UNIVERSITATEA BABEȘ-BOLYAI

FACULTATEA DE LITERE
ȘCOALA DOCTORALĂ DE STUDII LINGVISTICE ȘI LITERARE

THESIS SUMMARY

LINGUISTIC MANIFESTATIONS OF NON-FLUENT APHASIA IN ROMANIAN PATIENTS: A CASE STUDY

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CLUJ-NAPOCA
2024

Table of contents

This thesis is an exploration into the linguistic manifestations of non-fluent aphasia in the Romanian population. Aphasia is a neurological condition which affects language production and comprehension, being one of the most significant sequalae of stroke or brain injuries and affecting the quality of life of patients to a significant degree. There are two main reasons for this type of inquiry. The first one is to help advance the study of aphasia and offer clear linguistic descriptions of the conditions, to help understand the underlying speech impairments for better diagnosis and treatment. Secondly, and of importance to us as linguists, looking at the type of negative evidence offered by pathological speech allows us to refine theories of language and to narrow down the mechanisms that allow language to be formed.

The thesis contains seven chapters, including an introduction, a chapter dedicated to reviewing the literature on aphasia and the linguistic study of this condition, a chapter dedicated to the research questions and objectives, another one related to the methodology of the study, a chapter for the results, one for discussions, and a final conclusion. It also contains two annexes, including the full original corpus. In this summary, I briefly present the main points of the thesis, chapter by chapter.

The literature review chapter begins with a brief presentation of the anatomy, physiology, and neurobiology of language, to help guide the reader in understanding the modules of language that might be affected by the different types of aphasia and their varying etiologies. After this introduction, the chapter presents an overview of aphasia. This section includes the history of understanding and researching aphasia, as well as the different types of

aphasia with particular linguistic manifestations characteristic to each. What follows is an inventory of the main parameters for the linguistic study of aphasia. This subsection includes an introduction to the main parameters used for analysis in the present study as well, together with explanations of the typical values existent in Romanian, for non-pathological speech. That is because the reader of the thesis is not expected to have mastery of this language. Necessary translations, explanations, and glosses are provided throughout the thesis. Then, we move on to discussing some linguistic theories used in the study of aphasia that offer possible explanations as to the disrupted patterns of speech. I emphasize that these theories are presented as background information to serve as a secondary point of inquiry for the thesis, and are not subjected to analysis in the thesis as a main objective.

The next chapter is the one dedicated to the research questions and objectives. The thesis employs a qualitative design contoured around specific research questions, applied to an original corpus of speech samples gathered through interviews. The main research aim of the present paper is to describe the speech of Romanian aphasics and identify what is specific about it. This implies a multilateral approach to the analysis of the corpus, at different levels of analysis. In the literature, aphasic discourse was analyzed phonetically, morphologically, and as a unit with specific macro-features. Building on these aspects, the research questions that guide this study are:

Q1: To what extent are acoustic and articulatory features of vowels and consonants affected in aphasic speech in Romanian?

Q2: To what extent is the speech of non-fluent Romanian aphasics agrammatic?

Q3: What are the features of the Romanian motor and mixed aphasics' speech?

In order to answer these research questions, the present paper proposes the following objectives:

- O1: To compile an original corpus of speech samples from Romanian patients with motor and mixed aphasia.
- O2: To analyze specific acoustic parameters related to vowel formation in the corpus.
- O3: To analyze specific articulatory errors and compensatory behavior in the formation of consonants in the corpus.
- O4: To identify the instances of morphological errors encountered in the corpus.
- O5: To assess the degree of agrammatism in the corpus against a language-specific context.

- O6: To identify the patterns and particularities of pathological speech in the corpus.
- O7: To compare the data cross-linguistically with results from international literature across the analyzed variables.
- O8: To assess linguistic hypotheses in light of the results obtained via the analysis of the corpus.

The hypothesis assumed for the study is the null one, i.e., the errors will be the same as observed in international literature. As such, it is expected that the pathological speech samples of people with non-fluent aphasia will exhibit the following traits across the analyzed variables:

- Phonological errors:

Patients with non-fluent aphasia are expected to have non-congruent formant values for vowels compared to individuals with non-pathological speech, but not systematically or consistently. They are expected to display articulatory issues and phonemic paraphasia that reflect phoneme omission and substitution. Consonantic features are expected to be affected in hierarchy with place of articulation more frequent than voicing, more frequent than manner of articulation.

- Morphological errors:

Patients with motor and mixed aphasia are expected to display a noun-heavy speech, with omissions of functional items (articles, prepositions, conjunctions). Verbs are expected to be realized correctly for agreement with subject and mood, but not for tense. Where errors occur, omissions are expected to be more frequent than substitutions in non-fluent aphasia.

- Macrolevel errors:

Patients with non-fluent aphasia are expected to display an effortful, telegraphic speech, with breaks, fillers, and emotionally charged items. Echolalia and paraphasia are expected as specific traits.

The following chapter is dedicated to explaining the methodology of the paper, for data gathering, interviews, transcription, and analysis. In terms of data gathering, primary data for the analysis was gathered through an investigation protocol applied to patients of the neurological clinic of the County Emergency Hospital of Cluj-Napoca. A primary corpus of interviews from 14 patients was compiled. The investigation protocol is based on the Aphasia TalkBank protocol, but slightly modified for both cultural concerns, as well as a personal

concern for the patient. A similar albeit not identical methodology is employed in Kutasi (2019), with whom I have had personal communication regarding the suitability of this protocol for Romanian patients prior to adapting and implementing it myself as well. There are three steps in the protocol: spontaneous speech, semi-spontaneous speech, and procedural speech.

Spontaneous speech samples were elicited through the interview method. The questions asked were related to the patient's condition, their education, workplace, background, family, etc. Unlike the suggested Aphasia TalkBank protocol, I chose not to discuss the moment of the stroke, so as to not risk re-traumatizing the patient, especially since these interviews had been conducted within less than two weeks since the stroke. Instead, for a more complex question that could elicit a longer response, I asked the patients for a personal narrative of an important event in their lives, or when this prompt did not render successful results, I asked patients to tell me stories of places they have visited.

The purpose of this protocol was to obtain speech samples where we can observe fluency, the omission of or compensation through certain parts of speech, frequency of pauses for recollection, and other patterns of affected speech. This is considered to be a protocol that involves personal narratives as discourse type. However, as noted in Bryant, Ferguson, and Spencer (2016) "such samples var[y] considerably from individual to individual on the basis of topic and therefore semantic content, vocabulary and grammatical structure" which "complicate[s] comparison of conversational samples within and between individuals" (502). For this reason, more structures and samples were elicited through the second step in the protocol.

The protocol for semi-spontaneous speech is of the type image description. The first stage of this protocol is matching between word and concept. The patients were presented with images of everyday objects and asked to name them. Additionally, they were shown images with colors, and asked to give the name of the color. The second stage was eliciting a descriptive narrative from picture sequences or pictures with more complex components. Patients were shown 3 pictures and were asked to describe the characters and situation in each frame, and the subsequent event described by the series. This tests their ability to connect events in a series, to explain consequences and make inferences about the events. The pictures are the ones provided in the Aphasia TalkBank Protocol, including the "Umbrella Story" image, the "Broken Window Story" image, and the "Cat Stuck in a Tree" image. The purpose of this protocol was to obtain samples that allow for finding patterns in the disruption or cohesion between concepts and linguistic tags. Given that this was the part of the protocol that allowed for most consistency in the vocabulary used across patients, samples from this part were used

in the analysis of specific cases of misarticulation or phoneme disintegration, as well as word retrieval issues.

The protocol for procedural speech within the Aphasia TalkBank is to elicit the description of the process of making a peanut butter and jelly sandwich. To adapt this to the Romanian background, where these ingredients might not be obviously associated with a sandwich, and also to lighten the task, I asked the patients to explain how they would go about making a simple sandwich. The purpose of this protocol was to allow for research related to the description of an imagined task. This implies the use of verbs of movement and doing, as well as of an irrealis mood, which allows for a more complex morphological analysis.

The chapter continues with explanations regarding the process of obtaining approvals, some informed consent considerations, inclusion and exclusion criteria, a description of the recording conditions, and some notes about the transcripts. All transcripts were manually realized. The choice for manual transcripts was evident, since automated models are not yet well-trained for pathological speech, and especially in a language where the corpus of aphasic speech is as limited as it is for Romanian. The need for case-by-case interpretations and decisions resulted because, "[c]ompared to other neuropsychological assessment instruments, aphasia-related assessments are particularly difficult to computerize, [and therefore to automate,] as they typically depend on subtle and complex linguistic judgments about the phonological and semantic similarity of words, and also require the examiner to interpret phonologically disordered speech" (Adams et al. 2017, 1).

The first transcript for each patient was made using a modified template of the protocol provided by the Aphasia TalkBank. These transcriptions were orthographic, i.e., all utterances were transcribed as heard on recording, including noises, fillers, interjections, etc. In cases where background noise was too significant, or the patient's speech was too mumbled, the transcription was not made for that fragment (marked with 'XXX' on transcript). After reviewing these transcripts twice, each data sample was then evaluated for appropriateness and relevancy for inclusion in the study, on the various levels of analysis. Samples that were included in the paper for the qualitative analysis have been glossed for or translated in English, with specific instructions on the speech deviations.

The second round of transcripts was made to enable a morphological analysis. All noises, fillers, interjections, and all fragments of interviewer speech were removed, and words were parsed according to their parts of speech, with specific considerations for errors and false or abandoned productions.

In terms of the analysis, there were three major aspects to tackle in the thesis: a phonological analysis that included an acoustic exploration of vowels; a morphological analysis; and a macro-level analysis of discourse features reflective of aphasic speech. For the phonetic analysis, each recording was duplicated and then edited in order to create samples of short answers from the patients. For each patient included in this analysis, I identified the sequences that included productions of vowels in the selected contexts (the same or similar words across patients) and uploaded them into the Praat software for phonetic analysis as .wav files. For most subjects, these sequences were taken from the first part of the second protocol based on a single-item picture naming task. Formants were identified using the Praat software and doublechecked manually, and values for formants were mean frequencies of the manual selection of each vowel.

For plotting the vowels, the average value of F1 and F2 across patients was calculated. Then, these values were converted to values on the Bark auditory scale using Zwicker and Terhardt (1980), as made possible by the template provided by Deterding (2006). The vowels were represented on a chart where the F2 values constituted the x axis and the F1 values the y axis. As per Deterding (2006), this allows for "a representation of the open-close and front-back quality of the vowels" (n.p.). The vowels included in the study are /i/, /e/, /a/, /u/, and /ə/, for which the data was least corrupted. For /o/ and /ɨ/, speech samples registered noises and formant values were difficult to extract in the same context across all speakers.

For the morphological analysis, the count for each category was done manually and checked against the number of correct units for each protocol. Separately, an inventory of the instances of omission of functional words was taken from each full transcript. In order to check the degree of agrammatism, a contextualization for the most commonly omitted parts of speech was realized. The rate of omission for each part of speech considered for this part of the analysis was calculated by extracting the percentage of omissions from the total number of contexts (correctly realized + necessary but omitted).

For the macro-analysis of each patient's speech, I have counted the duration of in-speech pauses, the number of fillers and that of interjections used by each patient. Of particular interest are the instances of echolalia, mentioned individually, and of paraphasia as well, phonemic, neologistic, and semantic. For the analysis of the phonemic paraphasia, I have separated them by type, position of affected phoneme, type of errors produced, and consonantic feature affected in the case of consonants substitution.

The first important result of this thesis is the original corpus. A total of 14 patients were recorded for the present study. After further investigation into the exclusion criteria, three

patients were removed. P1 was not considered because for that interview a different protocol was used. For P6, the discharge papers recorded diagnosis of dysarthria, which is an exclusion criterion. P10 was not a native speaker of Romanian. The following table presents the corpus:

Patient	Age	Gender	Protocols completed	Interview duration	Aphasia type	Education	Urban/Rural provenance
P2	77	F	3 out of 3	20:33	motor	primary	urban
P3	86	F	2 out of 3	10:39	mixed	N/A	rural
P4	63	M	3 out of 3	11:15	motor	high school	urban
P5	66	F	3 out of 3	10:06	mixed	N/A	urban
P7	79	F	1.5 out of 3	18:42	motor	N/A	urban
P8	69	F	0.5 out of 3	14:18	motor	higher	urban
P9	50	M	3 out of 3	16:54	motor	N/A	rural
P11	74	M	3 out of 3	12:06	motor	N/A	urban
P12	72	M	1.5 out of 3	08:00	mixed	N/A	urban
P13	54	F	3 out of 3	07:47	motor	N/A	rural
P14	70	M	3 out of 3	12:24	motor	N/A	urban

In terms of the acoustic analysis, the following results emerged:

	F1 (Hz)				F2 (Hz)			
	Avram (1963), Șuteu (1963)	Teodorescu (1985)	Renwick (2012)	Present corpus	Avram (1963), Șuteu (1963)	Teodorescu (1985)	Renwick (2012)	Present corpus
/i/	310	236	330	434	2145	2144	2441	2030
/e/	399	461	522	484	1935	1778	1875	1941
/ə/	497	508	557	502	1479	1335	1480	1697
/a/	703	640	779	613	1310	1193	1369	1629
/u/	339	286	386	380	850	703	1194	1580

F1 values for /i/ are higher in the aphasic population, while values for /a/ are lower. This reflects a lowering of /i/ and a raising of /a/, since F1 values are inversely proportional to vowel height. F2 values are higher for all vowels except /i/, showcasing a fronting of back and central vowels. When plotting the values of formants for each vowel on a Bark scale, the following figure resulted:

F2 (Bark)
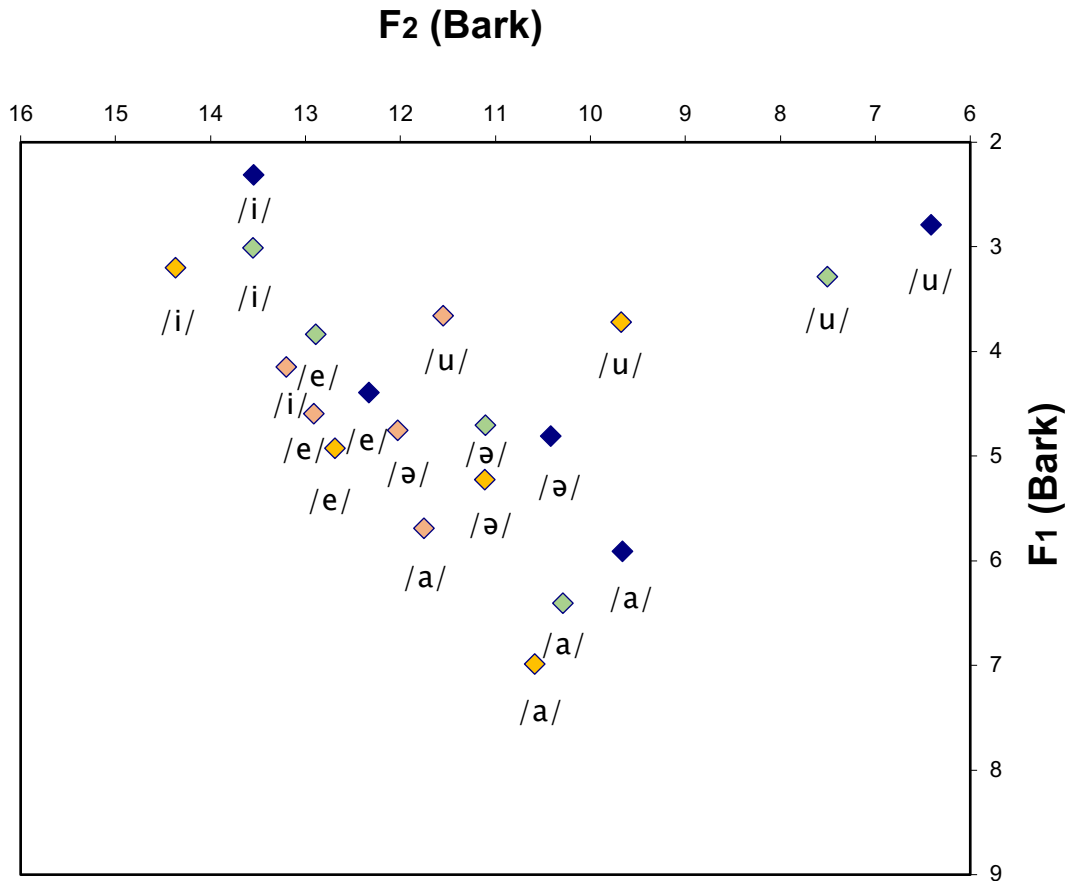
Distribution of vowels by formats (pink - present corpus; blue - Teodorescu (1985); green - Avram (1963), Şuteu (1963); yellow - Renwick (2012)).

As can be seen on the graph, the vowel space for aphasic Romanian is narrower than the space delimited by values from the three corpora of non-pathological speech. High vowels /i/ and /u/ are lowered, low vowel /a/ is slightly raised, and back vowels /a/ and /u/ are fronted. This distribution showcases a tendency for vowel centralization in aphasic Romanian, which is a phenomenon noted in other languages as well, at least for some vowels (including a lowered /u/ in Arabic in Hisham (2021); and other instances recognized in the literature and in individual cases in Haley, Ohde, and Wertz 2001).

In terms of the morphological analysis, the results show a preference for noun and verb usage among the patients. However, functional items were also used by the non-fluent aphasics.

Count of parts of speech by type in corpus

128	454
279	93
211	249
241	
105	
120	569
198	

■ Verbs ■ Auxiliaries ■ Articles ■ Nouns ■ Pronouns ■ Adjectives
■ Numerals ■ Adverbs ■ Prepositions ■ Conjunctions ■ Negations
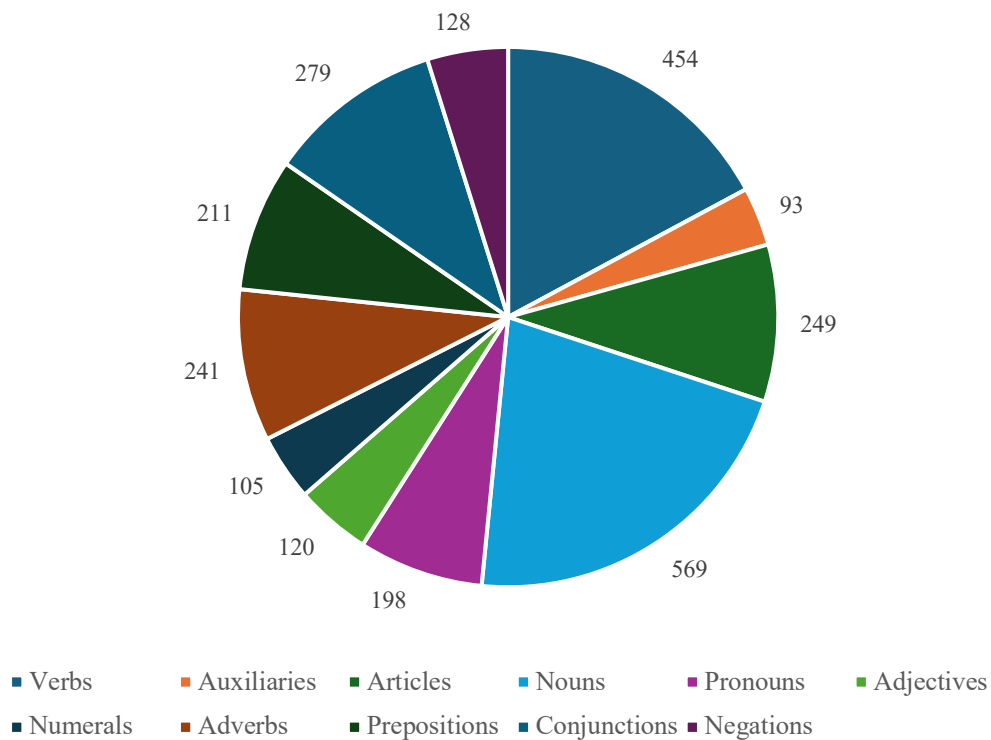
A total of 34 instances of morphological errors were registered, with 26 being omissions and 8 substitutions. That these patients displayed morphological errors is important, but it must also be mentioned that apart from these instances they produced correct utterances. In assessing the degree of agrammatism, we need to consider the rate of omission of functional items. The rate of omission was considered for articles (definite and indefinite), for prepositions, and the conjunction "să" for subjunctive. However, the percentages were not reflective of an important deficit. The only case that raised some questions is that of the indefinite article. Calculating a total for the corpus (including all patients) shows a 4.5% rate of omission for definite articles (5 omitted out of a total of 111 identified contexts) and a 44.9% rate of omission for indefinite articles (71 omitted out of a total of 158 identified contexts). As the indefinite article is placed before the noun as a separate word, this result could be indicative of a greater computational or—perhaps more likely—articulatory effort required by the indefinite compared to the definite article. Another aspect of interest to tackle when it comes to article use is related to misuse of gender agreement, which has been noted in the literature as well, and it can be indicative of a difficulty with valuation via syntactic operations of the gender morphemes on articles, or it can

be an issue of gender assignment which would represent an argument against the hypothesis that nouns are stored in the lexicon with their gender encoded.

Of interest for this part of the analysis was the difficulties patients had with numeral production. This is something that is generally noted in the literature on aphasic patients. The difficulties of producing complex numerals seems to be indicative of a syntactic deficit, since simple numerals can be produced via lexical retrieval, yet complex numerals are the result of conceptual operations that reflect syntactic derivations.

Another result of the morphological analysis that raised some interesting questions is related to verb usage. Linking and auxiliary verbs have been omitted in the corpus, but only in the present tense, which would signal a reduction in effort on the part of the aphasic speakers, since their presence is not required under pragmatic constraints. However, another issue is related to the use of subjunctive. The errors recorded in the corpus reflected the misuse of the subjunctive mood, and not of tense, as expected from the international literature. The analysis of examples of misuse of mood led to an inquiry into the Tense Pruning Hypothesis and provided evidence against it, on the basis of the order of negation, mood, and tense node realization.

Regarding the macro-level analysis, in-speech breaks were the most consistent, with all patients displaying the need for pause for thinking or trying to instantiate speech. Similarly, fillers occurred in the speech of all patients, which reflects a need to fill the silence that is left by their inability to produce speech. Fillers appear normally in non-pathological speech as well, but in the cases of the patients interviewed for this thesis, an abundance of such fillers was noticed. Fillers and breaks paired with another trait of aphasic speech which was self-repetition. Patients frequently repeated the same sequence in an attempt to formulate correct words or phrases or improve their pronunciation of the target word/phrase in cases where they noticed such errors. This behavior is indicative of the patients' awareness of their condition as well as the mistakes that occurred.

Another important trait of the aphasic speech is the presence of paraphasia. These are errors in word production that can be characterized as phonemic, semantic, or neologistic. All three types were present in the corpus. Of particular interest are the phonemic paraphasia which show phoneme omission and disintegration, which allowed us to examine the way in which consonants are affected in aphasic speech. In terms of the consonantic features that were affected in erroneous speech production, 24 of the substitution errors showed change in manner of articulation, 14 in place of articulation, and 12 in voicing. The most frequent substitutions were of a fronting nature, implying that muscle control especially of the root of the tongue is

weakened, making it more difficult for aphasics to produce back sounds. The presence of a few instances of backing as well could indicate a tendency for centralization of sounds, indicative of limited tongue movement. This would be consistent with results from the analysis of vowel formants which showed a tendency for vocalic centralization. Spirantization and gliding were also common types of substitutions, while stopping only occurred around half as frequently. This is consistent with muscle weakness and reduced articulatory force. Stops require a greater articulatory force than fricatives or glides, because of the mechanism of their formation. Pressure needs to build up because of a strong occlusion, and then be released with an explosion.

Another aspect to be examined when it comes to paraphasia is whether the produced non-words in aphasic speech follow the Sonority Sequencing Principle, which posits a hierarchy of sonority that allows for syllable formation in any given language. The sonority hierarchy of sounds is as such, from most to least sonorous: vowels > glides > liquids > nasals > fricatives > stops (Buckingham and Christman 2008, 130). The non-words produced by the aphasics included in this study all followed this principle, providing additional evidence to support it.

To conclude, this thesis presented an exploration of the main features of non-fluent aphasic speech in Romanian patients, by investigating their productions from an acoustic and phonological perspective, conducting a morphological inventory of correct utterances and errors, and looking for the specific traits that characterize a general pattern of non-fluent aphasia. The thesis concluded with the following answers to the research questions:

Q1: To what extent are acoustic and articulatory features of vowels and consonants affected in aphasic speech in Romanian?

The speech of non-fluent aphasics, native speakers of Romanian, shows a reduced vowel space, with a tendency for vowel centralization manifested through fronting of back vowels and lowering of high vowels. Consonant omissions, substitutions, and faulty additions were noted, with omissions being the most common. Manner of articulation was the most affected consonantic feature. Gliding and spirantization were among the most common changes in terms of manner of articulation, fronting more common than backing in terms of place of articulation, and voicing more common than devoicing.

Q2: To what extent is the speech of non-fluent Romanian aphasics agrammatic?

The data gathered in the present study shows a limited degree of agrammatism among non-fluent Romanian aphasic speakers. Omissions of functional items were more frequent than substitutions, but the presence of the latter phenomenon was noted as well. The context of functional item demand and realization shows a preserved knowledge of grammar, with the rate of errors being more indicative of a rational account based on the "economy of effort" hypothesis rather than generalized impairment. The conclusion was in favor of "agrammatism revisited," for which I highlight the following implications. First, this increases the demand for research into non-fluent aphasics, speakers of highly inflected languages, to obtain as much information as possible before reaching a conclusion regarding agrammatism in aphasia. Secondly, this can have implications for how we understand the relation of grammar and lexicon and their organization in the minds of speakers.

Q3: What are the features of the Romanian motor and mixed aphasics' speech?

The Romanian non-fluent aphasics display a telegraphic, effortful, syllabicated speech, rich in fillers, pauses, and interjections. Comprehension seems to be intact in non-fluent aphasics, with isolated exceptions for mixed aphasia.

Besides these answers, the thesis also provides a plethora of further research directions to be undertaken. All of these suggestions are based on the primary observations realized in this study. As such, they are informed and should provide a good starting point for fruitful research. The thesis is original in its corpus and approach to the data, and its impact stems from the characterization of non-fluent aphasia as informed by a Romanian-speaking population, with all the particularities that implies.

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