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Phonetic markedness, turning points, and anticipatory attention

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Abstract

Phonetic markedness regarding linguistically relevant tonal patterns (Accent 2, boundary tones) in Central Swedish is discussed. Both tonal markedness and F0 turning points are assumed to be important cues for anticipatory attention to grammatical structure during speech processing. Empirical evidence from neuro-linguistic and psycholinguistic experiments for the assumed relation between anticipatory attention and marked tonal patterns' association with Swedish word and clause structures is presented.

Introduction

The present article reviews results from neuro-linguistic and psycholinguistic studies on the perception of Central Swedish grammatically relevant tonal patterns and relates these results to the notions of ‘phonetic markedness’ and ‘passive attention’. We suggest that marked tonal patterns tend to be associated with relatively more kinds of grammatical structure as compared to their unmarked counterparts due to their intrinsic tendency to allocate attention. For example, Central Swedish Accent 2 is associated with more lexical information than Accent 1. On the one hand, it is the word accent associated with compounds, and on the other hand, it is thought to be lexically specified on a certain class of suffixes (Riad, 2009). Both neurophysiological (Roll et al., 2010) and response time studies (Söderström et al., submitted) suggest that Accent 2 is also ‘phonetically’ marked as compared to Accent 1. A similar co-occurrence of marked tonal patterns and increased association to grammatical structure is further illustrated with reference to other prosodic phenomena, such as Central Swedish boundary tones. We will begin by discussing the notion of ‘phonetic markedness’ before moving on to discuss ‘passive attention’ and finally to describe neurophysiological and behavioural results supporting our proposal.

Phonetic markedness

According to Trubetzkoy (1969), the *unmarked* member of a sound opposition should be the one that deviates the least from normal breathing and

the *marked* member should consequently be the one that deviates more from normal breathing. Although the definition was originally formulated with respect to segmental obstructions, it might be extended to also include suprasegmental structures. Furthermore, elements deviating more from normal breathing could also be expected to be more perceptually salient, and involve more effort in their production. Thus, similar to Trubetzkoy’s notion of markedness, Gussenhoven (2004) formulates an “effort code”, according to which a tonal pattern that is perceived as involving more production effort tends to be associated with an emphatic interpretation. Gussenhoven assumes this to be what underlies the common grammaticalisation of focus in terms of relatively wide F0-excursions. Consolidating Trubetzkoy’s and Gussenhoven’s ideas, it could be assumed that ‘marked’ tonal patterns should tend to be perceived as more emphatic.

Tonal markedness and passive attention

We further propose an extension of this idea of tonal markedness, namely that there is a natural tendency for marked – or perceptually salient – F0 contours to increase attention at different levels of speech processing. Sudden changes in the physical environment tend to draw our involuntary attention. In the auditory domain, such “passive attention” is triggered by onset and offset of sounds as well as significant change in pitch or loudness (James, 1860; Näätänen, 1992). Especially relevant for language is “an-

“anticipatory attention”, i.e. attention directed to upcoming events rather than to the triggering event itself (Näätänen, 1992; Posner & Petersen, 1990). We suggest that marked tonal changes tend to function as triggers for passive anticipatory attention to associated grammatical structures.

Markedness and word accents

An example of the relation between markedness and need for increased attention to certain features of the speech signal is constituted by Swedish word accents. Stressed Accent 2 syllables have a high tone, whereas stressed Accent 1 syllables have a low tone (HL*) (Bruce, 1977). High tones would generally be thought to be more marked than low tones, since they involve faster vocal fold movement. Moreover, since the Accent 2 H*L tone falls through the stable spectral state of the vowel of the stressed syllable, it can be expected to be perceived more saliently than the Accent 1 fall, which occurs earlier, in the pretonic syllable. Because of its association with the pretonic syllable, the Accent 1 HL* is likely to be realized phonetically by a fall through segments with more rapid spectral change and therefore not be perceived as saliently as the Accent 2 movement (House, 1990). In other words, Accent 2 can be considered to be the *phonetically* marked accent.

According to the reasoning above, the phonetic markedness of Accent 2 could be expected to draw listeners’ anticipatory attention to certain upcoming grammatically relevant aspects of the speech signal. Riad (1998; 2009), following Rischel (1963), has suggested that Accent 2 is lexically associated with a certain class of suffixes. Moreover, in Central Swedish, Accent 2 is the prosodic marker of compound words. Hence, it would seem likely that the marked Accent 2 tone could activate rapid anticipatory attention to possible associated suffixes or compound words.

Markedness and boundary tones

Similar reasoning can be applied to other marked tonal patterns. Left-edge boundary tones in Central Swedish are realized by a high tone in the last syllable of the first prosodic word in main clauses (Roll, 2006; Roll et al., 2009; 2011; Roll & Horne, submitted; Myrberg, 2010). The high left-edge boundary tone can be seen as a marked pitch excursion as compared to the alternative of not having a left-edge boundary

tone. This marked tonal pattern can be expected to allocate anticipatory attention to the main clause structure it is associated with. As for right-edge boundary tones, these low (usually HL) patterns can, due to their relatively sudden decrease in pitch, be seen as a pitch excursion deviating from a ‘default’ slow downward F0 drift. Accordingly, these right-edge tones are associated with additional structural information as compared to their absence, i.e. the closure of a clause.

Tonal turning points as attentional cues

Since changes in pitch draw involuntary attention to them, the initiation of rises or falls, i.e. the phonetic *turning points* in F0-patterns (Bruce & Gårding, 1978) are likely to call for anticipatory attention. According to this approach, Central Swedish word accents have been analysed phonologically as HL* or H*L contours which differ only in the timing of the fall in relation to the stressed syllable (Bruce, 1977, 1987). However, in accordance with Bruce (2005), we assume that not only is the word accent fall relevant for word accent distinction, but also the rise to the H* in the Accent 2 LH*L pattern. We suggest that phonetic turning points in marked tonal patterns activate early anticipatory attention to the linguistic structures they are associated with. In what follows, we will present neurophysiological as well as behavioural data supporting this view.

Neurophysiological evidence

Using Event-Related Potentials (ERPs), Roll, Horne, and Lindgren (2010) investigated the neurophysiological correlates of perceiving the rise in the LH*L pattern in words with Accent 2 suffixes, e.g. *minkar* ‘mink+pl’, as compared to the fall in the corresponding singular forms with LHL* Accent 1 pattern e.g. *minken* ‘mink+sg’. An early positive deflection, interpreted as an effect on the P200 component, was seen in the ERPs for the Accent 2 rise (Fig. 1). P200 is an electrophysiological component thought to reflect early allocation of attention following detection of behaviourally – or, in the case of language, linguistically – relevant acoustic changes (Näätänen, 1992). Further, the effects of mismatch between stem-tone pattern and suffix were investigated. Accent 2-associated suffixes yielded a late positivity, a ‘P600’ effect, when preceded by an Accent 1 tonal pattern on the stem, whereas Accent 1-associated suffixes were

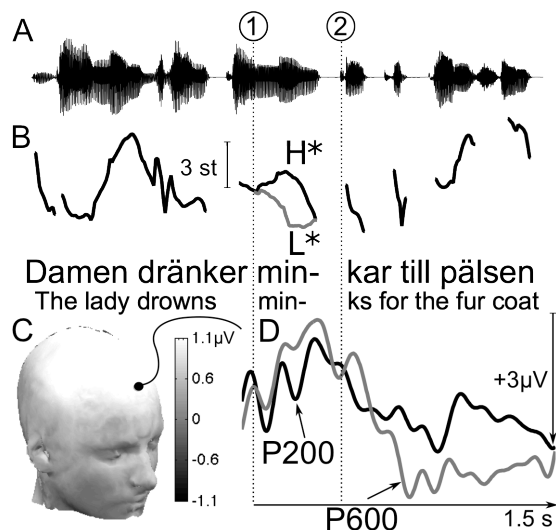


Figure 1. Waveform (A) and F0 (B) for a sentence containing an unfocused Accent 2 word (minkar 'minks') with matching (H*, black line) and mismatching (L*, gray line) word accent. Average Event-Related Potentials (ERPs) for 40 similar sentences and 22 participants are shown for the frontal electrode FZ (D). Vertical dotted lines indicate critical word/Accent 2 rise onset (1) and suffix onset (2). The Accent 2 rise yielded a P200 effect. Following a mismatching L* stem tone, the Accent 2 suffix -ar gave rise to a P600 effect. The central to anterior distribution of the P200 effect is also presented (C). Data from Roll et al. (2010).

unaffected by the preceding stem tone. The P600 reflects reprocessing of unexpected or incorrect structures. The results suggest a process where the turning point identifying the onset of the marked high tone triggered allocation of early anticipatory attention to its associated suffixes (P200), leading to facilitated processing of the suffix. In the absence of a marked stem tone, the suffix was not activated, which resulted in reprocessing of the word form (P600).

High left-edge boundary tones also give rise to a P200 effect as compared to their absence (Roll et al., 2009; 2011; Roll & Horne, submitted). Thus, similar to Accent 2, the rise to the marked tone in the last syllable of a word is perceived as linguistically pertinent, and allocates attention to its associated main clause structure. Therefore, it reduces the P600 of the word *inte* 'not' in embedded *att* 'that' clauses such as ...*att vandalerna intog inte Spanien* 'that the Vandals not conquered Spain', where *inte* shows main clause word order following the verb *intog* 'conquered'. The reduced P600 indicates that the

left-edge boundary tone in the last syllable of *vandalerna* 'the Vandals' makes the main clause word order more expected in spite of the embedded context.

If the P200 reflects early allocation of attention cued by grammatically relevant tonal events, it should also be seen for marked falls in the appropriate context. Effectively, Roll and Horne (submitted) found a P200-like positive effect even for HL right-edge boundary tones in the second noun (*vänneren* 'the friend') in sentences like *Lingvisten spöa vänneren och fonetikern stöp/stort i ett uppgjort lopp* 'The linguist beat the friend and the phonetician fell/greatly in a set-up race'. The P200 was followed by a later positivity, interpreted as a Closure Positive Shift (CPS), showing closure of the first clause (*Lingvisten spöa vänneren* 'the linguist beat the friend'). It thus seems that in this case, the marked fall constituted by the right-edge boundary HL pattern oriented attention to upcoming clause closure instead of clause continuation.

Psycholinguistic evidence

Support for the assumed phonetic markedness of Accent 2 has also been found in a response time experiment originally carried out to investigate the effects of tonal mismatch on the perception and interpretation of Central Swedish word accents (Söderström et al., submitted). Test stimuli consisted of short pronoun+verb utterances, with narrow focus placed on the pronoun so as to avoid the focal rise on the verb. The task was to decide as quickly as possible whether the verb was in the present or the past tense, i.e. either HAN röker ('HE smokes', Accent 1) or HAN rökte ('HE smoked', Accent 2) (see Fig. 2). Half of the stimuli had a stem tone/suffix mismatch. All stimuli were created by splicing together stems with suffixes. The hypothesis, based on the ERP research discussed above, was that words with an Accent 1 stem tone and Accent 2-inducing suffix would be the most difficult to process, because there was no H* tone to cue the upcoming Accent 2 lexicalized suffix. This finding was replicated in the response time study: mismatched Accent 1 stems followed by Accent 2-inducing past tense suffixes were indeed the most difficult to process (Fig. 2). Another interesting finding was that non-mismatched ("correct") Accent 2 words were more difficult to process as compared with non-mismatched ("correct") Accent 1 words in general. This was taken as further support for

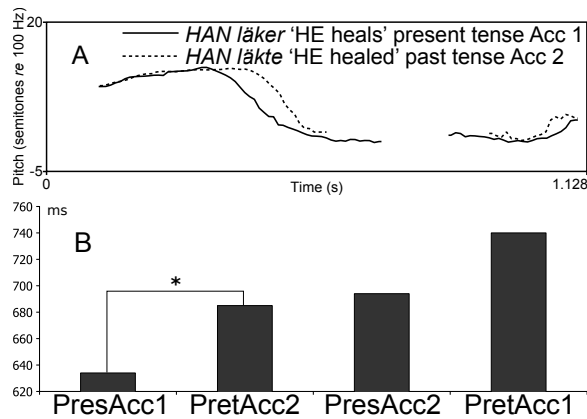


Figure 2. F0 curves for two Swedish utterances HAN läker 'HE heals' and HAN läkte 'HE healed', Accent 1 and 2, respectively (A). Mean response times for four conditions: 'Pres' = 'present tense', 'Pret' = 'past tense', so that e.g. "PresAcc2" = present tense word with Accent 2 associated with the stem (B).

the idea that Accent 2 is the marked member of the opposition and that Accent 1 is unmarked. As already stated above, this could be explained by the fact that the H* Accent 2 tone is associated with more word forms as compared to Accent 1. A further finding in the response time study was that words with an Accent 2 stem tone mismatched with an Accent 1 suffix were also difficult to process, although less difficult than Accent 1 stem tones mismatched with Accent 2 suffixes. An explanation for this is that many forms with Accent 2 including compound words are activated when an Accent 2 tone is heard, and must be deactivated when the Accent 1 suffix is heard.

Conclusion

Results from the empirical studies discussed above support the idea that phonetically marked tonal patterns in Central Swedish (Accent 2, boundary tones) constitute important cues for anticipatory attention in speech processing. Both tonal markedness and F0-turning points related to Accent 2 and boundary tones are associated with frequent, well-defined linguistic structures (Accent 2 suffixes, compounds, initial and final clause boundaries) in Swedish.

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