

# GERMAN OBSTRUENT SEQUENCES BY FRENCH L2 LEARNERS

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## ABSTRACT

We analyze voicing in sequences of obstruents with French as L1 and German as L2, languages characterized by strong differences in the voicing dimension, including assimilation direction. To that purpose, we study the realizations of two sequences of obstruents, where the first consonant, in final position, is fortis, and the second consonant, in initial position is either a lenis stop or a lenis fricative. These sequences lead to a possible anticipation of voicing in French, a direction not allowed in German given German phonetics and phonology. Highly variable realizations are observed: progressive and regressive assimilations, and absence of assimilation, often accompanied by an unexpected pause. Results show that French learners tend to perform better when the consonant is a stop than a fricative. Results are discussed as a function of French learners' mastering of German (final voicelessness, stop voicing, as well as phonological system).

**Keywords:** voicing assimilation, German, French, L1/L2 interferences, obstruents.

## 1. INTRODUCTION

In French, in contexts favourable to the occurrence of assimilation phenomena, when an obstruent in final position precedes another obstruent in initial position, which differs from the first one in the voicing dimension, there is in most cases a full or partial anticipation of the voicing characteristics of the second consonant on the first one [7] [11]. In German, voicing assimilation occurs in the opposite direction, and in limited contexts: in this language, in favourable contexts, a final obstruent (unvoiced) tends to devoice a following voiced fricative consonant in initial position [4]. These inverse assimilation directions are probably due to the strong differences existing between German and French with respect to the fortis/lenis feature. First, let us state more precisely that, in this paper, we use the term “voicing” (or “voiced”, “unvoiced” ...) to refer to an articulatory phenomenon, vocal fold vibration, which generates periodicity, and use the terms “fortis” and “lenis” to refer to the values of the phonological feature distinguishing (fortis) /ptkfs/ from (lenis) /bdgvz3/.

The distinction between fortis /ptk/ and lenis /bdg/ stops in German essentially relies upon the presence or absence of aspiration, whereas it essentially relies upon the presence or absence of voicing in French [6]. German lenis stops, contrary to French ones, are voiceless but tend to be voiced in intervocalic position [3]. Then, in German, there is a neutralization of the opposition between fortis and lenis obstruents in final position [13] [8], in favour of the fortis consonants, which means that final obstruents are always fortis in German. This is a strong constraint with a high level of priority [1]. Since final consonants are fortis and should stay so, assimilation, if any, is progressive and occurs from the final fortis, thus unvoiced, stop or fricative to the initial lenis fricative consonant. We mention only lenis fricatives as sounds subjected to assimilation here, since, according to Jessen [3] German lenis stops are unvoiced in nature and passively voiced by assimilation in intervocalic position. The realization of assimilation processes and their strength depend, among other factors, upon the importance of the prosodic boundary: it increases at lower boundaries and decreases at higher ones [4]. Previous studies on L2 show that cues related to the fortis/lenis distinction are at least partially acquired by L2 learners, especially advanced learners. In particular, Laeufer [5] underlined the difficulty encountered by French learners of English in the reduction of glottal pulses during the closure of English final voiced stops, whereas [2] showed that German advanced learners are able to voice French lenis fricatives in final position. Assimilation processes might be relatively difficult to acquire, as it was suggested by the study of Schmidt [10] concerning the acquisition of regressive assimilation of voicing by L2 learners of Spanish.

The aim of this preliminary study is to analyze sequences of obstruents in L2 which would constitute a case of voicing assimilation in L1 (and possibly, in L2) for French as L1, and German as L2, languages for which this assimilation occurs in the opposite direction. We will address the following questions.

- Do French L2 speakers keep their L1 patterns?
- Do their performances vary with their level?
- What is the role played by prosody, in particular the presence or absence of pauses?

Results will be discussed as a function of speakers' mastering of (1) voicelessness for final obstruents in German (called "FU" from now on, "F" standing for "final" and "U" for "unvoiced") and (2) phonetic differences in the realizations of the fortis/lenis feature for stops, in particular with respect to voicing.

To that purpose, we study the realizations of French non native and German native speakers (control speakers) in two sequences of obstruents, where the first member, a single consonant or a cluster, in final position, is fortis, and the second member, in initial position, is either a lenis stop, unvoiced in German in this position, (first case), or a lenis (voiced) fricative (second case). In both cases, the typical French realization implies a partial or total anticipation of voicing from the second to the first consonant. In German, the sequence should be unvoiced (first case) and the lenis fricative could undergo a partial or total assimilation of devoicing (second case).

## 2. PROTOCOL

### 2.1. Linguistic material.

Two sentences have been extracted from the IFCASL corpus [12], (S1): "Bei hohem Fieber legst du dich **ins Bett**" ("If your fever is high, get yourself **to bed**") and (S2): "Die Chance im Lotto zu gewinnen **ist sehr klein**" ("The chance of winning the lottery **is very low**"). The first sentence (S1) includes a sequence in which the unvoiced fortis /s/ in final word position precedes the lenis /b/ in initial word position ("ins **Bett**", end of the sentence). The second one (S2) includes a sequence in which the final fortis cluster /st/ precedes the initial lenis fricative /z/ ("ist **sehr**", end of the sentence).

### 2.2. Speakers and recording conditions

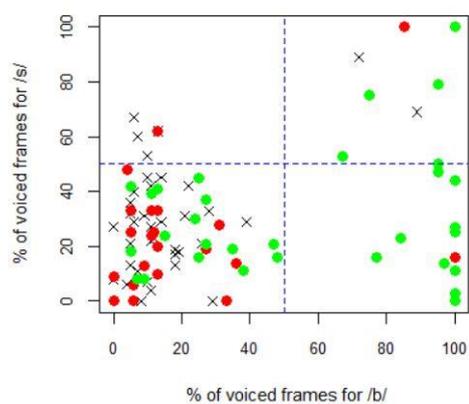
The subjects were seated in a quiet room and read the sentences from the screen of a Windows laptop, with a headset microphone (AKG C520) connected to an Audiobox (M Audio Fast track). Fifty six French learners of German ("FG" speakers), and forty native German speakers ("GG" speakers) recorded the corpus. The non native speakers were classified by French teachers of German into four categories, from A2 to C1. There were 25 A2 and 9 B1, gathered together and designed as beginners (34 speakers), 6 B2 and 16 C1 speakers designed as advanced learners (22 speakers).

Each speaker recorded each sentence once. Hence, there were 112 groups of obstruents (56 speakers x 2 sentences) for French speakers, and 80 for German speakers.

### 2.3. Acoustic cues

Segmentation was carried out by hand by the author, using Praat. We analysed the periodicity (glottal pulses) of the signal for each consonant of the consonantal sequence. It has been estimated by Praat "Voicing Report" function which provides the fraction of locally unvoiced frames during a segment, from which we deduced the fraction (the percentages) of voiced frames during the obstruent duration.

**Figure 1:** Percentages of voiced frames for /s/ and /b/ (sentence 1) by German native speakers (black crosses), French non native advanced learners (red points) and beginners (green points).



## 3. RESULTS

### 3.1. First sentence

In the /s/-/b/ sequence, in German, a fortis, thus unvoiced, fricative precedes a unvoiced lenis stop. The same sequence in French, where /b/ is voiced, would in most cases lead to a partial or total anticipation of voicing on the preceding /s/.

We first analyze the amount of voicing during the consonant (% of locally voiced frames, hereafter "voicing fraction") for /s/ and /b/ separately, and then for the consonants in sequence. We consider four groups of speakers: German native speakers (GG), French non native speakers (FG), as well as, among FG, advanced learners (Adv) and beginners (Beg). Figure 1 shows the amount of voicing for /b/ as a function of that observed for /s/, for the four categories of speakers. To compare the results, we used Pearson's chi-squared test analysis, provided by R software [9]. To that purpose, fractions of voiced frames were gathered into five intervals regularly spaced, i.e. [0,20], [20-40] ... [80,100].

**Results for /b/.** As expected, and as can be seen on Figure 1 (X-axis), there are large variations for beginners, whose voice fractions are scattered all over

the X-axis, whereas values for advanced learners and German speakers are relatively low (generally under 40%). Advanced learners have a median value slightly above that of German speakers (Table 1). All the possible pairwise comparisons between groups of speakers (GG vs. FG, Adv vs. Beg, GG vs. Adv and GG vs. Beg) are statistically significant (Table 2). Results for /b/ tend to show that a large part of beginners do not master German phonetics for /b/.

**Table 1:** Medians of the % of voiced frames, for /s/ and /b/ (sentence 1), for German native speakers, French advanced learners and beginners.

	Ge	Adv	Beg
/b/	11	12.5	57.5
/s/	27	22	24.5

**Results for /s/.** In most of the cases, the realizations are predominantly unvoiced (their voicing fractions are under 50%), whatever the speakers' first language and, for non native speakers, whatever the level (see Fig. 1, Y-axis, and Table 1). Voicing fractions indeed rarely exceeded 50%, a result which tends to show that a large majority of the non native speakers in the corpus are aware of the strong constraint concerning the voicelessness of final consonants in German (FU). We find no statistical differences between the groups of speakers (Table 2), even for the comparison between German and beginners. Concerning German speakers, the few relatively high values, say above 40%, are in general due to a progressive partial assimilation of voicing due to the presence of a sonorant consonant before /s/.

**Results for /s/-/b/ sequence.** For the sake of simplicity, we have considered four cases, according to whether the first and the second consonant are mostly voiced or mostly unvoiced, i.e. whether there are glottal pulses on more or less than 50 % of their durations.

Since /s/ is in general unvoiced, there is few « voiced-unvoiced » and « voiced-voiced » cases. The former case (“voiced-unvoiced”, Fig.1, upper left corner) is observed in only one case for French speakers. This was expected, since French L2 speakers are probably more aware of final voicelessness (FU) than of the voicelessness of /b/ in German in this position.

The “voiced-voiced” cases (upper right corner of Fig. 1), which might correspond to a “French-like” anticipation of voicing, are observed for 15% of beginners and less than 10% of advanced learners.

The “unvoiced-voiced” realizations (lower right corner in Fig. 1) are all produced by beginners but for only one exception. About a third of beginners produce this configuration. In most of the cases, there

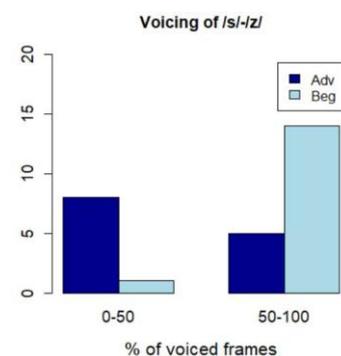
is a small unexpected pause (a silence, in general) or a schwa between /s/ and /b/, probably to make the sequence easier to produce. This result shows that most beginners do not anticipate voicing. We believe that the “unvoiced-voiced” sequences are produced by speakers who master FU, but are unaware of the fact that /b/ is generally unvoiced. Most “voicing fractions” for /b/ here are at 100%.

**Table 2:** P-values of chi-squared tests. Comparisons between the % of voiced frames for /b/ and /s/ (first sentence) realized by German speakers, French learners, advanced learners and beginners. Significant values are followed by a star.

	Ge/ Fr	Ge/ Ad	Ge/ Beg	Ad/Beg
/b/	0.002*	0.01*	0.00001*	0.008*
/s/	0.7	0.4	0.8	0.5

The “unvoiced-unvoiced” cases, typical of German realizations, are the most frequent configurations (lower left corner, Fig 1). These realizations are observed for a large majority of advanced learners (82%) and German speakers (87%). About half of the realizations made by beginners also fall into this area, but with voicing fractions for /b/ slightly higher than those observed for advanced learners and German speakers.

**Figure 2:** Distribution of the % of voiced frames for advanced learners (dark blue) and beginners (light blue). Second sentence. /s/-/z/ sequences.



### 3.2. Second sentence

In this sentence, the fortis /t/ of “ist sehr” sometimes disappears and the sequence is made up of two alveolar fricatives, the fortis /s/ and the lenis /z/. In this case, it is difficult to segment them with precision, so we decided to describe the sequence /s-/z/ as a whole. When /t/ is present, we analyze the final cluster /st/ and the initial /z/ separately.

German speakers omitted the /t/ in half of their realizations. Whatever the sequence realized (with or

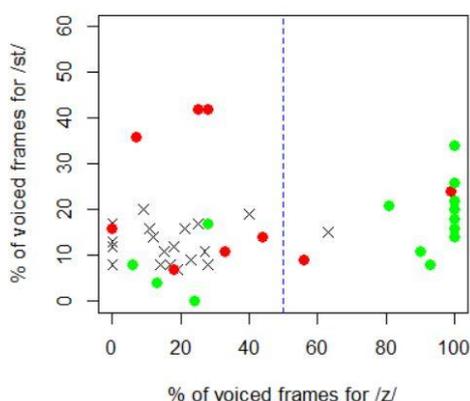
without /t/), they produced almost entirely unvoiced groups of obstruents (see Table 3).

**Table 3:** Medians of the % of voiced frames, for /st/, /z/ and /sz/ (sentence 2), for German native speakers, French advanced learners and beginners.

	Ge	Adv	Beg
/st/	15	16	18
/z/	14	28	96
/sz/	13	44	100

**Sequence /s/-/z/.** Figure 2 represents the distribution of the predominantly voiced and unvoiced realizations for this sequence. For beginners and advanced learners, the consonant /t/ is absent in about half of the realizations. For beginners, the fricative noise covering the whole sequence is most of the times entirely voiced (Median at 100%, see Table 3, mean at 85%), which corresponds to a “French-like” assimilation of voicing. There is only one unvoiced realization. For advanced learners, on the contrary, the realizations are highly variable (Median at 44%), with more unvoiced than voiced realizations. German realizations are all unvoiced.

**Figure 3:** % of voiced frames for /z/ (X-axis) and /st/ (Y-axis) for French advanced learners (red points), beginners (green points) and German speakers (black crosses). Sentence 2.



**Sequence /st/-/z/.** Figure 3 represents the % of voiced frames for /z/ as a function of the % observed for /st/. For beginners and advanced learners, the cluster /st/ in final position is always unvoiced (Median at 18% for beginners, at 16% for advanced learners). Concerning the initial consonant /z/, the realizations for beginners (Fig. 3, green points, X-axis) are either almost fully voiced or, in fewer cases, mostly unvoiced (Median at 96%, mean at 74%). For advanced learners, (Fig. 3, red points), /z/ is in general unvoiced (Median at 28%).

The sequences of final and initial consonants are thus either “unvoiced-voiced” or “unvoiced-unvoiced”.

Beginners produced in general “unvoiced-voiced” sequences (72% of the cases), whereas advanced learners produced in general “unvoiced-unvoiced” sequences (78% of the cases). When /z/ is fully voiced, we often observe the presence of a pause or a schwa after the unvoiced cluster /st/. The same observation was made for “unvoiced-voiced” realizations in the first sentence.

Due to the low number of occurrences in some cases, we mixed up results for advanced learners and beginners for the statistical analysis. All comparisons between the realizations of L1 and L2 speakers, for /st/, /z/ and /sz/, are statistically significant (p-values below 0.01, Pearson test).

#### 4. DISCUSSION AND PERSPECTIVES

Although there are still differences between German and advanced learners’ realizations, results show that most advanced learners produce unvoiced obstruent sequences, whereas French-like realizations would imply voiced sequences. This probably means that advanced learners are aware of the strong constraint concerning the voicelessness of obstruents in final position in German (FU). It is less simple to determine why they devoiced the following initial lenis stop in the first sentence. Does this come from their respect of FU, which would lead to the devoicing of the initial lenis stop (normally voiced in French)? Is it linked to their performance in German (i.e. they would produce unvoiced lenis stop in non intervocalic contexts)? They are less performant when the second consonant is the lenis fricative /z/ (about 90% of their realizations are unvoiced for the first sentence, and only 68% in the second one). This might be due to the fact that a lenis stop, even for French speakers, is more subjected to devoicing than a lenis fricative. We can also remark that most of the voiced realizations for /z/ are observed when the final cluster /st/ is reduced (/t/ omitted), which does not favor the realization of a progressive assimilation. In our corpus, all the German speakers but one devoiced /z/, but in this language, there are very few /s/ in initial position, which favors the devoicing of /z/ [5]. The same tendencies are observed for beginners who are nevertheless, as expected, less performant than advanced learners. We observe that beginners often use prosody (in particular the presence of a pause or a schwa) to produce “unvoiced-voiced” sequences, in between typical “French-like” and “German-like” realizations. More studies are planned to answer the questions this preliminary study raises, in particular concerning the link between each speaker mastering of the fortis/lenis feature and sandhi processes.

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