EVIDENCE FOR FINAL DEVOICING IN GERMAN? AN EXPERIMENTAL INVESTIGATION

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ABSTRACT

This investigation deals with the question of whether morpheme- and word-final devoicing in German is a case of complete or partial neutralization. Durational parameters measured from systematically varied utterances of two South German speakers lead to the suggestion that concerning vowel, occlusion and release durations, final devoicing is incomplete in some morphosyntactic positions.

1. INTRODUCTION

Final devoicing ("Auslautverhärtung") is one of the standard cases for the neutralization of a phonological contrast [7]. During the last ten years investigations were undertaken to show that neutralization of voicing in German final obstruents is incomplete [3]. In subsequent experiments O'Dell&Port [4] and Port&O'Dell [6] reported that in words with underlying voiced stops the duration of the preceeding vowel is significantly longer, that 'voicing into closure' is also longer on average, whereas occlusion and aspiration are shorter in this case. Since their results were gained in a reading task Fourakis&Iverson [2] claimed that the incompleteness of neutralization measured might be due to hypercorrection in reading. Therefore they performed an oral word conjugation test instead that gave no hint in favour of an incomplete final devoicing. Charles-Luce [1] draw attention to the question of whether neutralization might depend on the position and context of the affectable word-final obstruent in the sentence frame. Although his results were not systematic, in some cases of significant differences between underlying voiced and voiceless alveolars, position and context effects could be detected. Port&Crawford [5] discuss the effect of speaking styles and task conditions to approach the question of whether incomplete neutralization is artificial (e.g. orthographically induced) or not. In their production experiment they presented three words affectable by neutralization and their counterparts under different conditions (the words disguised in sentences, the words directly contrasted in sentences, and the words in isolation randomly presented). Their results suggest a voiced/voiceless contrast in the neutralization position when the crucial word pairs were directly contrasted in single sentences. The contrast they found for the isolated words in our opinion seems to be due to the fact that the word list was so small that Ss could gain evidence of the experimental purpose.

Considering as important the point brought into the discussion by Charles-Luce [1] we looked for a test design that is (i) suitable to vary German stops supposed to be affected by final devoicing (FD) systematically over the relevant contexts and (ii) complex enough to hinder the Ss from recognizing the experiment's objective.

2. TEST MATERIAL AND DESIGN

To meet both requirements in the examination of the range of neutralization in German stops words were chosen that allow the influence of final devoicing to be tested in five different positions: The final position representing the standard case for final devoicing (FD), subdivided into (1) the utterance- final and (2) the word but not utterance- final position, the morpheme- final but not word- final position in compounds, subdivided into (3) morpheme- final position with voiced and (4) with voiceless continuation. The intervocalic position (5) was added as control context which should not be affected by neutralization.

Therefore, words were selected which can be arranged in pairs fullfilling the FD condition in their rhymes and can easily be used to build compounds with voiced and voiceless continuation as well as word forms with the FD- affectable consonant in the intervocalic control position. Each place of articulation (labial, alveolar, velar) is represented by three word pairs with at least two different nuclei, one containing vowel+/l/ before the stop. All word forms are shown in Tab. 1.

Table 1: Word Material

Words are arranged according to place of articulation and position of the stop:
(1,2) utterance- or word-final,
(3) morpheme-final in voiced context,
(4) morpheme-final in voiceless context,
(5) intervocalic position

(1,2)	(3)	(4)	(5)
labial			
Bub	Büblein	Bübchen	Buben
Hup	Huplaut	Hupverbot	hupen
Hieb	Hiebwaffe	hiebfest	hieben
Piep	Piepmatz	piepsen	piepen
Kalb	Kälblein	Kälbchen	kalben
Alp	Alpweide	Alphorn	Alpen
alveolar			
Rad	Radlager	Radfahrer	Räder
Rat	ratlos	Ratschlag	Rates
Ried	Riedweg	Riedkanal	Riedes
miet	Mietwagen	Miet-vertrag	Miete
Wald	Wald-lichtung	Waldvogel	Waldes
alt	Altmetall	Altflöte	alte
velar			
Betrug	Truglicht	Trugschluß	betrügen
Spuk	Spuk-märchen	Spukschloß	spuken
Berg	Bergluft	Bergsteiger	Berge
Werk	Werk-meister	Werks-fahrer	Werke
Balg	Bälglein	Balgtreter	balgen
Kalk	Kalklager	Kalkfuhre	kalken

In preparation of the test stimuli these word forms were embedded in a sentence frame "Ich sage ... nochmal". For the utterance- final condition the word "nochmal" was omitted ("Ich sage...") resulting in 90 test sentences (18 words x 5 conditions).

To ensure that the subjects have no evidence of the experimental purpose also words with fricatives, nasals or liquids instead of the stop were used to construct derivatives of a similar shape and presented in the same frames. These sentences were read from cards containing the orthographic form of one sentence each by two South German native speakers (1f/1m) three times in randomized order.

Subjects were seated comfortably in a chair within a soundproofed room in front of a Neumann 11304-8 cardioid microphone. The sessions were recorded on audiotape (Telefunken M 15). The test words were analyzed for durational parameters by means of a Kay DSP Sonagraph 5500 (wide band 8kHz). The parameters are the duration of the vowel, the occlusion, the release and the word stem. By definition, vowel duration is measured from F2-onset after the preceeding consonant or consonant cluster to F2-offset (including the liquid if present) before the occlusion. Occlusion starts from that point and ends at the beginning of the release consisting of the burst and the following aspiration (if present). If a fricative followed the stop, then the release ends at the point with a clearly visible change in the spectral structure of the frication. Otherwise it ends when no energy was visually detectable in the sonagraph (at an input sensitivity of 45dB). Word duration is counted from the beginning of the consonant or consonant cluster which preceeds the vowel to the end of the release, thus covering the word stem only.

Additionally it was registered whether the stop was realized as voiced or voiceless, whether the consonant following the release was voiced or voiceless and whether it occurred within 40 ms or more.

3. RESULTS

Since the registration of voiced and voiceless bursts showed that only 51.9% of the phonologically voiced stops in the inter-

vocalic control position were phonetically voiced and since only one case of a phonetically voiced burst was found in the remaining material, only durational parameters were statistically analyzed.
A 5x2-factorial ANOVA (5 positions and 2 phonation types) was calculated for the durations of the word, vowel, occlusion and release pooled over subjects, words and places of articulation.
For the analysis morpheme- and word- (but not utterance-) final cases were omitted if the pause between the stop and the following consonant was 40 ms or more. Main effects and interactions are shown in Tab. 2, as well as a posteriori pair comparison results (Scheffe) for significant main effects and simple effects for significant interactions (α = 0.01). Position and phonation type are always of significant influence, the interaction between both only for the variables occlusion and release. For word duration the rank order of positions as shown by the Scheffe procedure reflects the fact that within a compound the target word stems are shorter than in the intervocalic control position while they are longer in word- and utterance- final position. The fact that word duration in utterance- final position (1) is significantly longer than in any other position might at least partly be due to final lengthening which should not occur in the other positions. On the other hand, in position (4) being the only position in voiceless context it is significantly shorter than in all positions with voiced context which are statistically not different from one another.
Scheffe pair comparisons for vowel duration separate the morpheme- final position on the one hand from the utterance- final and the control position on the other hand. For occlusion and release pair comparisons show the same structure. Duration in word- and utterance- final positions are significantly larger than the others. The morpheme- final positions differ from one another with the control position in between, which can be explained with respect to the significant interactions that were encountered concerning occlusion and release. In both cases the interaction is based on the phonation effect which occurs as expected for the control position and the fact that as expected as well there is no effect of phonation within the morpheme- final positions. Interestingly, there is a clear effect of phonation in the utterance- final position and additionally in the word- final position for release only (occlusion and release are longer in the voiceless case). The varying influence of phonation on the occlusion and release durations in different positions can be seen in Fig.1. Especially, in the control position (5) the durational differences between voiced and voiceless stops are evident.

Table 2: Analysis of variance results
PHON(1,2): Category of underlying stop (voiceles/voiced)
POS(1,5): Stop position (utterance-final, word-final, morpheme-final in voiced context, morpheme-final in voiceless context, intervocalic)

Main effects and interactions

	d.f.	F	p
Vowel			
POS	4,464	16.638	p<0.001
PHON	1,464	11.757	p=0.001
POSxPHON	4,464	1.478	p=0.208
Occlusion			
POS	4,464	78.292	p<0.001
PHON	1,464	55.766	p<0.001
POSxPHON	4,464	10.025	p<0.001
Release			
POS	4,464	74.286	p<0.001
PHON	1,464	36.017	p<0.001
POSxPHON	4,464	3.556	p=0.007
Word			
POS	4,464	77.268	p<0.001
PHON	1,464	27.783	p<0.001
POSxPHON	4,464	0.926	p=0.449

Simple effects within significant interactions

Occlusion
PHON within

POS(1)	1,422	11.348	p=0.001
POS(2)	1,422	3.683	p=0.056
POS(3)	1,422	2.853	p=0.092
POS(4)	1,422	3.851	p=0.050
POS(5)	1,422	136.771	p<0.001

Release
PHON within

POS(1)	1,422	13.473	p<0.001
POS(2)	1,422	6.943	p=0.009
POS(3)	1,422	1.493	p=0.222
POS(4)	1,422	0.085	p=0.770
POS(5)	1,422	38.990	p<0.001

Scheffe a posteriori pair comparisons (p<0.01) for significant main effects

Vowel 4 < 3 < 2 < 5 < 1

x ——— x
x ——— x

Occlusion 4 < 5 < 3 < 2 < 1

x — x x — x
x — x

Release 4 < 5 < 3 < 2 < 1

x — x x — x
x — x

Word 4 < 3 < 5 < 2 < 1

x x ——— x x

4. DISCUSSION

Taking the results overall, it emerges that neutralization in final stops in German is not simply final devoicing. Even for the control word forms with intervocalic non- neutralized stops phonetic voicing plays no important role, since only half of the realizations have voiced releases, while the durational differences are distributed according to phonation types under several conditions. For morpheme- final positions in compounds no effect of phonation type could be found in terms of vowel, occlusion and release durations. On the other hand, there is a clear effect for release in word- final and for release and occlusion in the utterance- final position from which the standard examples for final devoicing in German stops are taken, so that in these cases definitely no neutralization occurs.
As these results are taken from durational data in future work we will measure the distribution of spectral parameters over phonation types. Since the data are taken from only two South German speakers we plan to include Mid and North German speakers as well. Furthermore we intend to expand the material to contain fricative pairs as well.

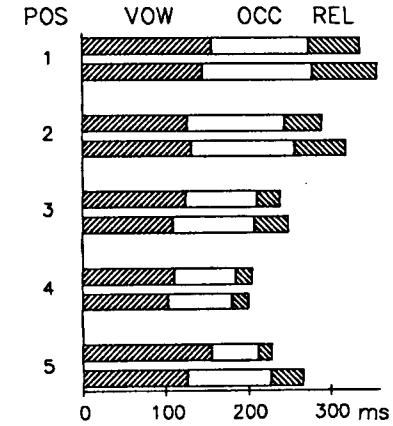

Fig. 1: Durations of vowel, occlusion and release for positions 1 to 5
(*lower bar:* voiceless; *upper bar:* voiced)

5. REFERENCES

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