Monosyllabic Lexical Pitch Contrasts in Norwegian

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Abstract

This paper examines the lexical tonal accent contrast in monosyllabic words in the Trøndersk dialect of Norwegian. The results of a production experiment in which speakers produced the unmarked accent and the circumflex accent showed that the tonal distinction is characterised by a difference in f0 maximum, f0 height at onset, f0 minimum and its timing, and height of the final Accent Phrase H tone. The presence of the tonal accent contrast on monosyllabic words is unusual among dialects of Norwegian and Swedish.

Index Terms: lexical pitch accent, Norwegian, monosyllabic

1. Introduction

Scandinavian tonal accent contrasts have been described extensively, both impressionistically and experimentally [1–10]. The two contrasting tonal accents in Norwegian and Swedish are referred to as accent 1 and accent 2 [11]. Depending on the variety in question, the tonal contours of the two contrastive accents of Swedish and Norwegian may differ in their tonal makeup (e.g., LH vs HLH) or they may have the same tones but different timing in relation to the segmental string (e.g., both HLH) [12]. An example from the Oslo variety of Norwegian of words distinguished only by the tonal accent is *bønder* "farmers" (accent 1, LH) and *bønner* "beans" (accent 2, HLH) (the segments of both words are pronounced /ˈbøn:ər/).

Researchers agree that the Scandinavian accent contrast is generally only found on polysyllabic words [6, 13, 14] and some regard all monosyllabic words as having accent 1 [15, 16]. One explanation for this difference - likely related to the origin of the contrast - is that since accent 2 has a later timing, it needs a second syllable in order for the later tones to surface [13]. This is in contrast with tonal languages from a wide variety of language groups such as Burmese, Mandarin, !Xoo or Mixtec, where each syllable can bear a tone [17], but similar to other pitch accent languages such as Basque [18, 19] or Serbo-Croatian [20]. However, a small number of dialects of Norwegian and Swedish, including some of the Trøndersk dialects, have been described as having a tonal contrast surfacing on monosyllabic words, due to apocope, final vowel deletion [21–23]. This is referred to as a contrast between the unmarked monosyllabic accent and the circumflex accent and describes a difference in the shape of the contour between the accents. While previous research focused on the characteristics of the lexical contrast in polysyllabic words, only few acoustic studies examined in detail the nature of the contrast in monosyllabic words [23, 24]. Furthermore, even within the Trøndelag dialectal region, not all varieties (e.g., the city of Trondheim) have the contrast on monosyllabic words (Gjert Kristoffersen, p.c.). Given the rather limited number of monosyllabic minimal pairs that differ only in the accent feature, it is possible that this phenomenon will disappear. One aim of this study was thus to document this prosodically unusual variety.

The major goal of this work was to investigate whether the lexical tonal accent contrast surfaces on monosyllabic words in the Trøndersk dialect and, furthermore, what the exact acoustic correlates of the contrast are. This dialect is spoken in the Trøndelag region, a variety of East Norwegian spoken in central Norway.

In the Trøndersk dialect, disyllabic words with accent 1 or accent 2 both have the same shape (previously described as HLH [2, 25, 26]) with the tonal contour aligned later in accent 2 words. The circumflex accent occurs on words that are disyllabic in other varieties of Norwegian, such as infinitive forms of verbs [22], for example *å glimte* 'to gleam'. Although the circumflex accent most commonly occurs on words that originally had accent 2, they can also form from accent 1 words [24]. In the Trøndersk variety, these words are generally pronounced without the final (unstressed) vowel, reducing them to monosyllabic words which retain the underlying tones.

A small scale acoustic analysis of a different Trøndersk dialect, that of Ålvundeid, found that the circumflex accent is characterised by a longer vowel and a higher f0 onset than the unmarked monosyllabic accent [24]. In comparison, the unmarked monosyllabic accent is simply an L tone in East Norwegian (Gjert Kristoffersen, p.c.). In the Ålvundeid study, all target words were focused by elicitation. It is therefore not clear which tonal events characterise the accent contrast itself (if any) and which arise due to pragmatic focus. In addition, the Ålvundeid study examined only two male speakers from each of three age groups ('old' (over 70), 'mid' (38 and 50), and 'young' (20/21)). The current study aims to separate the effect of sentence intonation from the lexical tonal accent in order to examine the features that characterise the contrast on monosyllabic words in ten speakers of the Trøndersk dialect. Specifically, recordings were made of native speakers of the Trøndersk dialect reading sentences containing monosyllabic words with either the unmarked accent or the circumflex accent, in neutral (non-focused) intonation.

It was expected that the circumflex accent would have a longer vowel, higher f0 at vowel onset and later alignment of tones than the unmarked monosyllabic words.

2. Methods

2.1. Speakers

Ten native speakers (four males, six females) aged 18-45 of Trøndersk were recorded reading sentences containing the target words. The speakers were from a variety of towns south and west of Trondheim, where the circumflex accent is known to occur (Stian Hårstad and Jørn Almberg, p.c.), such as Tingvoll, Oppdal, Rennebu, Surnadal, Sunndal.

10.21437/SpeechProsody.2014-141

2.2. Stimuli

Target words contained only voiced sonorant consonants next to the vowel, such as *smil* "smile" (unmarked) and *'smile* "to smile" (circumflex). (Recall that, in this dialect, the final *e* is apocopated.) The words all contained the vowel /i/.

In Norwegian, the accent phrase (AP) high boundary tone (H%) [13, 27–29] is associated with the final unstressed syllable in the AP [29]. In order to control for the effect of this H%, the target word was always two unstressed syllables before the end of an AP. The target word also followed two or three unstressed syllables at the beginning of the sentence, which were AP-external [26]. In this way, the accent of the target word avoided being affected by either the accent or the final H% of a preceding AP [27]. The target word was always followed by a contrastively focused word in the following AP, in order to ensure that the target word did not receive narrow focus.

Examples (with target words in bold): (AP = accent phrase, IP = intonational phrase, IU = intonational utterance)

Unmarked:
Det var et lim i en film, men ikke i et stykke.
((Det var et (**lim** i en)$_{AP}$ (film,)$_{AP}$)$_{IP}$, (men ikke i et (stykke)$_{AP}$)$_{IP}$)$_{IU}$
"There was glue in a film, but not in a play."

Circumflex:
Jeg vil smile i en film, men ikke i et bilde.
((Jeg vil (**smile** i en)$_{AP}$ (film)$_{AP}$)$_{IP}$, (men ikke (i et bilde)$_{AP}$)$_{IP}$)$_{IU}$
"I want to smile in a film, but not in a photo."

For each accent there were five target words, each produced three times, giving 15 tokens per accent per speaker, a total of 300 tokens (15 tokens x 2 accents x 10 speakers). The words of the different accents were minimal pairs, where the accent was the only difference between the words.

2.3. Procedure

Speakers were recorded in the phonetics studio at the National University of Science and Technology (NTNU) in Trondheim, Norway. The experimenter was the first author. The sentences were presented one by one on powerpoint slides, with the speaker in control of when to move to the next sentence. The sentences were randomised and interspersed with sentences containing disyllabic target words. The sentences were in the same order for all speakers. They were written in the standard Bokmål orthography and also in a transcription of Trøndersk. Speakers were asked to speak as they would at home. None of the speakers had difficulty following the instructions.

2.4. Measurements and Analysis

In order to fully examine the F0 contour and its alignment with the segmental string, the following measurements were obtained (Figure 1 depicts and defines all the labelled landmarks):

1. F0 maximum (H)
2. F0 minimum (L)
3. F0 maximum timing ((H-V1)/(Vowel duration))
4. F0 minimum timing ((L-V1)/(Vowel duration))
5. F0 height at vowel onset (V1)
6. Vowel duration (C3-V1)
7. AP H% tone height (APH)
8. Boundary slope ((APH-LTP)f0/(APH-LTP)time)

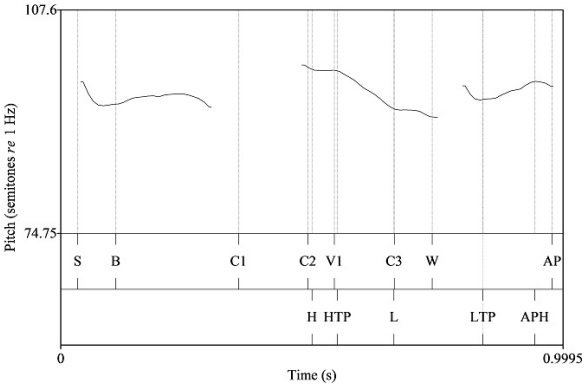

Figure 1: *Circumflex f0 contour of the word 'smile' showing measurement points.* S = beginning of the sentence; B = beginning of f0 rise; C1 = onset of target word; C2 = onset of second consonant (if present); V1 = vowel onset; C3 = onset of post-vocalic consonant; W = end of target word; AP = end of AP; H = f0 maximum, HTP = turning point from f0 maximum; L = f0 minimum; LTP = turning point from f0 minimum; APH = AP boundary tone.

All measurements were made on the target word. Duration was measured in milliseconds and f0 was measured in semitones in Praat [30]. Timing of f0 maximum and minimum were measured in milliseconds relative to vowel onset. These timings were then divided by the duration of the vowel, to get relative timing. This controlled for speaking rate differences. Boundary slope was measured as the difference in pitch between the turning point of the f0 minimum and the following AP boundary H%, divided by the duration between these two points.

Statistical tests consisted of a mixed model multiple linear regression analysis, conducted using the lme4 package in R [31]. The independent variable was accent and the dependent variables were the measures (f0 maximum and minimum and their timing, f0 at vowel onset, vowel duration, AP H% height, and slope of the rise to the AP-boundary tone). Speaker was included as a random effect. The reference level for accent was the unmarked accent. Since linear regressions do not produce *p*-values, the significance of accent as a predictor of each measure was calculated by a likelihood ratio test comparing a model that included accent as a predictor and one that did not [32]. This was conducted using the anova function in R, a likelihood ratio test for nested models.

3. Results

An average, time-normalised pitch track [33] for all target word productions by one female speaker (S16F) for the two accents is shown in Figure 2. This is representative of the other speakers. From this figure, it can be seen that the two accents are distinct. They differ in shape with the circumflex (blue line) having a higher f0 maximum and later f0 minimum timing than the unmarked accent. Furthermore, the circumflex accent has a higher f0 at onset.

Table 1 shows the statistical test results for each measure. The coefficient and t-values are from the linear regression tests

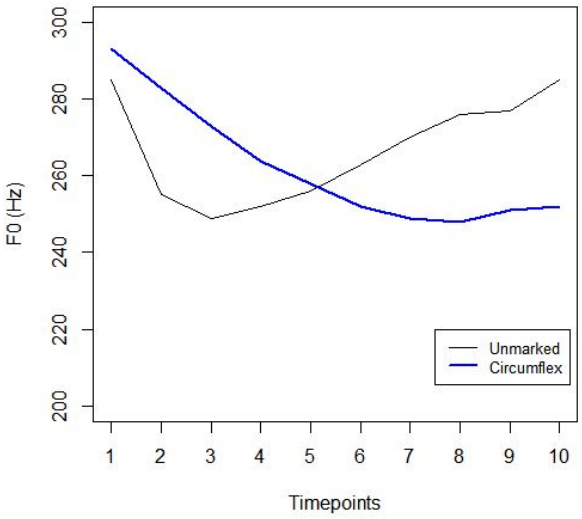

Figure 2: *Average, time-normalised f0 contour for one speaker.*

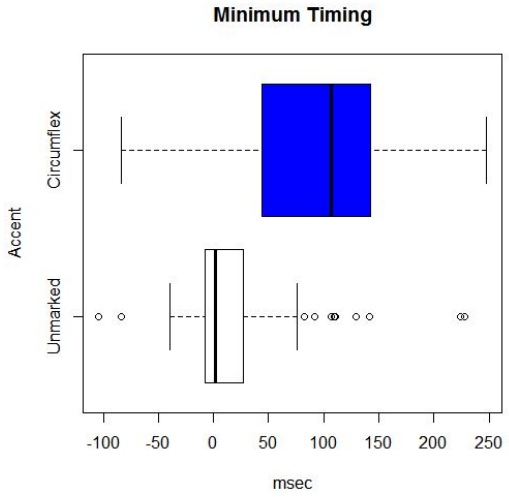

Figure 3: *F0 minimum timing by accent (unmarked in white, circumflex in blue).*

and the *p*-value is from the likelihood ratio test. A significant result (*) indicates that accent is a significant predictor of the measure. The sign of the coefficient tells the direction of the difference. Since the unmarked accent was the reference level, a positive coefficient means that for that measure, the circumflex accent has a higher average value than the unmarked accent, and a negative coefficient means the circumflex accent has a lower average value than the unmarked accent. For example, f0 minimum has a negative coefficient, meaning that the circumflex accent has a lower average f0 minimum than the unmarked accent.

Table 1: *Regression and likelihood ratio test results for each measure.*

Measure	Coef.	t-value	*p*-value
Vowel duration (msec)	-0.67	-0.12	0.906
F0 Maximum (st)	1.41	8.5	p<0.001*
F0 Minimum (st)	-0.47	-2.8	p<0.01*
F0 vowel onset (st)	1.71	9.9	p<0.001*
F0 max timing	-0.004	-0.07	0.956
F0 min timing	0.54	5.2	p<0.001*
Boundary slope	0.002	1.1	0.256
AP H% height	-0.5	3.3	p<0.01*

The results revealed that the two accents are differentiated by f0 maximum and f0 minimum height, f0 height at vowel onset, timing of f0 minimum (relative to vowel onset) and AP H% height. Table 2 shows the averages and standard deviations for each of these measures by speaker. (A negative number for timing means the f0 minimum occurred before vowel onset.)

The circumflex accent has a higher f0 maximum and f0 height at vowel onset, lower f0 minimum and AP H% tone, and later f0 minimum timing than the unmarked accent. Figure 3 shows the raw f0 minimum timing results pooled across speakers. The average f0 minimum timing for the unmarked accent is just after vowel onset, while that for the circumflex accent is over 100 milliseconds into the vowel.

4. Discussion

The results of this experiment confirmed that differences between the unmarked monosyllabic accent and the circumflex accent are present in Trøndersk. This is unlike many other varieties of Norwegian and Swedish in which this contrast is not found on monosyllabic words. The circumflex accent has a higher f0 maximum and onset, lower f0 minimum, later f0 minimum timing and lower AP H% tone than the unmarked monosyllabic accent. This indicates a wider pitch range and later timing for the circumflex accent. It should be noted that the height of the f0 maximum was not consistently found for all speakers and all words, and further testing showed that there were significant differences among the speakers for this measure. This suggests that this may not be as reliable a cue as the others for signalling the contrast. One reason for this was that for many tokens of the unmarked monosyllabic accent, there was no consistent point at which to mark the f0 maximum. The difficulty in reliably identifying the f0 maximum is consistent with the description of this accent as being just an L tone in this dialect.

While a previous acoustic study on the monosyllabic contrast [24] found vowel duration differences for the two accent types, speakers in this study did not use temporal cues to implement the lexical contrast. In the Oppdal dialect, there is a longer vowel in the circumflex accent, leading to an analysis of these syllables as being trimoraic [23]. The results from the current study suggest that this is not the case for all dialects of Trøndersk. The current results demonstrate that the circumflex accent can be realised without increasing vowel length.

It was also expected that the circumflex accent should have a steeper slope from the f0 minimum to the AP H% tone, due to the later timing of the f0 minimum for this accent; however, this was not found. The results instead revealed that the circumflex accent has a lower phrase boundary tone (H%) which in turn affected the slope. The circumflex accent thus has a later timing, lower f0 minimum and a lower AP H% tone. The lower AP H% tone could be due to the fact that the speaker simply does not have time to reach the natural H% target for the circumflex accent; however, this explanation seems unlikely, since the two

Table 2: *Mean results for each significant measure by speaker.* (The speakers marked F are female and M are male.) Results are in the form: Mean (SD)

	F0 max.		F0 min.		F0 onset		Minimum timing		APH	
Speaker	Unmark.	Circ.	Unmark.	Circ.	Unmark.	Circ.	Unmark.	Circ.	Unmark.	Circ.
S01F	95 (0.6)	96 (1.7)	93 (0.7)	94 (0.7)	93 (0.6)	95 (2.3)	-0.1 (0.1)	0.5 (0.7)	97 (0.4)	97(1.2)
S02F	95 (0.6)	99 (0.6)	92 (0.7)	91 (1.1)	93 (0.3)	99 (0.6)	0.9 (0.6)	0.9 (0.2)	98 (1)	97 (1.7)
S04F	94 (0.7)	94 (0.5)	92 (0.7)	93 (0.5)	92 (0.3)	93 (0.8)	0 (0.1)	0.1 (0.1)	96 (0.7)	96 (0.7)
S07M	86 (1.3)	89 (1.3)	88 (2.4)	87 (1.8)	88 (1.2)	89 (0.7)	-0.2 (0.4)	-0.4 (1)	90 (0.6)	89 (0.8)
S09M	86 (1.2)	88 (1.1)	84 (1.2)	83 (0.5)	85 (1.1)	86 (0.8)	-0.2 (0.4)	0.6 (0.3)	87 (0.8)	87 (1)
S10F	92 (0.9)	93 (1.3)	90 (0.7)	90 (0.9)	91 (0.5)	92 (1)	0.3 (0.4)	1.3 (1.2)	92 (0.5)	92 (0.8)
S12F	95 (0.7)	95 (0.7)	94 (0.6)	94 (0.5)	94 (0.6)	95 (0.8)	0.2 (0.3)	0.1 (0.3)	96 (0.8)	96 (2.1)
S13M	89 (1)	89 (0.8)	88 (1.2)	87 (1.2)	88 (0.7)	88 (0.9)	-0.1 (0.1)	0.8 (1.4)	90 (0.8)	89 (0.8)
S15M	83 (0.4)	85 (1.2)	82 (0.5)	80 (1.2)	82 (0.5)	84 (1)	0 (0)	1.2 (0.4)	86 (0.4)	82 (1.4)
S16F	95 (1)	98 (0.6)	96 (1)	95 (1)	96 (0.8)	97 (0.8)	0 (0.1)	0.1 (0.3)	98 (0.5)	97 (0.8)
Average	92	93	90	89	91	92	0.1	0.5	93	92

following syllables should be enough to reach this target, and the f0 contour did not reach any higher point after the AP.

The work presented here offers evidence of the lexical tonal accent contrast in monosyllabic words in Trøndersk. Future research will examine the realisation of both the unmarked monosyllabic accent and the circumflex accent in AP-final position and in a focus context, to determine how the contour is affected by sentence intonation and pragmatic factors. A comparison of those results with the findings of the current study will also indicate which cues are the most consistent in realising the monosyllabic contrast. Another direction of future research could be to compare the circumflex contour with that of accent 1 and 2 disyllabic words (depending on the accent of the word before apocopation), to examine whether the circumflex accent is indeed realised as a compressed form of the disyllabic tonal contour. This type of comparison could help to further elucidate the features that characterise the circumflex accent.

5. Conclusion

This investigation has shown that the circumflex accent is significantly different from the unmarked accent in monosyllabic words in the Trøndersk dialect of Norwegian. The acoustic analysis provides evidence that there is in fact a tonal accent contrast on monosyllabic words in this variety, at least in production. It remains to be determined whether listeners can perceive this tonal contrast on monosyllabic words and, furthermore, which of the cues indicated here are most salient for differentiating the accents.

This work provides an acoustic analysis of an unusual monosyllabic contrast in Scandinavian. Future work will examine how this contrast is affected by sentence intonation, thereby adding insight to how the lexical and phrasal levels of intonation interact.

6. Acknowledgements

We would like to thank Gjert Kristoffersen and his collaborators for their huge assistance in choosing target words and to Gjert for proof-reading the sentences and transcribing them into the dialect, as well as for comments on this paper. Special thanks to Wim van Dommelen for the use of the recording studio at NTNU, Trondheim. We also thank the anonymous reviewers for their helpful comments. The research used for this investigation was conducted with the support of the National Science Foundation Doctoral Dissertation Research Improvement Grant No. 1322700.

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