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# Impact of production complexity in German L2 by French native speakers: focus on /h/ and vowel duration contrast

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## **Abstract**

Research on foreign language speech production often focuses on repeated speech and read speech. To the best of our knowledge, only a few studies have investigated the role of the complexity of speech production tasks on the abilities to produce sounds in a foreign language. The present study aims to fill this gap. We recorded adult French native speakers with German as a second language (L2). The participants performed three speech tasks: word repetition, reading and picture description. Note that, the picture description task is a semi-spontaneous speech task, which can be considered to be closer to a real life speech experience than the two other tasks. We assume that L2 production complexity depends upon the three tasks and on the linguistic information provided: the sound in the repetition, the text in reading, and no linguistic information in picture description. We created two corpora of German speech: the FLACGS and the ProFee-FLACGS corpora. The speech resources were analysed regarding word initial /h/ and vowel duration contrast production. Taken together, our results show that both increasing L2 speech production complexity as well as conflicting grapheme-phoneme conventions in the two languages have an impact on production accuracy in L2 speech. Moreover, L2 learners tend to achieve native like productions when provided with a native German auditory input. Awareness of pronunciation differences between ones first and second language can help with the amount of correct sound production but it has very limited impact on the accuracy of the produced sounds.

## 0 Introduction

Second language learning represents a big part of education nowadays. In Europe, secondary school education includes at least one foreign language exam in order to get a high-school diploma. Learning two foreign languages is, at least in continental Europe, even more common. Empowering young adults to express themselves in different languages encourages international exchanges and mobility. Moreover, the advent of affordable digital technologies such as smart phones and the internet enable easy instantaneous oral communication with remote partners all over the world. New opportunities are continuously arising to practice our command of a foreign language not only on a written level, but more and more so in the oral modality.

In line with this observation, we investigated production difficulties for German second language (L2) learners with French as a first language (L1). We were interested in common production difficulties French L1 speakers have in German as a second language on a segmental level (e.g. vowel and consonant production) and on a supra-segmental level (e.g. lexical stress realisation). In the following, we focused on word initial /h/ productions as well as on the vowel duration contrast. The German vowel duration contrast also often described as lax and tense vowel contrast on the phonological level translates in differences of acoustic-phonetic properties (segment durations and vowel timber) of the uttered vowels. Some of the German phonological vowels find a counterpart in the French language. For instance, /œ/ - /ø/ - French: neuf /nœf/ (nine) / nœud /nø/ (knot), German: können /'kœnən/ (to be able to) / Söhne /'zø:nə/ (sons); /ɔ/ - /o/ - French: botte /bɔt/ (boot) / beau /bo/ (pretty), German: Sonne /'zɔnə/ (sun) / Sohn /'zo:n/ (son). Nevertheless, in German, the vowels do not only differ with respect to their quality but also to their phonetic duration: lax vowels tend to be produced as short vowels and tense vowels tend to be produced as long vowels (Becker 1998). In French this additional distinction is not phonemic. Thus, we expected production difficulties regarding phonetic vowel duration in French learners of German. In the following, we are going to pay special attention to the realisation of the phonetic vowel duration in German L2 speakers with French as a first language.

### *Syllable initial /h/ production*

In the English as a Second Language literature (ESL), French learners' of English productions were analysed with respect to syllable initial /h/ realisations (Janda & Auger, 1992; John & Cardoso, 2009; Kamiyama, Kühnert & Vaissière, 2011). Janda & Auger (1992) were studying syllable initial /h/ realisations, deletions and insertions across different speech tasks for six learners of English with French as a first language. The authors discussed the results with respect to hypercorrection. John & Cardoso (2009) went a step further and analysed syllable initial /h/ realisations, deletions and insertions with respect to the stress pattern of the syllable (stressed/unstressed), the word category (lexical word/function word) and to the environment preceding the syllable initial /h/ (pause, vowel, consonant). Kamiyama, Kühnert and Vaissière (2011) were interested in /h/-deletions and their various realisations. They separated "hard vowel

onsets” from null or empty onsets. However, none of these papers compared syllable initial /h/ duration between English native speakers and French learners of English. In German, one study realised by Zimmerer & Trouvain (2015b) where French native speakers’ productions of German words with syllable initial /h/ were analysed. The authors included both native speaker productions and non-native speaker productions in their data set. They also analysed syllable initial /h/ realisations with regard to the left context and segment duration. Findings showed that French learners of German tend to produce longer /h/ than native speakers.

### *Vowel duration contrast*

Works on vowel duration contrasts often focused on English as a foreign language where the vowel inventory includes vowels, which differ both in duration and quality (Major 1987; Flege 1992a; Munro 1993; Flege, Bohn & Jang 1997; Levy 2015). Especially the study by Flege, Bohn & Jang (1997) showed that learners of English with different first languages tend to have comparable strategies in producing and perceiving L2 vowels. Specific production and perception difficulties however were directly related to the vowel inventory of their L1. German, just like English, also does have vowels that differ in both duration and quality (Bennett 1968). Zimmerer & Trouvain (2015a) reported a perception study with German native listeners who judged long and short vowels produced in minimal pairs by French learners of German. They found that French learners of German have difficulties producing German vowels. The learners’ difficulties affect both short and long vowels, but especially short rounded vowels. The authors also reported that existing contrasts in the L1 (here French) such as /ø- œ/ are not always predictors for successful realisations in the L2 (here German).

Pronunciation difficulties that are related to conflicting orthographical conventions did not receive a lot of consideration in the literature. Dieling (1992) showed that Polish learners’ phonetic errors in German can be conditioned by interferences from their L1 orthography. Rolffs (2005) reported that Turkish learners of German tend to produce German double consonants as geminates like they would in Turkish. German and French orthographies also show differences in coding speech sounds. For instance, <z> is pronounced [ts] in German but [z] in French. In our study, production errors due to orthographic conventions in the two languages were expected in the reading tasks.

Corpus studies can shed some light on how L2 pronunciation differs from L1 pronunciation. Most recorded corpora present elicited speech in the form of repeated and read speech or semi-spontaneous assignments such as picture description and interviews (Granger 2002; Detey, Racine, & Kawaguchi 2011; Sönning 2014; Meister and Meister 2015; Turco, Dimroth, & Braun 2015). Non-scripted speech tasks that are closer to the challenges L2 speakers face outside the classroom are not very common.

Especially in German L2 pronunciation corpus research, studies are most often carried out on populations who share the same L1 (Lleó and Vogel 2004: L1 Spanish; Nossok 2007: L1

Belarushian; Zimmerer et al. 2014: L1 French). The advantages of homogeneous groups are that all the learners share the same phonemic system. As a consequence, the learners group has the same pronunciation difficulties in German, which restrains inter-speaker variation due to L1 background. In a pronunciation variety study as well as in a pronunciation class, student groups with a homogeneous L1 background allow to focus on pronunciation difficulties that are first language specific. For example, if we compare French and English natives regarding German L2 pronunciation, French specific problems with /h/-production are not at all relevant for English natives, whereas English natives may struggle to produce stable (i.e. non diphthongized) vowels, which is not a problem for French native speakers.

We know that production and perception difficulties in a second language depend on the phonemic differences that exist between a speaker's first language and the second language he or she is learning (Flege & Davidian 1984, Best, McRoberts, & Goodell 2001, Shoemaker 2014 etc.). For instance, the German language has a vowel duration contrast (e.g. Wiese 1996). That means that minimal pairs can be found that differ in meaning only by the change of vowel duration e.g. *messt* /'mɛst/ (you scale) *mähst* /'mɛ:st/ (you mow). The French language does not have a phonemic vowel duration contrast. Furthermore, the French language does not have a phonemic /h/ in its inventory whereas /h/ constitutes a frequent phoneme of the German language. According to Flege, MacKay, & Meador (1999), L2 speakers have particular difficulties in producing phonemic contrasts in their L2 they do lack in their L1. With appropriate training, L2 learners should be able to produce those sounds and sound contrasts (Flege, Takagi, & Mann 1995).

The present L2 production study included three speech tasks with increasing production complexity: oral repetition, reading and picture description. We recorded two corpora with comparable speaker populations (see section 2).

Our study aimed to investigate whether the production difficulties of L2 speakers depend on the complexity of the task. Regarding the vowel duration contrast, we were interested in whether the duration contrast production is more successful for some vowel pairs than others. Furthermore, we examine whether and how word initial /h/ phonemes are realised across the three speech production tasks. We will also briefly discuss whether visual representations of speech (spectrograms) can help learners with their productions. First, we present an overview of the phonemic differences between German and French. Then, we present the speech materials followed by the method and results sections of the study. Finally, the results will be summarized and discussed.

# 1 Differences between the phonemic systems of German and French

In this section, we present the major differences between the phonemic systems in French and German on a segmental level.

## 1.1 Vowels

In German, a vowel duration contrast: /i: - ɪ, ε: - ε, e: - e, a: - a, o: - ɔ, u: - ʊ, y: - ʏ, ø: - œ/ exists that is not phonemic in French. In the German vowel inventory, only schwa /ə/ is an exception to the vowel duration contrast.

German also has three diphthongs: /aʊ/, /aɪ/ and /ɔʏ/ whereas there are no phonemic diphthongs in French. Standard German does not have any nasal vowels. Standard French counts three in its phonemic inventory: /ɑ̃/, /ɔ̃/ and /ɛ̃/.

## 1.2 Consonants

Regarding the consonantal system, the French consonants /ʒ/ and /ɲ/ appear in German in loanwords only. The German consonant /ŋ/ does exist in French only in English loan words (e.g. *parking*). German includes the following consonants that are not phonological in standard French: the word initial /h/ fricative and the fricatives /ç/ *Ich-Laut* and /x/ *Ach-Laut* which tend to occur only in syllable and word-final positions.

In this study, we examine the vowel duration contrast as well as the word initial /h/ production in German native and L2 speech.

## 2 Speech material

In this section, the two speech resources that were used for the present study are presented. Both corpora were collected manually and follow an experimental design.

### 2.1 The FLACGS corpus

The *French Learners Audio Corpus of German Speech* (FLACGS corpus) was recorded to investigate differences between German speech in German native speakers and German L2 speakers with French as an L1 (Wottawa & Adda-Decker 2016).

All participants were recruited in Paris, France. Participation was on a voluntary basis. The recordings took approximately 45 minutes per participant.

#### 2.1.1 French learners of German (FG)

20 FG (10 women and 10 men) were recorded. The women were aged between 20 and 30 years,

the men between 24 and 32 (mean age of the FG group: 25,75 years). All FG as well as their parents had only French as their first language. They auto-evaluated their competences in German based on the *Common European Framework of Reference for Languages* (CEFR). In both gender groups, all levels were represented: A1/A2 up to C2. Furthermore, all participants had an equal or superior command of English compared to their German proficiency.

### 2.1.2 German native speakers (GG)

20 GG (10 women and 10 men) were recorded. The women were aged between 22 and 47 years, the men between 20 and 45 (mean age of the GG group: 31,35 years). All GG as well as their parents had only German as their L1. Although the GG speakers were born in different parts of Germany, their productions can be rated as standard German as there were no noticeable regional accents. Except for one female and one male participant who had no knowledge of the French language, all GG speakers were highly proficient in French (B1/B2 up to C2+ according to the CEFR). Their knowledge of English was equal or inferior to their proficiency in French. The great majority lived in France for several years.

### 2.1.3 Tasks

The participants performed three tasks of increasing production complexity:

1. Repetition task (audio): Participants heard short sentences over headphones they repeated immediately.
2. Reading task (text): Participants read aloud the texts *Nordwind und Sonne* and *Die Buttergeschichte*.
3. Picture description: The picture description task was the only task without linguistic information.

The *repetition task* aimed to investigate whether FG speakers are able to successfully produce lexical stress in different word positions, long and short vowel contrasts as well as consonants and consonant clusters that are unusual or different in the French language. We defined a set of 55 German words illustrating the phenomena of interest.

Carrier sentences (*Er sagt ... klar und deutlich* and *Ich sage ... klar und deutlich*) including 55 distinct words in central position were recorded by a female German native speaker. The participants listened to all the spoken utterances in a randomized order over headphones and repeated them.

The material of the repetition task was composed of words with lexical stress in different positions (first syllable, last syllable, penultimate syllable and ante-penultimate syllable), minimal pairs with long and short vowels e.g. *Hüte* /'hy:tə/ (hats) and *Hütte* /'hytə/ (hut), minimal pairs with a voiced or unvoiced plosive *glauben* /'glaʊbən/ (believe) and *klauben* /'klaʊbən/ (to cull).

Words that are difficult to pronounce because of their phonotactics for French native speakers: challenging consonants, clusters and glottal stops between vowels in adjacent syllables were included as well e.g. *Schächtelchen* /'ʃɛçtəlçən/ (small box), *erobernde* /er'ʔo:bændə/ (conquering).

*Reading task.* The participants were asked to read aloud two texts *Nordwind und Sonne* and *Die Buttergeschichte*. These two texts are reference material for German phonetics and have also been recorded in the Kiel corpus (Simpson, Kohler, & Rettstadt 1997). Both languages, French and German, use the Latin alphabet. But the letters and letter combinations do not necessarily code the same sounds e.g. *Mantel* (coat) is produced as ['mantl] by GG speakers. FG speakers are more likely to say [mã'tɛl] as the letter combination <an> corresponds to a nasal vowel in written French. Conflicting orthographic conventions are possible sources of pronunciation difficulties (Dieling 1992). For instance the graphic <z> is pronounced /z/ in French but /ts/ in German. Another example is the graphic <au> which is pronounced as the vowel /o/ in French but as the diphthong /aʊ/ in German.

The aim of the reading task is twofold:

- (i) check overall FG pronunciation difficulties, when reading;
- (ii) focus on difficulties that may arise due to conflicting orthographic conventions between German and French.

The reading task also allows us to compare prosodic patterns in different places of the utterance e.g. to compare how word stress is realised in the beginning, the middle and the end of an utterance with respect to prosody.

The *description task* aimed to collect semi-spontaneous speech. All participants described the same picture. The picture that was chosen for the task showed a boy and a girl playing ball and running over a meadow. In the background, there was a house with flowers in the yard and some hills and mountains. We concentrated our analysis on isolated words like *Haus* (house), *Mädchen* (girl), *Junge* (boy) and *Sonne* (sun). The image description is the only task where the participants did not have a linguistic support (written sentences, spoken utterances) to help them with their speech production. Before the participants started the image description, we made sure they knew the names of the items and actions represented in the picture.



NAME	<i>French Learners Audio Corpus of German Speech (FLACGS)</i>
LANGUAGE	German
SPEAKERS	40 speakers (20 male and 20 female) - 20 L1 German - 20 L1 French, L2 German (A2-C1/C2)
VOLUME	ca. 7 h of speech (35 250 words)
CONTENT	repeated, read and semi-spontaneous speech (picture description)
TRANSCRIPTION	manual using the German orthography
ALIGNMENT	MAUS-webservice (automatic) and manual checking

Table 1: Summary of the semi-spontaneous speech subset of the FLACGS corpus

## 2.2 The ProFee-FLACGS corpus

### 2.2.1 Study design

The *Progression and Feedback French Learners Audio Corpus of German Speech* (ProFee-FLACGS corpus) was recorded to investigate whether explicit pronunciation instruction help German L2 learners to improve their German pronunciation.

Over a semester of 12 weeks, first year university students majoring in English and German at *Université de Sorbonne Nouvelle - Paris 3* followed a stand-alone German pronunciation class. Two course sessions were occupied by written tests. The course program foresaw weekly speech assignments the students had to perform outside of the classroom. Four of these speech assignments were obligatory. For each sound file, the teacher filled out a feedback grid which was sent back to the students. A corrective feedback that was given after the actual recording was the least costly way to evaluate L2 pronunciation in a classroom setting (Olson 2014b). Research also has shown, that feedback can help to improve sound pronunciation (Olson 2014a).

### 2.2.2 German L2 learner groups

Participants were split up in two experimental groups: one whose teaching sessions were completed by spectrograms and another group, which was taught without this kind of visual illustration. In the following, the first group will be called AV (for audio and visual input) and the second group will be referred as AO (for audio input only). The equipment of the classroom conditioned the choice, which group would obtain visual input and which one would only get audio input.

The AV group consisted of 15 participants (all female), who were between 17 and 23 years old, the AO group consisted of 15 participants (13 female and 2 male) who were between 17 and 19 years old. At the first class, participants auto-evaluated their competences in German based on the *Common European Framework of Reference for Languages* (CEFR). In both training groups, the following levels were represented: A2 up to C1/C2. In English, all participants

indicated an equal or superior competence compared to their German level. In both training groups, all participants were French dominant.

### 2.2.3 German native control group

The German native control group (referred as CG in the following) consisted of 4 participants (3 female and 1 male) who were between 21 and 23 years old and who attended the AO group. All participants in this group as well as their parents had only German as L1. All German native speakers reported a good knowledge of French (B1/B2 up to C1 according to the CEFRL). Their knowledge of English was rated equally high (B2-C1). All of the CG lived in France for at least one year before starting classes at university.

Even if the participants of the CG were born and raised in different regions of Germany, their productions could be considered as standard German as none of them had a noticeable regional accent.

Students performed reading and picture description tasks over the semester. In this study, we only will consider the first picture description task students performed four weeks after classes began. This choice was made in order to increase the semi-spontaneous speech sample regarding word initial /h/ and vowel duration contrast production.

### 2.2.4 Tasks

The tasks relevant for our studies are picture description and reading. In this paper, we focus on picture description only, which aimed to collect semi-spontaneous speech. All participants described the same picture to ensure a common vocabulary set in the collected speech. In the classroom, the teacher made sure that the students knew the names of the items and actions represented on the picture. This way again, a common vocabulary set was ensured. Table 2 summarizes the subset of the ProFee-FLACGS corpus that is used to carry out the analyses.

NAME	<i>Progression and Feedback French Learners Audio Corpus of German Speech (ProFee-FLACGS)</i>
LANGUAGE	German
SPEAKERS	36 speakers (3 male and 33 female) - 4 L1 German - 32 L1 French, L2 German (A2-C1/C2)
VOLUME	ca. 1 h of speech (4 547 words)
CONTENT	semi-spontaneous speech (picture description)
TRANSCRIPTION	manual using the German orthography
ALIGNMENT	MAUS-webservice (automatic) and manual checking

Table 2: Summary of the first semi-spontaneous speech task of the ProFee-FLACGS corpus

The two speech resources could be explored in multiple ways. In this study, we focused on word initial [h] productions and the acoustic vowel duration analyses.

### 3 Methods

#### 3.1 Speech transcription and alignment

First an orthographical transcription of the recordings was realised. For the repetition and reading task, the transcription consisted mainly in checking the recording for false starts or other deviations from the sentences (repetition task) and the texts (reading task). For the semi-spontaneous speech part, a German native speaker did a faithful transcription of the recording manually. Second, the webMAUS (Munich AUtomatic Segmentation web service) (Schiel 1999; Kisler, Schiel, & Sloetjes 2012) performed the alignment of the speech signal with its transcription. This aligner generates a TextGrid file that can be opened with Praat (Boersma and Weenink 2016).

MAUS uses orthographic transcriptions to segment the speech signal. The orthographic transcriptions were realised manually and took hesitations, disfluencies and false starts into account. The TextGrids generated by MAUS comprise three tiers: the orthographic word, the canonical pronunciation of the word and the aligned phones.

The automatic alignment of each sound file was checked manually for boundaries and labelling. Phone boundaries of targeted phones and words were manually corrected if necessary. We also checked some aligned pronunciations, for instance when MAUS had to perform a graph to phone conversion for words that were not included in its dictionary. Performing those adjustments took about fifteen minutes for one minute of automatically aligned semi-spontaneous speech.

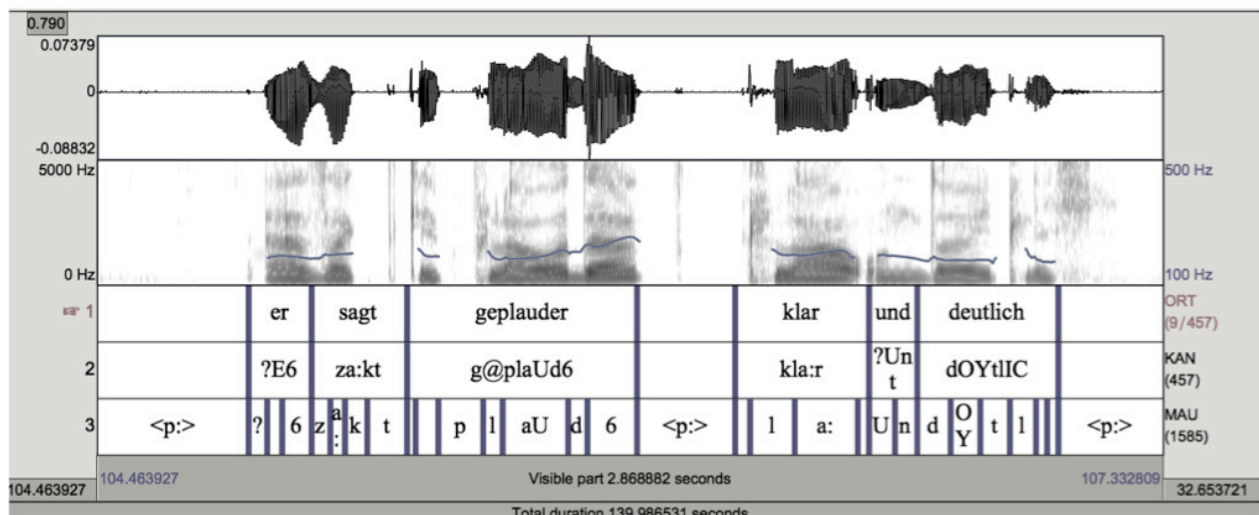


Figure 1 shows an example of the TextGrids generated with the web-MAUS.

## 3.2 Statistical analyses

In the present study, we were interested in the duration of word initial /h/ and short and long vowels in words with at least two syllables.

Statistical analyses were carried out with the R program (R Development Core Team 2008). As a statistical test, we privileged a two-way ANOVA with unequal sample sizes because of the high variance of tokens per task and per speaker in the semi-spontaneous speech tasks.

## 4 /h/ productions in word beginnings

One of the challenges faced by French native speakers learning German is the production of /h/. /h/ is frequent in the German language at the beginning of words or syllables and minimal pairs between /h/ and /ʔ/ are frequent *Haus* /'haʊs/ (house) versus /'ʔaʊs/ (out). In French, syllable initial /h/ is not phonological. We mainly present results from the FLACGS corpus. In addition, we take the ProFee-FLACGS corpus into consideration for the semi-spontaneous speech part in order to increase its sample size. Semi-spontaneous speech productions show rather different results than repetition and reading.

### 4.1 Word initial /h/ production

In the FLACGS corpus, speech material from all three tasks (repetition, reading and picture description) was used to study

1. whether German L2 speakers (FG) produce /h/ in word beginnings or rather tend to replace them by empty onsets or [ʔ];
2. whether FG produce /h/ with a similar duration compared to German native speakers' (GG) productions

Regarding the type of realisations ([h], empty onsets, glottal stop), we expected native like word initial /h/ productions in the repetition task. Regarding the reading task, we expected longer [h] realisations in the FG group than in the GG group. This hypothesis is in line with the findings of Zimmerer & Trouvain (2015b). The authors also reported a high number of glottal stop realisations instead of [h] in German L2 speakers with French as a first language. The picture description task is supposed to be more difficult for L2 speakers. We may thus expected both more /h/ omissions and when realised longer segments.

In order to decide whether the speaker produced [h], a glottal stop or an empty onset segment, a trained phonetician manually annotated the TextGrid files for /h/-productions. Figures 2, 3 and 4 illustrate how the decisions were made: if the spectrogram shows a noisy segment before a vowel, the speaker produces an [h] (see Figure 2), if the spectrogram shows a single (or sometimes multiple) bar right before the vowel as the result of a sudden air release, a [ʔ] was annotated (see Figure 3), if the word starts directly with a vowel that is not preceded by either the

noisy portion or the bar on the spectrogram, an empty onset was marked.

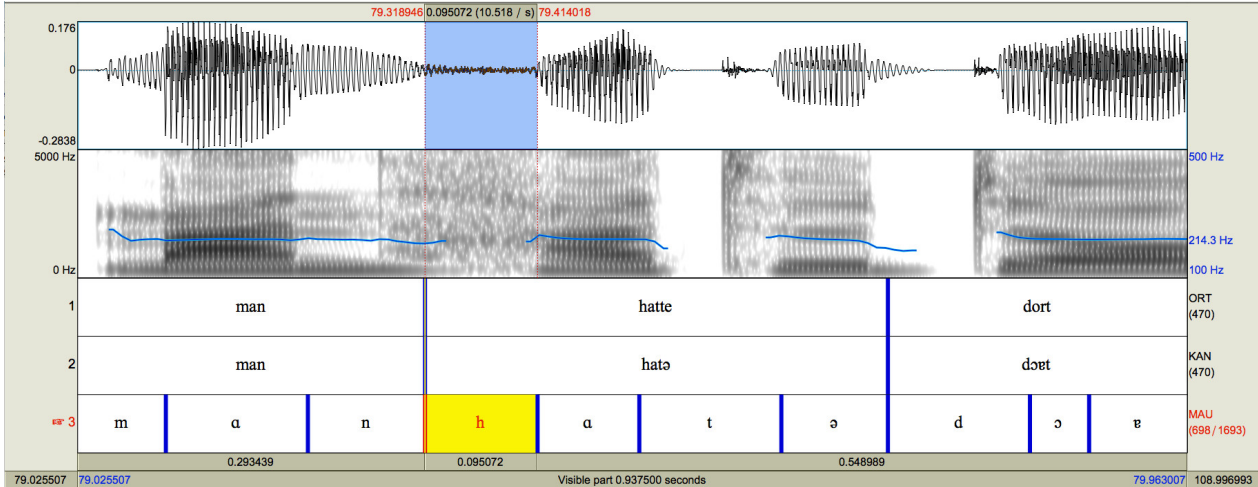


Figure 2: Word beginning with an [h]

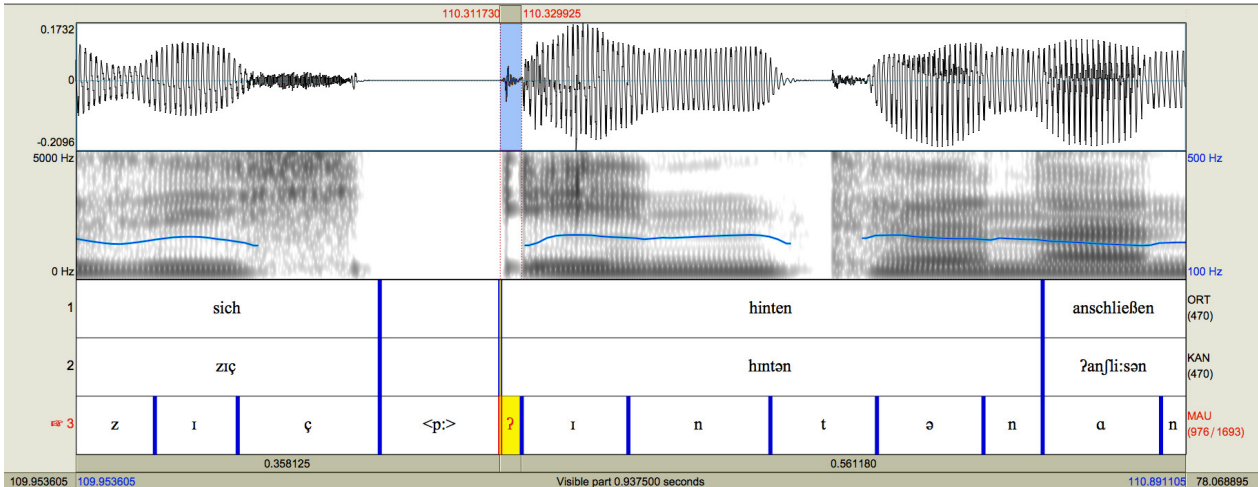


Figure 3: Word beginning with a [ʔ]

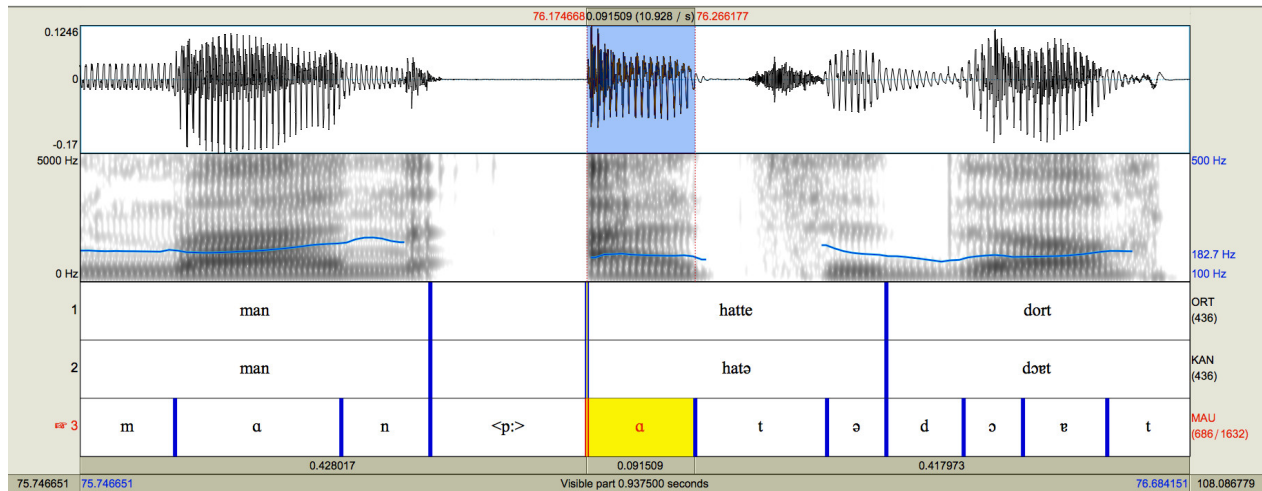


Figure 4: Word beginning with an empty onset

Table 3 displays all possible word initial /h/ and their realisation by FG in the FLACGS corpus. First, we observed that word initial /h/ production decreases with increasing complexity of the production task. The repetition task should be the easiest task for L2 speakers as they heard a native model they aimed to reproduce. The reading task was already more complex as participants did not have any auditory model to help them with their production. The most complex task was the picture description task. Participants were not provided with any linguistic information that could help them with their L2 speech production.

The results showed that a surprisingly high number of word initial /h/ (i.e. Table 3) are actually produced by the FG group: at least three out of four for the most complex task, the picture description. Table 3 also shows that indeed the production complexity of the task has an impact on /h/ production accuracy: the highest realisation figure was obtained in the repetition task (85 %) and the lowest in the picture description task. However, the difference of the canonical uttered word initial /h/ does not vary much between the reading (78 %) and the picture description task (75 %).

Furthermore, Table 3 confirms that word initial /h/ are more likely to be replaced by empty onsets than glottal stops except for the reading task where German L2 speakers produced one out of five word initial /h/ as a glottal stop. This result could be explained by conflicting grapheme-phoneme conventions between German and French. In written French, <h> are realised either as empty onsets or glottal stops. This decoding strategy might be transferred to texts written in German.

Phone realisation	Repetition task	Reading task	Picture description
[h] (canonical)	85 %	78 %	75 %
[?]	1%	20 %	9%
empty	14 %	2%	16 %
Tokens	77	104	71

Table 3: Realisations of word beginning with /h/ in German L2 speakers across tasks in the FLACGS corpus

The /h/ realisation figures from the subset of the ProFee-FLACGS corpus are presented in Table 4. In order to assess improvement in the two learner groups, we compared productions of canonical /h/ in word beginnings after 4 weeks of training. The table summarizes the number of words with a canonical /h/ in the beginning and their realisation in the three experimental groups: German native speaker control group (CG), the learner group in an audio-visual setting (AV) and the learner group with audio input only (AO).

We could observe that compared to the picture description task in the FLACGS corpus, the number of deletions and substitutions is very low (see Table 3). This result was most likely due to the fact that the participants of the ProFee-FLACGS already had four training sessions where their attention was drawn to substitution, insertion and deletion of segments in German L2 speech productions in French native speakers.

Both groups showed a very high number of canonical word initial /h/ realisations. The rates reported in Table 4 are comparable or higher to those obtained for the repetition task in Table 3. These results suggest that increasing *awareness* is helpful for production accuracy with respect to the presence of the target phoneme in L2 speech.

	CG	AV	AO
<b>Tokens</b>	<b>109</b>	<b>109</b>	<b>132</b>
[h]	100 %	89 %	97 %
[?] or empty	0%	11 %	3%

Table 4: Realisation rates of word initial /h/ in the ProFee-FLACGS corpus.

Tables 3 and 4 do not inform us about the quantity of word initial /h/ production of German L2 learners in comparison to German native speakers. /h/ is a fricative with very low energy. That is why we privileged a segment duration analysis rather than spectral analyses such as the centre of gravity or the intensity analyses of the segments.

## 4.2 The duration of word initial /h/ production

Figure 5 shows the duration of [h] in word beginnings in native German speakers (GG) and German L2 speakers (FG) in the FLACGS corpus. All words where [h] was produced in a different way (as [ʔ] or with an empty onset) were excluded from the plotted data in order to only compare actual [h] realisations of FG speakers to those uttered by the GG group.

In German native speakers, we observed that [h] is longer for the repetition task than for the other two tasks. This could be due to the prominent sentence position of the target words in the repetition task. In French learners of German, the prominent sentence position did not have the same effect on [h] durations compared to the other tasks.

We observed that in the repetition task, FG speakers behave native like. The duration differences of [h] in word beginnings of the two groups were almost identical. Regarding the reading task, we saw that the difference between the duration of [h] in GG and FG speakers was more important: FG produce much longer [h] than GG. Regarding the picture description task, word initial /h/ produced by the FG group were globally longer than those produced by GG speakers.

To summarize Figure 5, in reading and picture description, French learners of German tend to produce longer [h] in word beginnings than do German natives. A possible explanation is that the French learners may aim to be unambiguous by insisting on the first segment of the word. These findings are in line with those reported by Zimmerer & Trouvain (2015b) for read speech.

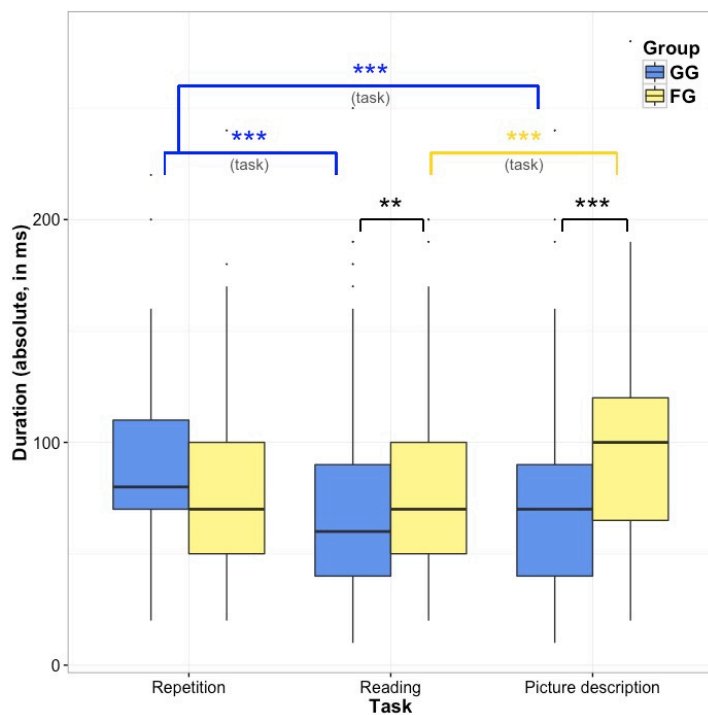


Figure 5: Duration of [h] in word beginnings in native and L2 speakers of German



Regarding the [h] production in a semi-spontaneous speech task, the ProFee-FLACGS corpus can give us some more insight. Compared to Figure 5, Figure 6 also shows the durations of [h] this time for the third experimental condition, i.e. the semi spontaneous speech task. Figure 6 however contains overall more data points of uttered [h] in the two learner groups because the realisation rates of canonical [h] productions were higher in this corpus subset than the FLACGS corpus with respect to the semi-spontaneous production task.

We observe that the duration of word initial /h/ in both learner groups was significantly longer than in German native speakers. Two explanations could justify this result:

1. increased awareness does not have an impact on the production accuracy duration wise
2. overall, the learner group produces longer fricatives than German native speakers.

The second possibility can easily be verified. We chose the fricative /f/ which is common to both languages and comparable to /h/. In Figure 7 the result of this analysis is plotted. Inferential statistics showed that duration differences between the AO learner group (mean: 80.98, SD: 45) and the German native speakers (mean: 72.45, SD: 35) are not significant. The AV group, however, produced longer [f] durations (mean: 96.24, SD: 54) than the other two speaker groups. This result can be explained by slower speech compared to the AO and CG groups. Nevertheless, figure 7 indicates that German L2 speakers with French as an L1 do not generally produce longer fricatives than German native speakers and that [h] production in German L2 speakers are different from German L1 speakers because they are not included in the French phonemic system. Thus, it seems to be the case such as suggested by Flege, 1987, /h/ is produced with familiar properties according to the L1 experience of the German L2 speakers.

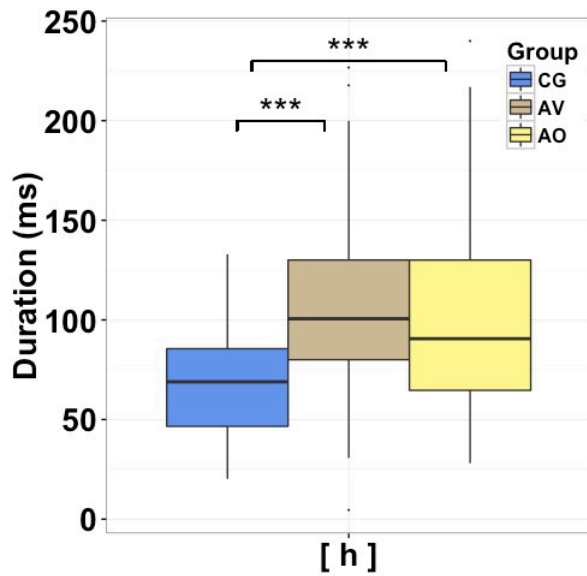


Figure 6: Duration of [h] (after 4 weeks of training) \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

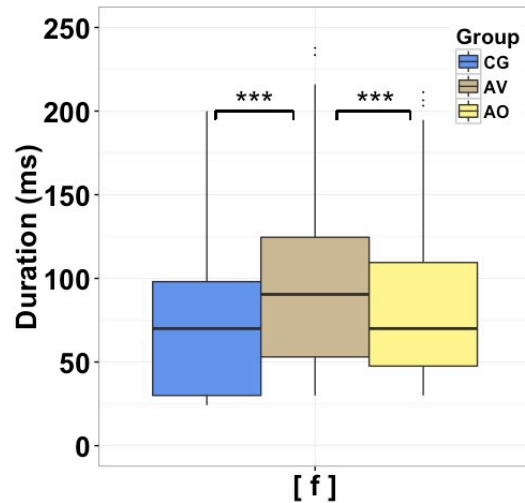


Figure 7: Duration of [f] (after 4 weeks of training) \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

## 5 Vowel duration contrast

In French there is no vowel duration contrast such as in German. The vowel length contrast in German is not only a matter of duration but also a distinction between lax and tense vowels. Numerous minimal pairs can illustrate the phonological difference between those vowels: *lache* /'laxə/ (to laugh) versus *Lache* /'lɑ:xə/ (puddle) and *bitte* /'bitə/ (please) versus *biete* /'bi:tə/ (to offer).

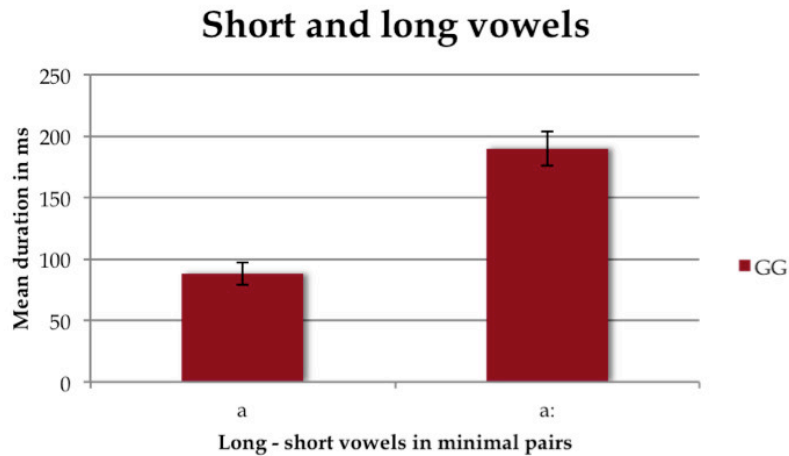


Figure 8: Absolute duration in GG speakers of long and short vowels

Figure 8 illustrates the vowel duration contrast in German native speakers (GG). This figure was created with the data of the FLACGS corpus' repetition task. In this data set, minimal pairs were presented that may be distinguished in terms of vowel duration. Figure 8 shows that in a controlled context (word repetition), German native speakers distinguished short and long vowels in terms of duration in minimal pairs. In a second step, we investigated whether this vowel duration contrast was also respected in German L2 learners with French as a native language.

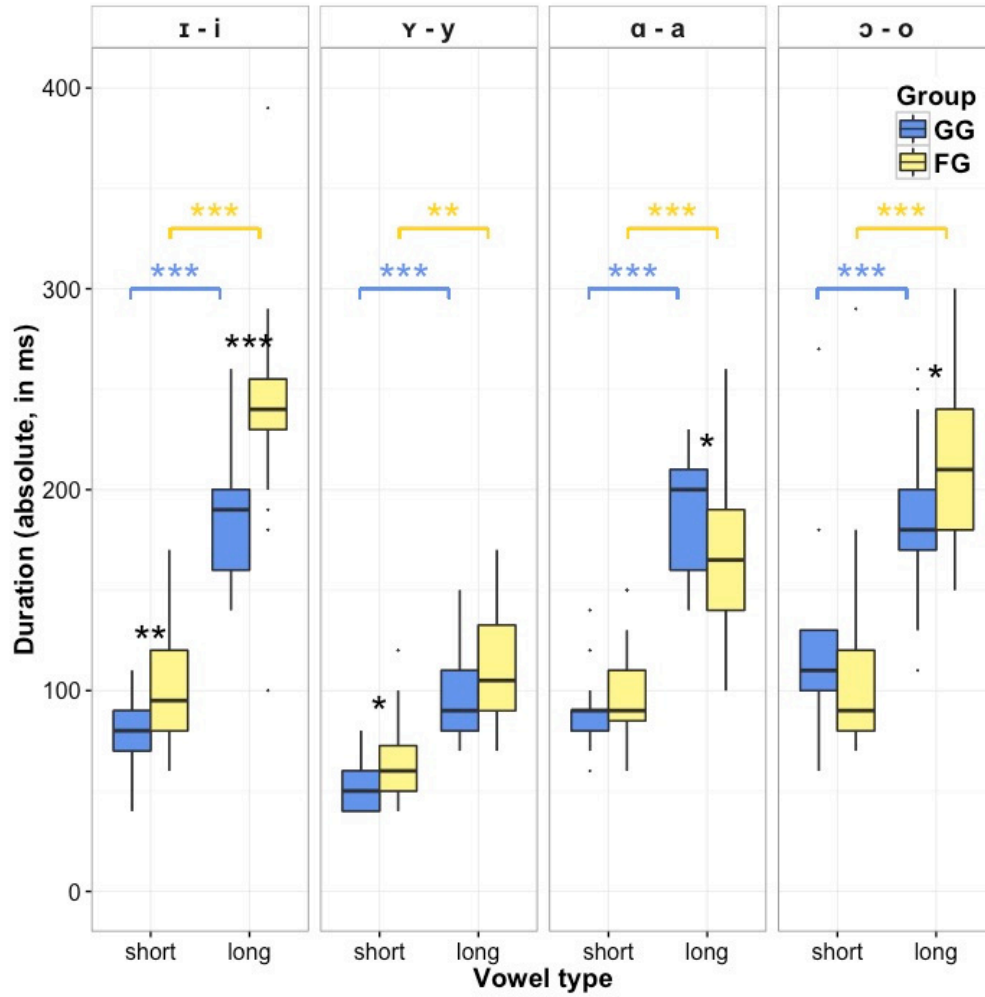


Figure 9: Short and long vowels in GG and FG, repetition task (FLACGS corpus)

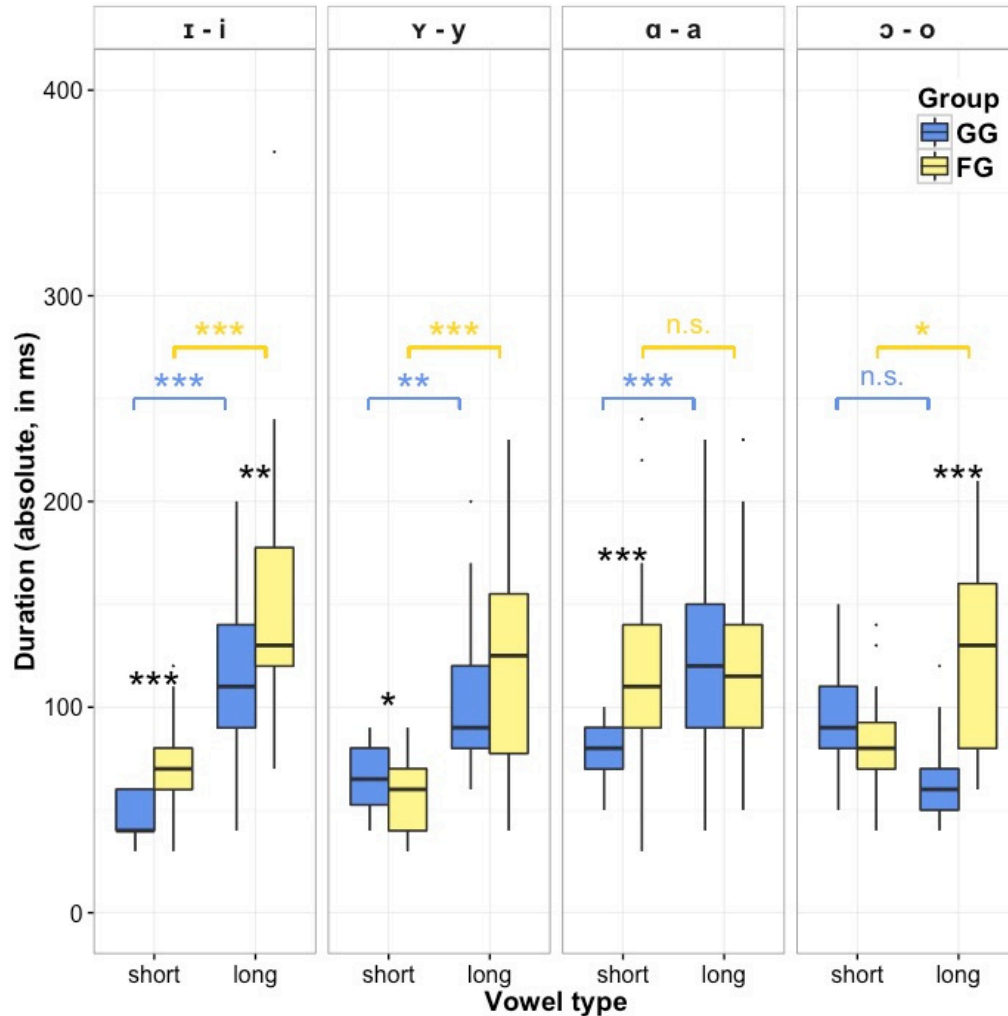


Figure 10: Short and long vowels in GG and FG, reading task (FLACGS corpus)

Figures 9 and 10 illustrate both German native speakers' (in blue) and German L2 speakers' (in yellow) vowel duration contrasts. The figures show that both groups performed a vowel quantity contrast for the minimal pairs represented in Figure 9. This result suggests that German L2 speakers with French as an L1 are sensitive to vowel quantity and are able to reproduce this contrast that is not phonological in their native language.

Similar to the findings concerning word initial /h/ (see section 4.1), German L2 learners behaved native-like when producing short and long vowels in the repetition task. As can be seen in Figure 9, vowel duration values were almost the same in German native speakers and German L2 speakers. With respect to the reading task, slight differences could be observed between the German natives and the German L2 speakers as illustrated in Figure 10. In particular for the short/long /a/-/a:/ vowel contrast, German L2 speakers tended to produce identical duration distributions while reading, which remained close to the duration distribution of the German native long /a:/ vowel. This suggests that French learners of German are not able to properly

produce duration opposition in /a/ vs. /a:/ without any auditory input. It should be mentioned that the duration contrast /a/-/a:/ was well performed by the French learners of German in the repetition task, which shows that FG speakers are able to imitate the pattern in their oral productions. However, being able to reproduce vowel quantity patterns does not automatically entail that FG speakers have contrastive perception of vowel quantity. Especially for minimal pair production, a great number of participants reported that they thought they were repeating the same word.

In Figure 10, the /ɔ /-/ o:/ contrast plotted for German native speakers shows the following intriguing result: the short vowel [ɔ] is at least as long as its long vowel counterpart [o:] in the reading task. That might be a result of differences between canonical transcriptions of German words and their realisation by native speakers e.g. *schon* (already) is transcribed as /'ʃo:n/ (normative pronunciation) but often realised as ['ʃɔn] (frequent variant). This may partly explain the observed results. Furthermore, we did not control for stress positions in the reading task, although sentence and word stress may have an impact on vowel duration.

The semi-spontaneous speech material (picture description) collected in the FLACGS corpus did not allow us to carry out analyses on vowel pairs. In order to add some analyses of semi-spontaneous speech as well, target words from the ProFee-FLACGS corpus subset were carefully selected.

German is a language that has a lexical stress. This implies that not all syllables of a German word have an equal weight (Féry 1998): stressed syllables are unlikely to be reduced; they are longer and differ in fundamental frequency as compared to the other syllables of the word.

The selected material from the ProFee-FLACGS corpus were words with two or more syllables that are not function words and contain a short or a long vowel in the stressed word position. With these criteria, we made sure that the vowel duration was not compromised by segmental reductions that may appear in unstressed syllables (Kohler 1996). Furthermore, the short and long vowel distinction is most frequently made on stressed syllables in the German language.

In the ProFee-FLACGS corpus, we focused on four vowel pairs: /ɪ/-/i:/, /a/-/a:/, /ɔ /-/ o:/ and /ʊ /-/ u:/. As reported in Wottawa, Adda-Decker, & Isel (2015), mid-front vowel pairs contrast more by vowel quality than by duration and were hence not considered here.

Table 5 shows the number of tokens according to each speakers group and each target vowel. Even if the group of German native speakers (CG) counted less participants (only four) than the two learner groups, the number of tokens across the three speaker groups was fairly similar. Describing a picture in ones mother tongue requires less effort than in a L2. Thus the speech productions of the CG group were more detailed and counted more variation regarding vocabulary and syntactic structures.

Vowels	4 weeks of training		
	CG	AV	AO
[ɪ]	69	87	95
[i:]	68	118	83
[a]	75	100	93
[a:]	41	41	47
[ɔ]	46	22	23
[o]	33	40	34
[ʊ]	73	108	102
[u:]	12	22	21

Table 5: Tokens of short and long vowels for each speaker group (ProFee-FLACGS)

Figure 11 shows plots of the relative duration of the vowels (see section 3.2). From the top to the bottom, the vowel pairs /ɪ/-/i:/, /a/-/a:/, /ɔ/ - /o:/ and /ʊ/ - /u:/ are illustrated. In each box short vowels are plotted on the left and long vowels on the right hand side.

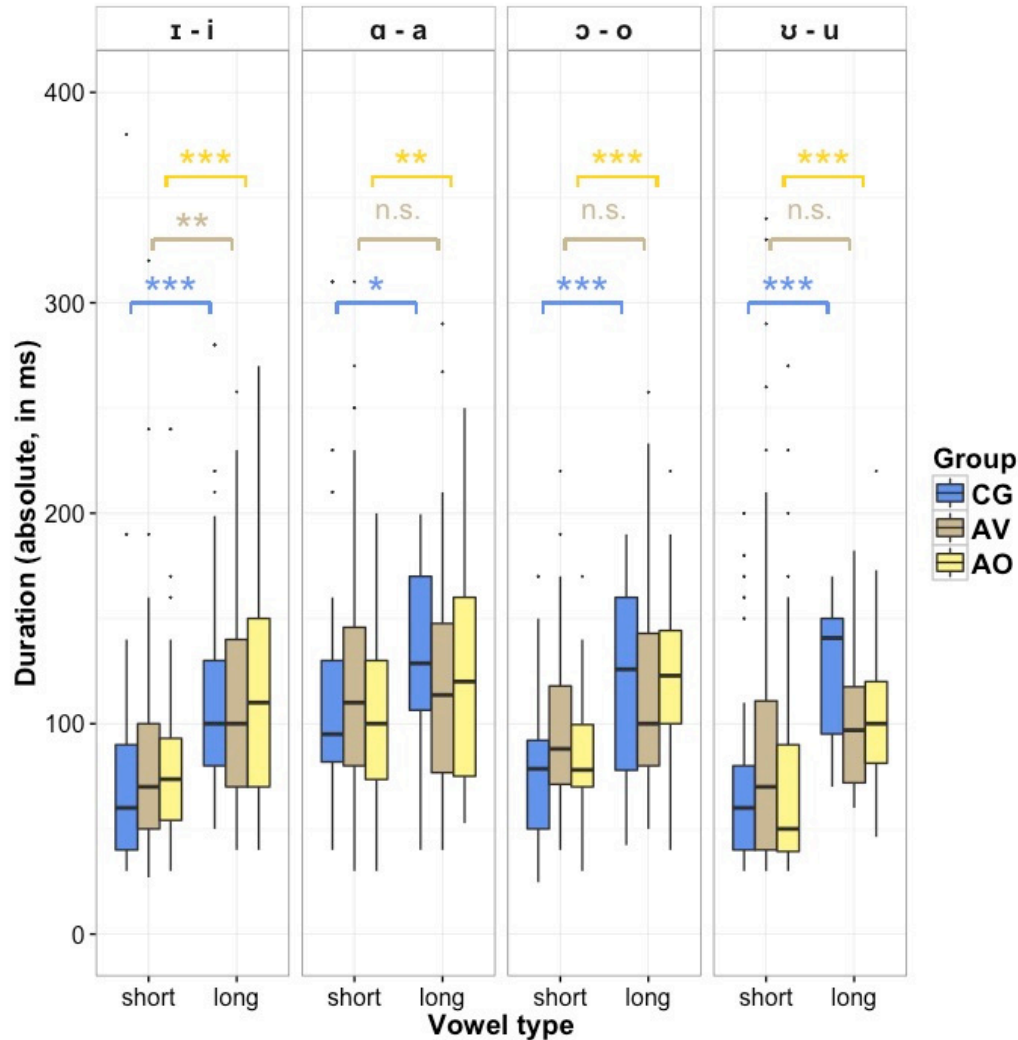


Figure 11: Relative durations of four vowel pairs (ProFee-FLACGS corpus) \*  $p \leq 0.05$ ; \*\*  $p \leq 0.01$ ; \*\*\*  $p \leq 0.001$

Regarding the vowel duration contrast productions in semi-spontaneous speech (after 4 weeks of training in a stand-alone pronunciation class), we observed that the German control group (CG) showed significant duration differences of all four vowel pairs. Only for [a] and [a:], no significant difference in duration was found.

The first learners group (AV: course material contained both audio and visual input), the duration difference between [ɪ] and [i:] is well marked, the other three vowel pairs /ɑ/ -/ɑ:/, /ɔ/ -/ɔ:/ and /ʊ/ -/ʊ:/ did not show a duration difference for the AV group whereas the second learners group (AO: course material contained audio input only) marked the vowel quantity difference well for those three vowel pairs. This difference between the two learner groups suggests that the AO group behaves more native like than the AV group. This group difference is probably due to speech competence differences within the groups.



With regard to the two other speech production tasks, it seems that the learners' performances in the semi-spontaneous task are comparable to those produced in the reading task. French learners of German realise vowel duration differences even in tasks without linguistic information. This successful production however, seems to be linked to the proficiency speakers have in their L2.

## **6 Discussion**

### **6.1 Evaluation of the chosen speech material**

The *French Learners Audio Corpus of German Speech* (FLACGS corpus) recorded during 2014/15 presents three types of speech: repeated, read and semi-spontaneous speech by both German native and German L2 speakers.

The semi-spontaneous speech part had very heterogeneous outcomes: some German L2 speakers, especially those with a high linguistic competence level, were comfortable talking several minutes about the pictures, others, often with a lower linguistic competence level (below B2), had to put much effort into realising sentences that link the drawn objects and actions to one another. Hence, the speech material of the picture description task, although useful for studying /h/ realisations in word initials, cannot be straightforwardly used for studies such as the vowel duration contrast, the collected speech material across all speakers is not rich enough.

### **6.2 Word initial /h/ production**

Overall, word initial /h/ productions seems to be less challenging than expected for French learners of German. This result stands in line with the findings of Flege & Hillenbrand (1984) who studied the production of French [u] and [y] in American native speakers. The vowel /u/ exists in the vowel system of both languages whereas the vowel [y] is part of the French vowel system only. The American native speakers of the study succeeded better native likeness in producing the vowel [y] than [u] compared to French native speakers.

Our study included material from speech production, only. The data we obtained from the word repetition study alone did not inform us

1. whether participants did perceive the word initial /h/ and reproduced the word erroneously or
2. whether the word perception was erroneous and resulted in an erroneous production.

In order to investigate the link between perception and production, an additional perception study is necessary.

Across the three tasks, we could observe a clear distinction between the repetition task and the other two tasks. However, the difference of the canonical uttered word initial /h/ did not vary much between the reading and the picture description task. In this line, it seems that the presence of auditory linguistic information helps most with word initial /h/ production in matters of

canonical production rates and segment duration.

Text (reading task) in comparison to no linguistic information (semi-spontaneous speech production) does not provide a considerable advantage to German L2 learners regarding word initial /h/ production. We have to take into consideration that the French orthography also uses <h> in word beginnings but the spoken words start with a vowel. Reading is a complex task especially in foreign languages. L2 readers are likely to mix up the contradictory orthographical conventions in order to assure a fluent speech rate and a pleasant sentence intonation. Under this light, we might have to reconsider the complexity of the chosen speech production tasks and classify reading and semi-spontaneous speech tasks as equally difficult. The influence of both tasks is yet different: erroneous decoding due to contradictory orthographical conventions provokes different errors than semi-spontaneous speech (see Table 3).

To summarize, German L2 speakers emphasize word initial /h/ duration except when they are in a word repetition situation.

### **6.3 Vowel duration contrast**

The vowel duration contrast production in German L2 speakers can be considered native like for the repetition task.

Regarding the reading task, the German L2 learners with French as L1 realised vowel quantity surprisingly well. That could be due to orthographic cues. In German orthography short vowels are often followed by a double consonant e.g. *sollte* /'sɔltə/ (should) and long vowels are often followed by a graphic <h> (*Dehnungs-h*) e.g. *Sohle* /'so:lə/ (sole). Studies on the role of orthography in L2 learners however have shown that the information orthography provides are seldom used by L2 learners (Dieling, 1983; Nimz, 2016).

Our results showed, the vowel duration contrast was realised for all examined vowel pairs except the /a-a:/ contrast in the reading task. This result could suggest that French learners of German might only have one /a/-sound they can produce without any auditory input.

In the semi-spontaneous production task, we observed differences between the two learner groups, which were recorded for the ProFee-FLACGS corpus. The AO (audio input only) group seemed globally to be constituted of more advanced German L2 learners than the AV (audio and visual input) group. That assumption could explain the differences in the vowel duration contrast for the vowel pairs /ɑ/-a:/, /ɔ/-o:/ and /ʊ/ - /u:/. The AO group marks a statistically significant difference regarding vowel duration for these three pairs whereas the AV group produced vowels with identical durations. The long vowels of the AV group for the pairs /ɑ/-a:/, /ɔ/-o:/ and /ʊ/ - /u:/ shared the same duration distribution as the short vowels of the CG (German native controls group).

## 6.4 A glimpse on the efficiency of increased awareness

The semi-spontaneous speech data extracted from the ProFee-FLACGS corpus gave us some insight on the effects of increased awareness in German L2 speech.

The results from word initial /h/ and the vowel duration contrast production showed that increased awareness can help learners with their production rates of segmentals. In other words, both learner groups were less likely to replace or delete word initial /h/ in their semi-spontaneous speech production compared to a population that was not particularly taught in pronunciation difficulties French native speakers might have in German.

However, production accuracy of target segmentals (word initial /h/ and vowel durations) is not improved by increased awareness. French learners of both groups still produced statistically significant longer word initial /h/ segments than the German native control group. The same trend can be observed for the vowel duration contrast. If awareness alone could help with the production accuracy, the AV (audio and visual input) group should perform better on the vowel pairs /ɑ/-/a:/, /ɔ/-/o:/ and /ʊ/ - /u:/ than they do (see Figure 11).

Awareness has its limits regarding second languages pronunciation. Nevertheless, it helps learners to monitor their own speech productions more closely.

## 7 Conclusion and Perspectives

In this contribution we investigated the effect of task complexity on German L2 production in French natives. To this end, we recorded two speech corpora of French learners of German in three different tasks of increasing complexity: audio repetition, sentence reading and picture description.

The first corpus (FLACGS) totals an amount of 7 hours of German speech (20 French natives and 20 German natives as control group). The second corpus was collected as part of a stand-alone pronunciation class and results in a total of 4 hours from 36 speakers (32 French natives and 4 German natives). The presented results involved all the data of the first corpus and a 1 hour subset of the second corpus. All data were manually transcribed and automatically segmented using the WebMaus platform. As the study focused on the realisations of /h/ and vowel duration contrast, all these segments were manually checked for boundary accuracy. For word initial /h/, the effective realisations were checked to decide between canonical [h], glottal stop or empty onset.

For /h/ we thus measured the respective realisation rates of [h], [ʔ] and empty onset across the three tasks as well as the segment durations of realised [h].

For the vowels, we investigated whether the French natives were able to realise the vowel duration contrast by means of longer/shorter segment durations as can be observed in German natives. In particular we were interested whether and how these durations vary across task complexity.

Our study reveals that German L2 speakers with French as a first language do not systematically replace word initial /h/ by glottal stops or empty onsets. Interestingly, results show that most of the word initial /h/ occurrences (87%) were well realised by the German L2 speakers in the auditory repetition task and that their durations matched the [h] durations of the German natives' productions. Most of the other segments corresponded to empty onsets rather than to glottal stops. Rates of canonical [h] production in reading and picture description were smaller but still surprisingly high (at least 75%). In the picture description task, German L2 speakers tended to replace canonical word initial [h] by empty onsets. In reading however, German L2 speakers rather produced [ʔ] when /h/ was not realised, which could have been triggered by the orthographic representation of <h>. As expected, the word initial [h] productions realised by the German L2 speakers were produced with longer segment durations in both the reading and the picture description task. As expected, increased *awareness* helps German L2 speakers with their canonical [h] productions. We observed fewer substitutions of word initial /h/ in German L2 speakers in the picture description in the speech data of the second corpus, where the subjects were specifically trained towards correcting this pronunciation difficulty. Segment durations, however are still longer for [h] in German L2 speakers than German native speakers after 4 weeks in a stand-alone German pronunciation class.

Regarding the vowel duration contrast, the results of the repetition task showed again that German L2 speakers were able to behave native like in this task. The vowel duration contrast in minimal pairs was well separated for all the examined vowel pairs. This trend was also observed in the reading task. Only the /ɑ-a:/ contrast was not marked by an acoustic duration difference in German L2 speakers. While describing a picture, one of the two German L2 speaker groups was able to mark the vowel duration contrast, whereas the other group only marked duration differences for the /i-i:/ contrast. These results are probably due to a lack in population homogeneity with regard to L2 proficiency. Hence, in order to better assess L2 speaker's progression over time, an examination of vowel quality could add more salient information than vowel duration only.

Overall, our work confirms that L2 production difficulties are linked to the task complexity, best pronunciation results being achieved for the audio repetition task. These results may then degrade when moving towards more complex production tasks, such as reading where conflicting grapheme to phoneme rules (as for <h> which is mute in French and a fricative segment in German) may introduce specific difficulties or for picture description, where the speaker is the author of the produced message. Audio and visual feedback to the learners was globally judged as a welcome addition although it did not translate into a clear pronunciation benefit. Further studies are required to disentangle this question.

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