INFORMATIVENESS AND SPEAKING STYLE AFFECT THE REALISATION OF NUCLEAR AND PRENUCLEAR ACCENTS IN GERMAN

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ABSTRACT

Two production studies on German were conducted to find out whether differences in the informativeness (comprising information status and focus) of sentence-initial and sentence-final referents (potentially carrying prenuclear and nuclear accents, respectively) influence the referent's prosodic realisation, elicited in two different speaking styles. As expected, informativeness has a clear effect on nuclear accent placement, with only few nuclear accents on given items. We also observe a subtle but systematic influence on the realisation of prenuclear accents, challenging a strict view on these prominences as being merely 'ornamental'. In fact, prenuclear accents were placed consistently and mostly rising, but their prosodic prominence increased with increasing newness of the target referent, e.g. by wider pitch range. Surprisingly, however, most contrastive items were produced with less prominence in both studies, due to a parallel structure in the experimental setup. A lively speaking style (mostly) enhances the observed effects.

Keywords: nuclear accents, prenuclear accents, prosodic prominence, information status, contrastive focus

1. INTRODUCTION

In studies on the relation between prosody and meaning in West-Germanic languages it is commonly assumed that the position and form of *nuclear* accents, defined as the last pitch accent in an intonation unit, is decisive for the interpretation of an utterance's information structure. Accordingly, the nuclear accent is considered the structural head of an intonation unit – often perceived as most prominent – and is thus assigned a special status in the prosodic hierarchy (e.g. [12]). In an English utterance like (1), e.g. (from [2]), different positions of the nuclear accent (indicated by capital letters) lead to an important difference in pragmatic meaning:

(1) David only wears a bow tie when teaching.
  a. David only wears a bow tie when TEAching.
  b. David only wears a BOW tie when teaching.

While the prosodic structure of (1a) indicates that teaching is the only situation in which David wears a bow tie, the prosody in (1b) suggests that he wears nothing but a bow tie while he is teaching.

The status of *prenuclear* accents – i.e. pitch accents that occur before the nucleus within the same intonation unit – is less clear. It has been claimed that prenuclear accents do not contribute much to the meaning of an utterance and that they are rather placed due to general principles of rhythmic organization [7]. Büring [6] claimed that prenuclear accents are optional, or *ornamental*, in many cases (especially on prefocal elements). In example (1), this would apply to the content words *David* and *wears*, which may or may not carry an accent, a choice whose impact on the interpretation of the utterance is a matter of some debate. Actually, however, there is evidence that in certain contexts prenuclear accents are placed consistently, and that they even indicate – however subtle – meaning differences: For German, e.g., givenness was found to slightly lower the peak of prenuclear accents in comparison with accents on new information [9], and contrastive prenuclear accents displayed higher and later F0 peaks than their non-contrastive counterparts [5].

From these rather vague results of the few previous studies on the relation between form and function of prenuclear accents in German we derive the motivation for our present study. It also includes a comparison with nuclear accents in the same setup which is meant to serve as a verification of the widely agreed assumptions. The study aims at finding out whether differences in the information status of a sentence-initial referent (potentially carrying a prenuclear accent) and a sentence-final referent (potentially carrying a nuclear accent) and the type of focus domain the referent is part of influence the referent's prosodic realisation. For both experiments we expect to find a positive correlation between the newness or *informativeness* (comprising information status and focus) of a target referent and its prosodic prominence, with clearer results for nuclear than for prenuclear accents. In addition, we test the influence of speaking style (neutral vs. lively) on the prosodic realisation of the target referents. We expect to find greater effects in the lively speaking style due to an increase in hyperarticulation.

2. METHOD

2.1. Speech Material

Two experiments were carried out separately, one for eliciting nuclear, one for prenuclear accents, based on the same setting with little variation in the speech material (see Table 1). For each position in the target sentence (nuclear and prenuclear), we selected 20 target words which were disyllabic for sentence-initial and trisyllabic for sentence-final referents. All of them carried lexical stress on the first syllable. We created 20 story sets for each experiment, with each story consisting of three sentences. The first (C1) and third sentences (T) were held constant, while the second sentence (C2) varied in order to render the target noun phrase *given*, *accessible*, *new* or *contrastive*.

Context 1 (C1)	Nach dem langen Winter freuten sich alle auf ein paar sonnige Stunden im Freien.
Context 2a (C2a) given	Die *Nonne* kümmerte sich um den Klostergarten. (*prenuclear*) OR Im Klostergarten blühte der erste *Mandelbaum*. (*nuclear*)
Context 2b (C2b) accessible	Im *Klostergarten* blühten die ersten *Pflanzen*.
Context 2c (C2c) new	Die Sonne schien schon den ganzen Tag und der Schnee war endlich geschmolzen.
Context 2d (C2d) contrastive	Der *Mönch* hat einen *Brombeerstrauch* gegossen.
Target (T)	**Die Nonne hat den/einen Mandelbaum gegossen.**

Table 1: Example story set – **Context 1:** After the long winter everybody was looking forward to a couple of sunny hours in the open. **Context 2a:** *Given (prenuclear)* – The *nun* was looking after the cloister garden. *OR Given (nuclear)* – In the cloister garden bloomed the first *almond tree.* **Context 2b:** *Accessible* – In the *cloister garden* bloomed the first *plants*. **Context 2c:** *New* – The sun had been shining all day and the snow had finally melted. **Context 2d:** *Contrastive* – The *monk* watered a *blackberry bush*. **Target:** The **nun** watered the/an **al**mond tree.

2.2. Procedure

In sum, 64 native speakers of German were recorded, i.e. 32 for each experiment (prenuclear: 24f, aged 19-30; nuclear: 26f, aged 18-58), with no reported speech or hearing disorders. Subjects were seated in a soundproof booth and were presented with one version of each of the 20 different mini-stories in randomized order on a screen using *PsychoPy*. Each experimental session consisted of two blocks to be read in a natural/casual speaking style (blocks 1 & 3) and two blocks to be read in a lively speaking style (i.e. pretended to read to family and friends; blocks 2 & 4). Subjects were primed by two auditorily (and visually) presented training items in a natural but swift speech rate which were recorded from a trained speaker. Before reading out the stories, subjects were asked to familiarize with the content by reading the stories for themselves. After producing each story, they answered a simple content question (e.g. 'Did the monk water the almond tree?') by pressing either *y* (for *yes*) or *n* (for *no*) on the keyboard. Sessions lasted about 30-45 minutes and subjects were paid for participation.

2.3. Annotation and Analyses

Sentence-initial and sentence-final referents were segmented on word and syllable level and assigned GToBI accent type labels in *praat* [3]. Lack of accent on a target word was indicated by '0'. For measuring pitch-related parameters, tonal minima and maxima within or surrounding the accented syllable of the target words were identified. The continuous parameters DURATION, INTENSITY, RANGE and SLOPE were analysed with linear mixed-effects models that tested for effects of informativeness and speaking style, using the lme4-package [1] in R [11]. In addition to these fixed effects, random intercepts for speaker, gender and target word entered the models. The categorical parameters ACCENT POSITION and ACCENT TYPE were analysed with loglinear modelling using the MASS-package [13]. Since loglinear modelling does not allow for random effects, these models only tested for main effects of informativeness and speaking style, as well as for an interaction between them. So far, only blocks 1 and 2 were evaluated in both experiments, i.e. 40 utterances per speaker (5 per condition and speaking style).

3. RESULTS

3.1. Nuclear Accents

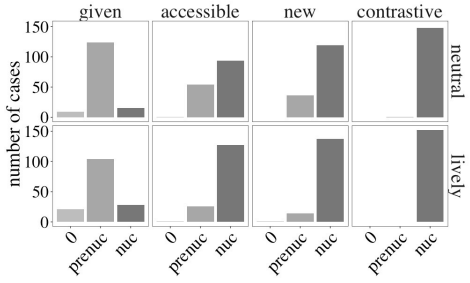
After excluding 68 cases (5 %) due to hesitations, creaky voice or a wrong answer to the content question, 1212 utterances entered the analysis.

As to the actual ACCENT POSITION on sentence-final target words we find main effects of both informativeness ($\chi^2(9) = 663.8$, $p < .001$) and speaking style ($\chi^2(3) = 34.4$, $p < .001$). In 86 % of the cases, given items are marked by prenuclear accents and deaccentuations (with the nucleus placed on the verb), while the number of nuclear accents increases from

accessible to contrastive items. The lively style generally leads to more nuclear realisations (Fig. 1).

Also the ACCENT TYPE (low, fall, high, rise) of sentence-final referents is found to be affected by both informativeness ($\chi^2(9) = 29.4$, $p < .001$) and speaking style ($\chi^2(3) = 108.7$, $p < .001$), leading to more deaccentuations in given, more high and rising accents in new, and more falling accents in contrastive items, plus more rising and fewer falling accents in the lively speaking style.

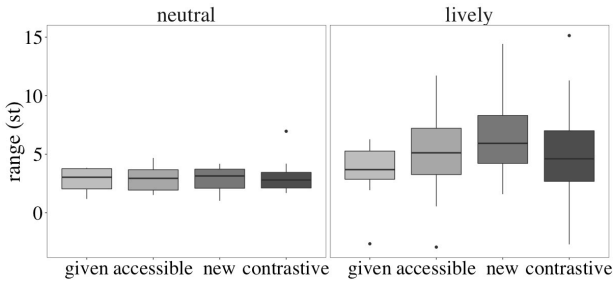
Figure 1: Accent positions on sentence-final referents in in both speaking styles.



Investigating phonetic parameters in referents carrying nuclear accents, informativeness has an effect on both SLOPE ($\chi^2(3) = 10.4$, $p < .05$) and RANGE ($\chi^2(3) = 14.7$, $p < .01$) in nuclear rises, showing wider range in new compared to given and accessible items and steeper rises in new compared to given items.

Style has an effect on SLOPE in rising and falling accents (rise: $\chi^2(1) = 29.5$, $p < .001$; fall: $\chi^2(1) = 49.8$, $p < .001$), with steeper excursions in lively compared to neutral speaking style. Similarly, RANGE is affected by speaking style in high ($\chi^2(1) = 4.6$, $p < 0.05$), rising ($\chi^2(1) = 38.5$, $p < .001$) and falling nuclear accents ($\chi^2(1) = 55.4$, $p < .001$), showing wider range in these accent types when read in a lively compared to a neutral manner (see Fig. 2).

Figure 2: Range (in semitones) of nuclear rising accents in both speaking styles.



With respect to INTENSITY, an effect of style can be observed for high ($\chi^2(1) = 12.6$, $p < .001$), rising ($\chi^2(1) = 12.5$, $p < .001$) and falling accents ($\chi^2(1) = 156.9$, $p < .001$), with target words being louder in lively speech. Moreover, an interaction of style and informativeness in rising and high nuclear accents (rise: $\chi^2(3) = 9.8$, $p < .05$; high: $\chi^2(3) = 8.5$, $p < .05$) is found, with generally louder items in the lively speaking style and increasing loudness with increasing informativeness for rises.

For durational measures, there is an effect of style on WORD DURATION in falling accents ($\chi^2(1) = 8.3$, $p < .01$), with longer words in neutrally read items, and on SYLLABLE DURATION in rises ($\chi^2(1) = 4.6$, $p < .05$), revealing longer syllables when read in lively manner.

In cases where sentence-final referents receive a prenuclear accent, an effect of style can be observed in all but one parameter. Items are produced with steeper rises and falls (rise: $\chi^2(1) = 11.1$, $p < .001$; fall: $\chi^2(1) = 9$, $p < .01$), both with wider range when read in a lively manner. Also, for INTENSITY, the lively style leads to louder words in high ($\chi^2(1) = 14.7$, $p < .001$), rising ($\chi^2(1) = 17.3$, $p < .001$) and falling prenuclear accents ($\chi^2(1) = 11.3$, $p < .001$). For WORD DURATION, an effect of style on low, high and rising prenuclear accents is found, showing longer durations for neutral speech.

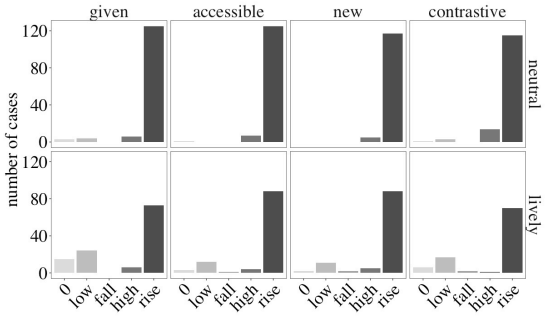
Informativeness affects RANGE in rising accents ($\chi^2(2) = 8.3$, $p < .05$), with wider range for new compared to given items. Furthermore, informativeness has an effect on WORD DURATION in low prenuclear accents ($\chi^2(2) = 7.5$, $p < .05$), in that new items are longer than given ones.

3.2. Prenuclear Accents

We had to exclude 22.9 % of the target sentence realisations, mostly because subjects produced a phrase break after the target word, turning potentially prenuclear accents into nuclear accents – this applied more often to items in lively speaking style. Still, 958 utterances remained for the analysis.

For the factor ACCENT POSITION on sentence-initial target words we find main effects of both informativeness ($\chi^2(3) = 17.4$, $p < .001$) and speaking style ($\chi^2(1) = 21.1$, $p < .001$), in that given as well as lively read items are produced more often without an accent than with a prenuclear one. However, only 7 % of the given target words are deaccented, whereas 84 % of all sentence-initial referents receive a rising accent.

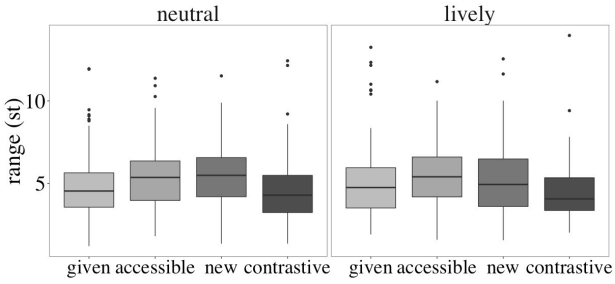
Figure 3: Accent types (including deaccentuation) on sentence-initial referents in both speaking styles.



Still, also the TYPE of ACCENT is found to be affected not only by speaking style ($\chi^2(3) = 86.1$, $p < .001$), with more deaccentuations and low accents in lively and more high accents in neutrally read items, but also by informativeness ($\chi^2(9) = 18.7$, $p < .001$): givenness leads to a larger number of low accents and deaccentuations, while new and accessible referents get more rising accents, and contrastive items are marked by a larger number of high accents (Fig. 3).

For rising prenuclear accents we find main effects of both informativeness ($\chi^2(3) = 37.8$, $p < .001$) and speaking style ($\chi^2(1) = 159$, $p < .001$) on SLOPE, with higher values for given, accessible and new items compared to contrastive ones, and a generally higher slope in all conditions when read in a lively manner. Looking at RANGE in prenuclear rises, we observe an effect of informativeness ($\chi^2(3) = 40.6$, $p < .001$), with wider range for given, accessible and new compared to contrastive items, and wider range for accessible and new compared to given items (Fig. 4). For high prenuclear accents only an effect of style is found ($\chi^2(1) = 11.3$, $p < .001$), with a wider range for lively than neutrally read items.

Figure 4: Range (in semitones) of prenuclear rising accents in both speaking styles.



INTENSITY in prenuclear rises is affected by style ($\chi^2(1) = 25.7$, $p < .001$), with lower intensity values for items read in a neutral manner. Additionally, there is a main effect of informativeness on intensity in rising prenuclear accents ($\chi^2(3) = 19$, $p < .001$) with given, accessible and new items being realized louder than contrastive ones. With respect to high prenuclear accents, only style ($\chi^2(1) = 7.2$, $p < 0.01$) has an effect on intensity, showing higher values in the lively speaking style. In low prenuclear accents an effect of informativeness ($\chi^2(3) = 7.9$, $p < 0.05$) on intensity can be observed, which reveals that new items are produced louder than contrastive ones.

As to durational measures, prenuclear rising accents are found to be affected by informativeness with respect to WORD DURATION ($\chi^2(3) = 50.3$, $p < .001$) and SYLLABLE DURATION ($\chi^2(3) = 46$, $p < .001$), with longest durations for contrastive items as well as longer durations for accessible and new items compared to given ones (both styles). Also, low prenuclear accents are affected by informativeness in their WORD DURATION ($\chi^2(3) = 11.1$, $p < 0.05$) and SYLLABLE DURATION ($\chi^2(3) = 16.4$, $p < .001$), given items being shorter than contrastive ones. With respect to style, only an effect on SYLLABLE DURATION in prenuclear rises can be observed ($\chi^2(1) = 17.8$, $p < .001$), showing longer syllables in lively speech.

4. DISCUSSION AND CONCLUSIONS

Our results confirm a positive correlation between the informativeness of a sentence-*final* referent and the degree of prominence of its prosodic realisation in German: The number of nuclear accents increases from given through accessible and new to contrastive items, and newer target words are marked by more prominent accent types. In other words, speakers use nuclear accents systematically to express meaning differences. A lively speaking style further enhances the degree of prominence of a specific accent type by adjusting the phonetic parameters, e.g. by an increase in pitch range and slope (there is a considerable amount of speaker-specific variation, though, e.g. with respect to speech rate). Very similar effects have recently been found for nuclear accents in American English in the same experimental setup [8].

The results of the experiment on sentence-*initial* referents are much more subtle but also confirm the expected correlation between informativeness and prosodic prominence: The newer the referent the wider the range and the steeper the rise. More precisely, most target words receive a prenuclear rising accent (even textually given words, which may to some extent be explained by a *repeated-name penalty* effect [10]) but both the distribution of accent types and the adjustment of continuous phonetic parameters (depending on the accent type) show some small but systematic effects, challenging a strict view on prenuclear accents as being merely 'ornamental'. Again, a lively speaking style (mostly) enhances the observed effects. In fact, the consistent marking of sentence-initial items by prenuclear accents may be explained by rhythmic reasons, in that the two most prominent positions in a (German or English) utterance are near the beginning and near the end [4].

Against our expectations, however, contrastive target words are produced as least prominent in both experiments (except for durational measures). This is because most subjects produced a rather flat hat pattern in the (contrastive) double focus condition. Presumably, speakers did not feel the need to make the contrasted items prosodically prominent since the contrast is already expressed by the parallel syntactic – as well as semantic-pragmatic – structure.

5. REFERENCES

[1] Bates, D., Maechler, M., Bolker, B., Walker, S. 2015. *lme4: Linear mixed-effects models using Eigen and S4*. R package version 1.1-8.

[2] Beaver, D., Clark, B. 2008. *Sense and Sensitivity. How Focus Determines Meaning.* Wiley & Sons, Chichester.

[3] Boersma, P., Weenink, D. 2015. *Praat*. Doing phonetics by computer. Version 5.4.06.

[4] Bolinger, D. 1986. *Intonation and its parts: Melody in spoken English.* Stanford University Press.

[5] Braun, B. 2006. Phonetics and phonology of thematic contrast in German. *Language and Speech* 49(4), 451-493.

[6] Büring, D. 2007. Intonation, Semantics and Information Structure. In: Ramchand, G., Reiss, C. (eds), *The Oxford Handbook of Linguistic Interfaces.* Oxford University Press, 445-474.

[7] Calhoun, S. 2010. The Centrality of Metrical Structure in Signaling Information Structure: A Probabilistic Perspective. *Language* 86(1), 1-42.

[8] Chodroff, E., Arthurs, A., Kurian, P., Pazol, J., Cole, J. 2018. Categorical and gradient effects of information structure on nuclear prominence in American English. Poster presentation at MidPhon 23, Northwestern University, Evanston, IL.

[9] Féry, C., Kügler, F. 2008. Pitch accent scaling on given, new and focused constituents in German. *Journal of Phonetics* 36(4), 680-703.

[10] Gordon, P., Grosz, B., Gilliom, L. 1993. Pronouns, names, and the centering of attention in discourse. *Cognitive Science* 17, 311–347.

[11] R Core Team. 2017. *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria.

[12] Shattuck-Hufnagel, S., Turk, A., 1996. A prosody tutorial for investigators of auditory sentence processing. *J. Psycholinguist. Res.* 25, 193–247.

[13] Venables, W.N., Ripley, B.D. 2002. *Modern Applied Statistics with S*. Fourth Edition. New York: Springer.