



STRESS AND INTONATION IN SPANISH FOR AFFIRMATIVE AND INTERROGATIVE SENTENCES

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ABSTRACT

The aim of this research is to study prosodic structure in Spanish. We present an experimental approach to the complex relationship that exists between intonation and lexical stress, and relate it to syntactic structure variations. Results indicate the preeminence of the accentual unit as minimal segment in the prosodic structuration of Spanish. This work has enabled us to elaborate prosodic prediction rules for speech synthesis, taking into account the variability of the three main acoustic parameters.

INTRODUCTION

Prosodic features are inherent components of language [1]. A situation without prosody does not exist: if a message is not prosodically 'normal' it is an ill-formed prosodic message. Prosody is at the center of both the structure of the language and its mechanism. In this sense, it is the prosodic structure which will give the listener the first orientation to follow to decode the message. Thus, it appears that prosody can be defined as an organizing frame which allows the segmentation of the speech signal into entire units. These units can be decomposed in several elements that emerge in many different ways according to the situation.

Prosody has constituted, for the last twenty years, one of the main thrusts of the phonetic experimental research. Most descriptions, that establish typologies by parametric definitions, are, however, too general and global. It is therefore necessary to develop an approach which considers both the structure of the acoustic properties and of lexical units, as well as the morphosyntactic level.

Studies on Spanish have shown that stress can be defined as the essential factor for prosodic structuration of speech. There is no agreement, however, in the determination of the acoustic values of stress and their respective roles [2], [3], [4]. Opinions differ as well regarding the definition and delimitation of prosodic units. Several authors have suggested that it is necessary to consider all the acoustic parameters [5] that characterize the phonic substance, while others privilege duration or affirm that systematic analysis of F0 variations are enough to reveal the prosodic structuration of utterances [6], [7].

METHODOLOGY

The first step of the work presented in this paper is the constitution of a corpus based on strict constraints. The corpus design must enable us to validate the linguistic presuppositions chosen for the approach which involves increasing linguistic complexity with the aim of observing the influence of the syntactic structure on some prosodic structures in relation to a referential statement. The nature of our research has entailed elaborating a wide corpus (316 sentences x 10 repetitions) and therefore makes possible to obtain the construction of an average-contour lexicon. In this way, we were able to reveal the structural 'rendez-vous' between the linguistic and prosodic units. This linguistic notion (the existence of 'rendez-vous' points between the syntactic and intonative structures) is developed by V. Aubergé [8]. It is a matter of assigning a global nature to intonation contours: an intonation curve being the result of a movement decomposed into a string of 'carried' and 'carrying gestures'. Our investigation enables us to extract the contours at a subordinate level from the general outline of sentences (global shape). So we can display here the global nature of the melodic contour of the sentence which supports some internal syntagmatic outlines according to the rhythmic structure.

We are more particularly interested in the variability of accentual parameters for substantives. We study it by varying noun phrases and verb phrases in referential utterances. According to the different positions of stress in Spanish, selected substantives contain the three main stress positions which are also contained in the elements on either side of the substantive (Adjectives and Prepositional Phrases formed with toponyms). These variations of the structure of macrosegments are inserted at major boundaries or precede the substantive, the latter belonging to a main clause or a subordinate clause.

Prosodic data were analyzed analogically. Hence, we have used an F0 detector providing the F0 and intensity of the speech wave in real time, thus obtaining oscillograms from which the numerical data have been extracted with a PC and a digitizing tablet.

For the segmental level, F0 is coded with 3 values for each syllabic nucleus (at the beginning, at the end and at an intermediary point of the most stable part of the vowel), whereas for intensity only the highest point has been kept. As for duration, the measurements have concerned vowels and consonants by applying the duration features proposed by Ch. Abry & al. [9]. Figures 1, 2, 3 here below give an illustration of such

acoustic measurements for each typology of Spanish stress: proparoxyton, paroxyton and oxyton.

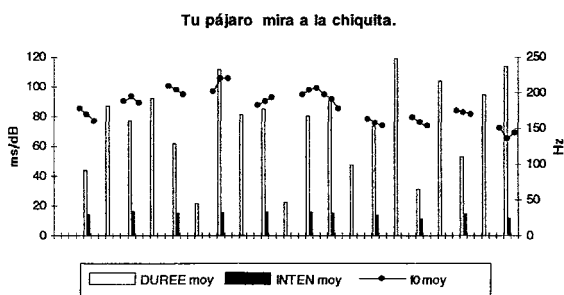


Figure 1 Duration, Intensity and Pitch for proparoxyton type at the final of noun phrase

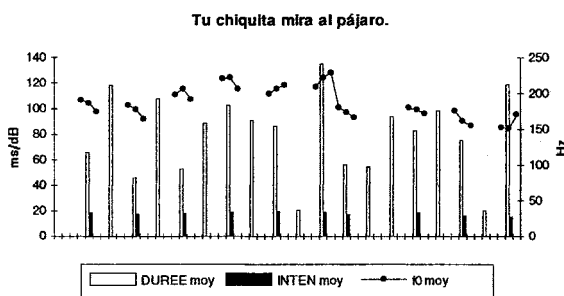


Figure 2 Duration, Intensity and Pitch for paroxyton type at the final of noun phrase

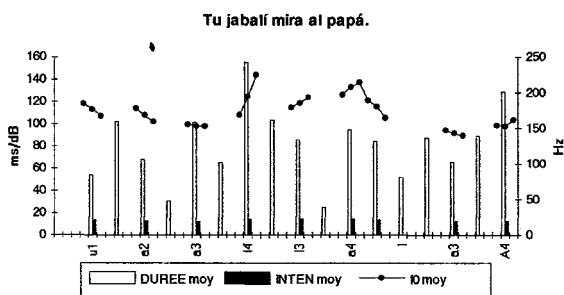


Figure 3 Duration, Intensity and Pitch for oxyton type at the final of noun phrase

RESULTS

The most significant results indicate that the outline of major phrases and the contour of prosodic words and their variability, are based on specific accent types. Likewise, the pitch contour for the proparoxyton stress unit at the final of noun phrase (e. g., «tu pajar», Figure 1) is established by a global ascendant contour. Here stress is not established by having a prominence but by an upward jump of pitch from pretonic to tonic whereas the speech pattern of paroxyton stress at the same position (e. g., «tu chiquita», Figure 2) can be identified by a global concave movement. About oxyton stress unit (e. g., «tu jabali», Figure 3) it is important to note that we also have a global concave contour but with a strong rise on the tonic segment which is located at the end of noun

phrase. This phenomenon is due the conjunction of stress and intonation. These figures reveal contrasting pitch movements where word syllables are lexically stressed (rises and falls). However, the realisation of a rising final movement is always observed. It is used at the final of the noun phrase, which is due to the presence of a major boundary (predicted from the relation between the syntactic and intonative structures). Regarding duration variations, regularities in the event of occurrence of the longest vowel (situated at the nominal boundary) are independent of stress category. This duration increase is determined by the syntactic position of vocalic segment. It is noteworthy that for the proparoxyton type, the duration contributes to the accentual prominence. This does not hold for paroxytonic type. For the oxytonic type, a constant progression of duration is observed (Figure 3).

The study of the evolution of the different parameters as a function of the position of the prosodic word in syntactic structure reveals interesting features. Indeed, when the stress units are analyzed as the last element of the sentences different prosodic contours emerge. Such syntactical variations give to proparoxyton unit stress (e. g., «al pajar», Figure 2) a hat-shaped pattern. It implies a weak melodic prominence on the tonic segment, with a global declinaison of pitch, which is justified by the fact that it is an affirmative sentence. For the paroxyton (e. g., «la chiquita», Figure 1) we also obtain a hat-shaped pattern, but the prominence on tonic segment is much stronger. The oxyton stress unit is characterized by a concave pattern (e. g., «al jabali», following Figure 4) with the realization of a downward jump at the beginning and a terminal rise, which confers a strong prominence to the tonic. It is interesting to point out that here lexical stress is more relevant than intonation. No declination at the final intoneme is observed. Maximal durations appear on the last segment of the verbal syntagma, neutralizing or reinforcing the accentual structure of the selected unit.

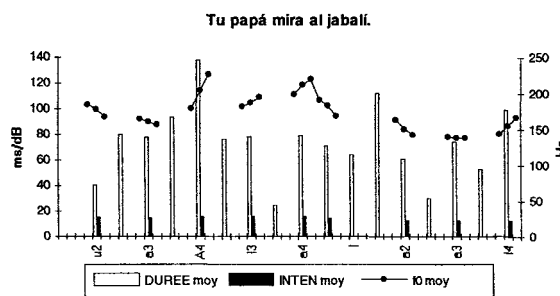
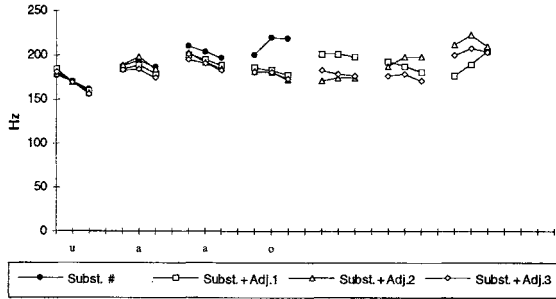


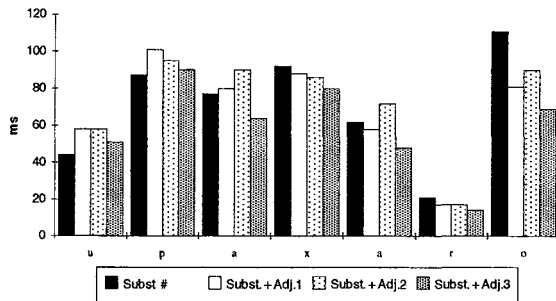
Figure 4 Duration, intensity and Pitch for oxyton type at terminal major boundary

Our linguistic approach also allow us to investigate how prosodic units vary according to the accentual structure of neighbouring units and to their gramatical category. The proparoxytonic unit, for example, is formed with 'pajaro' in the nominal syntagma (assertive modality). Analysis shows that only F0 and duration are relevant

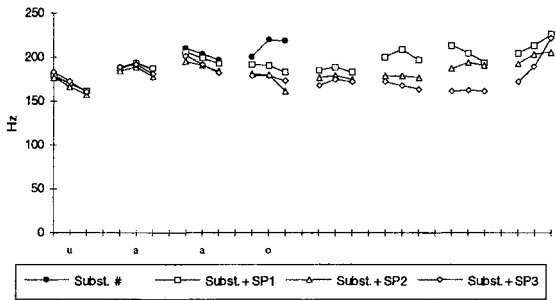
parameters. Intensity variations are too weak, as can be observed in the previous figures.



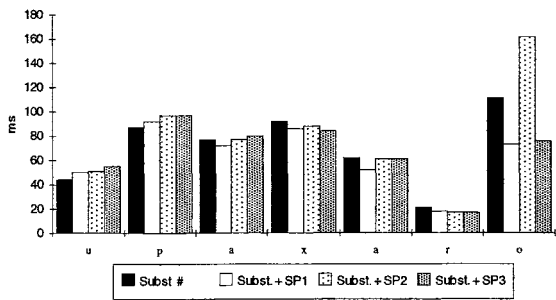
Figures 5a Contours for the prosodic word at the final of the noun phrase with expansions formed by varying the adjective accentual structure



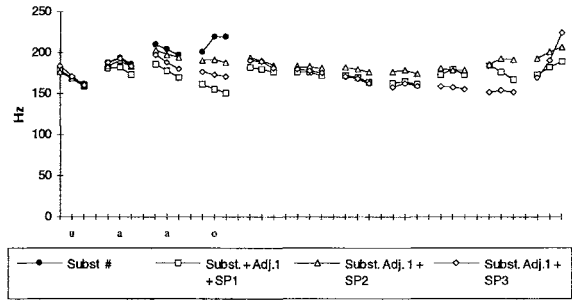
Figures 5b Duration for the prosodic word at the final of the noun phrase with expansions formed by varying the adjective accentual structure



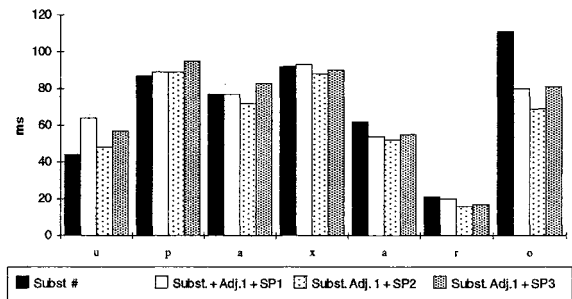
Figures 6a Contours for the prosodic word at the final of the noun phrase with expansions formed by varying the accentual structure of the prepositional group



Figures 6b Duration for the prosodic word at the final of the noun phrase with expansions formed by varying the accentual structure of the prepositional group



Figures 7a Contours for the prosodic word at the final of the noun phrase with expansions formed by varying the accentual structure of the adjective and the prepositional group



Figures 7b Duration for the prosodic word at the final of the noun phrase with expansions formed by varying the accentual structure of the adjective and the prepositional group

It can be observed that with the expansions the prosodic word loses its original contour (Subst. #). A new, circumflex contour arises, irrespectively of the nature of the neighbouring units (accentual structure, grammatical nature, morpho-syntactic structure). This change is due to the modification of the syntactic boundary. It must be noted that all the units which are located at the end of the nominal phrase present raising pitch movements.

Finally, comparing between modalities enables us to examine how far modal changes mediate the prosodic structure of the stress unit. The pitch movements in Figures 8, 9, and 10 show the key points at which the influence of intonation on the accentual structure is most relevant. The line indicates the average fundamental frequency (175 Hz), which was used as reference.

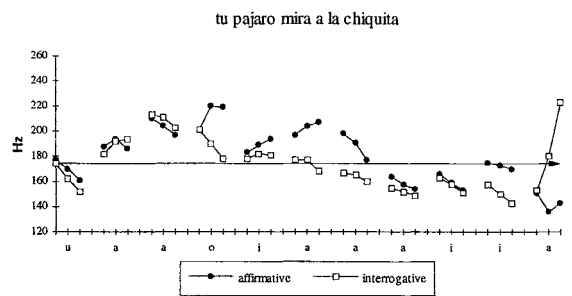


Figure 8 Proparoxyton type

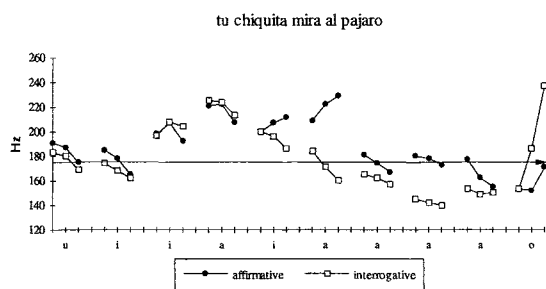


Figure 9 Paroxyton type

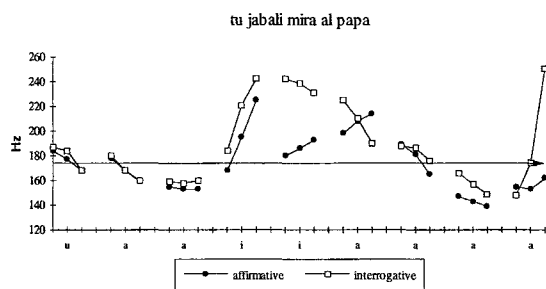


Figure 10 Oxyton type

It is clear that certain modal discrimination cues appear well before the end of the sentence (fall versus heavy rise). For the assertive sentence a progradient group appears at the non-terminal major boundary. For the interrogative sentence, we obtain a clear decrease of the fundamental frequency (Figure 8). This phenomenon occurs with the verb as well. It presents a progradient group for assertive modality and a falling contour for interrogative modality alternatively (Figures 8, 9, 10). Apart from the upward movements of pitch for affirmative modality and the decrease for interrogative modality early in the speech chain, we can observe that the assertion pattern involves several melodic ruptures (at the final the noun phrase and in the verbal phrase), from which three intonemes are derived. The increasing syntactic complexity tends to extend melodic ruptures and thus the number of intonemes in the assertive sentence. Conversely, this is not observed for the interrogative sentences. The latter are characterized by regularities such as the presence of a high raising movement of the pitch until the noun phrase. Then, it is followed by a slight decrease and, at the end of the verbal phrase, by an abrupt pitch increase (which makes more prominent the tonic segment, or neutralizes the accentual features).

CONCLUSIONS

A unique and unvarying strategy of the accentual realization does not exist. The realization varies according to the accentual category of the selected unit. The accentual pattern of the prosodic word varies as a function of the syntactic structure of the sentence and of its position in the sentence. The latter determines its accentual configuration, i.e., the absence or presence of a major boundary, minor boundary or internal position.

The general intonation of the sentence does not prevent accentual structure to emerge individually, as long as every stress unit corresponds to a specific configuration. The analysis of accentual parameters, shows that lexical stress may be due to a prominence of the fundamental frequency, duration, and to a lesser extent, the intensity. For F0, the prominence can also be obtained by a melodic rupture towards the proparoxytonic substantive. The data bank we have constituted will be the development of prediction rules that take into consideration the variability of three main acoustic parameters for more or less complex sentences. These rules, together with their implementation in a TTS system, constitute the logical follow up of our work.

In the future, we aim at confirming our work with other speakers as well as to extend the prosodic analysis to lexical items which are not substantives.

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