COMPARISON OF PITCH PROFILES OF GERMAN AND FRENCH SPEAKERS SPEAKING FRENCH AND GERMAN

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ABSTRACT

This study examines the pitch profiles of French learners of German and German learners of French, both in their native language (L1), and in their respective foreign language (L2). Results of the analysis of 84 speakers suggest that for short read sentences, French and German speakers do not show pitch range differences in their native production. Furthermore, analyses of mean *f0* and pitch range indicate that range is not necessarily reduced in L2 productions. These results are different from results reported in prior research. Possible reasons for these differences are discussed.

Keywords: Pitch Range, L1, L2.

1. INTRODUCTION

Learning a foreign language after childhood is not an easy task. Apart from learning new vocabulary, the learner also has to cope with a different grammar. The correct acquisition of the phonetic and phonological systems of the L2 has been found to be particularly hard. These systems comprise segmental as well as suprasegmental aspects which can differ between the L1 and the L2. Interferences based on the L1 system often lead to wrong productions and to an audible foreign accent (e.g., [4, 5, 12, 13]).

Concerning suprasegmental differences – the focus of this article – languages have been shown to differ in their (global) long term distributional (LTD) pitch profiles, and these encompass different aspects: differences in pitch range, and the exact alignment of pitch accents. Evidence suggests that differing pitch ranges and the systematic use thereof, are characteristic for languages and linguistic communities (e.g., [2, 3, 9, 10, 16, 17, 19, 20]) and actually allow for a categorization of languages and language groups (e.g., [2]).

Furthermore, based on 10 speakers of each language, [9] provided evidence that French speakers produced a higher mean *f0* than German speakers, and showed differences in the pitch range when speaking in their native language.

With respect to L2, producing the correct *pitch (range)* has been shown to be hard for language learners in several studies (e.g., [7, 8, 15, 18, 24]). For instance, Finnish learners of Russian, or Dutch learners of modern Greek, have been found to produce smaller pitch ranges compared to the respective native speaker groups (e.g., [18, 24]). A study investigating the language pair French – German, based on 7 speakers per L1, replicated the finding of a reduced pitch range in each of the L2 learner groups [25] compared to their native productions. Possible explanations for the production of a reduced pitch range in L2 are learners' lack of confidence and their concentration on segmental accuracy.

There are, however, also studies suggesting that reduced pitch range does not always occur (e.g., [1]). Connected to this is the finding that increased L2 proficiency may also lead to an increased pitch range (e.g., [24, 25]).

From the point of view of (late) learners of a language, the problem of acquiring the pitch range in L2 correctly is twofold: First, they have to acquire the correct productions of L2 pitch patterns (i.e., exact shapes and the placements of pitch movements), and secondly, they need to produce them with the same pitch range as native speakers.

This article aims to investigate two aspects of pitch range:

- Firstly, we explore to what extent the pitch range of French and German (native) speakers is language dependent, i.e., whether German and French native speakers show different pitch ranges when speaking their native language.
- Secondly, the article tackles the question whether German learners of French and French learners of German reduce the pitch range when speaking L2, and to what extent this behaviour changes when speakers have a deeper knowledge of the L2, or when they have a model native speaker on which they can base their L2 productions.

2. MATERIALS AND METHOD

2.1. Materials

The materials for the analysis presented here are taken from the IFCASL learner corpus [11, 23]. The corpus consists of L1 and L2 recordings of French and German speakers. For the analysis, we selected 6 sentences per language. In the respective L2, speakers read 3 sentences (*read condition*), and 3 different sentences were read after hearing a model native speaker (*heard condition*). In the native language, speakers only read the 6 sentences without having listened to a model speaker. Therefore, each participant contributed 12 sentences to the analysis. Overall, 40 native speakers of German (20 female, 20 male, mean age 27.2) and 44 native speakers of French (22 male, 22 female, mean age 26.6) were analysed. 21 of the French speakers were beginners (BEG) (A1-B1 proficiency level), whereas 23 speakers were advanced learners (ADV) (B2-C1 proficiency level). Of the 40 German participants, 19 were ADV, and 21 were BEG.

On average, the French sentences consisted of 7.8 words (9.1 syllables) and the German sentences consisted of 8 words (11 syllables). This difference was not significant. Overall, 1008 sentences were selected (12 sentences * 84 speakers). Of these, 33 (3%) had to be excluded due to problems with the automatic pitch extraction process, leaving 975 sentences for further analysis.

2.2. Pitch Analysis

Pitch analysis was performed as follows. First, *f0* was extracted automatically in all sentences, using an ESPS algorithm ("get_f0", [22]) with time steps of 5 ms for female, and 10 ms for male speakers.

Secondly, a manual inspection and correction (i.e., removal of data points) of the extracted pitch contours was performed in PRAAT [6]. The corrections included the removal of octave jumps, removal of the first two measures after a voiceless interval, and of the last two measures before such an interval (to eliminate artificially big range values resulting from the vocal folds' need to reach the intended vibration rate), as well as other artefacts (e.g., due to creaky voice).

The remaining data was then used to calculate mean *f0* and pitch range in semitones (ST) for each sentence individually with the JMP software [21]. The conversion from Hz was performed with the following formula:

(1) Range [ST] = 39.863 * log10(Max*f0*/Min*f0*)

3. RESULTS

To answer the first research question, i.e., to what extent French and German native speakers produce a different pitch profile when speaking their L1, a first analysis compared the pitch profiles in the 6 native productions read by the French and German speakers. These were analysed in mixed models with ITEM and SPEAKER as random variables, L1 (French, German) and GENDER (female, male) as fixed factors, as well as the interaction of L1 and GENDER. We analysed mean *f0*, and pitch range in ST, to compare the pitch profiles of the two groups.

The first statistical model had mean *f0* as the dependent variable. French female speakers had a mean *f0* of 203 Hz (SD 21.6), male French speakers produced the read sentences with a mean *f0* of 118 Hz (SD 18.5). German female speakers' mean *f0* was 215 Hz (SD 17.3), whereas German male speakers had a mean *f0* of 121 Hz (SD 18.9, Figure 1). The statistical model indicates that only GENDER was a significant factor (male speakers produced a significantly lower mean *f0*, $F(1,1)=455.1$, $p<0.0001$; Figure 1). The interaction was not significant, nor was native language (but there was a slight trend ($p=0.056$) for French speakers to have a lower *f0* than German speakers).

Furthermore, a separate statistical model investigated pitch range in ST as the dependent variable, but with the same factors. French female speakers had a range of 9.08 ST (SD 3,54), French males produced a range of 9.1 ST (SD 3.1). The German speakers patterned as follows, females: 8.57 ST (SD 3.3) and males 10.02 ST (SD 3.3, Figure 2). In this model, no effect was significant, nor was the interaction.

Figure 1: Distribution of mean *f0* in Hz depending on L1 (F=French, G=German) and gender in their respective native productions.

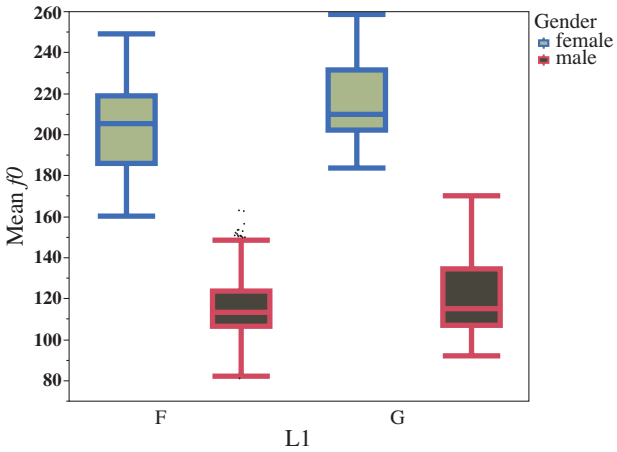
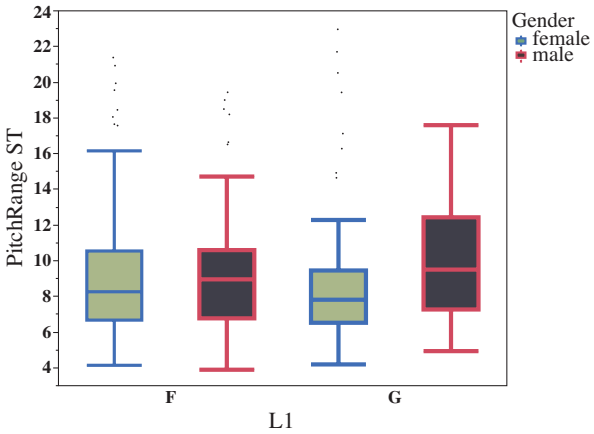


Figure 2: Pitch Range in ST for French and German speakers in their respective native productions.



To summarise the first analysis, no difference was found in the native pitch profiles between the French and German speakers when they uttered sentences in their native languages ('native sentences'). A trend emerged showing slightly higher mean *f0* values for German compared to French speakers.

The second analysis investigated whether language learners reduced their pitch range when producing L2 compared to their L1.

French female speakers had a mean *f0* of 203 Hz in their L1 productions; their mean *f0* for German was 205 Hz (see also Table 1). For male French speakers, the mean *f0* were 117 Hz and 118 Hz for L1 and L2, respectively. German female speakers had a mean *f0* of 217 Hz when reading in their native language, their mean *f0* for French was 216 Hz. Their male compatriots had a mean *f0* of 121 Hz in both their native and their French productions. Overall, German speakers had a slightly higher mean *f0* than the French speakers. As with native productions the mean *f0* values for female speakers was higher than for the male speakers.

Table 1: Mean *f0* values [Hz] and pitch range in ST (standard deviation in parenthesis) for the speakers, depending on L1, task language and gender (F=French, G=German, f=female, m=male).

L1	Task Lang	Gen	Mean *f0*	Range *ST*
F	F	f	203 (21.9)	9.7 (4)
		m	117 (18.2)	9.3 (3.2)
	G	f	205 (20.4)	10 (4.3)
		m	118 (15)	9.2 (3.3)
G	G	f	217 (17.4)	8.1 (2.3)
		m	121 (19.3)	9.7 (2.9)
	F	f	216 (18.8)	8.4 (3)
		m	121 (20.9)	9.5 (3.3)

Table 2: Mean *f0* values [Hz] and pitch range in ST (standard deviation in parenthesis) for the speakers, depending on L1, task, (L2) level and gender (F=French, G=German, f=female, m=male, R=Read, H=Heard).

L1	Task	Level	Gen	Mean *f0*	Range *ST*
F	R	BEG	f	209 (22.5)	9.9 (4.9)
			m	119 (15.4)	8.5 (3.5)
		ADV	f	201 (17.9)	10 (3.8)
			m	117 (14.7)	10 (3)
	H	BEG	f	200 (20.9)	8.7 (3.7)
			m	111 (17.9)	7 (2.5)
		ADV	f	189 (17.3)	8.5 (2.6)
			m	107 (13)	8.8 (2.3)
G	R	BEG	f	212 (19.7)	9 (3.6)
			m	122 (20.5)	9.1 (3.2)
		ADV	f	221 (16)	7.5 (1.9)
			m	120 (20)	10 (3.1)
	H	BEG	f	215 (21.7)	8.5 (2.6)
			m	121 (12.5)	9.8 (3.3)
		ADV	f	220 (15.5)	7.1 (1.7)
			m	122 (12.4)	9.4 (2.8)

The statistical analysis of all native sentences (all were in the *read* condition) with SPEAKER and ITEM as random factor, and L1, GENDER and TASK LANGUAGE and their interactions as dependent variables, revealed that mean *f0* was significantly different between German and French speakers ($F(1, 79.81)=4.9$, $p<0.05$), as well as between male and female speakers ($F(1,396.2)=526.78$, $p<0.0001$). No other factor or interaction was significant.

Concerning the statistical analysis of pitch range as the dependent variable with the same factors as input, no factor was significant, nor was there any interaction.

A third analysis aimed at investigating to what extent hearing a native speaker had an effect on pitch patterns produced by the learners, and whether increased L2 proficiency had any significant influence on pitch profiles. Therefore, only L2 utterances were analysed in the *hearing* condition. The dependent factors were again mean *f0*, and range in ST. Speaker and item were random factors. The model included L1, TASK, GENDER, as well as L2 LEVEL (ADV, BEG), and all interactions (Table 2).

The model indicated that L1 ($F(1,79.16)=9.8$, $p<0.01$), TASK ($F(1,8.003)=8,9$, $p<0.05$), GENDER ($F(1,75.74)=582.3$, $p<0.0001$), and the interaction of L1 and TASK ($F(1,8.003)=10.8$, $p>0.05$) were significant. No other factors or interactions were significant. Mean *f0* of French learners was significantly lower than mean *f0* of German learners. Heard sentences were significantly lower than read sentences, and female speakers were significantly

higher in their mean *f0* than male speakers. Concerning the interaction, post hoc Student's t tests showed that the French speakers produced significantly lower mean *f0* values in the heard (L2) condition compared to any other condition. No other conditions were significantly different.

The same statistical model with pitch range as the dependent variable showed that the interaction of L1 and GENDER significantly influenced pitch range ($F(1,75.17)=4.75$, $p<0.05$). A post hoc Student's t test revealed that this was driven by German female and male speakers who differed significantly from each other.

4. DISCUSSION & CONCLUSIONS

The first question that was investigated in this article was whether differences between French and German speakers exist when they read sentences in their respective native language with respect to their pitch range. The results of a *f0* analysis of sentences from the IFCASL corpus shows that there were no differences between speakers of the two language groups in their LTD measures of pitch range and mean *f0*. There was a weak trend for French speakers to have a lower mean *f0* than German speakers. No difference was found for the groups with regard to pitch range. This result is different from the results reported by [9], who found that German speakers produced lower mean *f0* values than French speakers did. However, in their study, they investigated 10 speakers per language in contrast to the 40/44 speakers per language in our study. Their speech material consisted of 5 sentence passages, whereas here, only short sentences were analysed. Our results seem to replicate findings by [25] who did not find a pitch range difference between the native utterances of French and German speakers (in an analysis of 7 speakers per language, calculating the Pitch Dynamism Quotient as a measure for pitch range, as for instance in [14]). With respect to results reported for instance in [1], it seems that for the LTD measures reported here, French and German cannot be distinguished. However, other pitch profile measures, which, for instance, include linguistically based analyses, or the investigation of the location and alignment of pitch accents are likely to yield interesting insights into the differences between French and German pitch profiles.

The second part of the analyses investigated the extent to which pitch range is reduced in foreign language productions. The results of this analysis did not show a difference in the read speech of the two speaker groups, irrespective of whether they read sentences in German or in French. This result differs from the results reported in [25], who found a reduced pitch range both for German native speakers speaking French as well as for French speakers speaking German, compared to productions in their respective native language. It is also different from the results of studies that investigated speakers of different L1 backgrounds (e.g., [18, 24]). There are several possible reasons: First, [25] found the biggest differences between native and non-native productions when speakers read short stories; here, only short sentences were analysed. Furthermore, the number of speakers that were recorded for the studies was different (7 per language group in [25]; 5 per group in [18]; 9 and 7 (female) speakers in [24]; 40 and 44 here).

The question as to whether increased proficiency or differences in tasks resulted in different pitch profiles cannot be answered conclusively. Concerning pitch range, neither task nor proficiency level (nor the interaction of these factors) proved to be significant. A possible explanation for not finding a clear effect of proficiency level is that in earlier studies the length of the utterances were longer, thus the LTD measures were based on more syllables per sentence or several sentences in a passage (e.g., [9, 25]). We expect more variation in pitch profiles in the analysis of longer, more coherent texts, i.e., in discourse.

There was only one apparent interaction in the mean *f0* analysis: the interaction of task and L1, where the French speakers showed different mean *f0* values for the *read* condition compared to the *heard* condition. A preliminary investigation of the model speakers shows that the mean *f0* of the German speaker was lower (97 Hz (SD 1.8)) than the mean *f0* of the French speaker (130 Hz (SD 7.6)). This difference might have led to a lower mean *f0* in the French speakers' *heard* productions.

Further research investigating the exact role of model speakers in the language learning context, and the comparison of longer and shorter utterances (e.g., stories vs. sentences) seems to be a promising path in the investigation of pitch profile differences across languages.

5. ACKNOWLDEDGMENTS

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