



Productions of /h/ in German: French vs. German speakers

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Abstract

This paper investigates the production of /h/ by French learners of German in comparison to German native speakers. Anecdotally, French speakers are assumed to delete /h/ when speaking German. We investigate the extent to which learners have problems producing /h/ and if advanced learners show different production patterns than beginners. When French speakers produce /h/ our analysis focuses on whether their utterance is comparable to that of native speakers'. The analysis is based on 34 words occurring in a learner corpus with read speech. Our results indicate that complete deletion is quite rare. Beginners sometimes omit /h/ but they predominantly realize it as [ʔ] or other forms of glottalization. Advanced learners are more successful in producing /h/ native-like. Native speakers and most advanced learners realize /h/ as [h] or [ɦ] depending on the voicing status of the left context. Presumably, native(-like) realizations are based on no or a low degree of adduction of the vocal folds whereas beginners apply a high degree of vocal fold adduction, i.e., hyperarticulation. This results in a difference of the duration of the /h/-segments as our measurements show. Our findings may have important implications for language teaching, aiming at the reduction of a foreign accent.

Index Terms: speech production, L1-L2 interferences, French, German, glottal fricative, breathy vowel

1. Introduction

Learning a foreign language (L2) acquired after childhood usually involves interferences with the native language (L1), especially at the phonological and phonetic level, e.g. [1-8]. For instance, if one language of a language pair lacks a phoneme (or its features) completely, interferences can arise when the same segment is present in the other language of the pair. One such example is the segment /h/ in the language pair German and French. In German, /h/ is a phoneme but it is absent in the French phonological system (e.g. [9-10]). French learners of German (or any language where /h/ is a phoneme) are assumed to have some problems acquiring this segment. Stereotypically, German speakers omit /h/ when mimicking a French accent in German [11]. Results of linguistic studies investigating the pair English and French (where the situation is similar to the German/French language pair) indicate that French learners of English have indeed a hard time learning the correct use of the glottal fricative /h/ in English, e.g. [12-16]. Recent results also show that similar problems arise when French native speakers learn German [11, 17]. This study aims at replicating these earlier findings and at extending them by posing four research questions:

1. How often do the French learners omit /h/?
2. What strategies do the French learners use alternative to a glottal fricative and deletion? A possible strategy is to replace the fricative by a glottal stop [17].
3. Do glottal fricatives of French learners differ from those of native German speakers regarding relative duration?

Recent studies showed that there are such differences, indicating that French speakers tend to hyperarticulate /h/ in many contexts [11, 17].

4. Are French learners more native-like concerning /h/-production when they have reached a higher proficiency level of German?

In the next section, we explain some essential acoustic features of /h/ in German, before we describe the pronunciation data used for the analysis of /h/-productions by German and French speakers. After the analysis, the results will be discussed and we conclude with some remarks on the implications of these results for teaching and learning an L2.

2. Materials and methods

2.1. /h/ in German

Before we analyze the production of native speakers of German and French learners of German, a short overview of the essential acoustic properties of /h/ is necessary. These properties will also be used in a labeling scheme for the analysis of the data that will be explained in section 2.3.

The phoneme /h/ occurs in German only at the syllable onset, immediately followed by a vowel. /h/ is generally assumed to be a voiceless glottal fricative, which is also reflected in its standard phonetic transcription [h]. However, the actual realization of /h/ is highly variable and dependent on the context in which it occurs [9]. Some have characterized /h/ in German as a voiceless vowel when preceding a vowel, due to the position of the vocal folds during its production [18, 9]. Especially in an intervocalic position, the fricative can be produced as a completely voiced fricative [19-21]. In such contexts, breathy voice can be seen as the main acoustic correlate of /h/ [22]. Therefore, depending on the context, we expect quite different variants of /h/ realized by both L1 and L2 speakers. For this reason the left context in which /h/-initial words occurred was divided into *voiced* (vowels and sonorants), *voiceless* (voiceless obstruents), and *utterance-initial* (henceforth: *initial*; occurring after a silent pause). Note that due to final devoicing, in German there are no voiced final fricatives or stops that could precede /h/.

2.2. Data

The data for our investigation of the /h/-productions stem from the IFCASL learner corpus of French and German speakers [23] with recordings of read speech of 50 native speakers of each language, both in their respective L1 as well as in L2. For this study, 30 speakers (21-53 yrs, M: 26 yrs), (10 speakers – 5 males, 5 females from three different groups) were randomly selected:

- NAT: native speakers of German,
- ADV: French advanced learners of German (B2-C1)
- BEG: French beginners of German (A1-B1).

The speakers were recorded in different tasks. First, all tasks were presented in the L2, before the same tasks with similar material had to be completed in the L1. The first part was

reading aloud sentences (n=31) that were presented on a computer screen (*read* condition – e.g. the German sentence *Frankfurt liegt in Hessen*, ‘Frankfurt lies in Hesse’). In the following part, *repeat* condition, the participants heard a sentence (n=29) produced by a native speaker which was also written on a screen and they subsequently read this sentence aloud (e.g. the sentence *Alte Häuser sind charmant*, ‘Old houses are charming’; NAT read these sentences without listening to the native speaker). Finally, speakers read aloud the short story “The three little pigs” (*story* condition). Since the speakers produced the same items, a comparison between L1- and L2 speakers is possible.

2.3. Labeling scheme for the /h/-productions

For the analysis, we selected the sentences and the parts of the story that included an /h/-initial word (34 tokens in total, see Table 1). For the labeling, performed by both authors and a research assistant using PRAAT [24], the following scheme was established. If labels differed, agreement was reached on the respective label. If the exact location of a segment was not possible to be established, this was marked (see analysis section below). Labeling also included the segment preceding the /h/. Because the left context has an impact on the voicing status of the /h/ in question, we established whether the segment was acoustically voiced or unvoiced, and whether the word occurred in utterance-initial position. Furthermore, if the left context was produced differently than expected, e.g. by inserting a pause or inserting a vowel after a consonant, this was marked. Next, the segment /h/ was labeled with 5 different categories (see also Fig. 1-4):

- a *voiceless* glottal fricative [h],
- a *voiced* glottal fricative [ɦ],
- a form of *glottalization* (e.g., glottal stop or other forms of glottalizations),
- a *fricative other* than /h/ (e.g., [x] or [ç]),
- *deletion* of /h/.

Because there were rather different glottal strategies present, we decided to investigate these in more detail (see section 3.2). Therefore, we split the glottal strategies into 8 categories, adapted from the labeling scheme proposed in [25]: [ʔ], subharmony, glottalization, diplophonia, aperiodicity, dampening, fricatives other than [h, ɦ], and multiple forms of glottalization. For the first analysis in 3.1, we treated all glottal strategies as one.

Table 1. Distribution of the 34 /h/-tokens.

	Read	Repeat	Story
Utterance-initial	1	1	0
Voiceless	2	2	10
Voiced	5	4	9

We also determined the duration of the /h/-segment and the duration of the remainder of the /h/-initial word with a PRAAT script [24] in order to calculate the duration ratio of the /h/-segment and the remainder of the /h/-word. All statistical analyses were performed with JMP [26].

3. Analysis and results

For the analysis, we split the labeled /h/-productions (34 tokens x 30 speakers = 1020 in total) occurring in the three

different production tasks (read, repeat, story) and the left context (initial, voiceless, voiced).

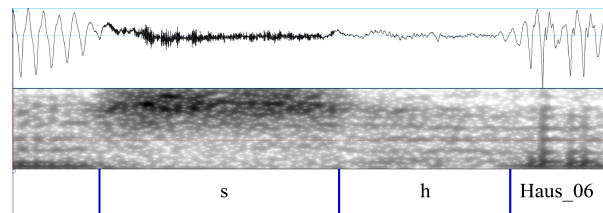


Figure 1: Example of an unvoiced glottal fricative [h]. Left context: [s], in the words ‘ins Haus’, ‘into the house’.

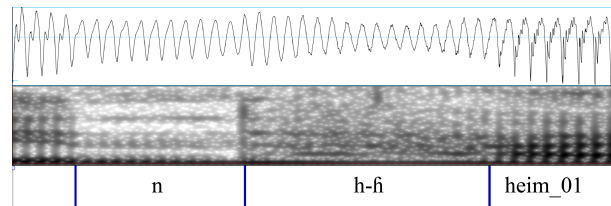


Figure 2: Example of a voiced glottal fricative [ɦ]. Left context: [n], in the words ‘gehen heim’, ‘go home’.

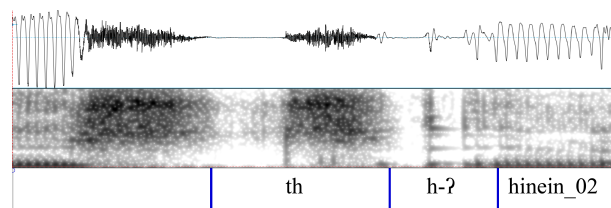


Figure 3: Example of a (multiple) glottalization strategy. Left context: [tʰ], in the words ‘nicht hinein’, ‘not into’.

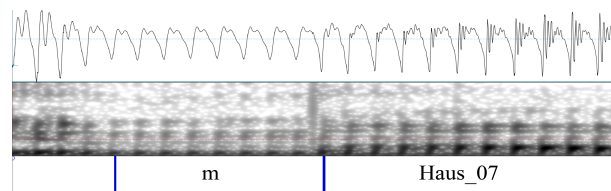


Figure 4: Example of an /h/-deletion. Left context: [m], in the words ‘dem Haus’, ‘the house’.

3.1. /h/-realizations

The first analysis was conducted to investigate how often French and German speakers deleted /h/ or how often a different production was realized. We excluded cases with the following productions: wrong word (e.g., *herein*, ‘in’ instead of *hinein*, ‘into’); a very reduced variant where the number of segments was different from the canonical form (e.g. [ham] instead of [habn] for *haben*, ‘to have’); speech errors; a pause preceding a word which was not utterance-initial (interpreted as a sign of hesitation and thus changing the context); a change to the voicing status of the left context. Overall, 74 utterances were excluded from this analysis (11 by NAT, 17 by ADV, 46 by BEG). The remaining 946 cases went into the first analysis (see Fig. 5-6) examining the different strategies used by the three different speaker groups.

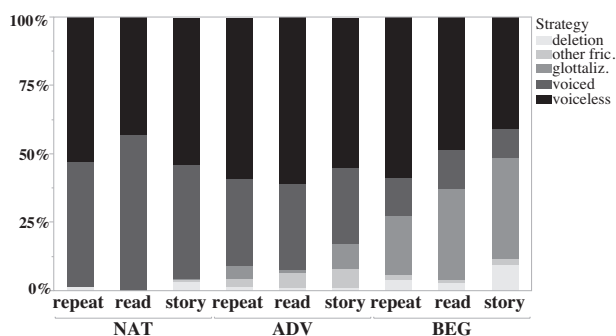


Figure 5: Realizations of different speaker groups depending on the condition.

In Figure 5 we can see that there are some differences concerning the /h/-realizations between the conditions. Although in general, speakers across all groups show slightly more variation in the story condition, that is, there are more strategies and their frequency is higher compared to the repeat and read condition, the results in each group are rather constant across the conditions.

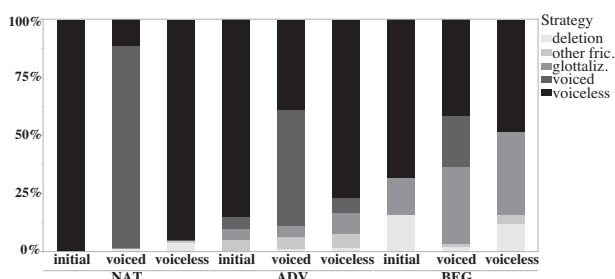


Figure 6: Realizations of different speaker groups depending on the left context.

When we pool all realizations together for each group (irrespective of the condition) we can see in Figure 6 that the native speakers (nearly) always produce a voiceless glottal fricative when a voiceless consonant (95%) or a pause (100%) precedes [h]. ADV follow this pattern (77% and 85%, respectively). BEG produce [h] when the left context is voiceless in only about 50% of the time, and in about 68% of the cases [h] utterance-initially. When the left context is voiced, NAT usually produce voiced fricatives (87%). In half of all cases this is valid for ADV, and only 22% of the productions of BEG show an [ɦ] after a voiced segment. Among BEG, 16% of all initial /h/-productions are a form of glottalization, however, this form of production raises to one third in the two other conditions. Deletions of /h/ (the assumed main realization for BEG) show a range between 2% (after a voiced segment) and 16% (after a pause), ADV never delete utterance-initially, but delete in 1.2% of the cases after voiced segments, and 1.5% after voiceless segments. NAT speakers never delete initially, 1.3% after voiced segments and in 3.7% after voiceless contexts.

To investigate whether there was a difference between the speaker groups, we compared the correct production of /h/ for the two groups. Every instance of [h] and [ɦ] was counted as correct (labeled '1') whereas every other production was counted as incorrect (labeled '0'). A mixed model with CORRECT /h/ as dependent variable, ITEM and SPEAKER as random factors, and GROUP (NAT, ADV, BEG), TASK (repeat,

read, story), CONTEXT (initial, voiced, unvoiced) and the interaction of GROUP and TASK, as well as GROUP and CONTEXT as fixed factors was calculated. NAT produced /h/ correctly in 97% of the cases (SD: 0.16), whereas ADV have correct /h/-productions in 87% of the cases (SD: 0.34) and BEG in 58% (SD: 0.49). Results indicate that GROUP is a significant factor ($F(2,29.95)=5.98, p<0.01$), as is TASK ($F(2,45.55)=4.23, p<0.05$). Post-hoc tests indicate that BEG are less correct than both NAT ($t=3.35, p<0.01$) and ADV ($t=2.42, p<0.05$), but the latter are not different from each other. Concerning TASK, the post-hoc analysis indicates that the story condition is significantly different from the repeat condition ($t=2.69, p<0.05$). No other comparison was significantly different.

3.2. Glottal strategies replacing /h/

So far, all glottal strategies (except for fricatives) have been treated as one. In the following analysis we investigate to what extent the glottal strategies of the different speaker groups are comparable. For this analysis, 145 productions were analyzed (2 by NAT, 39 by ADV and 104 by BEG). Table 2 gives an overview of the strategies. Note that there was no instance of diplophonia in any production. The two instances produced by German speakers were a fricative, and substitution with multiple glottal gestures. ADV most often produced another fricative, e.g. [x] instead of [h]. The next most common realization was multiple glottalization strategies. The pattern for BEG is different: they most often produce glottal stops, with the next most frequent realization as multiple glottal strategies.

Table 2. Glottal strategies other than glottal fricatives.

	NAT	ADV	BEG
Aperiodicity	0	0	5
Dampening	0	0	3
Fricative	1	18	6
Glottal Stop	0	4	42
Glottalization	0	3	10
Subharmonic	0	6	11
Multiple	1	8	27
Sum	2	39	104

3.3. Relative duration of [h] and [ɦ]

In the next step, we analyzed whether the duration of h/-productions by French learners are similar to those of German native speakers. As a normalization procedure a duration ratio was calculated for each of the /h/-productions by dividing the duration of /h/ by the duration of the remainder of the /h/-initial word. For this analysis, we had to exclude further 67 cases where no clear boundary could be established for the acoustic measurements of the duration ratio (44 by NAT, 20 by ADV, 3 by BEG). Furthermore, analysis was only conducted for [h] and [ɦ], whereas instances of glottalized versions, other fricatives and deleted versions were excluded. This left us with 703 instances of glottal fricatives. Statistical analyses were split, such that the voiced and the voiceless version of the segment were analyzed separately. Results are shown in Figure 7.

In a final step, a mixed model was calculated for each of the two segments separately. In each case, DURATION RATIO was the dependent variable, GROUP (NAT, ADV, BEG) the independent variable, and SPEAKER and ITEM the random factors. For [h], the model showed that GROUP was a

significant variable ($F(2,27.47)=4.3$, $p<0.05$), and post-hoc t -tests showed that NAT differed from ADV ($t=-2.68$, $p<0.05$) and BEG ($t=-2.35$, $p<0.05$), but the latter two did not differ significantly. The same analysis for [ɦ] did not reveal language group as a significant predictor for duration ratio.

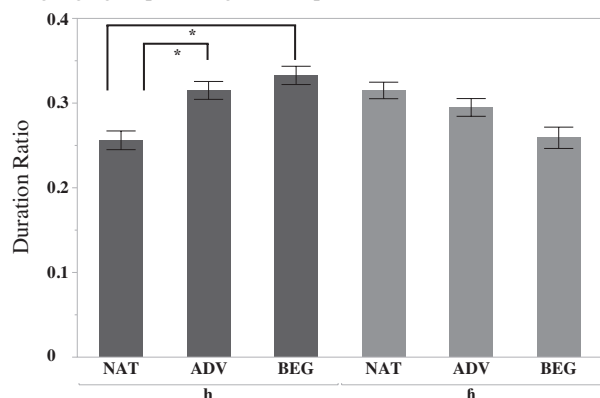


Figure 7: Duration ratios for the speaker groups.

4. Discussion and conclusions

How hard is the acquisition of the segment /h/ for French learners of German? This is the underlying question of the analysis presented here. Our results indicate that French speakers have indeed some problems acquiring the correct production of /h/. This can be seen in the overall high number of deviant production strategies compared to German speakers. However, the results also indicate that, contrary to the general anecdotal belief, French speakers completely delete /h/ only in a few instances. Far more often than deletion, they use a glottal stop or another form of glottalization. Vowel-initial words in German are often produced with a glottal stop or other forms of glottalization. This realization is not represented orthographically and probably assumed as a non-segment by non-experts. This could explain the stereotypical belief of a *deletion* of /h/ rather than a *glottalization*.

Another possible explanation for the small number of complete deletions could be orthography. All of the items reported here were taken from the IFCASL learner corpus, which consists of read speech material. It could be interesting to investigate whether other speech styles show similar tendencies, or whether not having an <h> present in writing has an impact on the frequency of /h/-deletion.

Furthermore, even when the French learners of German produce a glottal fricative, their productions are somewhat different from the productions of native speakers. On a general level, French speakers seem to hyperarticulate /h/ in comparison to German native speakers (see also [11, 17] for German, and [12, 13] for English). First of all, the duration ratio for [h] is smaller for German than for French speakers. Secondly, the qualitative difference in the production strategies also points into this direction. Whereas the /h/ becomes overwhelmingly voiced in a voiced context for German speakers, French learners show more voiceless fricatives and glottalized productions. The latter do not occur in native /h/-pronunciations at all.

These results are compatible with ideas on phonation types based on Ladefoged [27] assuming that the opening of the glottis is on a continuum from maximally open (here for voiceless [h]), over breathy voice (here for voiced [ɦ]), modal

voice, creaky voice (here for glottalized versions) to completely closed glottis (here for a glottal stop). The many glottalized segments for /h/ of the French learners point to a tendency towards a *high* effort for vocal fold *adduction*, whereas the native and native-like /h/-production strategies show correlates of vocal fold *adduction*, and in a voiced context a *low* effort for adduction. Future studies have to show the physiological details of the glottal activity for the /h/-productions by native and non-native speakers. These studies also have to explore the variation of two types of /h/-productions where the present study falls too short. First, the glottalized segments deserve more research. In our study it was hard to distinguish between a glottal stop, creak, creaky voice, and combinations thereof. Second, the variations of [ɦ] show a broad range from a voiced fricative to a breathy vowel with virtually no spectral boundary to the adjacent voiced segments.

The present study shows that /h/ in German spoken by native speakers show more realizations than simply a voiceless glottal fricative which is specified by the upcoming vowel on a *supra-glottal* level (“unvoiced vowel”). However, it must also be taken into account the coarticulatory effects on the *glottal* level leading to unvoiced segments after an unvoiced context (a pause or an unvoiced obstruent) and to *voiced* /h/-productions after a voiced context which comprises vowels and sonorants.

The French learners show a great range of variability in their /h/-productions, including many glottalized forms among BEG (fewer among ADV) but also few voiced segments among BEG (more among ADV) and just a few deletions in the BEG group (and nearly none in the ADV). This gives a more detailed picture of how /h/-production as one eminent feature of French accent in German (and English) evolves during the language learning process. At the end of this process we can see that ADV apply strategies that are more similar to NAT strategies, and that the duration measurements are also closer to the productions of German native speakers.

An interesting observation can be made about the effect of listening to a native speaker prior to /h/-production by beginners (Fig. 6). The amount of glottalized productions for /h/ and /h/-deletions is lower for the repeat condition than for the other two conditions. This is also connected to the question to what extent language teaching is affected by the results reported here. If learners, especially beginners, have a good standard speaker that produces native-like /h/, they seem to pick up on the cue and are better in producing the segment than in pure reading tasks. Perceptual training studies could further verify this hypothesis. The results reported here have also important repercussions for language teaching on a more general level. For more advanced learners, language teaching could also focus on the different strategies that can be used to produce /h/ in German. Finally, if French speakers did learn to use less effort for /h/ and refrained from hyperarticulating the fricative, they would decrease their accent and improve their intelligibility.

5. Acknowledgements

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