Recognizing Lexical Units in Portuguese

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Abstract

Recognizing the lexical units in the speech chain in Portuguese is one of the most difficult problems in processing, as the listener must delimiting them, facing distortions, pauses and hesitations, in addition to sociolinguistic and contextual phonetic variants. Such phenomena indicate that, in a pre-lexical phase of recognition, the receiver restores the information received, with inferences through the crossing of contextual data extracted from utterances (intake) with those coming from their permanent memories (topdown processes). The boundaries between lexical units are opaque, particularly when they are clitic due to external closed juncture or sandhi. Spontaneous speech frequently presents distortions and ruptures, instead of signaling ways to the listener, for dividing the speech chain into larger, gradually smaller phrases, until reaching lexical units. There are even ruptures at the inframorphemic and even intrasyllabic level. The difficulty in delimiting is very great when the listener is faced with new words. The methodology is bibliographic and I examined the texts of researchers who have addressed the topic. I conclude that the absence of isomorphy between the phonological and the morphosyntactic words challenges a scientific explanation of how the listener solves this contradiction, since, for the lexical item, she/he must pair the intake with the respective phonological lexical item in her/his mental dictionary.

Keywords: lexical units, processing, speech chain, Portuguese, closed juncture or sandhi, phonological and the morphosyntactic words

1. Introduction

Lexical unit recognition in the speech chain raises very complex questions that will be examined in this paper. Among such issues, I will deal with one relating to slicing, with emphasis on Frauenfelder's (2002) ideas, such as the mapping of one into many, that is, ambiguity.

For delimiting the speech chain lexical units, the listener must face, at a minimum, the following problems:

a) the distortions, pauses and hesitations that characterize spontaneous speech;

b) sociolinguistic variants, determined by geographic, social, cultural, age, genre and even idiosyncratic factors;

c) contextual phonetic variants, determined by the phenomenon of coarticulation;

d) items delimitation opacity, in particular, clitics or unstressed words as the result of phonetic changes, that junctions or closed external sandhi present;

e) new lexical items not stored in the phonological mental lexicon.

2. Distortions, Pauses and Hesitations That Characterize Spontaneous Speech

The pioneering works of Trager (1958), Trager & Bloch (1941), Goldman-Eisler (2016; 2018), Pittenger et al. (1960) and McQuown (1971) empirically demonstrated that spontaneous speech develops with distortions, pauses and hesitations.

Whether it is because we have difficulty for planning new information, or finding the right word to cover the idea; whether to choose the appropriate register or style for the communicative situation, or because erroneous calculations were made to control the vocal gestures synergisms, the fact is that spontaneous speech presents distortions and ruptures that do not coincide, instead of signaling ways to the listener, for dividing the speech chain into larger, gradually smaller phrases, until reaching lexical units. There are even ruptures at the inframorphemic and even intrasyllabic level, as I will demonstrate.

An experiment carried out with Elementary School 8th grade students, whose goal was verifying their discrepancies

between pauses, as well as hesitations in oral narratives and the punctuation signaling the written narrative syntax, we found pauses and hesitations in students' oral narratives, in all the levels already mentioned (Scliar-Cabral & Rodrigues, 1994). This paper deals, only, with pauses and hesitations that harmed the receiver in recognizing the lexical unit, as shown in the examples:

a) [ˈew ˈfuj pĩ] (I was draw…), in which the child hesitated on the first syllable, instead of enunciating the entire word [pĩˈtar] (drawing): the complete sentence would be [ˈew ˈfuj pĩˈtar] (I was drawing). Part of the sentence, that is, the verb phrase, was later corrected, but preceded by a pause of 222 ms: [ˈfuj pĩˈtar] (was drawing).

b) [ˈdejliˈf] (hence he f…). I will return to this example when discussing the processes of external closed juncture or sandhi. Now, I am dealing with hesitations that make it difficult for the receiver to recover the lexical unit: in this case, the subject was trying to say [ˈfes] (did), but a false start occurred lasting 197 ms. and he stopped at the syllable initial consonant, the voiceless fricative [f].

Distortions phenomena, such as pauses and hesitations indicate that, in a pre-lexical recognition phase, the hearer restores the received information, with inferences through the crossing of contextual data extracted from the utterances (intake) with those coming from their permanent memories (topdown processes).

3. Sociolinguistic Variants

Although the same phoneme sociolinguistic variants can be very discrepant, this does not constitute a factor for preventing a lexical unit recognition, as the phonological system is the same. For example, when emitting the third segment of the word /ˈkuRta/ (short), speakers may produce the following variants [r, x, R, ɾ, ʁ, h, ɣ], depending on their sociolinguistic variety.

If we examine the first two possible variants [r, x], we will see that they do not share any phonetic feature, except the feature [+cons]. In effect, the first is a liquid apicoalveolar vibrant consonant, while the second is a voiceless velar fricative consonant, but the listener will recover the word /ˈkuRta/ (short), as children recorded it (intake) from their sociolinguistic variety, during language acquisition, in their phonological mental lexicon.

The main argument in favor of this hypothesis is that it is neither possible nor necessary for our lexical memory to record all sociolinguistic variants of the same word phoneme in the phonological mental lexicon. It remains to demonstrate empirically, at which processing stage, the intake conversion of what was heard occurs for matching it with the phonological item in the mental lexicon.

There is a lot of empirical evidence that such conversion occurs at a very early operations stage. Researchers use pseudowords or logatomes (invented items built with phonemes and their combinations compatible with those existing in Portuguese) as experimental stimuli, which target are inferential treatment explanations that take place without lexical access, such as, for example, tests of initial vowel (also a syllable) and of the consonant deletion (Scliar-Cabral, Morais & Arruda Nepomuceno, 1991).

I will comment on data obtained by Arruda Nepomuceno (1990), relevant to the argument, from her doctoral research, of which I was the advisor. She applied several tests to a population of 91 subjects, distributed into three groups: illiterate, 21 subjects, G1; semi-literate, 45 subjects, G2 and literate, 24 subjects, G3. One of the hypotheses raised was the alphabetic system knowledge effect on the syllable segmentation metaphonological abiliity, more precisely, that only subjects with the alphabetic system knowledge (G3, literate) would be able to delete the syllable initial consonant. For this goal, the researchers designed a tool that consisted of two lists of twenty pseudowords, the first, a VˈCV type, as in the example 'aˈfu' and the second, a ˈCVC type, as in the example 'fur'. The VˈCV type was applied first to demonstrate that illiterate and semi-literate people would not be able to erase the first segment of the CVC type, not because they had not understood the command, as they were able to do so, without any difficulty, in the VˈCV type (as can be seen, the first segment is a syllable, consisting of only one vowel).

Most of the responses, after applying the instrument, surprised the researchers, as they were not foreseen in the hypotheses: the illiterate and semi-literate, instead of eliminating the stimuli initial segment, accommodated the pseudoword heard to an approximate word of their own phonological mental lexicon, for example, for the stimulus 'fur', they answered "furo" (hole). Thus, G1 provided 21% of responses with lexical access and G2, 12% in the initial segment deletion test in VˈCV; in the initial segment erasure test ˈCVC, G1 provided 31% of responses with lexical access and the G2, 17%. This occurred because illiterate and semi-literate people were unable to control the natural compulsion, upon hearing a linguistic stimulus, to access a known word in their phonological mental lexicon, therefore, with approximate meaning.

Responses followed the subject's sociolinguistic variants and are evident in the initial consonant deletion test, whose

stimulus was ´CVC, therefore, ending with a consonant, which always presents many sociolinguistically determined variants: according to stimulus 9 /´fuR/, for the last segment, there are the the following sociolinguistic variants: [r, x, R, ɾ, ʁ, h, ɣ].

As I stated at the beginning of part 2, such sociolinguistic phonetic variants do not constitute a factor that prevents the recognition of a lexical unit, to delimit the speech chain lexical units, as the phonological system is the same. The difficulty in delimiting the speech chain lexical units occurs when the variants are lexical, such as: "tangerina" (tangerine), "bergamota" (bergamot) or "vergamota" (vergamot): Brazil Southern; "mexerica" (tangerine): Southeast region; "mimosa" (tangerine): Curitiba. Other lexical variants: "mandioca", "macaxeira", "aipim", "maniva", "castelinha", "uaipi", "maniveira" and "pão-de-pobre" for cassava. I will move on to the third problem, the contextual phonetic variants, determined by the coarticulation phenomenon.

4. Contextual Phonetic Variation

The contextual phonetic variation problem, as a result of coarticulation, clearly demonstrated through cinefluorography and electropalatography (Garman, 1990: 10-15), challenges an explanatory theory of how we segment the speech chain, because there are many interdependence relationships between the mental representations of our articulatory movements and the way we analyze the acoustic signal: the commands for producing sounds are syllabic and not for each isolated phoneme performance.

Therefore, the articulatory cycles for each of the muscles, all necessary for the phonemes performance that make up a syllable, are not isochronous, nor in appearance independent of each other: some cycles in the preceding segment even anticipate the following segment cycles.

Among the theories that try to solve this problem, Blumstein & Stevens' (1981) spectral template theory and Studdert-Kennedy's one (1981), which proposes the non-existence of an intermediate phase for phoneme identification, stand out. The existence of physical invariants in the acoustic signal, as proposed by Blumstein and Stevens, is inconsistent with the distortions and sociolinguistic variants in the speech chain and both theories do not account for coarticulation, which upsets mental representations traditional notions of speech units and their processing.

Units larger than the syllable, as well as the syllable itself, including a single segment, were explained a long time ago by the Prague Linguistic Circle and the Firthians, based on prosodic phenomena, as well as phonetically conditioned allophones descriptions. As an example, retroflexization (distant change) in Sanskrit, formalized by Allen (1951), and vowel harmony are cited, and, more recently, theories that develop rhythmic patterns notions to support performances: all of this does not invalidate challenging an explanatory theory of how we segment the speech chain. I will move on to the fourth challenge regarding the speech chain items delimitation.

5. Lexical Items Delimitation Opacity: External Closed Juncture or Sandhi

I will then discuss extremely complex challenges for lexical unit recognition: external closed junctures or sandhi, the identification of unstressed words (clitics), the isomorphy absence between phonological and morphosyntactic words and the lexical unit format in the dictionary phonological mind.

Daniel Jones (1931) considered the lexical item limits as marked by prosodic saliences, that is, the longest duration, the stronger stress, or the highest frequency, called by the Prague Linguistic Circle as a culminative function: Troubetzkoy (1939) called the obligatory prosodic saliences as aphonematic delimiters signals, either at the lexical units beginning or at the end. He also pointed out that, in the sentence, there is a redistribution of the prominences of all lexical units in favor of a syllable that is more prominent than the others, in a single unit.

Troubetzkoy also added phonematic signs (which perform a phoneme) to the prosodic simple or complex saliences, provided by the speech chain to delimit lexical units: this is the phoneme exclusive distribution, or its combinations, whether at the lexical unit start or end. In Portuguese, we have the example of the nasal diphthong /´ẽj/, which only appears at the lexical unit end, as in /po´rẽj/ (however); an example in English is the aspirated velar consonant /h/, which only appears at a syllable start, as in /hat/.

Such phonetic signals (which perform phonemes) can be positive or negative: the examples I have already provided were positive signals. In BP, there are only five or six consonants (according to some phonological theories) that can appear at the end of a lexical unit, namely |S|, |R|, |W|, /w/. /y/; (some phonologs add the archiphoneme |N|), which can also appear at the end of a lexical unit internal syllable, when they no longer appear as positive signals of a lexical item final delimitator. However, whenever consonant signals perform phonemes /p/, /b/, /t/, /d/, /k/, /g/, /f/, /v/, /m/, /n/, /ɲ/, /l/, /ʎ/ /these are at the start of a syllable, which could also be the lexical unit start (except consonants /ɲ/

and /ʎ/, the last one only appears at the personal pronoun "lhe" /ʎI/ (him, her) and both also appear in linguistic loans.

Phonemes /l/, /r/ are in second place in the cluster with stops and fricatives /f/, /v/, as in the examples /ˈkɔbrI/ (copper), /ˈsiklU/ (cicle), /ˈvidrU/ (glass), /ˈlivrU/ (book). Note that semivowels /w/, /j/ can appear at the syllable end, in decreasing diphthongs, or at the syllable start, in increasing diphthongs, called imperfect, as they are in free variation with the respective homorganic vowels /u/, /i/, when the speaker produces a hiatus, instead of the diphthong. Such ambiguities found in this step reaffirm Frauenfelder's (2002) proposal of mapping one into many.

I will show, however, below that prosodic signals alone are not enough to delimit lexical items, because, in the speech chain, when lexical units are joined to each other, profound changes can occur, due to the isomorphy absence between the morphosyntactic and the phonological units, also highlighted by Mattoso Camara Júnior (1964: 68-97; 1969: 54-9) and due to the external closed juncture or sandhi, which I will detail below.

Trager & Bloch (1941) introduced the concept of closed external juncture, as the modifications resulting from the encounter between the final and starting utterances segments. The concept was extended to changes resulting from contact between lexical unit segments and even to those resulting from contact between morpheme segments, within a lexical unit (closed internal juncture), phenomena discovered by Hindus, with emphasis on Panini, under the name of sandhi, when describing Sanskrit.

Junctures can be closed or open: in the first case, such considerable changes occur that the boundaries between units disappear, while in the second, the delimitation remains clear. The *liason* phenomenon in French is one of the most evident closed external juncture examples, as in *Il était un bon élève* (he was a good student), in which the syllabic separation becomes: I.lé.tai.tun.bo.né.lè.ve, therefore, the boundaries between lexical items were eliminated, proving that acoustic cues are not sufficient to delimit lexical units in the speech chain.

Let us examine some examples of external closed juncture or sandhi in BP (the phonetic transcriptions refer to my own sociolinguistic variety):

a) contact between the final consonant and the lexical unit starting vowel: [ˈmar] (sea) + [aˈazul] (blue) = [ˈmaɾaˈzul], whose syllabic separation becomes [ˈma.ɾa.ˈzul];

b) final unstressed vowel assimilation /a/ by the starting unstressed vowel of the following lexical unit: [ˈluva] (glove)+ [uˈzada] (weared) = [ˈluvuˈzada], whose syllabic separation becomes [ˈlu.vu.ˈza.da];

c) final segment crasis with the following identical starting segment: [ˈboka] (mouth) + [aˈzeda] (sour) = [ˈbokaˈzeda], whose syllabic separation becomes [ˈbo.ka.ˈze.da]; or [ˈmezas] (tables)+ [sepaˈɾadas] (separated) = [ˈmezasepaˈɾadas], whose syllabic separation becomes [ˈme.za.se.pa.ˈɾa.das].

In the example [ˈdejliˈf], already mentioned, taken from an oral narrative, we find two lexical units [daˈi] (then)+ [ˈeli] (he), which, in the narrator's oral production, when people came into contact, those two lexical units underwent major changes: the final hiatus [a'i] + the starting stressed vowel ['e] became the decreasing oral diphthong ['ej] and the boundaries that delimited them disappeared completely.

Evidences explained so far demonstrate that other information is necessary for the slicing and recognition of lexical units in the speech chain. One hypothesis is that there are parallel processing and others that are circular: the prosodic processing and the syntactic information; the phonological units and morphophonemic rules processing, when provisional operational hypotheses (it is necessary to emphasize that they are not conscious) are continually tested, with the internalized linguistic knowledge help, until solutions compatible with their contexts are found. This hypothesis is plausible, if we consider that adjustments are made continuously on the speech chain production.

In fact, probabilistic calculations eliminate the need to take all acoustic signals into account, one by one, in an exhaustive manner, due to numerous factors such as redundancies, contextual constraints and the occurrences frequency. The experiments on the uniquiness point, for a lexical unit identification (Marslen Wilson, 1984; Tyler & Wessels, 1983) and on restorations (Warren, 1970), provide strong evidence in this regard.

The isomorphy absence between the phonological and the morphosyntactic words, with regard to the units slicing to be processed, challenges the explanation of how the receiver solves such conflict, considering that, for recognizing them, he will need to pair the intake (the information which he extracted from the speech chain) with the respective phonological lexical item in his mental dictionary.

The first tendency is considering such units as similar to those commonly known as "words", delimited in writing by blank spaces at the start and end. It is very common to find in psycholinguistic literature mention to "word recognition" experimental paradigms (we must consider that linguists do not agree on the 'word' notion.

According to Dubois et al. (1973: 327), "In structural linguistics, word notion is often avoided due to its lack of rigor". Vendryès' warning (C.I.P.L.,1949: LXI), in the closing session of the VI Linguists' International Congress, in Paris, leads to caution, when using the term "word" in research:

We were able to see at the debates center notions understood in different ways and where revision is necessary. Such, for example, is the very notion of the word. The discussion that focused on the relationships between morphology and syntax made us feel the terms ambiguity used so commonly. It seemed that the word represents different species, depending on whether we are looking at the lexicon ,at morphology or at syntax (C.I.P.L., 1949: LXI).

If we define the phonological word as the one that contains the most prominent syllable (this is a relative criterion, as each language has one or two parameters to mark it, such as duration, stress or frequency) on a given scale, a contour will be obtained, marked by prominence that must coincide with each phonological word.

Such patterns do not, however, solve the problems for recognizing lexical units, due to the closed external junctures, which we have already examined, and the clitics or unstressed words (the latter, as the name indicates, because they do not have a more prominent syllable).

Therefore, prominences are not enough to slice the morphosyntactic units, which we can define, either as a free grammatical morpheme (articles, pronouns, prepositions and conjunctions), or as a lexical unit whose reference is external to grammar (nouns, verbs, adjectives and most adverbs), able of occupying the node of any syntactic category, that is, a syntactic class (Chomsky, 1965: 28).

Next, I will discuss some hypotheses that attempted to solve the disagreement between phonological and morphosyntactic units.

At least, two different types of phonological mental lexicon are proposed, one for purely grammatical morphemes and another for lexemes proper.

The purely grammatical morphemes paradigm is closed to a new unit registration: it is made up of a very small items number and their distribution contexts in use (syntagmatic axis) is rigidly determined. The articles distribution, in Portuguese, is a proof. Such characteristics guarantee their automation during the language acquisition process and, although most of them are clitics (unstressed words) and, therefore, suffering numerous distortions in the speech chain, the listener can easily restore and predict them. In Portuguese, purely grammatical morphemes include articles, pronouns, prepositions, conjunctions and some adverbs (deictics of place and time).

Lexemes themselves are linked to external references to the any language grammar, open to the continuous registration of new entries and they are made up of hundreds of thousands of units, therefore, to be recognized in the speech chain, after delimiting them; they must be paired with the respective representation in the phonological mental lexicon. In Portuguese, lexemes comprise units that can only be nouns, verbs, adjectives and most adverbs: they can never be unstressed words.

The existence of two different phonological mental lexicon types, in separate files, the purely grammatical one and the one that lists the stems of verbs, nouns, adjectives and deictic adverbs was proven by Fromkin's model (1973) and by neuroscience experiments (Friederici, 2011).

The research methodology is quite diverse: Fromkin was based mainly on empirical data provided by the Slip of the Tongue Phenomena (STP), (Brown & McNeill, 1966): these are mistakes produced when we speak, which can be at the phonetic feature level, as in the example [po′nɛka dʒi ′blastʃiku] (**b**lastic **t**oll), instead of [bo′nɛka dʒi ′plastʃiku] (**p**lastic **d**oll); at the phoneme level, as in [′bɔza ′ɤɛla] (**r**eautiful **b**ose), instead of [′ɤɔza ′bɛla] (**b**eautiful **r**ose); in terms of syllabic level, as in the example [′siza dʒi ′kamẽtu] (**ce**se of **hou**ment), instead of [′kaza dʒi si′mẽtu] (**hou**se of **ce**ment); on a morphological level, as in [asi′dozu dolo′rẽtʃi] (pain**ent** accid**ful**), instead of [asi′dẽtʃi dolo′rozu] (pain**ful** accid**ent**); at a lexical level as in [dolo′rẽtʃi asi′dozu] (**accid**ful **pain**ent), instead of [asi′dẽtʃi dolo′rozu] (**pain**ful **accid**ent); at a syntactic level, as in "Ele dormiu por **causa que estava** com sono" (He slept **because for the reason** he was sleepy) instead of "Ele dormiu porque estava com sono" (He slept **because** he was sleepy); and at a semantic level, as in "O médico prestou **assistência técnica** ao paciente" (The doctor provided **technical assistance** to the patient), instead of "O médico prestou **assistência** ao paciente" (The doctor provided **assistance** to the patient).

I will close with the fifth challenge to a lexical item delimitation in the speech chain.

6. New Lexical Items That Are Not Registered in the Mental Lexicon

It is remarkable our ability for processing new lexical items not archived in the mental phonological dictionary, to which we are continually exposed, given the human experience dizzying advances, if the speaker has already adapted

them, in the case of linguistic loans, to the phonological system and its respective Brazilian Portuguese phonotactic rules, as, for example, in ['uatʃi'zapi]' for 'WhatsApp'. If the speaker has not done it, the listener must carry out the restorations, as I examined in the article, under penalty of not recognizing them.

7. Final Remarks

In this paper, I set out examining the complex issues involved with a lexical unit recognition in the speech chain, such as ambiguity.

To recognize them, such lexical units must be delimited in the speech chain, which implies the resolution of the following problems: distortions, pauses and hesitations; sociolinguistic variants; contextual phonetic variants; the opacity in a lexical item delimitation, especially clitics or unstressed words due to closed external junctures or sandhi and to new lexical items.

I explained that, faced with the distortion phenomena, with pauses and hesitations, the listener restores the information received, making inferences by crossing the contextual data extracted from the utterances (intake) with those coming from their permanent memories (topdown processes).

As for the same phoneme sociolinguistic variants, this does not constitute a factor that prevents a lexical unit recognition, because listeners convert variants to their sociolinguistic variety, when they "hear" the item in their inner speech. What prevents the listener from reaching the lexical item basic meaning are the sociolinguistic lexical variants, when they differ from their variety, as in the examples: tangerine, bergamot or vergamota and mimosa.

Regarding contextual phonetic variation, determined by coarticulation, it continues to challenge an explanatory theory of how we segment the speech chain, because there are many interdependence relationships between the mental representations of our articulatory movements and the way we analyze the acoustic signal: the commands for producing sounds are syllabic and not for each isolated phoneme performance.

Another challenge to a lexical unit recognition, to which we dedicated more space in the paper is the absence of isomorphy between the phonological and morphosyntactic words and their format in the phonological mental dictionary. Changes result from the encounter between the final and starting utterance segments, between the final and starting segments in lexical units (closed external juncture) and even those resulting from the contact between the final and starting segments in morphemes, within a lexical unit (closed internal juncture), phenomena discovered by the Hindus, especially Panini, under the name sandhi, when describing Sanskrit.

The isomorphy absence between the phonological and the morphosyntactic words, with regard to the slicing of the units to be processed, challenges the explanation of how the receiver solves such conflict, considering that, to recognize them, he will need to pair the intake (the information he extracted from the speech chain) with the respective phonological lexical item in his mental dictionary. I then examined some proposals on how the phonological mental lexicon is organized to conclude that there are two different types of phonological mental lexicon, in separate files, the purely grammatical one and the one that lists the stems of verbs, nouns, adjectives and deictic adverbs.

One of the greatest contributions to the lexical unit delimitation was to highlight the prosodic saliences, that is, the longest duration, the stronger stress or the highest frequency, called by the Prague Linguistic Circle as culminative function: Troubetzkoy (1939) called them obligatory prosodic saliences as aphonematic delimiters signals, either at the start or at the end of lexical units. To these, Troubetzkoy added simple or complex phonematic signals, representing phonemes, which can be positive or negative, such as the examples, in Portuguese, respectively, of the nasal diphthong /'êj/ which only appears at the end of the lexical unit, as in /po'rẽj/ (however) and the consonants /r/, /ɲ/ and /λ/ (the last with an exception in the 3rd person oblique personal pronoun, 'lhe' and the last two with the exception of linguistic loans).

The last challenge addressed in the lexical item delimitation, in the speech chain, was how we are able for processing new ones, not archived in the mental phonological dictionary, concluding that it is possible, as long as the speaker has already adapted them, in the case of linguistic loans, to the phonological system and the respective phonotactic rules of Brazilian Portuguese. If the speaker has not done it, the listener must carry out the restorations, under penalty of not recognizing them.

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