Imitating alignment differences in German nuclear accents – is (L+H)* a category?

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In the framework of autosegmental metrical phonology [1, 2], pitch accents are considered to be associated with metrically stressed syllables (abstract link), while the actual alignment of H(igh) and L(ow) tonal targets may vary; cf. Fig. 1a) for a "medial-peak" accent (L+H*) with L before and H in the stressed syllable, and Fig. 1b) for a "late-peak" accent (L*+H) with L in and H following the stressed syllable. Based on results from categorical perception and imitation paradigms, the alignment difference between medial peaks and late peaks has been considered categorical in German (and English) [3, 4]: Medial-peak accents are associated with information new to the discourse and late-peak accents with self-evident, sarcastic meaning [4, 5]. At the same time, phonetic alignment differences in German rising-falling contours (henceforth, LHL contours) have been shown to signal linguistically meaningful distinctions, e.g., contrastive vs. non-contrastive topics [6]. In a production study on the prosody of information-seeking questions (ISQs) and rhetorical questions (RQs) in German, Braun et al. [7] found nuclear LHL contours in both *wh*-ISQs and *wh*-RQs. Yet, while L+H* L-% (alignment as in Fig. 1a) was typical in *wh*-ISQs, in *wh*-RQs both L and H were often aligned in the stressed syllable (L+H)* (as in Fig. 1c) – a contour not (yet) described for German [8].

To test whether the difference in tonal alignment between *wh*-ISQs and *wh*-RQs is categorical or whether it is a case of phonetic gradience, we conducted two imitation experiments (cf. [3, 9, 10]). Participants from Southern Germany imitated three different resynthesized nuclear LHLs: L+H*, L*+H, (L+H)*, cf. Fig. 1a)-1c). If there is a three-way categorical contrast of German LHLs, we expect speakers to maintain three distinct contours. If (L+H)* is a phonetic variant of either medial- or late-peak accents, we expect a two-way distinction, i.e., imitations of (L+H)* mapping on medial- or late-peak accents. In Experiment 1, participants heard different *wh*-questions with a nuclear LHL, e.g., *Wer malt denn Mandalas?* 'Who draws mandalas?' [ˈman.da.las]. Each target was presented 3 times in a row, before speakers imitated the contour as accurately as possible. There were 24 trials: 4 trisyllabic items x 3 contours x 2 manipulation directions (half of the contours were resynthesized from naturally produced medial-peak accents and half from naturally produced late-peak accents). In Experiment 2, speakers imitated the LHLs from Exp. 1 (again 24 trials), but unlike in Exp. 1, each contour was presented only once, followed by 2000ms of silence and a sine tone (150 or 450Hz) to ensure that phonetic information had decayed and storage was necessary [11-13].

Preliminary results show a difference between the experiments (so far 4 speakers each). In Exp. 1, three distinct contours emerge (for the whole experiment, Fig 2a). In Exp. 2, the three distinct contours are maintained in the first half of the experiment, while imitations converge onto late-peak accents for the second half (Fig. 2b). Speakers' ability to produce three distinct contours, in general, seems to suggest a three-way alignment contrast for German nuclear LHLs and hence (L+H)* as a category. When speakers cannot rely on the immediate phonetic trace, but need to store the signal (Exp. 2), an increasing number of LHL imitations might prompt speakers to store and produce a very frequent accent in the daily input [cf. 10], i.e., late peaks in Southern German [14, 15]. We are currently testing more speakers to corroborate the results. We will also include imitations from two more varieties of German (Northern and Swiss German, testing on-going), which differ from Southern German in the tonal alignment in LHLs [17-19], and vary in the extent of daily exposure to different LHLs [14, 19, 20]. Following [9], we will use cluster analyses [16] to identify the distinctiveness of LHL contours for different speaker groups. To conclude, our study contributes to the understanding of phonological representations in intonation considering the interplay between phonological working memory, regional variety, and frequency of occurrence of contours in the daily input.
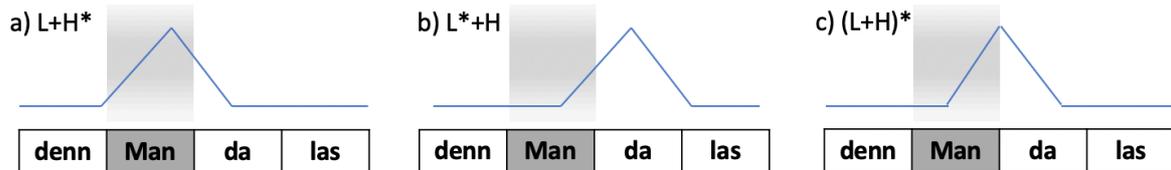
Fig. 1. Schematic representation of rising-falling contours in German: a) medial-peak accent (L+H*), peak aligned in the stressed (grey-shaded) syllable; b) late-peak accent (L*+H), peak aligned in the syllable following the stressed one; c) accent found in German rhetorical questions [7], both L and H aligned in the stressed syllable. Note that a) and b) are GToBI [8] notations, c) is our own label).
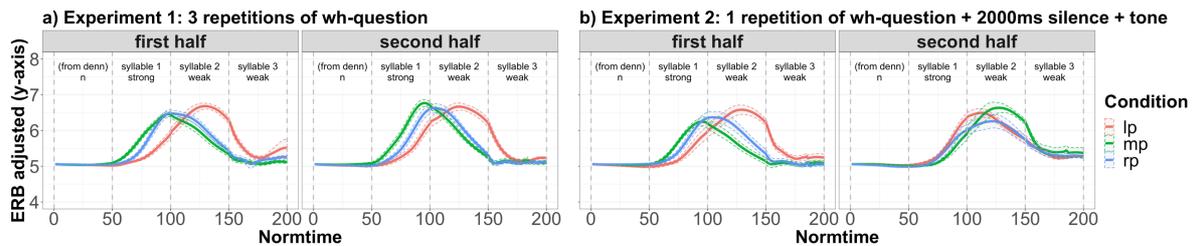

Fig. 2. Average f0 contours (ERB) of sentence-final object, e.g., *Mandalas*, preceded by the final segment /n/ of *denn* of imitative productions in Experiment 1 (N = 4 subjects, left panel) and in Experiment 2 (N = 4 subjects, right panel), split by experimental half; f0 values were extracted with Prosody Pro [21] (50 measurements per unit) and adjusted to start at the same f0 value. The three different input conditions are colour-coded (late-peak accent (L*+H) in red, medial-peak accent (L+H*) in green and "rhetorical"-accent (L+H)* in blue).

[1]   Ladd, D. R., *Intonational phonology*, 2nd ed. Cambridge: Cambridge University Press, 2008.
[2]   Pierrehumbert, J. B., "The phonology and phonetics of English intonation," PhD Thesis, Massachusetts Institute of Technology, Dept. of Linguistics and Philosophy, Boston, USA, 1980.
[3]   Pierrehumbert, J. B. and Steele, S. A., "Categories of tonal alignment in English," *Phonetica,* 1989.
[4]   Kohler, K., "Terminal intonation patterns in single-accent utterances of German: Phonetics, phonology and semantics," *AIPUK,* vol. 25, pp. 115-185, 1991.
[5]   Pierrehumbert, J. B. and Hirschberg, J., "The meaning of intonational contours in the interpretation of discourse," in *Intentions in communication,* Cambridge: MIT Press, 1990, pp. 271-311.
[6]   Braun, B., "Phonetics and phonology of thematic contrast in German," *L&Speech*, pp. 451-493, 2006.
[7]   Braun, B., Dehé, N., Neitsch, J., Wochner, D., and Zahner, K., "The prosody of rhetorical and information-seeking questions in German," *L&S,* vol. 62, pp. 779-807, 2019.
[8]   Grice, M., Baumann, S., and Benzmüller, R., "German intonation in autosegmental-metrical phonology," in *Prosodic typology.* Oxford: OUP, 2005, pp. 55-83.
[9]   Chodroff, E. and Cole, J., "Testing the distinctiveness of intonational tunes: Evidence from imitative productions in American English," in *Proceedings of Interspeech*, 2019.
[10]   Braun, B., Kochanski, G., Grabe, E., and Rosner, B., "Evidence for attractors in English intonation," *JASA,* pp. 4006-4015, 2006.
[11]   Gathercole, S. E., Hitch, G. J., Service, E., and Martin, A. J., "Phonological short-term memory and new word learning in children," *Dev. Psychology*, pp. 966–979, 1997.
[12]   Plomp, R., "Rate of decay of auditory sensation," *JASA*, pp. 277-282, 1964.
[13]   Baddeley, A. D. and Hitch, G. J., "Working memory," *The psychology of learning and motivation.* v London: Academic Press, 1974, pp. 47–90.
[14]   Kügler, F., *The intonational phonology of Swabian and Upper Saxon.* Tübingen: Niemeyer, 2007.
[15]   Truckenbrodt, H., "Upstep on edge tones and on nuclear accents," in *Tones and tunes.* Berlin: Mouton, 2007.
[16]   Genolini, C., Alacoque, X., Sentenac, M., and Arnaud, C., "kml and kml3d: R Packages to Cluster Longitudinal Data," *Journal of Statistical Software* , pp. 1-34, 2015.
[17]   Atterer, M. and Ladd, D. R., "On the phonetics and phonology of "segmental anchoring" of F0: Evidence from German," *Journal of Phonetics,* pp. 177-197, 2004.
[18]   Braun, B., "Effects of dialect and context on the realisation of German prenuclear accents," in *Proceedings of ICPhS*, Saarbrücken, Germany, 2007, pp. 961-964.
[19]   Leemann, A., *Swiss German intonation patterns.* Amsterdam / Philadelphia: John Benjamins Publishing Company, 2012.
[20]   Peters, B., Kohler, K., and Wesener, T., "Melodische Satzakzentmuster in prosodischen Phrasen deutscher Spontansprache - Statistische Verteilung und sprachliche Funktion [Meldodic sentence accent patterns in prosodic phrases of German spontaneous speech - Statistical distribution and linguistic function]," in *AIPUK 35a*, Kiel: IPDS, 2005, pp. 185-201.
[21]   Xu, Y., "ProsodyPro - A tool for large-scale systematic prosody analysis," in *Tools and Resources for the Analysis of Speech Prosody (TRASP 2013)*, Aix-en-Provence, France, 2013, pp. 7-10.