

Phonetics and Phonology of lexical stress in Polish verbs

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ABSTRACT

This paper explores the usage of antepenultimate and penultimate stress in 1st person plural past tense verb forms in Polish. Although Polish generally has penultimate stress, prescriptive grammars treat these verb forms as an exception, assigning antepenultimate stress. It has been argued elsewhere that penultimate stress is possible in these forms, although in colloquial speech. Data from 40 native speakers confirm that penultimate stress is used, but reveal that it is not restricted to colloquial speech: more than three quarters of speakers used penultimate stress when reading a literary text. Stress was auditorily transcribed by six independent judges. High inter-transcriber agreement was achieved when stress coincided with accent, the acoustic correlates of which were found to be F0 peak and syllable duration. A second experiment, using speech synthesis, revealed that the predominant stress pattern for reading was also the preferred pattern for speech synthesis, even on formal literary texts.

1. THEORETICAL BACKGROUND

Polish has a strong tendency towards a regular primary stress on the penultimate syllable, and a secondary stress on the initial syllable [19,7]. Notable exceptions are 1st and 2nd person plural forms of verbs in the indicative past. According to Polish prescriptive grammars, antepenultimate stress is assigned to these forms [1], which are built by adding to the past stem elements that are remnants of the auxiliary być “to be” [14].

- (1) sprowadzili-śmy
moved.MPL-aux.1.PL
“we moved”

In (1) the element “-śmy” and its equivalent for the 2nd person past tense plural “-ście” are treated as verbal auxiliary clitics [10]. Evidence in favour of their clitic status is the fact that they can appear on hosts other than the verb [6], as in (2):

- (2) Kogo-ście zobaczyli?
who-2.PL saw.MPL
“who did you see?”

Despite a consensus in the prescriptive grammars, there is apparently some optionality in stress placement in the verb forms mentioned above, in that they may receive penultimate instead of antepenultimate stress. According to [4], this variation is conditioned both socially and stylistically.

The authors claim that antepenultimate stress is used in the “cultivated form” and penultimate stress in less cultivated speech [4:41]. They point out that even highly educated speakers use penultimate stress in informal situations.

A phonological explanation for the variation is the changing status of the person-number agreement marker [4, 14]. For some speakers it might no longer be treated as a clitic, thus not affecting the stress pattern of the word as in (2), but instead be incorporated into the word as an affix. In the latter case, the person-number marker would count towards the regular penultimate stress rules, shifting the stress one syllable to the right. If, on the other hand, it is an auxiliary clitic, it is considered extrametrical [9], and does not affect the stress pattern of the verb, hence antepenultimate stress.

In the experiments described below we first investigate the extent to which antepenultimate and penultimate stress is used in the verb forms of the type given in (1) across a number of speakers when reading a literary text (section 2). Secondly, we collect listeners’ judgments as to the acceptability of penultimate stress across different text registers and investigate whether antepenultimate stress can be taken as evidence for the clitic status of the person-number marker (section 3).

2. STRESS PERCEPTION TEST

Considering that the above mentioned studies are based on introspection, or auditory analysis of few speakers, our first task was to investigate whether speakers place stress in verb forms of the type given in (1) on the antepenultimate or penultimate syllable and to what extent optionality is found.

Since the perception of stress cannot be taken for granted, especially in a language where stress is not used contrastively, we approached the problem from two angles. First we collected judgments on stress placement from a number of subjects and measured inter-transcriber consistency. Second, we investigated acoustic correlates of stress in terms of duration of and F0 peak alignment on the antepenultimate and penultimate syllables of these verb forms. We additionally investigated F0 peak alignment relative to the onset of the antepenultimate and penultimate syllables. It is important to point out here that in the corpus we used, nearly all cases of these verb forms had a pitch accent on the stressed syllable, so that in this study we are mainly investigating perceptual and acoustic aspects of *accent* rather than of stress alone. It is important to note that Polish is considered a weak stress language and the acoustic correlates of primary stress are highest F0 and a sharp F0 slope

on syllables carrying primary stress, in relation to unstressed syllable, as reported by [7].

2.1. Method

The experiment made use of a part of Polish Intonational Database [11]. The set included recordings of 40 speakers of Polish, aged between 19 and 38, all students and academics, reading a literary narrative text. Three sentences containing four verbs in the past tense 1st person plural masculine were selected for analysis. The four verbs were as follows:

- (3)
- (a) sprowadzili-śmy
moved.MPL-aux1.PL
“we moved”
 - (b) kupili-śmy
bought.MPL-aux1.PL
“we bought”
 - (c) postawili-śmy
put.MPL-aux1.PL
“we put”
 - (d) wieźli-śmy
transported.MPL-aux1.PL
“we transported”

The corpus contained one rendition of each verb by each of the 40 speakers, constituting 160 tokens.

Six native speakers of Polish, aged between 22 and 36, all students and academics, participated in the test. Subjects listened to recordings of one sentence at a time and were instructed to indicate the syllable on which they heard stress in the selected verb forms. Three subjects performed the test in the Saarbrücken phonetics lab and three over the Internet.

The stimuli for which there was total inter-transcriber agreement were used for acoustic analysis. They were divided into two groups, those with antepenultimate and those with penultimate stress.

Since syllabification is not clear-cut [17], the sequence ‘li-śmy’ was syllabified in two alternative ways: one where the alveolo-palatal fricative /ʃ/ is a part of the final syllable ‘śmy’, and one where it is part of the penultimate ‘li’.

Duration measurements were taken for all stimuli of the whole verb, and its antepenultimate and penultimate syllables (according to both syllabifications). Syllable durations were then expressed as a percentage of the total word duration in each case. The duration values of the same syllable (antepenultimate or penultimate) in stressed and unstressed cases were directly compared.

The F0 peak alignment was measured in relation to the onset of the antepenultimate syllable, whether stressed or not. Additionally, the position of the F0 peak was measured as a percentage value relative to the duration of the stressed syllable.

2.2. Results

Auditory analysis by six independent transcribers showed that less than a quarter of the database recordings (9/40) had antepenultimate stress in the 1st person plural past tense verb forms. Speakers were consistent as to which form they used. Stress assignment was affected by neither age, sex nor educational qualifications (to the limited degree these could be investigated, given the homogeneity of the corpus – see 2.1).

Inter-transcriber agreement was high. There was complete agreement across all six transcribers in 93% of cases. Agreement was even higher (95%) when word stress was manifested as a nuclear peak accent (L+H*) [18] (see Figures 1 and 2). Transcriber disagreement occurred mainly in penultimate cases.

In cases of total transcriber agreement, F0 peak alignment in relation to the onset of the antepenultimate syllable was found significant ($p < 0.001$). The F0 peak was aligned late in the stressed syllable. On average, it was aligned at 93% of the duration of the stressed syllable (87% for antepenultimate syllable, 99% for penultimate syllable, although the results for the penultimate syllable are less reliable due to microprosodic influence of the fricative). For this analysis the syllabification was ‘li.śmy’.

Additionally, both antepenultimate and penultimate syllable durations were significantly different in the stressed and unstressed cases ($p < 0.001$ and $p < 0.05$ respectively). The results are equally significant regardless of whether /ʃ/ is treated as belonging to the penultimate syllable or the final one. Taking the syllabification ‘li.śmy’, stressed antepenultimate syllables were on average 15% longer than unstressed ones and stressed penultimate syllables were on average 5% longer than unstressed ones. With the syllabification ‘liś.my’, the stressed penult was 9% longer.

Figures 1 and 2 show examples of F0 traces of the sentence containing the verb ‘postawiliśmy’ (see 3c) with different stress assignment spoken by two different speakers. Syllable boundaries are indicated by vertical lines and shaded areas represent the stressed (accented) syllable: penultimate in Fig. 1 and antepenultimate in Fig. 2.

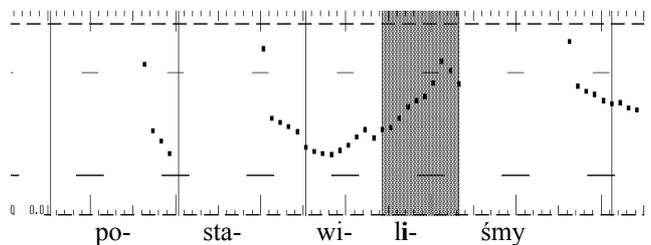


Figure 1. F0 trace for an example of *penultimate* stress on *postawiliśmy* “we put”.

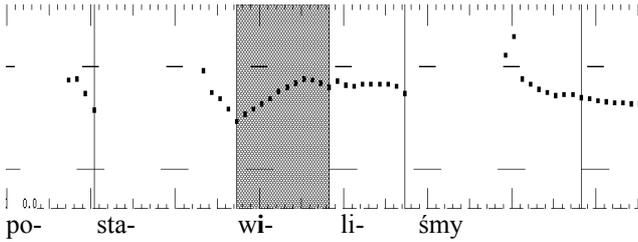


Figure 2. F0 trace for an example of *antepenultimate* stress on *postawiliśmy* “we put”.

3. STRESS PLACEMENT ACCEPTABILITY TEST

In the second part of the study we attempt to verify the claim in [4] that stress placement is inter alia conditioned by stylistic factors. To do this we chose two text types: excerpts from literary texts, representing a formal text style, and sports reports, representing the more colloquial end of the scale. We investigate how far text register influences acceptability judgments when we change the stress assignment in these sentences.

An additional experiment investigates the status of the past tense person-number marker. We test the hypothesis formulated in [14] that the difference in stress assignment (antepenultimate or penultimate) implies that the person-number marker is either treated as a clitic or not, respectively.

We tested these hypotheses by constructing synthetic speech material. Although the use of speech synthesis brings with it a considerable reduction in naturalness, it has the advantage of ensuring that only one aspect of the speech is manipulated, namely stress placement.

3.1. Method

We constructed stimuli using the Polish module [16] of the Festival speech synthesis platform [3]. Festival is a general multilingual speech synthesis system developed at the Centre for Speech Technology Research at the University of Edinburgh. The Polish module uses concatenative di-phone based synthesis. The system offers a full and flexible environment for development of language specific modules. By default, Polish stress rules in Festival always assign stress on the penultimate syllable. For the purpose of this experiment, a user dictionary was modified by hand to allow a change in the stress assignment on the verbs of interest.

Ten native speakers of Polish took part in the experiment. The Magnitude Estimation paradigm [5, 12, 15] was used to elicit acceptability judgments. This method has proved a reliable measure of judgments producing statistically significant results [2]. For the presentation of stimuli the WebExp software was used [13].

In the first part of the test, sentences from two text types (literary and sport) were presented. Stimuli varied as to the stress assignment on past tense 1st person plural verb forms, i.e. antepenultimate or penultimate. For the second part,

sentences presented had a person-number marker attached as a clitic to a clause initial constituent of the type given in (2), and the rest of the sentence varied as to whether the 1st person plural verb was stressed on the antepenultimate or penultimate syllable. This means that by attaching the person-number marker to a host other than a verb it was clearly treated as a clitic in the first part of the sentence. The data for both parts of the experiment together consisted of a set of 60 sentences. Two pseudo randomisations, including 60 fillers, were used, each for half of the subjects.

The experiment was administered as follows. First, a training phase was carried out, in which subjects were familiarised with the magnitude estimation task. This was followed by a practice phase, in which subjects heard synthesised stimuli, and finally the experiment proper. No modulus was provided i.e. subjects did not evaluate each sentence in relation to one model token (modulus) but always in relation to the previous item. In this latter phase, subjects evaluated the synthesised stimuli in a self-paced experiment. The subjects were also instructed not to pay attention to the synthesis segmental quality and word choice, but instead were asked to judge the acceptability of the pronunciation of the sentences. They were not explicitly asked about the acceptability of the stress placement.

In order to compensate for individual differences in scaling across participants the data was normalised. This was done by first log-transforming the scores and then calculating z-scores to create a common scale for all subjects. The result is that the participants’ scores are all on the same scale with a mean of 0, Standard Deviation of 1 and the remaining between-condition variance is symmetrically distributed around zero, without affecting differences between conditions.

3.2. Results

Taking all the stimuli together penultimate stress was preferred and the differences in acceptability scores between antepenultimate and penultimate stress were significant ($p < 0.01$).

An ANOVA analysis revealed a significant interaction between text type (literary/sport) and stress (antepenultimate/penultimate) ($p < 0.01$). No significant order effect was found for stress preference in either text type. Further tests were carried out to explore effects within each text type. In the text type ‘literature’, penultimate stress was significantly preferred ($p < 0.01$) over antepenultimate stress. For text type ‘sport’ there was a tendency to prefer antepenultimate stress, although it was not significant.

In the second part of the stress placement acceptability test, an ANOVA analysis was performed to investigate the relationship between acceptability of tokens containing a fronted person-number marker (with a clear clitic status), followed in the next clause by a verb with either antepenultimate or penultimate stress. In this part of the experiment no significance was found for the preference of either stress pattern.

4. DISCUSSION

The experimental findings from the first experiment show that despite the fact that all speakers had at least university level education and were reading a formal style text, penultimate stress was the predominant stress pattern produced on the 1st person plural past tense verb forms.

Where stress was reliably perceived by all transcribers, it corresponded to accent, with significant peak alignment and duration differences between stressed and unstressed syllables.

Although subjects' acceptability judgments were sensitive to text register, this sensitivity showed, contrary to indications in the literature, that the preference for penultimate stress was stronger on formal literary texts. The tendency for subjects to prefer antepenultimate stress on sports reports, albeit insignificant, is left unexplained.

Despite the limited data analysed, the study indicates that not only do the majority of speakers assign penultimate stress in these verb forms when reading aloud, but that subjects also found penultimate stress acceptable when it was implemented in speech synthesis, even on formal texts. These results thus have implications for speech synthesis stress assignment rules. It appears, at least in formal texts, that penultimate stress can be assigned to these verb forms across the board. Nevertheless, further research is needed to investigate how synthesis systems should deal with the more colloquial texts.

ACKNOWLEDGMENTS

The first author is funded by the International Post-Graduate College "Language Technology and Cognitive Systems". We would like to thank Maciej Karpiński for the Polish intonational database, Krzysztof Marasek for help with synthesis, Frank Keller for help with WebExp software, Christoph Scheepers and Andrea Weber for help with statistical analysis and Berthold Crysmann for advice on morphological aspects.

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