Articulatory anchors for tonal targets in rising pitch accents

Doris Mücke; Martine Grice
IfL Phonetik, University of Cologne, Germany,
{doris.muecke; martine.grice}@uni-koeln.de

Résumé:
Cette étude examine la variation dans l'alignement des cibles intonatives haute et basse des accents de hauteur montants L+H relativement aux repères acoustiques de la chaîne segmentale au moyen desquels ils sont réalisés. Une explication à cette variation sera présentée en termes d'ajustements dans l'alignement des cibles de F0 en relation avec des gestes articulatoires définis de manière dynamique.*

1. Introduction

This study investigates variation in the alignment of low and high F0 targets in rising L+H* pitch accents relative to acoustic landmarks in the segmental string upon which they are realised. It will offer an explanation for this variation in terms of adjustments in the alignment of F0 targets in relation to dynamically defined articulatory gestures [1].

In German it has been argued that alignment may be affected by the status of the pitch accent in the intonational hierarchy (nuclear, prenuclear) – analogous to closely related languages such as Dutch and English [2,3] – and by the dialectal background of the speaker [4].

In a comparison of prenuclear and nuclear accents in the varieties of German spoken in Vienna and Düsseldorf, we confirm that the F0 targets for prenuclear and nuclear accents differ systematically in alignment. Further, although prenuclear accent alignment in the Vienna and Düsseldorf varieties is similar, the difference between nuclear accents is striking.

2. Method

We constructed meaningful sentences with the same target words in nuclear and prenuclear position, including the following segmental string **C1 V1** C2 V2 C3 V3 (C = nasal [n, m], V1 = non-high vowel [a, ɛ], V2 = high vowel [i] such as in "Nahni nah(m)" [na:ni na:], 'Nahni took').

Two speakers from each variety were recorded using a Carstens Articulograph AG100 (sensors placed on tongue tip and body, and lower lip). We manipulated phonological vowel length (short/long) in the accented syllable, and articulation rate (normal/fast). Turning points in the F0 contour and acoustically defined segment boundaries were labelled following [2], as well as articulatory targets in the vertical plane [5, 6]. For consonantal gestures, this was the maximum for the primary constriction (lower lip or tongue tip) in C1 and C2. For vocalic and transvocalic gestures [1], these were the V1-to-V2 tongue raising movement and the minimum between the C1 and C2 constrictions respectively.

3. Results

Results are presented here for one speaker in each variety. Figure 1 shows alignment patterns typical of F0 targets with segments and gestures for prenuclear and nuclear accents in the Vienna and Düsseldorf varieties.

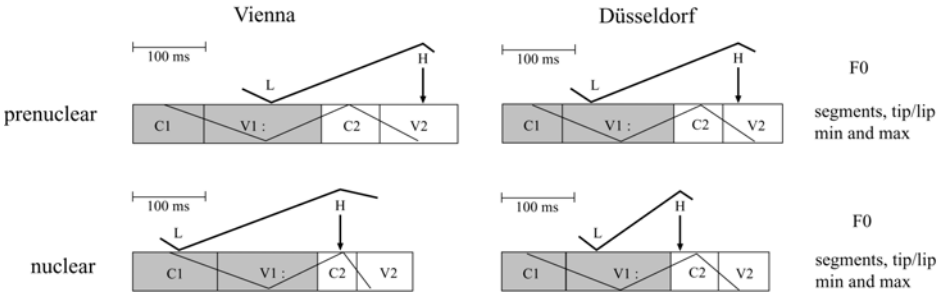

Figure 1: Alignment patterns of L and H with segments and articulatory targets (accented syllable grey)

For **Vienna**, we can observe a clear shift of both of L and H from prenuclear to nuclear accents: both L and H occur in exactly one segment earlier in the nuclear condition. Although the dura-

tion of the *rise* remains more or less constant (increasing by 4% (8.7ms) for CV: contexts and 0.6% (1.3ms) for CVC), there is a considerable lengthening of the onset consonant (C1) of the accented syllable: an increase of 19% (18.8ms) in CV:, and 24% (22.1ms) in CVC. This durational adjustment is not a function of a linear increase in duration of the whole of the accented syllable: the vowel is shorter in nuclear position by 14% (-23.91ms). In articulatory terms, prenuclear L and H align with articulatory targets for gestures corresponding to V1 and V2 respectively (here transvocalic minima of tip/lip constriction), whereas nuclear L and H align with the preceding consonantal targets (here consonantal maxima of tip/lip constriction): C1 and C2, constituting a shift of one position to the left in the articulatory domain too.

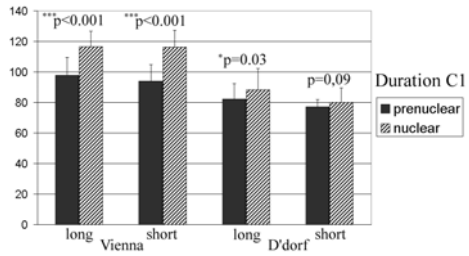

Figure 2: Mean duration and standard deviation of the onset consonant (C1) of the accented syllable

Düsseldorf shows a similar shift in the F0 target for H from prenuclear to nuclear position, from the nucleus of the postaccented syllable (V2) to the intervocalic consonant (C2), and in the articulatory domain to the corresponding gestures. However, what is immediately apparent from Figure 1 is that the rise is substantially shorter: 43% (-87.3ms) for CV: and 48% (-81.8ms) for CVC, and that the target for L does not change: It stays within the accented vowel (V1), aligned with the corresponding articulatory minimum of the transvocalic gesture.

Thus, although both Vienna and Düsseldorf shift the H target to the left, they employ different strategies to ensure that the rise is fully realised. Whereas Vienna realises the rise with the same duration, and even increases the duration of the onset of the accented syllable, C1, the target for nuclear L, Düsseldorf shortens the rise time and makes it steeper. Both strategies are considered to involve *compression* in terms of [7], since the rise is fully realised and thus not *truncated*. However, the two strategies are quite different. Vienna can be seen to *accommodate* the rise (shifting both targets and adjusting durations of anchor segments), whereas Düsseldorf *compresses* it (allowing the F0 targets to come closer together in time).

Although the question as to why nuclear H tones are realised earlier was not directly adressed, it is likely that tonal crowding is responsible, involving a further tone after the H. Since the nuclear syllable is followed in all cases by four unstressed syllables before the phrase boundary, there is unlikely to be time pressure from a straight edge tone. This means that the extra tone is either part of the pitch accent (resulting in a tritonal pitch accent) or is a phrase accent. If there is indeed tonal crowding, then the two varieties adjust their alignment in different ways. Vienna *acccomodates* the rise, whereas Düsseldorf *compresses* it. What they have in common is that in nuclear accents they reorganise their alignment by shifting the H target from one anchor to an earlier one, as indicated by the discrete shift from one gesture to another.

4. References

[1] BROWMAN, C.P. & GOLDSTEIN, L. (1988). Some Notes on Syllable Structure in Articulatory Phonology. *Phonetica* 45, 140-155.

[2] SCHEPMAN,A., LICKLEY,R & LADD, D.R. (2006). Effects of vowel length and "right context" on the alignment of Dutch nuclear accents. *Journal of Phonetics* 34(1), 1-28.

[3] SILVERMAN, K. & PIERREHUMBERT,J. (1990). The timing of prenuclear high accents in English. In Kingston, J. & Beckman, M. (eds.), *Papers in Laboratory Phonology I.* Cambridge: C.U.P.

[4] ATTERER,M. & LADD,D.R. (2004). On the phonetics and phonology of "segmental anchoring" of F0: evidence from German. *Journal of Phonetics* 32(2), 177-197.

[5] D'IMPERIO,M., NGUYEN,N. & MUNHALL,K.G. (2003). An articulatory hypothesis for the alignment of tonal targets in Italian. *Proceedings of the 15th ICPhS*, Barcelona, Spain, 253-256.

[6] MÜCKE, D. & GRICE,M. (2004). Gestural anchors for F0 targets in German speech: an EMA-study, *International Conference on Tone and Intonation*, Santorini, September 2004.

[7] LADD, D. R. (1996). *Intonational Phonology*. Cambridge: C.U.P.