Final aspiration as a phrase boundary cue in Swedish: the case of *att* 'that'

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Abstract

The Swedish word *att* /at/ is associated with two grammatical functions: a) (part of) a subordinate conjunction and b) an infinitive marker. This pilot study, with 5 short spontaneous discourses from 3 male speakers shows a correlation between pauses after *att* and aspiration of /t/ in *att*, where aspiration can be interpreted as a kind of final lengthening involving the release phase of the stop consonant. We also show a tendency for *att* with aspiration to be associated with the grammatical function of subordinate conjunction. Further, we are able to show a tendency for the infinitive marker to be unaspirated in the normal case, while the subordinate conjunctions are characterized by final aspiration in 40% of the cases.

1 Introduction

Previous studies on phrasing have shown how prosodic cues such as pauses and final lengthening serve to signal boundaries in spoken discourse (Bruce et al. 1993; Horne et al. 1995; Fant & Krakenberg 1991; Swerts 1997). It has also been observed that even segment-related secondary articulations are often associated with phrase-boundaries (see e.g. Dilly et al 1996 for a discussion of phrase-initial vowel glottalization in English).

1.1 Purpose

The goal of this paper is to present pilot data from Swedish that illustrate how segmental strengthening (realized as final aspiration in the subordinate conjunction *att* /at/) can be a useful cue for detecting clause boundaries in speech recognition and parsing algorithms.

1.2 Theoretical background

Segmental 'strengthening' and 'weakening' processes are explained by relating their input and output sound categories to a scale of sonority (for a discussion, see Hyman, 1975). According to the sonority scale, vowels are assumed to be the most sonorant segments, whereas aspirated stops and affricates are the least sonorant segments (see Fig. 1). Consonant strengthening, involving a movement to the left on the sonority scale is often observed for example at the beginning of stressed syllables.

![Figure 1. The sonority scale.](image)

In the present study, it will be shown how the strengthening of /t/ in *att* to a strongly aspirated variant occurs in phrase final position in Swedish. This final aspiration can be analysed as signalling the end of a speech fragment which forms part of an uncompleted message.

Aspirated and unaspirated variants of voiceless stops are common in several Germanic languages as contextually conditioned variants. Their distribution is highly predictable in terms of phonetic context. In English, aspirated variants are observed to occur at the beginning of stressed syllables. In Swedish, aspirated stops are also found in this position (Englendrand 1993; Krull 1991), but are even found in "final" (Lindblad, 1998), or "prepausal" (Garlen, 1988) position. Aspirated voiceless stops are characterized by a period of noisy airflow after the burst that lasts for a considerable period of time. For Swedish, the lower boundary for perception of aspiration is about 40 ms (Lindblad, 1998). Below that level, aspiration is not perceived.

![Figure 2: To the left: waveform of [at\^] with final aspiration. To the right: Waveform of [at\'] without final aspiration.](image)
Distribution of att followed by a pause and/or with final aspirated /t/ in absolute numbers. To the left: cases where att is followed by a pause; to the right: cases where att is not followed by a pause. The upper, lighter layer shows the cases where the final /t/ is not aspirated, whereas the lower, darker layer shows the cases where /t/ is aspirated.

3b (right): Distribution of att followed by a pause collapsed over att as infinitive marker and att as a subordinate conjunction. To the left: cases where att is followed by a pause; to the right: cases where att is not followed by a pause. The upper, lighter layer shows the number of cases of att as an infinitive marker, whereas the lower, darker layer shows the number of cases of att as a subordinate conjunction.

3 Results

In the five discourses studied, att occurs 99 times. Of these, att functions as a subordinate conjunction in 67 cases, as an infinitive marker in 8 cases, and as part of other, more complex subordinate conjunctions in 24 cases. Thus, att as a subordinate conjunction is more frequent than att as an infinitive marker. (It should be pointed out that an additional 17 cases of the infinitive marker occurred in the data in the reduced form [o:]). In what follows, we will only look at the 75 cases where att occurs as a single subordinate conjunction or before an infinitive.

Fig. 3a shows that 18 of the 75 investigated cases of att were followed by a pause. 17 of these cases also had an aspirated /t/, which makes a strong implication, i.e. that pauses are connected with aspiration. However, from a comparison of Fig. 3a and 3b we find that the opposite is not true: of the 57 cases where att was not followed by a pause, 21 of the cases showed final aspiration. Thus, the implication that aspiration automatically leads to a pause following att is not true.

4 Discussion and conclusion

Many studies have claimed that pauses are used for planning, and that pauses therefore are often found at clause boundaries (see e.g., Chafe 1979; Beattie 1980). Other studies have shown that final lengthening signals boundaries in spoken languages (Bruce et al 1993; Horne et al 1995). Aspiration could be considered to be one kind of final lengthening involving the release phase of the final stop consonant. This would lead us to look for a correlation between pauses and final aspiration, i.e. that an att followed by a pause should also have an aspirated /t/. Indeed, this is what has been observed in this pilot study.

Finding this, we can conclude that there is a correlation between pauses and final aspiration. When looking at the distribution of the two types of atts followed by a pause, we find that most of these cases involve att as a subordinate conjunction. Although it is not possible to prove it statistically, since the number of infinitive atts is so low, we would still like to suggest that att as a subordinate conjunction is more likely to be followed by a pause.

The question is what happens if we take away the cases where att is followed by a pause and see if we can observe any differences in aspiration between att as a subordinate conjunction and att as an infinitive marker.

What we find, however, is that 0% (0 of 6) of the realizations of infinitive att have final aspiration, while 40% (21 of 51) of the realizations of att as a subordinate conjunction have final aspiration. Although the low number of cases with att as an infinitive marker makes it impossible to run statistics on this result, it is worth stressing the fact that when the cases followed by pause were excluded, none of the infinitive atts had final aspiration, while 40% of the atts as subordinate conjunction had final aspiration.

In this study, we have tried to show a correlation between aspirated /t/ in the frequently occurring homonym att in Swedish, and its function as a subordinate conjunction. Although this is only a pilot study, it nevertheless suggests that aspiration of final /t/ in att could be a useful cue in, e.g., developing algorithms for speech recognition and parsing. If att has final aspiration and is followed by a pause it is more likely that we are dealing with the realization of att as a subordinate conjunction, rather than the realization of att as an infinitive marker.

The tendencies we have found so far show that it would be fruitful to carry out a larger investigation, preferably with more cases of att as an infinitive marker.

References