSION

1. Descriptive Statistics

1.1. Descriptive Statistics of the Boston Aphasia Examination Results for the Experimental Group.

The results of the descriptive statistics (graph 1) of the Boston Aphasia Examination for the Experimental group indicate that the average severity score of aphasia is 2.10, showing that most patients experience moderate to severe aphasia.

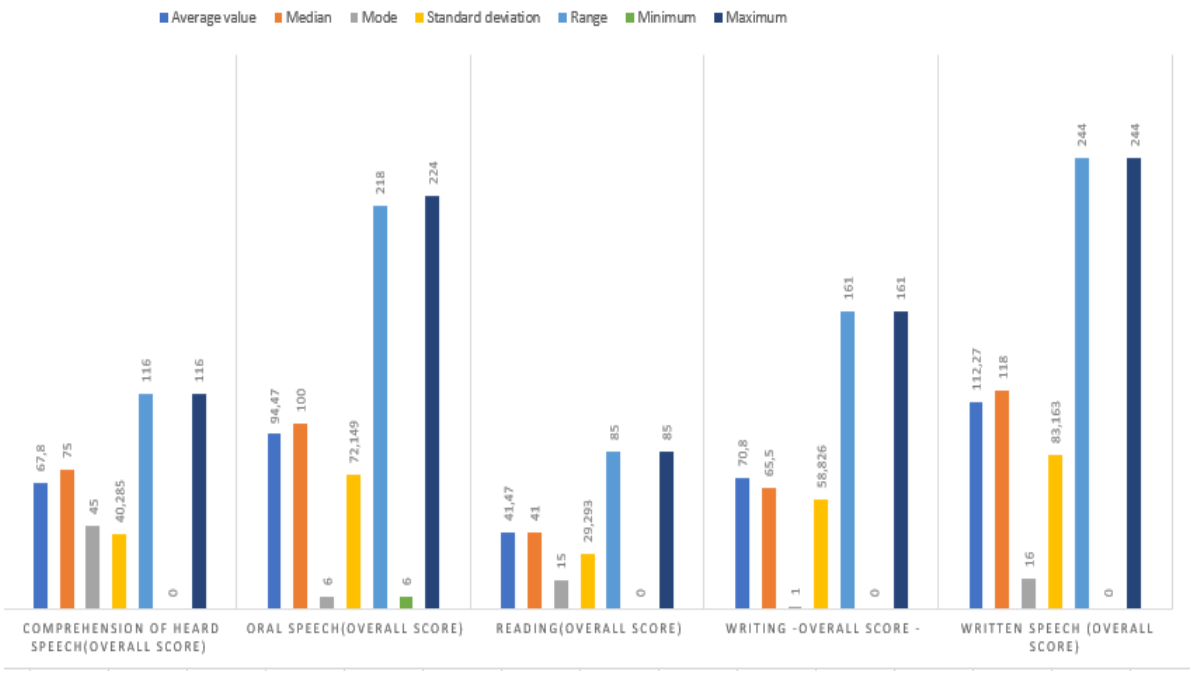


Graph 1. Descriptive Statistics of Speech Characteristics in Aphasia.

The following parameters, such as melodiousness, phrase length, articulatory mobility, and grammatical form, show similar trends. All these parameters have a mode of 1, interpreted as a prevailing severe impairment of language function, but there are individuals with different degrees of deficit. Parameters like paraphasia, phrase repetition, and finding necessary words have higher mode values, indicating that they experience milder to moderate difficulties in the respective areas of language skills. The average score for understanding spoken speech is 4.40 out of 7, interpreted as moderately affected ability of patients to comprehend spokenly conveyed information.

The results of the examination of various aspects of language skills in patients with aphasia (graph 2) demonstrate diversity in the degree of impairment and variability in their abilities. In the area of understanding spoken speech, participants show an average score of

67.8 out of 116, with significant variability in the results. Complex tasks related to understanding complex relationships pose particular challenges for patients. In the area of spoken speech, the average score is 94.47 out of a maximum of 222 points, indicating severely affected speech ability. Tasks such as phrase repetition and naming present challenges, while automated speech and singing are more easily achievable. Reading with an average score of 41.47 out of 86 indicates moderately affected reading ability, with sentence reading aloud and reading comprehension being the most challenging. Writing with an average score of 70.80 out of 174 reveals moderately to severely affected writing ability, with difficulties especially noted in picture description writing and dictation writing. The overall result from all language tests, including reading and writing, shows significant variability in patients' abilities, with an average score of 112.27 out of a possible 260. All of this highlights the undeniable complexity and variability in the affected language skills in aphasia.



Graph 2. Descriptive statistics of composite results from the Boston Diagnostic Aphasia Examination.

These observations support the idea that aphasia affects various aspects of language, including speaking, comprehension, reading, and writing. The results also confirm information from previous studies regarding the nature and symptoms of aphasia (Lesser,

1989; Asenova, 2009; Simonska, 2009; Tsenova, 2012; Raychev et al., 2012; Veleva-Goranova, Vasileva & Nedev, 2011), which were presented in the theoretical part of the dissertation. Associated alexia and agraphia are also often identified, confirming the varied language symptoms in aphasia, depending on various factors such as the severity and type of aphasia, as well as brain impairments.

1.2. Comparative Results from the Phonology Test for the Experimental and Control groups

The analysis of the results from Subtest 1 (Table 1) clarifies a significant difference in the mean values between the Experimental Group (EG) and the Control Group (CG). The CG demonstrates high proficiency in completing tasks, achieving near-maximum scores and rarely making mistakes, unlike the EG. In Subtest 2, the EG also shows lower mean values, with greater variability in the results. Subtest 3 is the most challenging for the CG, requiring high levels of attention and short-term memory. However, once again, individuals in the EG exhibit significantly lower scores. The overall result from the Standardized Assessment of Phonology in Aphasia (SAPA) indicates that the phonological skills of the Experimental Group are substantially lower, supporting **Hypothesis I** regarding a significant impairment in phonological processing in aphasia. In the Control Group, no impairment in phonological processing is observed, and errors there can be explained by other factors such as fatigue or age-related characteristics. Statistically significant differences are found between the two groups regarding the results of Subtests 1, 2, and 3, as well as the overall SAPA result ($p = 0.000$).

Table 1. Comparison of mean values, standard deviation, and error between EG and CG.

Group		Means	Standard Deviation	Standard Error
Subtest 1	Experimental	32,07	23,896	4,363
	Control	62,73	2,612	,477
Subtest 2	Experimental	29,47	19,873	3,628
	Control	48,93	4,571	,835
Subtest 3	Experimental	23,23	23,499	4,290
	Control	58,27	10,014	1,828
Total SOFA score	Experimental	84,03	62,314	11,377
	Control	170,03	14,207	2,594

1.3. Descriptive Statistics of the Results from the Phonology Test for the Experimental Group.

The results of the descriptive statistics for the Experimental Group can be seen in Table 2. Reading aloud of real words with a mode of 20 indicates the presence of patients with maximum scores, which can be interpreted as preservation of the global reading pathway. In contrast, reading aloud of pseudowords shows significantly lower results with an average value of 7.50 out of 20, further confirming the impairment of the phonological reading pathway in patients with aphasia. Errors in reading include various types of substitutions, additions, complicating, and omission of elements in words. Similar trends are observed in reading aloud of pseudohomophones, where patients struggle with difficulties related to semantic and phonemic assimilation of words. In contrast, reading aloud of non-standard words shows more consistent results with an average value of 8.70 out of 15, indicating a tendency towards global reading. Errors here include substitutions, additions, and omissions of elements in words. Overall, the study highlights the variability in reading among patients with aphasia and contributes to a better understanding of the affected phonological mechanisms.

Table 2. Descriptive Statistics of the Results from the SAPA Test for the Experimental Group.

Sample/Composite Score Name	Average value	Median	Mode	Standard deviation	Range	Minimum	Maximum
Real words	11,43	11,50	20	7,925	20	0	20
Pseudowords	7,50	6,00	0	7,361	20	0	20
Pseudohomophones	4,43	4,00	0	3,954	10	0	10
Non-standard words	8,70	8,50	15	5,808	15	0	15
Subtest 1 total score	32,07	30,00	0	23,896	65	0	65
Rhyming real words	8,30	10,50	0	5,718	15	0	15
Rhyming pseudowords	6,77	9,00	0	5,805	15	0	15
Lexical decision	5,93	7,50	0	3,841	10	0	10
Minimal pairs	8,47	8,50	0	5,513	15	0	15
Subtest 2 total score	29,47	34,00	0	19,873	55	0	55
Repetition of real words	5,40	6,50	0	4,039	10	0	10
Repetition of pseudo-words	2,77	3,00	0	2,700	8	0	8
Real word blending	3,50	2,00	0	3,989	10	0	10
Nonword blending	2,30	0	0	3,436	10	0	10
Real word parsing	5,27	0,5	0	6,225	15	0	15
Nonword parsing	4,00	0	0	5,133	15	0	15
Subtest 3 total score	23,23	14,50	0	23,499	65	0	65
Total SAPA score	84,03	76,50	0	62,314	180	0	180

In the analysis of the results for rhyming of real words (average score of 8.30 out of 15, mode of 0) and pseudowords (average score of 6.77 out of 15, mode of 0), the average scores reflect significant difficulties. Common errors include difficulties with pairs like "роза-коза" (rose - goat) and "фОза-нозА" (fOza-nozA) due to the placement of stresses. In the "Lexical decision" task, patients demonstrate difficulties in distinguishing real words from pseudowords, with an average score of 5.93 out of 10. In the "Minimal Pairs" task, an average

score of 8.47 out of 15 and a mode of 0 highlight difficulties in recognizing identical and different syllables by auditory means. Errors involve incorrect assessment of pairs such as "мист-нист" (mist-nist).

The results from the repetition of real words (average score of 5.40 out of 10, mode of 0) indicate patients with serious difficulties. The results from the repetition of pseudowords are similar (average score of 2.77 out of 10, mode of 0). The observations support the hypothesis of disruptions in the phonological output lexicon and buffer, as well as in the phonological short-term memory, as proposed by Friedman, Biran, and Dotan (2013). Phonological paraphasias are often observed in the repetition of real words, which is explained by the involvement of the phonological output lexicon and buffer.

The results from the blending and parsing tasks of real and pseudowords indicate serious difficulties among patients with aphasia, evidenced by low average scores and a mode value of zero for all tasks. Errors include substitutions, additions, omissions, and combined errors, where patients replace, add, or omit phonemes. Another characteristic error is repeating phonemes without blending them and blending phonemes into syllables but not into whole words. Difficulties in blending and parsing real and pseudowords are likely due to possible impairment of the phonological output buffer. In parsing tasks, words are often divided into syllables and/or other elements rather than phonemes, resulting in substitutions, additions, and omissions. This phenomenon often leads to patients being unable to complete parsing tasks at all.

The composite results for each Subtest 1, 2, and 3 confirm the observations already described, particularly highlighted by the zero mode for all subtests. Subtest 3 poses the greatest difficulties for patients, with the pseudoword tasks being inaccessible to a large portion of them, reflecting challenges in perceiving and processing new linguistic information. The overall composite score from the SAPA, with an average value of 84.03 out of 190, underscores moderately to severely affected phonological skills in patients with aphasia. The standard deviation of 62.31 indicates variability in the results, reflecting differences in phonological skills among patients.

The analysis of descriptive statistics exposes the diversity and extent of impairment in different aspects of language in the EG. There is a significant impact observed in understanding spoken language, spoken, and written speech, with the latter being the most

severely affected. The Hypothesis of Primary systems is confirmed, emphasizing that difficulties in phonological skills in aphasia can lead to serious deficits in reading and writing.

2. Reliability of the SAPA Test Battery

The conducted analysis of reliability coefficients (Cronbach's alpha) for the utilized tests. These coefficients are of essential importance as they reflect the internal consistency of both the tests as a whole and the individual items within them. High reliability is observed with Cronbach's alpha coefficients close to 1 for the tests examining phonology in aphasia, as well as for the tests investigating spoken and written language in the Boston Diagnostic Aphasia Examination. This demonstrates their stable internal consistency and their ability to measure language skills in patients with this communicative disorder, both in spoken and written language, as well as in the domain of phonology. High Cronbach's alpha coefficients for the reading (0.87) and writing (0.88) tests, understanding spoken language (0.738) highlight the good internal consistency of the individual subtests. The coefficient for spoken speech (0.669) indicates a moderate level of internal reliability. The phonology test stands out with high reliability, with Cronbach's alpha coefficients ranging from 0.94 to 0.96 for different subtests.

3. Correlation Analysis

The correlation analysis, presented in Table 3 by Pearson correlation coefficient, supports hypothesis (II) regarding the influence of phonological processing on spoken and written language in this acquired communicative disorder. It reveals a strong and statistically significant positive correlation between the condition of phonology and writing skills (subtest 2: 0.795, subtest 3: 0.750, subtest 1: 0.617) and reading skills (subtest 1: 0.869, subtest 3: 0.768, subtest 2: 0.702), with most correlations showing a high degree of dependence (from 0.7 to 0.9).

Table 3. Pearson Correlation Coefficient

		Boston Test			
		Written Language (Reading)	**Written Language (Writing)**	**Understanding of Auditory Speech**	**Spoken Speech**
SAPA Subtest 1	Pearson Correlation	,869**	,617**	,671**	,692**
	Sig. (2-tailed)	,000	,000	,000	,000
SAPA Subtest 2	Pearson Correlation	,702**	,795**	,655**	,825**
	Sig. (2-tailed)	,000	,000	,000	,000
SAPA Subtest 3	Pearson Correlation	,768**	,750**	,699**	,874**
	Sig. (2-tailed)	,000	,000	,000	,000

4. Regression Analysis, ANOVA, Factor Analysis

4.1. Relationship between Phonological Processing and Listening Comprehension

The results of multiple regression emphasize that about 55% of the variation in listening comprehension can be explained by phonological processing, with analysis of variance (ANOVA) further confirming this relationship ($F=10.592$, $p <0.001$). Factor analysis distinguishes Subtest 3 as a primary factor explaining 84% of the variation inlistening comprehension. The analysis indicates that phonological processing is a critical factor for listening comprehension and that improving this ability may have a positive effect on communicative skills and speech understanding in the studied group.

4.2. Relationship between Phonological Processing and Spoken Language

The results of multiple regression show that approximately 78.9% of the variation in spoken language can be explained by phonological processing, with analysis of variance (ANOVA) demonstrating its statistical significance ($F=32.472$, $p=0.000$). The results of the factor analysis indicate that Subtest 3 is the most strongly associated factor with spoken language. The findings suggest that phonological processing is a very strong predictor of

spoken language, and its influence is highly significant and clearly dominant. The analysis supports **hypothesis II** - the relationship between the condition of phonological processing may have prognostic value for the condition of spoken language in aphasia.

4.3. Relationship between Phonological Processing and Reading

The results of multiple regression indicate that approximately 79.2% of the variation in reading is explained by phonological processing, while analysis of variance (ANOVA) demonstrates the statistical significance of the relationship (F=33.052, p=0.000). The results of the factor analysis show that Subtest 3 has a strong and positive influence on reading, explaining 84% of the variation in it.

4.4. Relationship between Phonological Processing and Writing

Multiple linear regression shows that phonological processing explains 65.6% of the variation in writing ability among individuals with aphasia, while analysis of variance (ANOVA) reveals that the relationship is statistically significant (F=16.513; p= 0.000). Factor analysis provides evidence that Subtest 3 is the most strongly associated factor with writing abilities, explaining 84% of the variation in writing abilities in the studied population.

The results confirm **hypothesis II**, demonstrating that preserved phonological processing is associated with improved reading and writing abilities, making it a potential predictor for these language skills. This fact provides a basis for successfully utilizing preserved phonological skills in supporting patients during the recovery of written language.

5. Relationship between Demographic Factors and the Condition of Phonological Processing, Spoken, and Written Language in Aphasia

5.1. Influence of Gender on the Condition of Phonological Processing, Spoken, and Written Language in Aphasia

To assess possible differences between genders across various parameters such as severity of aphasia, comprehension of spoken language, spoken, and written language, a combined analysis of variance (ANOVA) and t-test for equality of means between different groups is employed. This analysis highlights the lack of statistically significant differences between

genders in the studied population when it comes to aphasia and its associated communicative skills. These data reject **Hypothesis I**, as gender did not influence, but the importance of phonological processing on spoken and written language is even more evident, dismissing the explanation of gender as a factor influencing the results of individuals in the Experimental Group.

5.2. Influence of Age on the Degree of Language Impairment in Aphasia

The results indicate that age has a limited impact on the severity of aphasia, as only about 0.9% of the variations in the outcome are dependent on it, with analysis of variance (ANOVA) confirming that the model is not statistically significant ($F = 0.257$, $p = 0.616$), supported by linear regression analysis (-0.095).

5.3. Influence of Age on Listening Comprehension in Aphasia

The studied influence of age on listening comprehension in the Experimental Group indicates that it has a limited effect, explaining about 31.6% of the variation in auditory speech comprehension, with analysis of variance (ANOVA) showing that the influence of age is not statistically significant ($F = 3.096$, $p = 0.089$), supported by linear regression analysis (-0.316).

5.4. Influence of Age on Spoken Language in Aphasia

The results indicate that age explains approximately 10.4% of the variation in spoken language, with analysis of variance (ANOVA) showing that the influence of age is not statistically significant ($F=3.241$, $p = 0.083$), and linear regression analysis additionally showing (-0.322) that age does not have a statistically significant influence on spoken speech.

5.5. Influence of Age on Reading in Aphasia

The analysis of the impact of age on reading abilities shows that only about 8% of the variation in reading can be explained by age, with the results of the analysis of variance

(ANOVA) not showing statistically significant influence (F=2.438, p=0.130), supported by linear regression analysis (-0.283).

5.6. Influence of Age on Writing Abilities in Aphasia

The impact of age on writing abilities is analyzed. The results from linear regression analysis indicate that 29.5% of the variation in writing abilities can be explained by age, with the analysis of variance (ANOVA) not showing statistically significant influence of age on writing (F=2.663, p=0.114), confirmed by linear regression analysis (-0.295).

5.7. Influence of Age on Written Language

The results from linear regression analysis show that only about 8.7% of the variation in written language can be explained by age, with the analysis of variance (ANOVA) supporting this due to the values of the F-statistic and p (Sig.= 0.098), which are not sufficiently low to establish statistical significance, further supported by the linear regression analysis (-0.308).

5.8. Influence of Age on Phonological Processing

The analysis of the impact of age on the results of Subtest 1 and Subtest 2 in the Experimental group does not show statistically significant correlations, with only about 3.5% and 5.3% of the variation, respectively, being explained by age. The results from the analysis of variance and linear regression analysis also do not establish statistically significant effects of age on the overall results of these subtests. In contrast, the analysis of the impact of age on the results of Subtest 3 yields statistically significant results, indicating that age explains about 18.3% of the variation in Subtest 3. The results from the analysis of variance and linear regression analysis also confirm a statistically significant effect of age on this subtest. Older individuals with aphasia perform less well in Subtest 3. These results may be explained by various aspects of cognitive functioning (e.g., memory and attention) and linguistic skills. Older individuals may have weaker cognitive resilience, which hampers their abilities for word blending and parsing, as well as information retention. The influence of age on the overall SAPA score explains about 10% of the variation in phonological processing, with the

analysis of variance (ANOVA) showing no statistically significant relationship (F=3.124, p=0.088) between age and the overall SAPA test result, confirmed by multiple linear regression (-0.317).

5.9. Influence of Education on Phonological Processing, Spoken, and Written Language

The analysis of variance (ANOVA) shows that for almost all areas of language abilities and parameters, there are no statistically significant interactions with the educational level of individuals. Particularly noteworthy are the statistically significant differences in reading results, indicating the influence of education on this aspect of written language skills ($F = 3.828$, $p = 0.034$). The presence of a statistically significant relationship between education and reading may be explained by greater reading experience among patients with higher educational status, which likely aids in the retention of their skills following brain damage.

5.10. Influence of Residence and Birthplace on Phonological Processing, Listening Comprehension, Spoken, and Written Language

The study focuses on the influence of factors such as residence and birthplace on phonological processing in patients with aphasia. Grouping the data according to capital city, urban, and rural areas reveals interesting trends, with participants from urban and capital environments showing closer values in aphasia severity and various aspects of language abilities, including listening comprehension, spoken speech, reading, and writing, compared to those from rural areas. However, the statistical analysis, presented through ANOVA and MANOVA, does not support a statistically significant influence of residence on the measured parameters in patients with aphasia. Consequently, the connection between urban environment and better communicative skills is more complex and likely influenced by other contextual factors.

The finding that demographic factors such as gender, age, duration of aphasia, residence, and birthplace do not significantly impact the condition of phonological processing, spoken, and written language underscores the importance of phonological processing itself in language abilities in individuals with aphasia and rejects **hypothesis I.** This result highlights the influence of phonological processing as a key factor, regardless of the individual's

demographic characteristics. This may have practical applications in the field of speech therapy, emphasizing the importance of assessing and addressing phonological processing in the diagnosis and treatment of patients with aphasia.

6. Relationship between Aphasia Duration and Phonological Processing

There is no observed relationship between the time elapsed since the onset of aphasic disorder and the moment of phonological processing assessment (aphasia duration). Linear regression analysis for the results of Subtest 1 shows that only 1.4% of the variability in phonological processing can be explained by the time elapsed since the onset of aphasia. Similar trends are observed in Subtest 2 and Subtest 3, where only about 8% and 4% of the variability, respectively, can be attributed to aphasia duration. Analysis of variance and multiple linear regression do not support statistically significant influences of time on the results of these subtests, as evidenced by the constant values of F and the coordinates of multiple linear regression. Similar conclusions are drawn regarding the overall result of the aphasia phonology test.

7. *Influence of Aphasia Severity on Phonological Processing*

Linear regression analyses on the results of Subtests 1, 2, and 3 in the context of the Standardized Assessment of Phonology in Aphasia (SAPA) underscore the significant influence of aphasia severity on various aspects of phonological processing in patients. For Subtest 1, it was found that approximately 36.8% of the variation in the degree of phonological processing can be predicted by the severity of aphasia, while for Subtests 2 and 3, the percentages are 40.5% and 53.1%, respectively. For the overall SAPA result, it is 51.8%. Statistical significance is highlighted by ANOVA (Subtest 1: $F=16.302$, $p < 0.001$; Subtest 2: $F=19.028$; Subtest 3: $F=31.691$; overall CAT result: $F=30.111$, $p < 0.001$) and multiple linear regression (Subtest 1: 0.607; Subtest 2: 0.636; Subtest 3: 0.729; overall SAPA result: 0.720).

In conclusion, the data from the conducted statistical analyses clearly emphasize the important role that the severity of aphasia plays in phonological processing in patients. These

results are of paramount importance as they highlight the link between the severity of aphasia and phonological processing, thus supporting **Hypothesis II**, that more severe language impairments will be accompanied by more significant issues in phonological processing.

SUMMARY AND CONCLUSIONS

1. The diagnostic tool "Boston Diagnostic Aphasia Examination" (Goodglass & Kaplan, 1983), successfully measures language qualities in its spoken and written form in aphasia among Bulgarian patients.

2. The diagnostic tool "Standardized Assessment of Phonology in Aphasia - SAPA" (Kendall et al., 2010), adapted for the characteristics of the Bulgarian language, effectively measures the condition of phonological processing in aphasia.

3. Individuals with aphasia exhibit impaired quality of phonological processing.

4. The condition of phonological processing in aphasia influences and is a predictor for the condition of spoken and written language in aphasia; the more affected phonological processing in aphasia, the more impaired the spoken and written language.

5. Phonological processing is a stronger factor for the condition of spoken and written language in aphasia than the influence of other factors such as the time between onset of aphasia and assessment, as well as various demographic factors (gender, age, education, birthplace, and residence).

6. The extent of phonological processing impairment is directly proportional to the extent of language function impairment; the more affected phonological processing, the more affected the language ability.

7. The examination of phonological processing as part of speech therapy diagnosis is valuable and necessary, providing important information regarding suitable therapeutic interventions.

RECOMMENDATIONS

Based on the results obtained from the study and data analysis, the following recommendations can be proposed:

1. **Implementation of the Standardized Assessment of Phonology in Aphasia (SAPA) as a diagnostic tool.**
2. **Integration of phonological processing examination into routine practice for aphasia.**
3. **Development of individualized therapy plans focusing on phonological processing.**
4. **Provision of training and guidelines for speech therapists regarding phonological processing in aphasia.**
5. **Development of potential therapeutic methods and strategies to support phonological processing.**
6. **Integration of results into therapy programs for individuals with aphasia.**

Implementing these recommendations could enhance examination and therapy for aphasia by directing efforts towards key aspects of phonological processing and assisting in the integration of this approach into overall speech therapy practice.

LIMITATIONS

Despite the positive aspects of the study and the obtained results, the following limitations should be considered:

1. **Generalizability limitations:** The sample of participants studied may not be representative of the entire population with aphasia.

2. **Validity limitations of the instruments used due to the lack of derived normative values for both tests.**

3. **Limitations in the ability to control external influences:** Influences from external factors that were not controlled during the study (e.g., participants' external emotional conditions).

It is important to take these limitations into account when interpreting the study. In the future, additional studies with larger samples and a wider range of participants may help build a more comprehensive understanding of the issues under investigation.

CONCLUSION

This dissertation has investigated the influence of phonological processing on spoken and written language in individuals with aphasia. Through conducting a detailed scientific study, followed by statistical analysis and hypothesis testing, it has been confirmed that phonological processing plays a significant role in both the spoken and written forms of language in this communication disorder.

Hypothesis I, which proposed that phonological processing is affected in aphasia, was confirmed. This result further emphasizes the importance of phonological processing in understanding language difficulties in aphasia. The assumption that demographic factors and the duration of aphasia influence the degree of impairment in phonological processing and manifestations in written and spoken forms of language was not confirmed. This result highlights the independence of phonological processing from external factors and underscores its key role in the language symptomatology of this acquired communication disorder.

Hypothesis II, which proposed that the condition of phonological processing is related to the qualities of spoken and written language in aphasia, was successfully proven. The results show that individuals with greater impairment in phonological processing experience more pronounced difficulties in both spoken and written forms of language. The role of phonological processing as a predictor for the condition of spoken and written speech in aphasia is established. It is also proven that the degree of impairment in phonological processing directly correlates with the degree and severity of language impairment. This result provides information about the relationship between phonological processing and the overall severity of aphasia.

CONTRIBUTIONS

The dissertation contributes to understanding aphasia and the role of phonological processing in the context of spoken and written language through an extensive and in-depth theoretical review, introduction of the methodology of scientific research, as well as statistical analysis and interpretation of the results.

The contributions of this work are divided into the following categories:

1. Theoretical Contribution:

The theoretical review presents classical and contemporary approaches and theories in the field of aphasiology, outlining significant hypotheses regarding the relationship between spoken and written language in aphasia, as well as potential impairments in phonological processing. Valuable data regarding the epidemiology of the communication disorder and its symptomatology are presented. An analysis of current disease classifiers concerning aphasias is conducted. The information presented in the theoretical review contributes to a better and contemporary understanding of the disorder, providing a basis for further research in this scientific field and creating a broader context for addressing the issue.

2. Methodological Contribution:

A foreign diagnostic tool for assessing phonology in aphasia, the "Standardized Assessment of Phonology in Aphasia - SAPA," has been successfully developed and adapted to the characteristics of the Bulgarian language. The study not only provides important data on the relationship between phonological processing and spoken and written language in this disorder but also introduces an accurate and reliable diagnostic tool into the Bulgarian scientific space, optimizing and modernizing the speech therapy diagnostic process.

3. Empirical Contribution:

The study provides a large dataset regarding the condition of phonological processing and the qualities of spoken and written language in aphasia, as well as the influence of

various factors on these parameters. A database is created that can be used in future scientific research.

4. Practical Contribution:

The provided information is of particular benefit to speech therapists and researchers seeking a better understanding of the interrelation between phonological processing and spoken and written language in patients with aphasia. The diagnostic tool for assessing phonology in aphasia (SAPA) can be successfully applied by speech therapists in their diagnostic practice, with the information it provides being used to create profiles of language characteristics, particularly phonological processing in patients. Profiling patients would support the development of therapeutic programs for the recovery of spoken and written language.

5. Methodological Contribution:

The methodological approaches and statistical methods used in the dissertation can serve as a model for future research in the field of aphasia and language disorders.

6. Social Contribution:

The extracted data on the epidemiology of aphasia and stroke, specifically their prevalence among younger individuals, represent a valuable informational resource that can significantly contribute to raising public awareness of these health challenges and the importance of prevention. The obtained information can be used to shape educational campaigns aimed at increasing public awareness of the risks associated with stroke and aphasia, as well as promoting a healthy lifestyle and prevention of factors contributing to their occurrence. Such initiatives could play a key role in preventing stroke and aphasia by promoting timely medical and speech therapy care, regular medical check-ups, and the prevention of language function through early speech therapy diagnosis in adults.

7. Future Directions for Scientific Research:

Directions stemming from the conducted dissertation may include several aspects for future research in the field:

(1) Conducting a more in-depth analysis of phonological processing, including the study of specific phonological mechanisms and processes that may be affected in aphasia;

(2) Investigating the interaction between phonological processing and other cognitive processes and carefully analyzing their relationship and influence on language functions;

(3) Exploring phonological processing in different types of aphasias and identifying the specific characteristics of each form of aphasia;

(4) Analyzing possible external and internal factors that may influence phonological processing in aphasia, including the effects of medications, psychological factors, and others;

(5) Developing and testing effective therapeutic strategies aimed at improving phonological processing in patients with aphasia;

(6) Applying the scientific discoveries and therapeutic strategies in real conditions with patients to assess their impact and contribution to improving language abilities in aphasia;

(7) Conducting controlled experiments and additional studies with groups of patients to provide a broader perspective on issues related to phonological processing in aphasia;

(8) Utilizing modern technologies and data processing to support the study and analysis of phonological processing.

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