The role of pitch accent in discourse comprehension and the markedness of Accent 2 in Central Swedish

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Abstract

In Swedish, words are associated with either of two pitch contours known as Accent 1 and Accent 2. Using a psychometric test, we investigated how listeners judge pitch accent violations while interpreting discourse. Forty native speakers of Central Swedish were presented with auditory dialogues, where test words were appropriately or inappropriately accented in a given context, and asked to judge the correctness of sentences containing the test words. Data indicated a statistically significant effect of wrong accent pattern on the correctness judgment. Both Accent 1 and Accent 2 violations interfered with the coherent interpretation of discourse and were judged as incorrect by the listeners. Moreover, there was a statistically significant difference in the perceived correctness between the accent patterns. Accent 2 violations led to a lower correctness score compared to Accent 1 violations, indicating that the listeners were more sensitive to pitch accent violations in Accent 2 words than in Accent 1 words. This result is in line with the notion that Accent 2 is marked and lexically represented in Central Swedish. Taken together, these findings indicate that listeners use both Accent 1 and Accent 2 to arrive at the correct interpretation of the linguistic input, while assigning varying degrees of relevance to them depending on their markedness.

Index Terms: Swedish, accent, prosody, psychometric test, markedness, functional load

1. Introduction

Prosody serves various linguistic purposes ranging from encoding formal attributes of words to facilitating interactive aspects of discourse [1, 2, 3, 4]. Pitch accents, for instance, not only modify meanings as in the Swedish words *ánden* 'the duck' and *ànden* 'the spirit', but also manage information structure, in particular to set focus on the new and important information in discourse. While there is an increasing amount of behavioral, psycholinguistic and neuroscientific research on diverse prosodic functions, relatively little of it has operationalized them in communicative settings. In the present study, using Swedish prosody as a working model, we aim to contribute to the field by examining the relative importance of pitch accents – formal (i.e., lexical) and interactional (i.e., focal) functions intertwined – for a functioning spoken communication. We focus on Central Swedish (the Stockholm variety), where there is a phonological contrast between two tonal patterns, and at least one of them is marked (i.e., lexically represented) [5]. The terms 'Accent 1' and 'Accent 2' (hereafter indicated by superscripts) are typically employed to refer to the tonal contours of words holistically. Beside the lexical tonal distinction, intonational pitch accents are included in these terms. The intonational part, in turn, can be associated with two types of pitch accent, realizing perceptually stronger and weaker prominence. These intonational prominence levels are called 'big' and 'small' accents, previously referred to as 'focal accent' and 'word accent' respectively [6, 7, 8, 9, 10]. The present study concerns Accent 1 and Accent 2 in the big accent condition, which is constituted by a rising pitch accent (LH). Accent 1 comes out as L*H, and Accent 2 as H*LH, where '*' indicates that the preceding tone is associated in the stressed syllable. The tonal patterns of big Accent 1 and big Accent 2 followed by a L% edge tone in Central Swedish are displayed in Figure 1 (created using the MOMEL algorithm [11] in Praat [12]). The objective here is two-fold. Firstly, we investigate the functional load of complex big accents for discourse comprehension. Second, we explore any potential processing differences between Accents 1 and 2.

2. Background

2.1. Functional load of accents

From a traditional phonological perspective, Swedish accents are often claimed to have a low functional load [5, 13, 14]. The main argument hinges on the fact that the number of surface contrastive minimal pairs, like *anden*[1] 'the duck' and *anden*[2] 'the spirit', is limited to a few hundred [13], most of which differ also in morphological structure, e.g., *and*[1] 'duck' vs *ande*[2] 'spirit' [5, 15], and/or belong to different word classes, e.g., *rutten*[1] 'the route' (definite noun) vs *rutten*[2] 'rotten' (past participle). Contrasting forms are thus unlikely to appear in the same syntactic context [5, 15].

While the functional load is low for semantic purposes, several psycholinguistic [14, 16, 17] and neurolinguistic [18, 19, 20] studies provide converging evidence that accents facilitate processing of simple and complex word forms in Swedish. For instance, using cross-modal fragment semantic priming, Althaus et al. [14] indicated that word accents are utilized for lexical access as accent mispronunciations failed to prime semantically related targets. Similarly, in a cross-modal

forced choice experiment, Felder et al. [16] documented the role of word accent in word identification and showed that the listeners can discriminate words with segmentally identical first syllables on the basis of accents. In a reaction time experiment, Söderström et al. [17] investigated the role of word accent on interpreting inflectional morphology, as they are morphologically conditioned, and indicated that mismatching accents increased listeners' reaction times while predicting suffixes.

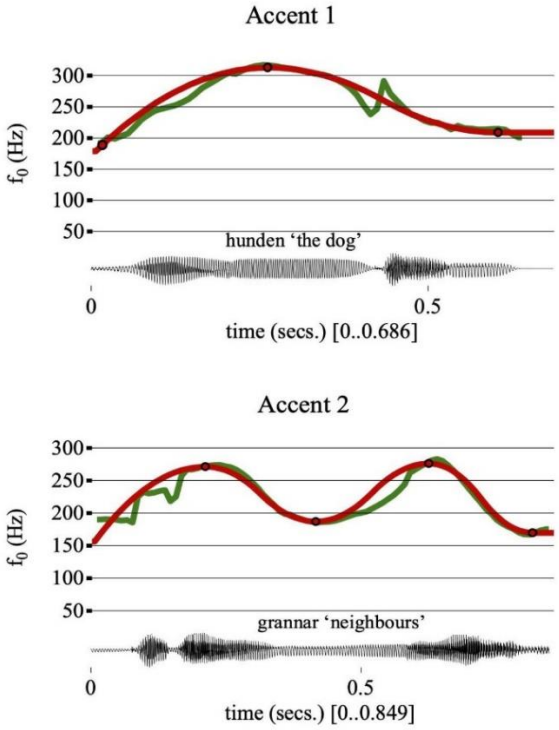

Figure 1: *Tonal patterns of Accent 1 and Accent 2 with big accent in Central Swedish. f0 (green line) was calculated with optimised max/min f0 and displayed with interpolated quadratic spline (red line).*

2.2. Markedness of accents

Swedish pitch accents have been discussed in the context of markedness, and in many descriptions, a representationally privative distinction has been suggested, whereby Accent 2 is taken to be marked [5, 21, 22]. According to this assumption, it is only Accent 2 which includes a lexical tone as part of the lexical representation of morphemes, and Accent 1 is treated as post-lexical, consisting only of pitch accents assigned by intonation. The lexical tone of Accent 2 associates to the primary stressed syllable and thereby causes the intonational pitch accent to be realized to the right of it. In the absence of a lexical tone, the intonational pitch accent associates directly with the primary stressed syllable in Accent 1 [5]. The marked status of Accent 2 in Central Swedish has been corroborated by behavioural and neural findings [17, 18, 19]. Söderström et al. [17], for instance, indicated longer response time when Accent 1 wrongly preceded a suffix requiring Accent 2. This increased processing load for Accent 2 words with mismatched accents was argued to be due to the lexical specification of Accent 2.

Other researchers have proposed an opposite distinction, where Accent 1 is regarded as lexically specified and Accent 2 as the unmarked, default pattern [16, 23, 24]. Lahiri et al. [23], for instance, argue that Accent 2 is more general and predictable while Accent 1 is more ad hoc and unpredictable. Along the same lines, Felder et al. [16] assert that only Accent 1 is lexically specified in the lexicon and in support of this assumption, indicated that listeners were faster in choosing the tonally correct word when the accent pattern was Accent 1. The authors concluded that Accent 1 words benefited from the accent information more than Accent 2 words, and claimed that accent information can aid in lexical access only if it is specified in the lexicon. Accordingly, only lexically specified Accent 1 words would provide accent information in their lexical entries. It should be noted that these opposing views ascribe different expectations to the notion of markedness. While the former account ties representation to markedness, the latter one maintains a more abstract specification [25].

3. Present study

The work described in this paper is part of a larger research project investigating the lexical and focal functions of prosody and their relevance for an efficient spoken communication across diverse languages using both psychometric and electrophysiological measures. Here we focus on Central Swedish and investigate consequences of pitch accent violations for discourse comprehension with a psychometric paradigm. In contrast with previous research, pitch accent violations are embedded in discourse in this study. A change in pitch accent might lead to incongruence in relation to discourse. For instance, after a given context like *Det är ett landlevande däggdjur med en kort svans och en lång och böjd näsa som kallas för ett tryne.* 'It is a terrestrial mammal with a short tail and a long and curved nose called a snout.', to a question like *Vad såg Sven?* 'What did Sven see?', the answer is likely to be *Sven såg grisen*[1] 'Sven saw the pig'. Here we examine whether the wrong accent assignment impairs understanding of the discourse. The accent violations do not yield a semantic anomaly per se, in the present study, but rather reflect an accent mispronunciation as in *Sven såg grisen*[2] 'Sven saw the pig [accent mispronunciation]'. The specific research questions to be answered are:

1. How do listeners judge pitch accent violations in discourse in the context of a particular informational focus?
2. Do listeners demonstrate different sensitivities to violations of Accent 1 and Accent 2?

In order to answer these questions, native speakers of Central Swedish are presented with auditory dialogues, where the test words are pitch accented either appropriately or inappropriately with respect to the given context. The task of the participants is to judge the correctness of sentences carrying test words. It is hypothesized that words with incongruent pitch accents would be harder to integrate with the dialogue, and thus be judged as incorrect by the listeners. We further predict differences in perceived correctness of violations depending on the accent pattern. When the correct accent is unmarked, violations of it will not interfere as much with the discourse, as in the reverse situation where the correct accent is marked and violated. Violations of the marked accent should elicit lower correctness scores than violations of the unmarked accent pattern.

4. Methodology

4.1. Participants

Forty native speakers of Central Swedish were recruited using an online research platform, called Prolific (www.prolific.com) [February, 2023]. Nineteen were female, and the mean age was 28.9 years (*SD* = 4.4), ranging from 22 to 38 years. Informed consent was signed prior to testing, and participants were rewarded with £6 for their participation. The study was approved by the Ethics Board of the Social Sciences Faculty of Radboud University (Project code: ECSW-2020-049).

4.2. Stimuli

One hundred sets of short auditory dialogues were used as stimuli. Each dialogue took place between a male (from Stockholm, 54 years old) and a female (from Stockholm, 64 years old) speaker with phonetic training, and consisted of a background sentence, a wh-question and an answer sentence. The background sentence provided context for the dialogue, the wh-question inquired about a specific information, and the answer presented the required critical test words. The test words were disyllabic Swedish nouns, carrying either Accent 1 [SIN.DEF.NOM] or Accent 2 [PLU.IND.NOM] (50 dialogues per pattern). The test words in the answer sentences were pitch accented either congruently or incongruently (Table 2). Experimental stimuli were recorded in an anechoic chamber using a Brüel & Kjær 1/2" Free-field Microphone (Type 4189/L/001) with preamplifier (Type 2669/L) and conditioning amplifier (Type 2690/0S2), and the sound interface Antelope Orion Studio Synergy Core (sampled at a rate of 48 kHz with 16 bits per sample).

4.3. Experimental procedure

The study was programmed and implemented online using Lime Survey (GWDG Academic Cloud). Desktop usage was required to enhance control over the online environment. To ensure participant engagement and attentiveness, timing data were observed and participants were required to enter a unique completion code at the end of the testing. The task of the participants was to listen to the auditory dialogues and judge the correctness of answers on a 6-point ordinal scale, ranging from 1 (totally wrong) to 6 (totally right). Each participant was presented with both congruent and incongruent versions of utterances, but heard only one version of each dialogue.

4.4. Data analysis and results

Descriptive results are presented in Figure 2. The total counts were illustrated in stacked bar graph, and the data points were displayed in a box and whisker plot for the congruent and incongruent conditions of Accent 1 (ACC1) and Accent 2 (ACC2). The scores were tested using Wilcoxon signed-rank test, the non-parametric equivalent of the paired two sample *t*-test, and the results indicated a statistically significant difference between the congruent and incongruent conditions of ACC1 ($Z = -5.315$, $p < 0.0001$) and the congruent and incongruent conditions of ACC2 ($Z = -5.511$, $p < 0.0001$). Overall these results indicate that both accent violations affected the acceptability of answers negatively; however, there was a statistically significant difference in the perceived correctness of accent violation depending on the accent pattern ($Z = -4.485$, $p < 0.0001$). The perceived correctness level for the ACC1 violation (Accent 1 pronounced as Accent 2) was higher than the ACC2 violation (Accent 2 pronounced as Accent 1). In other words, Accent 2 pronounced as Accent 1 resulted in a lower correctness score than Accent 1 pronounced as Accent 2.

Table 2: *Excerpts from experimental dialogues of Accent 1. Critical items are underlined.*

Dialogue	**Accent 1**
Context	Vill du springa fort så är en pitbull, labrador eller golden retriever bra. *If you want to run fast, a pit bull, labrador or golden retriever is good.*
Question	Vilket djur ska Sven ta med på löprundan imorgon? *Which animal will Sven take with him on his run tomorrow?*
Congruent	Imorgon ska Sven ta med <u>hunden</u>[1] på löprundan. *Tomorrow Sven will take <u>the dog</u> with him on his run.*
Incongruent	Imorgon ska Sven ta med <u>hunden</u>[2] på löprundan. *Tomorrow Sven will take <u>the dog [accent mispronunciation]</u> with him on his run.*

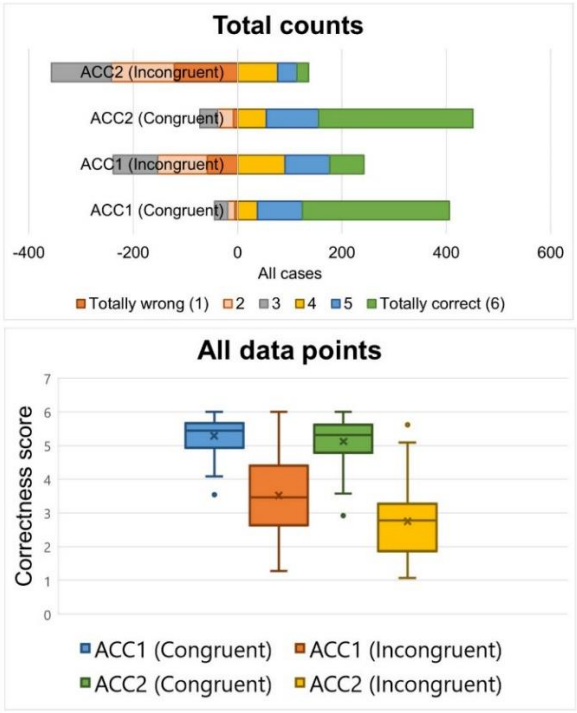

Figure 2: *Stacked bar graph of total counts (top). For visualization purposes, zero is placed in the middle of the scale. Positive distribution [4, 5, 6] roughly represents correctness; negative distribution [1, 2, 3] roughly represents wrongness. Box and whisker plot with mean, median, minimum, maximum, second and third quartile values as well as outliers (bottom).*

5. Discussion

Using correctness judgments and examining psychometric measures, we investigated whether/how pitch accent violations affect the perceived correctness of an answer to a question with respect to a given context in Central Swedish. As predicted, the results indicated that answers with incongruent accents were judged as incorrect by listeners, indexing that both Accent 1 and Accent 2 violations interfere with the coherent interpretation of discourse. The results further indicated an asymmetry in processing of Accent 1 and Accent 2 violations. Accent 2 pronounced as Accent 1 led to a lower correctness score compared to Accent 1 pronounced as Accent 2, suggesting that the listeners were more sensitive to pitch accent violations in words carrying Accent 2 than in words with Accent 1. In the following, we will discuss these results in detail.

In Swedish, given that there are only a few hundred words that can be distinguished by pitch accent and segmental information is sufficient for distinguishing words, pitch accents are claimed to be redundant for semantic distinctive purposes. Nevertheless, Swedish has kept these accents more than a thousand years [15, 27] and there is a strong correlation between accents and suffixes [26, 27]. Furthermore, there are psycho- and neuro-linguistic evidence documenting that pitch accents contribute to the processing of simple and complex word forms [14, 16, 17, 18, 19, 20]. The current findings provide evidence for the functional role of pitch accents at the discourse level, in that an inappropriate accent pronunciation interferes with the interpretation of a message, as corroborated by statistical differences between the acceptability of congruent and incongruent accents. The present study suggests that pitch accents can be used in instant processing tasks such as discourse comprehension, despite being seemingly insufficient for semantic distinction purposes.

The results further expose an asymmetry in the processing of Accent 1 and Accent 2, in line with the markedness claims. In the literature, Accent 2 is widely acknowledged as the marked and lexically represented pattern [5, 28]. As reviewed in the Introduction, the marked status of Accent 2 in Central Swedish has been established by behavioural and neural findings [17, 18, 19]. Other researchers, however, claim that Accent 1 should be regarded as marked and lexically specified in the lexicon [23, 24] and provided experimental evidence in this respect [16]. Although they do not find asymmetries between the two accent patterns, Althaus et al. [14] argue that the unmarked accent pattern of the relevant lexical item should be activated regardless of the wrong accent pattern. For instance, assuming Accent 1 as marked, Accent 2 violations should not interfere with the interpretation as much as Accent 1 violations should. Given that the application of the wrong accent pattern for Accent 2 words resulted in lower correctness scores and as such higher costs for speech perception, our results are in accordance with the markedness notion of Accent 2 [5, 21, 28]. In other words, Accent 2 words are only activated if they bear their lexically represented tone, whereas Accent 1 words are not affected by accent mispronunciations, providing further support for Accent 2 being lexically represented [21], and as such falsifying the claims of Accent 2 being unmarked [23, 24].

One might question the interference of accent mispronunciation with discourse comprehension assuming that language users often accommodate incorrect accent use in everyday language – to varying degrees depending on their experience and attitude to the correct use of accents. Put differently, one might claim that the present findings reflect metalinguistic and/or prescriptive judgments rather than relevance and/or markedness of accent information for discourse comprehension. Despite being highly relevant, the attitude observations were out of the scope of the present paper. However, it can be speculated that attitude-related impact, if any, would be present for both Accent 1 and Accent 2 mispronunciations, and thus be potentially inconsistent with the asymmetry reported here. Experience and exposure to different accent patterns might have some consequences for the results. For instance, Accent 1 is claimed to have a higher predictive power than Accent 2 in that there are fewer possible continuations associated with Accent 1, making Accent 1 more constraining [15]. The constraining effect of Accent 1 has been evidenced by increased surprisal of listeners when it wrongly preceded a suffix requiring Accent 2 [18, 19], and the unpredictability of Accent 2 has been used as an argument for its markedness [28]. Along the same lines, although not reported here, our electrophysiological findings with the current experimental material documented a larger sustained negative event-related potential response to Accent 2 violations, reflecting uncertainty associated with the discourse, compared to Accent 1 violations. This pattern of results suggests that the application of wrong accent pattern for Accent 2 words yields higher costs for spoken communication than for Accent 1 words. These findings and assumptions strengthen the validity of current findings indicating not only that accent mispronunciations increase the processing load in discourse comprehension but also that accent patterns differ in their constraining effects.

Taken together, these findings suggest a functional role for Swedish pitch accents when scrutinized with a dynamic processing approach rather than a traditional semantic perspective [13, 15, 29]. It is evident that listeners rely on pitch accent information not only to access and recognize lexical items but also to narrow down lexical competitors and infer upcoming morphological strings and discourse constituents. In line with the extensive literature on the predictive mechanisms found at several levels of linguistic processing [30, 31, 32, 33], it can be argued that pitch accents have a predictive, facilitative function in Swedish (for a detailed discussion, see [15]). The results further consolidate the marked status of Accent 2 given the fact that the application of the wrong accent pattern for Accent 2 words results in lower acceptability. These findings provide evidence that listeners not only use pitch accents for a coherent interpretation of the discourse but also give different weights of relevance to them depending on their markedness.

6. Conclusions

The current findings suggest that Swedish pitch accents play an essential role in discourse comprehension. The sensitivity to the accent violations indicates that listeners employ both Accent 1 and Accent 2 to achieve a coherent interpretation of the linguistic input. The results furthermore consolidate the marked status of Accent 2 as listeners are more sensitive to pitch accent violations in Accent 2 words than in Accent 1 words.

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