EVALUATING PHONOLOGICAL STATUS: SIGNIFICANCE OF PARADIGM UNIFORMITY VS. PROSODIC GROUPING EFFECTS

Renate Raffelsiefen & Caren Brinckmann

Institut für Deutsche Sprache, Mannheim, Germany
{raffelsiefen, brinckmann}@ids-mannheim.de

ABSTRACT

A central concern of linguistic phonetics is to define criteria for determining the phonological status of sounds or sound properties observed in phonetic surface form. Based on acoustic measurements we show that the occurrence of syllabic sonorants vs. schwa-sonorant sequences in German is determined exclusively by segmental and prosodic structure, with no paradigm uniformity effects. We argue that these findings are consistent with a uniform representation of syllabic sonorants as schwa sonorant sequences in the lexicon. The stability of schwa in CVC-suffixes (e.g. the German diminutive suffix *-chen*), as opposed to its phonetic absence in a segmentally comparable underived context, is argued to be conditioned by the prosodic organisation of such suffixes external to the phonological word of the stem.

Keywords: paradigm uniformity, phonological word, phonological status, German, schwa

1. INTRODUCTION

An early Structuralist approach to defining the phonology–phonetics boundary is to posit a level of representation which is identical to phonetic surface forms except that properties resulting from the specific position of a sound within the spoken chain are idealised away from. This includes all effects resulting from coarticulation with preceding or following sounds or from syllabic organisation [1]. The level in question corresponds to the output of the lexicon in Lexical Phonology [8] and is here referred to as "lexical" or "phonological".

The idea of defining a phonological level purely in terms of restrictions of possible relations to phonetic surface forms is also explored in the framework of Articulatory Phonology [3][6]. Some relevant criteria are stated in (1):

(1) a. If the presence of a sound/sound property in phonetic form can be described in terms of timing and magnitude of independent gestures, as well as position within prosodic constituents, that sound/sound property **could** belong to the level of phonetics only, and lack phonological status.

b. Conversely: If the presence of a sound/ sound property in phonetic form cannot be so described it **must** be represented in the lexicon.

Assuming it is impossible – under the same conditions (including same register and speech rate) – that a given timing or magnitude restriction can cause an effect in one form, but not in the other, the 'contrast criterion' follows:

(2) An independent gesture **must** be assumed in the lexicon if there is at least one register where a phonological opposition exists.

Applying these criteria partially settles the question of phonological status of schwa in German. Assuming the sonority scale [obstruents < nasals < l < r < vowels] the generalisation is that schwa does not surface whenever the preceding segment is less sonorous than the following sonorant, which is realised as a syllable nucleus then. The English loanwords *slog*[ə]n 'slogan' and *pan*[ə]l 'panel' are adopted as *Slog*[n̩] (or *Slog*[m̩]) and *Pan*[l̩], respectively [7]. Schwa surfaces only when the preceding segment is equally or more sonorous than the following segment. Hence, schwa is retained in the English loanwords *Barr*[ə]*l* and *Tick*[ə]*t*. Surface schwa systematically contrasts with forms without schwa (*Barr*[ə]*l* vs. *Kerl* 'guy', *Tick*[ə]*t* vs. *strikt* 'strict', *Karr*[ə]*n* 'car' vs. *Farn* 'fern'), which by criterion (2) shows that phonetic schwa must be lexical (*Barr*/ə/*l* vs. *Kerl*). By contrast, syllabic sonorants contrast neither with nonsyllabic sonorants nor with schwa sonorant sequences, leaving open the possibility that lexical schwa, due to its articulatory properties (weak, if any, constrictions), "disappears" as a result of organising the surrounding gestures.

2. PARADIGM UNIFORMITY EFFECTS

Paradigm uniformity (PU) represents the systematic occurrence of some sound/sound property in a position where it is phonologically unjustified (e.g. preconsonantal vowel length in Scottish *agr*[iː]*d* 'agreed' [9]), as a means of satisfying a condition requiring sameness of sound structure with respect to a paradigmatically related word in which that property is phonologically justified (final vowel length in Scottish *agr*[iː]). PU effects typically give rise to contrasts between words with the relevant paradigmatic relations (e.g. *agr*[iː]*d* - *agr*[iː]) and words whose paradigm includes no relevant licensor (e.g. *gr*[i]*d* 'greed'). The need to represent the length contrast in Scottish *agr*[iː]*d* vs. *gr*[i]*d* in the lexicon follows from the contrast criterion in (2). Assuming that the condition of sameness refers to lexical representation we propose the following criteria:

(3) a. If a sound/sound property in phonetic word form is licensed by the occurrence of that sound/sound property in some other member of the paradigm that sound/sound property must be lexically specified in all word forms involved

b. Conversely: If a sound/sound property in phonetic word form is not affected by PU, it could be strictly phonetic.

2.1. Production experiment

Applying the PU criterion (3) to the analysis of syllabic sonorants in German, a set of 51 target words ending in /ən/ was compiled for a phonetic production experiment.

2.1.1. Target words ending in /ən/

Each of the target words (TWs) belongs to one of the following paradigm classes depending on which word forms exist in the paradigm:

1. all three endings: -C, -Cə, -Cən (e.g. 'boat' *Boot*, *Boote*, *Booten*; 12 TWs)
2. two endings: -C and -Cən, but not -Cə (e.g. 'flood' *Flut*, **Flute*, *Fluten*; 4 TWs)
3. two endings: -Cə and -Cən, but not -C (e.g. 'mare' **Stut*, *Stute*, *Stuten*; 21 TWs)
4. one ending: -Cən, but neither -C nor -Cə (e.g. 'roast' **Brat*, **Brate*, *Braten*; 14 TWs).

/ən/ is preceded by a plosive in 31 TWs and by a fricative in the remaining 20 TWs. Words with a sonorant preceding /ən/ are excluded because of their irrelevance to the present study.

To control for word frequency effects the frequency of each TW was computed with COSMAS II [4], using all available written and spoken corpora (currently 1.8 billion running word forms). These raw frequency values were converted into logarithmically scaled frequency classes based on the raw frequency of the definite article *der*.

2.1.2. Carrier sentences

For the recordings, the TWs were embedded in two types of carrier sentences:

1. meaningful carrier sentences (MFCs) designed to be read as meaningful utterances (e.g. *Die Kinder haben die Kappen vergessen.* 'The children forgot the caps.')
2. near-meaningless carrier sentence (MLCs) *Ich habe "..." gesagt*. (e.g. *Ich habe "Kappen" gesagt.* 'I said "caps".')

In all sentences the TW is the penultimate word, carrying the nuclear pitch accent. 242 sentences were used as fillers leading to two sets of 293 sentences. Both sets were randomised separately for each participant.

2.1.3. Participants

5 female and 5 male native German speakers aged between 23 and 50 years participated in the recordings. They come from different German regions, and none of them was aware of the aim of this study.

2.1.4. Recording sessions

The recording sessions took place in a recording studio and lasted around 45 minutes for each participant with a pause in the middle of the session. Speakers could choose their preferred reading tempo. Whenever they stumbled or misread a target item, they were asked to repeat the sentence. The recorded speech data were stored directly as WAV files.

2.1.5. Segmentation and transcription

All 1020 realisations of the TWs (10 speakers × 51 TWs × 2 carrier sentence types) were segmented and transcribed phonetically closely following the labelling conventions of [11] using Praat [2]. The segmentations and transcriptions were double-checked by two phoneticians.

2.2. Results

The 1020 phonetically labelled realisations of the TWs were subjected to analyses of cross-classifications and analyses of variance.

The four *paradigm classes* do not differ significantly from each other regarding the percentage of TWs realised with a schwa. In a large number of cases (89%) the schwa is not realised in the TW. However, the realisation of schwa is significantly influenced by the type of the *consonant in the onset* of the word-final syllable. While 16% of TWs with a plosive onset are realised with a schwa, only 2% of the TWs with a fricative onset are realised with a schwa. In MFCs these percentages are even lower (plosive: 5% vs. fricative: 0%) compared to TWs in MLCs (plosive: 27%, fricative: 3%).

The *speakers* exhibit significant idiosyncratic differences regarding the percentage of realised schwas. Two speakers (one male, one female) did not realise a single schwa in the TWs, while one female speaker realised a schwa in 31% of the cases. Sex, age, and region of origin of the speaker were not found significant influencing factors.

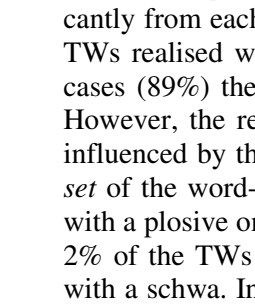
The type of *carrier sentence* has a significant effect on the percentage of realised schwas, which can be attributed to the overall shorter duration of TWs in MFCs (376 ms) vs. MLCs (475 ms). The *frequency class* of the TW does not have a significant effect on the percentage of TWs realised with schwa.

These results show that sonorant syllabicity is not affected by PU. Specifically, plural forms like [platn̩] *Platten* 'boards', whose paradigm includes a form with phonetic schwa ([platə] *Platte* 'board') are indistinct from forms like [ʃatn̩] *Schatten* 'shadow', whose paradigm includes no form with surface schwa.

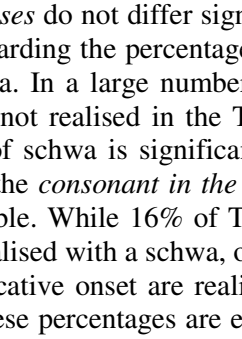
3. ROLE OF PROSODIC ORGANISATION

In contrast to the PU analysis for Scottish *agreed* assumed here, Scobbie et al. [9: 1620] "see no formal phonological necessity to increase the size of the inventory by splitting each high vowel into two categories". They propose morphemic structures like *agree#d* versus *greed*, to which rules of phonetic interpretation are sensitive. This analysis is not consistent with the criterion in (1b). As an alternative they propose that phonetic interpretation is sensitive to the prosodic contrast in (4), where the suffix is not integrated into the phonological word of the stem [9]. However, these structures are ill-formed in that the final syllable includes a phonological word boundary, instead of being properly included in all higher constituents [10].

(4)a

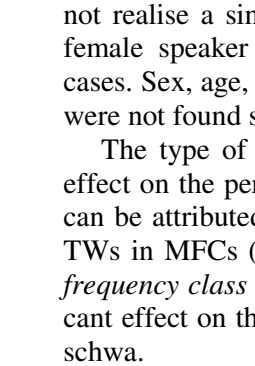


b.

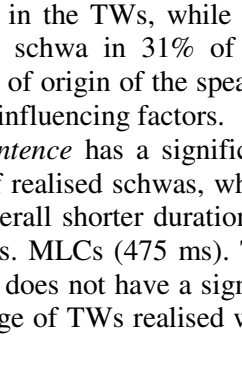


Unlike the vowel length contrast between *greed* and *agreed*, the contrast between American English *rifle*, with syllabic [l], and the suffixed word *rueful*, with schwa [5], does lend itself to an analysis in terms of prosodic organisation as in (5).

(5)a.



b.



Empirically, PU effects differ from contrasts resulting from prosodic grouping as follows. PU effects presuppose the existence of a paradigmatically related licensor (e.g. *agree*) whereas prosodic grouping effects require only the recognition of word-internal constituents, with which prosodic word boundaries align. The observation that the presence of schwa depends on the presence of the adjectival suffix *-ful*, regardless of whether the stem recurs, indicates that suffix recognition suffices for licensing the prosodic structure in (5b). Further while PU necessarily targets stem material (ruling out a PU-analysis to account for the presence of schwa in the affix in (5b)) prosodic grouping effects potentially affect the entire word. In (5b) foot-external schwa may correlate with foot-final lengthening of the vowel and with an increased amplitude of [f]. To the extent that the sound effects in question can be related to specific positions within the prosodic structures they need not be granted phonological status.

3.1. Experimental evidence

To test the effect of prosodic organisation on the occurrence of schwa in German, we compiled a list of 36 disyllabic target words. 15 TWs are derivates with the diminutive suffix *-chen* (e.g. *Breichen* 'porridge-DIM'), 21 TWs are segmentally similar words where final *-chen* is not a suffix (e.g. *Speichen* 'spokes'). Computation of frequency classes, design of carrier sentences, participants, recording session, segmentation, and transcription were identical to the PU experiment (section 2.1).

Statistical analyses revealed that non-diminutives and diminutives differ significantly in the percentage of TWs realised with schwa. 58% of all diminutives are realised with a schwa opposed to only 17% of non-diminutives. Considering only those cases where a schwa is realised, the duration of the schwa does not differ significantly between non-diminutives and diminutives (mean duration across all speakers and stimuli with realised schwa: 59 ms).

Again, the idiosyncratic preferences of speakers have a large influence on the percentage of realised schwas. For example, female speaker VP10 realised 66% of all TWs with a schwa, whereas female speaker VP02 realised only 4%. Nevertheless, all speakers exhibit the same pattern in that a larger percentage of diminutives is realised with a schwa compared to non-diminutives.

The type of carrier sentence has a significant effect on the percentage of realised schwas and their duration. Yet, the higher rate of schwa realisation in diminutives compared to non-diminutives is identical for MFCs and MLCs. The frequency class of the TW does not have a significant effect on the percentage of TWs realised with schwa.

3.2. Discussion

The results indicate that the prosodic groupings are analogous to the English structures in (5). Specifically schwa persists in the non-integrated suffix *–chen* but not foot-internally, allowing for uniform representation with schwa in the lexicon.

4. CONCLUSION

We argue that proper evaluation of the phonological status of sounds/sound properties presupposes proper identification of PU effects versus prosodic grouping effects. Sounds/sound properties affected by PU effects must be specified lexically whereas any sound effect which can be described in terms of the position within (lexically encoded) prosodic structure could result from phonetic interpretation.

The absence of PU effects described in section 2 is consistent with lexical representations of syllabic sonorants as schwa-sonorant sequences. Indeed, such representations would explain the absence of PU-effects. This is because PU-conditions would be satisfied assuming lexical representations like /platə/ – /platən/. By contrast, hypothetical lexical representations like /platə/ – /platn̩/ would raise the question of why alternations such as /platə/, with schwa, versus /platn̩/, without schwa, are unaffected by PU effects.

Likewise the presence of schwa in German *chen*-suffixations, as opposed to the "expected" occurrence of syllabic nasals after palatal fricatives, is consistent with lexical representations of syllabic sonorants as schwa-sonorant sequences. This is because the occurrence of schwa can be related to the independently motivated prosodic organisation of the suffix *-chen* outside the phonological word of the stem (e.g. the superheavy rhyme in *Veilchen* /faɪlçən/ 'violet').

5. REFERENCES

[1] Anderson, S.R. 1985. *Phonology in the Twentieth Century*. Chicago: The University of Chicago Press.

[2] Boersma, P., Weenink, D. 2007. Praat: doing phonetics by computer (Version 4.5.16). http://www.praat.org/ visited 07-Mar-07.

[3] Browman, C.P, Goldstein, L.M. 1992. Articulatory Phonology: An overview. *Phonetica 49*: 155-180.

[4] COSMAS II. http://www.ids-mannheim.de/cosmas2/ visited 07-Mar-07.

[5] Kenyon, J.S., Knott, T.A. 1953. *A Pronouncing dictionary of American English*. Springfield: Merriam-Webster.

[6] Krakow, R. A. 1999. Physiological organization of syllables: A review. *Journal of Phonetics 27*: 23-54.

[7] Mangold, M. 1990. *Das Aussprachewörterbuch*. Mannheim: Dudenverlag.

[8] Mohanan, K. 1986. *The theory of Lexical Phonology*. Dordrecht: Reidel.

[9] Scobbie, J. M., Turk, A. E., Hewlett, N. 1999. Morphemes, Phonetics and Lexical Items: The Case of the Scottish Vowel Length Rule. *Proc. 14th ICPhS*, 1617-1620.

[10] Selkirk, E.O. 1995. The prosodic structure of function words. In: Beckman, J. et al. (eds), *Papers in Optimality Theory*. Amherst: GLSA Publications, 439-470.

[11] Turk, A., Nakai, S., Sugahara, M. 2006. Acoustic Segment Durations in Prosodic Research: A Practical Guide. In: Sudhoff, S. et al. (eds), *Methods in Empirical Prosody Research*. Berlin: de Gruyter, 1-27.

Acknowledgements: We thank Uta Panten for her careful assistance with the experiments. Annegret Barfs and Ralf Winkler helped conducting pilot studies. Thanks to Markus Hiller and one anonymous reviewer for helpful comments.