On the manifestation of stress in African languages

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Abstract

The main aim of this paper is to survey and analyse the various ways in which stress is manifested in African languages. The present paper focuses on word stress only.

Stress is reported to occur in Bantu languages, for example Xhosa, Tswana and Swahili, and also in West Atlantic languages like Fula and Wolof. These two language families (Bantu and West Atlantic) turn out to have completely different manifestations of stress; indeed, in the latter family stress manifestation is complex.

My preliminary acoustic investigation of Pular (one variety of Fula) shows that both pitch and intensity may play a role in stress manifestation.

1. Introduction

For decades it has been known that three factors play a role in prosody: pitch, length and intensity. Of these three factors, the last, namely intensity, is never found without concomitant effects on the other two, simply because articulatory energy cannot be switched on and off at a fast enough rate. Now let us consider what kind of prosodic systems have been described in the languages of the world.

Length is the one factor which is normally described for every language; although there do exist languages with no phonological length distinctions. But what about pitch and intensity?

Obviously, for any given language, the most fully exploited of the factors pitch and intensity is the one which will find its way into the descriptions of that language. So, for example, in Indo-European languages intensity has been well described because most of these languages have stress systems that bear much phonological information. Pitch and non-phonemic length are largely slaves of the stress system. In a sense they take on very natural parameter settings and leave the burden of distinctiveness to the stress system by which they are dominated.

In most African languages, on the other hand, it is pitch that has been described, because tonal systems play a central role in these languages. Intensity has hardly been studied in tone languages because it is largely the slave of the tonal system.

So, in short, we normally expect very natural or default properties for pitch in stress languages and for intensity in tone languages.

However, I would like to plead for a more circumspect description of languages. Both the dominant and the recessive prosodic systems need to be described. Even though the properties of the recessive system may not be well elaborated, they cannot be assumed to always take on default values. Otherwise it would be impossible for a stress language to change into a tone language or vice versa. In this spirit, I have started investigating the stress-like properties of both tonal and non-tonal African languages. In this paper I report my findings on some Southern Bantu and some West Atlantic languages. In particular, I have carried out acoustic analyses of the Pular variety of Fula and am currently analysing the Wolof of Senegal.

1.1 Prominence

The factors of pitch and intensity which I just mentioned are probably the historical basis for tone and stress systems respectively. But tone and stress systems have evolved beyond these origins. The major difference between the two is that tone can bear distinctive information on any syllable, while stress depends on one syllable being sufficiently prominent compared with neighbouring syllables. In other words, in a tonal system, tone can, at least potentially, carry more distinctions per 100 syllables than stress.

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It is well known that prominence can be expressed either by intensity (with concomitant effects on pitch and length) or by pitch alone, namely in pitch accent languages like Japanese which were so en vogue in the late 90's.

Therefore, in examining African language with respect to stress properties, it is important to bear these two possible realisations of prominence in mind. And at the same time, length must at least be controlled for, especially in languages with contrastive length in consonants or vowels (or both).

By taking this approach, I do not mean to diminish the importance of research into other prosodic systems in languages, e.g. intonation (Connell & Ladd 1990 and Laniran 1994) or the search for fuller functionality in tone and stress within the same language (see for instance Hyman and Katamba 1993: 34).

1.2 Stress

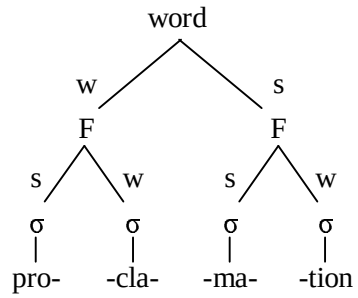
Let us now take a closer look at stress. Here I will restrict myself to primary stress. As mentioned above, stress is a suprasegmental feature of utterances which can be defined as perceived prominence. Prominence is manifested in one member of a class of smaller units which make up a larger unit (which is usually termed a domain). Thus, for example, one syllable within the word domain carries prominence. (This is word stress.) One word bears prominence within the phrase domain. (This is phrasal stress).

Prominence is characterised (e.g. by Crystal 1990: 332) as a higher degree of (articulatory) energy used in producing the unit which bears stress. However, this single articulatory factor produces three acoustic manifestations: pitch (as in English and Swahili), intensity (for instance in English) and length (e.g. English and German, and also ostensibly in Tswana, Sotho, Xhosa and Fula). Later in this paper I will claim that in fact none of the Southern Bantu languages that I just named has a true length distinction.

1.2.1 Representing stress

In the framework of *metrical phonology*, stress can be represented by using either a metrical tree, as in (1a) or a metrical grid, as in (1b):

(1) a. Metrical tree



(Where F stands for "foot", s = "strong" and w = "weak". A foot is (roughly) a stressed syllable followed (optionally) by one or more unstressed syllables, "strong" = more prominent.)

b. Metrical grid

```
        *              word level
      *   *            foot level
    *   *   *   *      syllabic level (moras)
  proclamation
```

The formalisms of l(a) and (b) are quite similar, and in many cases equivalent. In both cases, it is assumed that phonologically only the vowels bear stress (even though we know that acoustically consonants located next to a stressed vowel can be louder, higher-pitched or longer; this can be regarded as a local assimilation). All researchers agree that higher-level constituents which bear stress are projections of syllable nuclei (even though they may refer to constituents containing nuclei, such as rhymes, syllables or feet).

In the tree model, the lowest-level node which is linked to the highest-level node via strong nodes only, is the most prominent. In the grid model, stars are assigned according to the rules of each level, and the most prominent syllable is the one which has the highest number of stars above it.

Both models share the principal goal of specifying the position of primary stress. Unfortunately, neither model is particularly successful in determining the position of secondary stress, although it can at least be expressed more directly in the grid model, as can be seen in examples (2a) and (2b).

(2) a.
```
  *
  *   *
  import = 'import (NOUN)
```
b.
```
      *
  *   *
  import = im'port (VERB)
```

These examples show that in English stress is not fixed.

1.2.2 The position of word stress

Generally, the position of stress in languages can be classified by two partially related criteria: fixed vs. non-fixed and predictable vs. lexical (=unpredictable). These criteria overlap only in the case of fixed stress position, because this is clearly always predictable.

The logically possible combinations of these criteria are exemplified in **Table 1**.

	Fixed	Non-fixed
Predictable	Polish (penultimate), Hungarian (1st syllable), Swahili (penultimate)	Kara (Papua New Guinea)
Lexical	(impossible: fixed stress is always predictable!)	English, Modern Greek

Table 1: *The typology of possible word-stress positions in languages.*

1.2.3 Major properties of word stress

In order to be linguistically useful, I initially considered all aspects of word stress for my analysis of stress. For the purposes of this introduction, I will simply list six properties of word stress which have been used in the recent literature (cf. Hayes 1995), each followed by a comment on its applicability to the languages under consideration:

1. STRESS HIERARCHIES: Every word that belongs to a lexical category contains a syllable that carries the *primary* stress. Hence, no stressless lexical words occur.

   (This can only sensibly be investigated using a large corpus, and in any case it is unlikely to be contradicted in the languages investigated here, which have quite open syllable structure and a high proportion of long words.)

2. CULMINATIVITY**:** Every word has exactly one syllable carrying the primary word stress, while other stresses (where these only occur in long words) are subordinated to the primary stress as secondary stresses.

   (This property combined with the first one (stress hierarchies) is called the *culminative* property of stress. No words were discovered in which secondary stress could be ascertained. This aspect of stress could therefore neither be confirmed nor contradicted on the basis of the material investigated here.)

3. DELIMITATIVITY: Primary stress is located near the borders of the stress domain, thus signalling its edges. This tendency is enhanced by the fact that the strongest non-primary stress tends to be on the opposite side of the domain from the primary stress. This is called the *delimitative* property of stress.

   (No putative counterexample to the "three-syllable window" of primary stress was discovered in my material. Secondary stress did not occur.)

4. QUANTITY SENSITIVITY: Syllable weight affects stress placement. Weight distinctions coincide with syllable composition, in which complex syllables count as heavy, and simple syllables as light. Heavy syllables generally attract stress irrespective of their position in the word. In some languages (e.g. Hausa and English), closed syllables and syllables with long vowels are heavy, and typically stressed.

   (This may be an important factor in the stress system of Fula.)

5. RHYTHMIC DISTRIBUTION**:** Stress is rhythmically distributed. In other words, there is rhythmic alternation which may lead to an interpretation of stress as the reflex of binary organisation imposed on strings of syllables, in alternating patterns. Stress enhances maximal contrasts between adjacent elements, binary alternation being simply the maximal degree of rhythmic organisation compatible with the requirement that adjacent stresses are to be avoided.

   (Secondary stress could not be found. The non-stressed syllables had a syllable-timed rhythm – i.e. each unstressed syllable was just as prominent (or non-prominent) as any other in the domain.)

6. LACK OF ASSIMILATION**:** A stressed syllable node does not induce stress on the syllable nodes in its neighbourhood.

(Again, my material did not contain words with more than one stress, so this property could not be examined.)

2. Stress manifestation in African languages

As mentioned above, stress is generally manifested by intensity (with accompanying effects on pitch and length). In Swahili it is manifested by pitch alone. In West Atlantic languages such as Wolof and Fula, and in Southern Bantu languages like Xhosa, Tswana, Sotho word stress is allegedly manifested by length alone.

2.1 Penultimate lengthening in Southern Bantu languages?

The claim, which is current in linguistic circles, that Southern Bantu languages have "penultimate stress" (i.e., by implication, penultimate word stress) is blatantly false. It has its origin in the reports of authors such as Batibo (2000) and Mosaka (2000) (on Tswana, Sotho, Xhosa and Zulu) that length is distinctive in these languages, and that it denotes the end of a word or phrase.

The fact is that length in these languages is not phonemically contrastive. Rather, it is a purely phrasal phenomenon which lengthens the (phonologically short!) vowel of a phrase-penultimate syllable (under specific conditions which I will outline shortly).

I propose that actually an extra vowel position which is devoid of phonological content floats at the right edge of certain sentence types and is inserted into the phonological representation to the left of the last syllable. This empty vowel is filled by the spreading of the melody of the preceding vowel (i.e. the vowel of the penultimate syllable).

Why does the impression arise that this process also occurs in single words? A single word spoken in isolation does manifest penultimate syllable lengthening – but precisely because such a vowel is *phrase* final (and the phrase is of the correct type, e.g. declarative).

Phrase-penultimate vowel lengthening does not occur in certain sentence types (e.g. interrogatives). Yet it does occur in the most common sentence type: declaratives. In other words, a word spoken in isolation is assumed to be a declarative. If one asks a speaker of one of these Southern Bantu languages to pronounce a single word as a question (e.g. an elliptical question for verification of a particular noun), the penultimate vowel is *not* lengthened (just as it is not lengthened in any interrogative sentence). For example, the current president of South Africa has the name **mbeeki** in most contexts; but if a single utterance consists of the question '(Did you say) Mbeki?', it will be **mbeki**, without penultimate vowel lengthening.

So in conclusion we can say that the so-called word stress in Southern Bantu languages is a red herring. It does not exist as a word-level phenomenon, but only at the phrase level, and only with certain sentence types. This lengthening phenomenon has no effect on the (tonal) prosodic system of the languages concerned.

2.2 Word stress as length in West Atlantic languages?

Let me begin my discussion of West Atlantic languages by thanking Peter Gottschligg for sharing his wide knowledge of these languages with me, and in particular for telling me his intuitions on their stress systems.

I would like to claim that vowel length in West Atlantic languages is not the major (perhaps not even any) manifestation of stress. Here I refer specifically to Pular (the Fuuta Jaloo variety of Fula spoken in Guinea) and Wolof (spoken in Senegal). Firstly, vowel length (in any syllable of the word) is contrastive in these languages. This in itself does not preclude vowel length as a manifestation of stress (after all, English has both contrastive vowel length and a length manifestation of stress), but it does refute the claims of Batibo (2000) and Mosaka (2000) that long vowels in "Fula" mark word stress. Secondly, I found little or no indication of a length contrast within the first-syllable short vowels. I will describe the process involved in searching for such a contrast in a moment.

First of all, I measured the length of short and long first-syllable vowels in minimal pairs with each of the 5 vowel qualities. The results are given in Table 2.

Word	*Length of first V (in msec)*	*gloss*
bhiri	50	trace
bhiiri	363	wipe, erase
fetere	44	rock
feetere	210	madness
amugol	50	dance
aamugol	261	be lazy
sodugol	51	prohibit, prevent
soodugol	268	buy

Table 2: *Examples (words spoken pair-wise in isolation – disyllables and trisyllables).*

The range of lengths of short first-syllable vowels was from 44 to 51 milliseconds – apparently an indication of a possible stress distinction. The range of lengths of *long* first-syllable vowels was larger: from 210 to 363. Moreover, the ratio of any short vowel to the corresponding long vowel (i.e. to the long vowel with the same quality) had quite a wide range: from 14% for /i/ to 21% for /e/.

I next visually compared the lengths of short vowels in first syllables with those of short vowels in second or later syllables. You can do the same yourself by looking at the spectrograms in the Appendix. Again, there were no significant differences in length.

Clearly, this process should be repeated on a larger corpus of words; but stress is definitely not manifested primarily by length (otherwise we would not have these minimal pairs), and I strongly suspect that it is not manifested secondarily by a perceptible difference in length.

So my next question was: Is stress manifested by pitch in these languages?

2.3 Word stress as pitch in Fula?

It is extremely noticeable that there is a difference in the "tone pattern" of short and long vowels in the pitch traces in the Appendix. The first vowel of all words is at a medium pitch. But words with a short first vowel have a noticeable rising pitched on the final vowel, while those with a long first vowel show a slight drop in pitch throughout the word. Is this observation significant?

If this pattern were robust, it would indicate that the most prominent syllable in a word without a long vowel is the final one (because of its distinctive rising pitch), and that the most prominent syllable in a word with a long first vowel is the first vowel itself (because of both its higher pitch and its length).

Unfortunately, this pretty picture is dulled slightly by the evidence from one of the short-first-vowel words in context: in sentence-final position its last vowel had a lower pitch than its first vowel. The word in question had a marked glottal closure (almost stop) at the end, perhaps indicating some sentence-level phenomenon that is unrelated to word stress. A more down-to-earth explanation is that the observed rising pitch is simply a list intonation, like in English *an apple, an orange and a banana*, where the first two words have a rising pitch and the last word has a falling pitch. So clearly, these word pairs should be elicited again in the reverse order.

2.4 Word stress as intensity in Fula?

The traditional view is that Fula has the same type of expression of accent as Indo-European languages, i.e. basically intensity. I therefore examined the RMS energy trace of my words with a short-long vowel contrast in the first syllable. The evidence is not conclusive in that there is no sharp decay in energy after the first syllable of the analysed words. But at least there is a slight decay, as you can see from the figures on the handout.

This is surprising in view of the information that I have received from a very reliable source (Peter Gottschligg, p.c.) that there is a wide variety of stress systems in the Fula languages, both of the fixed and the non-fixed predictable type.

3. Instead of a conclusion

The evidence presented here is clearly very preliminary in nature. However, it is by no means incompatible with current views on the manifestation of stress. I will now quickly comment on each of the 6 properties of word stress that I mentioned earlier and then sketch a possible scenario which would explain the facts accrued so far.

1. STRESS HIERARCHIES: These could not be ascertained.
2. CULMINATIVITY**:** Only weakly ascertainable. The difference in prominence

between (putatively) stressed and unstressed syllables was small.

3. DELIMITATIVITY: This could not be examined on material with a maximum of 3 syllables.
4. QUANTITY SENSITIVITY: Also not ascertainable; in my material heavy syllables were always word-initial.
5. RHYTHMIC DISTRIBUTION: Not ascertainable with such short words.
6. LACK OF ASSIMILATION: Not ascertainable.

Finally, here is a possible scenario which would explain the facts that I have so far (without wishing to claim that there is sufficient evidence to support it at the present stage).

1) If no heavy syllable is present in a word, stress the first vowel. (Manifestation: higher pitch (*pace* some rising word-final pitches) and higher intensity.)
2) If a heavy syllable is present in the word, stress it. (Manifestation: highest pitch and greatest length.)

In any case, I would like to rule out the hypothesis that there is no accent in Fula, and will now concentrate my efforts on additional types of word: those with heavy syllables in non-initial position, and longer words.

4. References

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Appendix

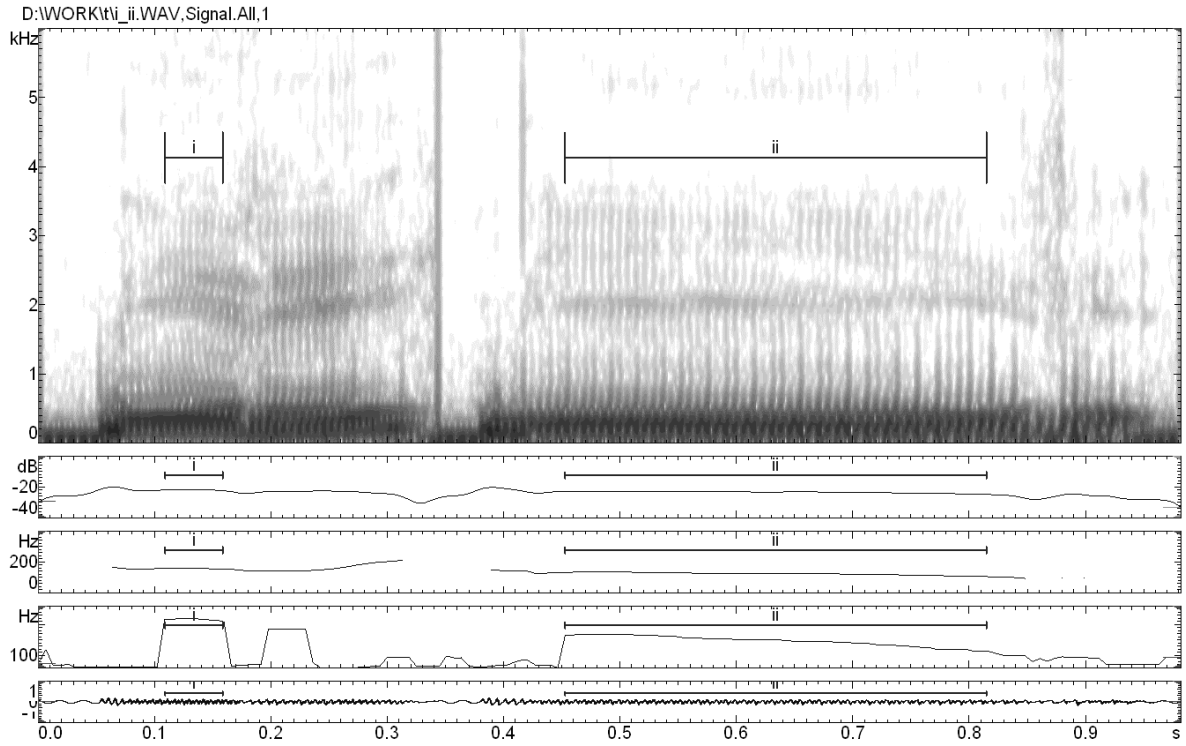

Figure 1: ***Spectrogram, RMS energy trace, 2 pitch traces (S.I.F.T. and harmonic grid) and waveform of Pular*** *bhíri* ***'trace' (left) and*** *bhíiri* ***'wipe, erase' (right).***

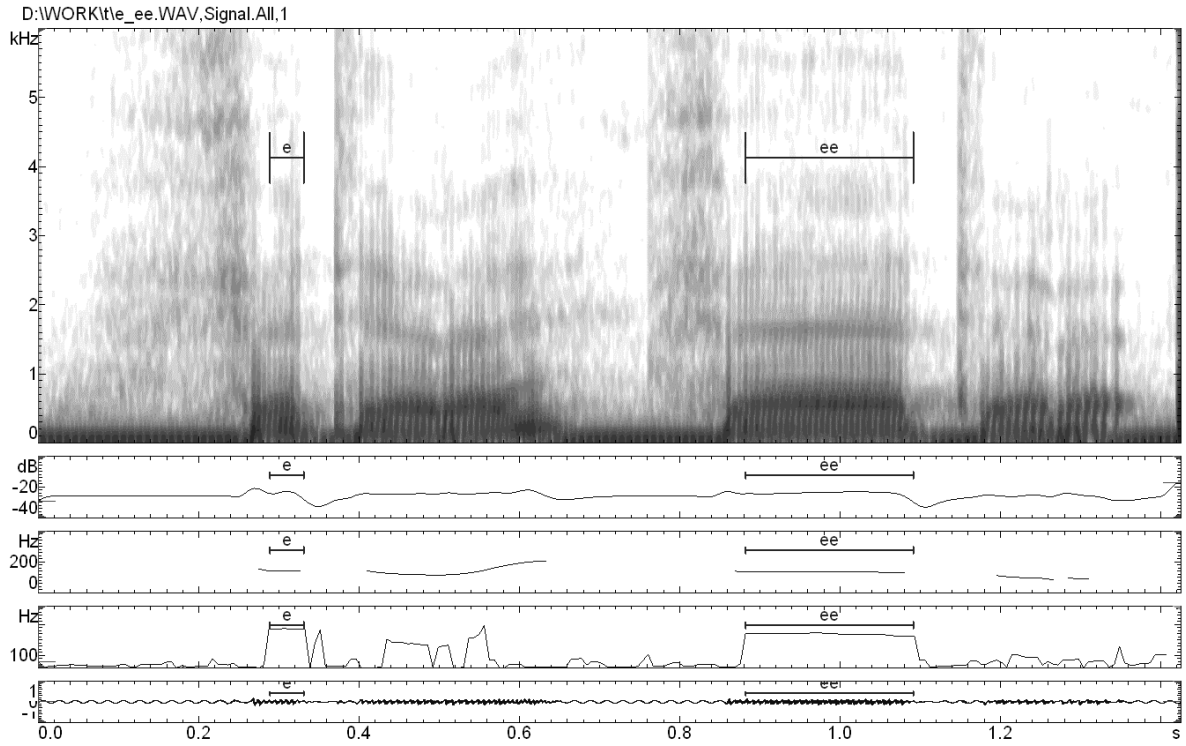

Figure 2: *Spectrogram, RMS energy trace, 2 pitch traces (S.I.F.T. and harmonic grid) and waveform of Pular fétere 'rock' (left) and féetere 'madness' (right).*

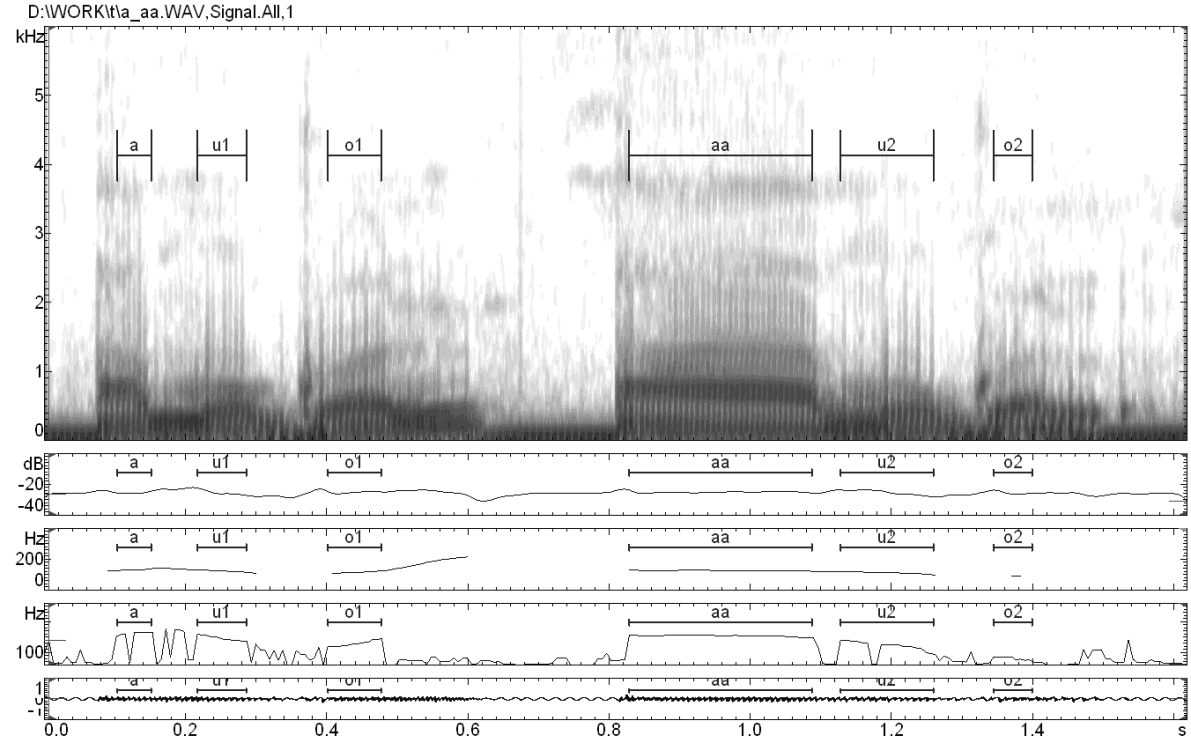

Figure 3: *Spectrogram, RMS energy trace, 2 pitch traces (S.I.F.T. and harmonic grid) and waveform of Pular ámugol 'dance' (left) and áamugol 'be lazy' (right).*

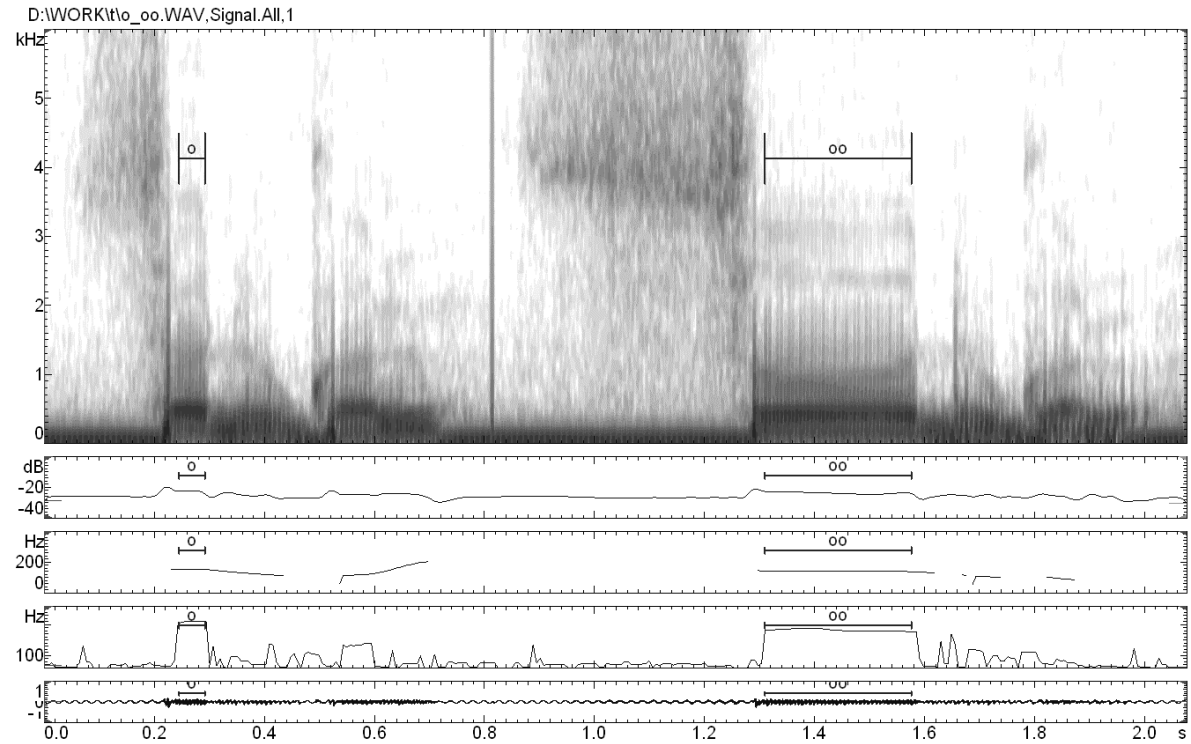

Figure 4: *Spectrogram, RMS energy trace, 2 pitch traces (S.I.F.T. and harmonic grid) and waveform of Pular sódugol 'prevent' (left) and sóodugol 'buy' (right).*

Acoustic analysis software: ST^x (Institut für Schallforschung der Österreichischen Akademie der Wissenschaften – wad@kfs.oeaw.ac.at).