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LONGITUDINAL STUDY OF PHONETIC DRIFT IN L1 SPEECH OF LATE CZECH-FRENCH BILINGUALS

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ABSTRACT

This study investigates temporal development of phonetic drift (i.e., when L1 pronunciation is affected by acquiring an L2 language) in the L1 speech of four Czech university students (two female and two male) who went to study in Toulouse as part of the Erasmus programme. Having started studying L2 French at the age of twelve to sixteen, they are considered the so-called Czech-French late bilinguals. The subjects were recorded reading out a Czech text and producing semi-spontaneous speech in three sessions – immediately after their arrival, and then at the end of the first and the third month of their stay in France. Based on acoustic analyses, we statistically evaluated the formant frequencies of vowels, the spectral moments of the fricatives /ɦ/ and /x/, and the production frequency of schwa in the word-final position, which is a distinctive pronunciation feature for Toulouse French. Even though speech and its development are highly individual, we were able to witness certain pronunciation shifts regarding all the examined phones. However, the majority of statistically significant shifts were linked to the formant values of vowels.

Keywords: phonetic drift, late Czech-French bilinguals, vowel quality, spectral moments, word-final schwa

1. Introduction

The influence of the first language (L1) of an adult speaker on the acquisition of the second language (L2) has been studied extensively at the phonetic level (see Aoyama & Guion, 2007; Colantoni & Steele, 2007; Curtin, Goad & Pater, 1998; Holliday, 2015; Kijak, 2009; Major, 1986, among many others). However, the influence of L2 on L1 of an adult speaker, who started to learn the L2 after the age of six and thus is considered a late-bilingual speaker, is a topic explored by fewer recent studies which typically deal only with partial issues. The majority of them compare the L1 of monolinguals with the L1 of late-bilinguals living in an L2 country for a couple of years, both recorded once at a specific time (see, e.g., Bergmann, Nota, Sprenger & Schmid, 2016; De Leeuw, 2008; Kupske & Alves, 2016; Lang & Davidson, 2019; Major, 1992; Mayr, Price & Mennen, 2012; Stoehr, Benders, van Hell & Fikkert, 2017; Sůčková, 2020; Ulbrich & Ordin, 2014).

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However, longitudinal studies investigating the evolution of L1 of the late bilinguals are rare (see section 1.1 below).

The existence of several differences between the Czech and French languages, both at segmental and suprasegmental levels (Hévrová, Bořil & Köpke, 2020; Hévrová, 2021; Paillereau, 2015; Skarnitzl, Šturm & Volín, 2016), encouraged Hévrová (2021) to suppose that L1 of Czechs living in Southern-French Toulouse and its surroundings will be influenced by their everyday use of French. The comparison of their L1 with the L1 of Czech monolinguals supported the hypothesis. However, in studies based on the comparison of a group of L1 late-bilinguals with another group of monolinguals, it is complicated to distinguish whether the differences between their L1s exist only due to the effect of moving to the L2 country or whether it was already present before (Hévrová, 2021). To deal with such issues, this paper features a longitudinal study capturing a gradual evolution of L1 of a speaker moving to an L2 country.

1.1 Longitudinal studies of L2 influence on L1

The effect of an L2 influence on the L1 is often referred to by a wide range of terms where three of them are the most common (Gallo et al., 2021; Köpke, 2004): a first language attrition, a cross-linguistic influence (CLI) and a phonetic drift. The first language attrition is commonly associated with a non-pathological and non-ageing effect of changes in L1 of a late bilingual resulting from a long-term immersion into an L2 environment (Köpke & Schmid, 2004; Kornder & Mennen, 2021). These changes are linked to a decreased L1 use and input (cf. De Leeuw, 2019) and are considered to be "long-term L1 changes", according to Chang (2019, p. 192). Contrarily, the phonetic drift refers to "ostensibly short-term changes" in bilinguals' L1 speech resulting from "recent L2 experience" (Chang, 2019, p. 192) and L2 "exposure" (Tobin, Nam & Fowler, 2017, p. 46). A phonetic drift is linked with "cases of a subtle phonological restructuring in the L1" (Chang, 2012, p. 249). Finally, the term CLI introduced by Sharwood Smith (1983) means any influence of one of a speaker's languages on another (cf. Jarvis & Pavlenko, 2008; Pavlenko, 2000). In the present study, we will be examining phonetic drift as this term best captures the nature of L2 influence on L1 of our bilingual respondent similarly to other studies (e.g., Chang, 2012; Tobin et al., 2017).

Speech Learning Model (SLM) (Flege, 1995) and its revised version SLM-r (Flege & Bohn, 2021) are widely employed in studies of phonetic L2 influence on L1 (see, e.g., Bergmann et al., 2016; Chang, 2010; De Leeuw, 2008; Hévrová, 2021; Kornder & Mennen, 2021; Lang & Davidson, 2019; Mayr et al., 2012; Sůčková, 2020). The key suppositions of SLM is that L1 and L2 exist in a common phonetic space and interact with each other (Flege, 1995; Flege & Bohn, 2021), which may lead not only to a non-native L2 speech production but also to a less native-like L1 production (see, e.g., Sancier & Fowler, 1997; De Leeuw, Schmid & Mennen, 2010; Bergmann et al., 2016; Mayr, Sánchez & Mennen, 2020; Hévrová, 2021). Results of acoustic analyses of the less native-like L1 production may be interpreted as the assimilation or dissimilation effect (see De Leeuw, 2019) according to the type of changes occurring in L1 phones. Assimilation is a shift of an L1 sound towards an L2 category, while dissimilation refers to the speaker's effort to maintain a difference between L1 and L2 sound, leading to greater acoustic distance between these two sounds (De Leeuw, 2019). Both assimilation and dissimilation effects are commonly linked with a phonetic drift (Chang, 2012; Kartushina, Hervais-Adelman, Frauenfelder & Golestani, 2016), and the type and extent of a change vary widely with individual bilinguals (Bergmann et al., 2016; De Leeuw, Tusha & Schmid, 2018; Major, 1992; Mayr et al., 2012). For instance, in De Leeuw's (2008) analysis of the tonal alignment of prenuclear rise, two of ten late German-English bilinguals exceeded the monolingual German norm at the end of the rise in their L1, thus evincing a dissimilation instead of expected assimilation; in the remaining eight bilinguals assimilation was confirmed. These results follow the SLM-r supposition that L2 sound production and perception do not solely depend on the phonetic systems of L1 and L2 of the bilinguals but also on many endogenous factors which may vary within an individual bilingual and thus cause the differences in organisation and interaction between L1 and L2 phonetic categories in the bilingual's common phonetic space.

According to the Second Language Linguistic Perception model (L2LP) (see Van Leussen and Escudero (2015) for the revised version), in the final state of L2 learning, L2 learners separate L1 and L2 grammars and language activation modes that allow them to attain optimal perception of L2 and preserve the one of L1 (Escudero, 2005). To maintain the optimal L1 and L2 perception and production, learners must be exposed to rich L1 and L2 input, otherwise L2 will affect L1 (Elvin and Escudero, 2019).

Longitudinal studies examining phonetic drift in L1 of late bilinguals during a short stay in an L2 country are rare; the majority of studies focus on L2 English, in which participants are often considered as early bilinguals due to their age of L2 acquisition. Chang (2012) focused on L1 of 36 American English learners of Korean. From this sample, a group of 19 "functionally monolingual" learners were selected (3 males and 16 females) and enrolled in a 6-week Korean language course of 4 hours per weekday at the South Korean university. The participants reading a word list in L1 were recorded in five instances after each week of the course. Nine native Korean monolingual speakers represented a control group with the same reading task. Significant changes in the first formant (F1) values of L1 vowels produced by female learners after five weeks of the course were found; the size of the male group was insufficient for statistical significance. The drift was consistently unidirectional for all vowels in general in accordance with the mutual position of Korean and English vocalic systems instead of assimilation of individual's L1 vowels. Mayr et al. (2012) also found assimilation in F1 of the whole L1 vocalic system in the study of phonetic attrition, while this was not observed in Hévrová (2021).

Kartushina et al. (2016) showed that phonetic drift could appear very quickly, i.e., after one hour of intensive training of target foreign vowels. Interestingly, five weeks of intensive L2 courses and staying in an L2 environment sufficed for phonetic drift appearance in the work of Chang (2010, 2012) but not in the study of Lang and Davidson (2019). The discrepancy between the two studies might be related to external factors such as the number of hours of L2 learning classes or characteristics of the vowel system of each language. Nevertheless, because of these differences and variability of individual speakers as described by SLM-r, the time duration of contact with the L2 to cause the phonetic drift cannot be precisely determined.

In Chang (2013), the phonetic drift was stronger in novice learners (learners with no prior knowledge of the L2) rather than in experienced learners enrolled in the same language program. In contrast, it occurred more in advanced learners than in beginners (Herd, Walden, Knight & Alexander, 2015) and in a long-term L2 country stay than in a short-term stay (Lang & Davidson, 2019). According to studies by Flege (1987) and Major (1992), the more speakers are proficient in L2, the more drift occurs. Consequently, the result of this study seems to cast doubt on Chang's hypothesis (2013) that the drift gets greater with less experienced speakers.

Looking at the respondents in studies on phonetic drift, most studies consider a few speakers as a group (see, e.g., Chang, 2012) or are focused on a single speaker (see, e.g., Sancier & Fowler, 1997). Moreover, longitudinal studies focusing on more than one speaker analysing a phonetic drift of each speaker individually are rare. For this reason, we have decided to analyse the speech of 4 speakers separately.

1.2 L2 influence on L1 of late Czech-French bilinguals

L2 influence on L1 of late Czech-French bilinguals was examined by Hévrová (2021) both at a segmental and suprasegmental level. Two experiments were conducted in which L1 speech production in a reading aloud task and semi-spontaneous speech of late Czech-French bilinguals, mainly living in Toulouse geographical area, was compared with that of Czech monolinguals. In the first experiment, a perception test revealed that Czech monolingual listeners perceived the bilinguals' semi-spontaneous L1 speech as significantly less typically Czech sounding than Czech monolingual speakers, but this was not the case for the reading task. In the second experiment, the speech of 17 bilinguals and 17 monolinguals was analysed acoustically, and the phonetic cross-linguistic influence (CLI) was mainly found in spectral characteristics of several of the bilinguals' vowels, /ɦ/ and /x/, in the non-conclusive intonation patterns as well as in the frequency of use of schwa in the word-final position. A correlation analysis was performed between phonetic L2 influence on L1 and several extralinguistic factors, such as the frequency of use of L1 by the bilinguals, their length of residence in France, proficiency in L2 and preferences for either L1 or L2 country, culture and language. A significant link of phonetic L2 influence on L1 in /ɦ/ in semi-spontaneous speech and in /x/ in the reading task with the proficiency in French of the late bilinguals was found. Bilingual with a higher proficiency in French showed less phonetic attrition than those with a lower proficiency.

1.3 Acoustic properties of selected elements of Czech and French phonetic system

Standard Czech and Standard French[1] differ in the number of vowels (see Table 1) and their articulatory properties (see Table 2 for the relation of formant values of monophthongs). In Toulouse French (spoken mainly by people born and living in the geograph-

[1] Language varieties preferred in television or radio broadcast and education; geographically typical for the Bohemian and Paris regions respectively.

ical area of Toulouse), some speakers do not distinguish between /e/ and /ɛ/, /a/ and /ɑ/, /o/ and /ɔ/ and /œ/ and /ø/ in their speech production, while others make this distinction or use /e/ and /ɛ/, /a/ and /ɑ/, /o/ and /ɔ/ and /œ/ and /ø/ according to rules different from Standard French (Courdès-Murphy, 2018; Durand, 2009). Most often, nasal vowels in Toulouse French are pronounced as an oral vowel followed by a very short nasalised vowel and a long nasal consonant (Durand 1988; Delvaux, Kathy, Piccaluga & Harmegnies, 2012).

Czech /ɦ/ and /x/ are two fricatives that do not exist in Standard French or Toulouse French. Hévrová (2021) calculated four mean spectral moments (centre of gravity (*COG*), standard deviation, skewness and kurtosis) of /ɦ/ and /x/ from the L1 semi-spontaneous speech and /x/ in a reading aloud task of 17 Czech female monolinguals, data collected by Tykalová et al. (2021) (see Table 3). The spectral moments of Czech /x/ were also measured by Sedláčková (2010) on recordings of read news in Czech Radio 1 – 'Radiožurnál' by 21 Czech moderators (also see Table 3).

Some French speakers may pronounce a schwa at the end of specific words (so-called 'e-muet' – the dumb 'e') (cf. Brun, 2000). At the geographical level, this schwa (hereinafter referred to as final schwa) is rarely pronounced by speakers from Northern France, while it is often pronounced by southern French speakers. The pronunciation of the final schwa is practically systematic in Toulouse French, and its duration is usually longer in the production of Toulouse French speakers than the French from Marseilles (cf. Coquillon, 2005). From the phonetic point of view, the final schwa corresponds to the sound [ə] stuck to the last pronounced consonant of the word or, in very few attested cases, to the last pronounced vowel of the word with a consequence of creating a new syllable (Carton, Rossi, Autesserre & Léon, 1983; Coquillon, 2005; Durand, Slater & Wise, 1987). At the orthographical level, the final schwa may match up with the letter 'e' at the end of the word, but it may also be pronounced even if there is no such letter (cf. Coquillon, 2005). For example, 'mère' may be pronounced as [mɛRə] (see Pustka, 2011), 'alors' as [alɔRə], and 'avec' as [avɛkə] (see Carton et al., 1983).

French speakers may express a hesitation by employing the final schwa, and Candea (2000) proposed to use duration as a parameter for distinguishing a final schwa as a simple indication of the geographical origin of the speaker from a final schwa as an expression of hesitation. In the corpus of production of Standard French speakers, the final schwa labelled as the expression of hesitation lasted from approximately 150 to 500 ms. The final schwa was rarely found in Standard Czech (Průchová, 2016), while a schwa separated from the words by silences is commonly employed for an expression of a hesitation (Šulecová, 2015; Volín, 2010).

Table 1: Vowels of Standard Czech and Standard French. Source: Léon (1997); Volín (2010); Skarnitzl et al. (2016).

		Standard Czech	**Standard French**
Monophthongs	Oral	ɪ, iː, ɛ, ɛː, a, aː, o, oː, u, uː	i, e, ɛ, a, ɑ, u, o, ɔ, y, ø, œ
	Nasal	-	ã, ɛ̃, œ̃, ɔ̃
Diphthongs	Oral	o͡u, a͡u, ɛ͡u	-

Table 2: Differences among formant values of Standard Czech, Standard French and Southern French vowels. Note: StCZ = Standard Czech, StFR = Standard French, SFR = Southern French. Dark grey colour means the most important difference, grey indicates important difference, light grey means less important difference. According to: Skarnitzl and Volín (2012); Tubach (1989); Paillereau and Chládková (2019); Gendrot and Adda-Decker (2005); Woehrling (2009).

Vowel	F1	F2
/ɪ/ or /i/	StCZ > StFR and SFR	StCZ < StFR and SFR
/ɛ/	StCZ > StFR and SFR	StCZ < StFR and SFR
/a/	StCZ > SF > StFR	StCZ < SF < StFR
/u/	Some differences but not possible to determine precisely	Some differences but not possible to determine precisely
/o/	StCZ > StFR and SFR	Some differences but not possible to determine precisely

Table 3: Four mean spectral moments of Czech fricatives /ɦ/ and /x/. Centre of gravity (*COG*), standard deviation, skewness and kurtosis of /ɦ/ in semi-spontaneous speech and of /x/ in read news, reading task and semi-spontaneous speech.

	COG **(Hz)**	**St_dev (Hz)**	**Skewness**	**Kurtosis**
/ɦ/ semi-spontaneous (Hévrová, 2021)	337	580	23	876
/x/ read news (Sedláčková, 2010)	1191	1373	3	18.1
/x/ reading task (Hévrová, 2021)	1127	1622	7	86
/x/ semi-spontaneous (Hévrová, 2021)	1199	1654	6	83

1.4 Hypotheses

Concerning the SLM, SLM-r, L2LP, the results of studies on phonetic drift, the CLI found in the L1 speech of late Czech-French bilinguals (Hévrová, 2021) and the phonetic differences between Czech and French, (i) we predict phonetic drift may appear in L1 speech of Czech Erasmus students in Toulouse, more particularly in spectral moments of their /ɦ/ and /x/ (due to the lack of their L1 input in accordance with the L2LP), use of the final schwa in the semi-spontaneous speech and some formants of several vowels, mainly: F1 of /aː/, F1 and F2 of /ɛ/, F1 and F2 of /ɛː/, F1 and F2 of /ɪ/, F1 and F2 of /iː/. With respect to the consideration of individual differences corresponding to SLMr, (ii) we predict a large variability in the type and amount of the drift in the L1 speech of Czech Erasmus students in Toulouse.

2. Method

2.1 Respondents

For the present study, we recorded the L1 speech produced by 5 native Czech students coming from Bohemia of the Czech Republic to Toulouse for Erasmus, living in the Toulouse area during their stay. All respondents claimed that they had not lived in any region with a strong variety of Czech, nor had they spoken with a Moravian accent. They all self-reported having a good English proficiency level (B2 or C1). They all started to learn French during their grammar school (being approximately from 12 to 16 years old) except for one speaker who only attended 4 hours of online French learning one month before coming to Toulouse. This particular respondent scarcely used French at the university in Toulouse since most of their classes were in English; because of these facts, we decided to exclude this speaker from the studies. For the remaining four speakers, see Table 4.

Table 4: Personal data and language background of speakers.

Speaker	Sex	Age	Foreign countries where they lived for more than 6 months	Czech region they lived the longest
LS1	M	33	Poland (13 months)	North Bohemia
LS3	F	21	none	Central Bohemia
LS4	M	27	France – Angers (6 months)	Central Bohemia
LS5	F	20	none	South Bohemia

2.2 Procedure

The L1 speech of each student was recorded at three distinct times: first, when the student arrived in Toulouse, second, after about five weeks of the student's stay in Toulouse and third, after about three months of the student's stay there. Table 5 gives the precise number of days after arrival when the recordings were made. The first author of the article was quickly notified about the exact day of students' arrival to Toulouse. Nevertheless, this was not always possible, and for two students, the initial recording was delayed. The first author of the present article recorded the students' speech production in a quiet recording studio (PETRA) at the University of Toulouse Jean-Jeaurès using a sound card MOTU UltraLite-mk3 and Neumann TLM 49 microphone located around 20 cm from the speakers' mouth.

Table 5: Days after arrival (A) when the recording was made.

Speaker	1st recording	2nd recording	3rd recording
LS1	A+2	A+40	A+90
LS3	A+1	A+35	A+92
LS4	A+15	A+35	A+93
LS5	A+21	A+36	A+87

During each recording session, at first, the participant had to produce one minute and a half of semi-spontaneous speech in French (speaking about one or more proposed or free topics) before starting to accomplish the speech production tasks in Czech. This was performed in order to ensure the authentic environment in which our students lived: speaking French during the day and switching to Czech occasionally. The proposed topics were: plans for holidays or the weekend, typical day, studies, family, hobbies, and others. The first speech production task in Czech consisted of one minute and a half of semi-spontaneous speech in Czech (hereafter SS) on one or more proposed topics similar or identical to those proposed for the production of semi-spontaneous speech in French. The second speech production task consisted of reading aloud a short Czech text (i.e., reading task, henceforth RT). For the first recording session, a short text extracted from Čapek (1960) was used; for the second session, we used a short text from Čapek (1939) and for the third session, a short text called 'Milánek' was employed which is a part of standardised protocol for language and acoustic assessment and analysis. All the texts are frequently used for the research purposes at the Institute of Phonetics of Charles University. The texts were similarly long and easy to read. Other production tasks were also recorded but not used for the present study.

2.3 Acoustic analysis

All recordings were orthographically transcribed into phrase tiers, semi-automatically segmented and labelled into word and phone tiers in Praat (Boersma & Weenink, 2019). The segmentation and labelling were manually corrected following the rules of segmentation (Machač & Skarnitzl, 2009); for instance, the vowels' boundaries were placed according to the presence of full formant structure, and initial glottal stops and final voice decay time were not considered as a part of the vowel. The annotation of the final schwas [ɘː] was guided by their duration, sticking to the end of the word and a perceptual creation of a new syllable. The schwa separated from the end of the word by a glottal stop [ʔ] was not considered a final schwa.

Four spectral moments of /ɦ/ and /x/ were measured automatically using a Praat script, computing the mean of the given spectral moment from the second third of the vowel duration to minimise the coarticulation's effect on the formant value. The F1 and F2 values of vowels were measured in the middle third of their duration using the Burg method in Praat (Boersma & Weenink, 2019). Three different settings of the method were used with window size of 25 ms and 50 Hz pre-emphasis in all cases: (i) the maximum number of formants: 5, formant ceiling of 5500 Hz, (ii) max. 5 formants and 3000 Hz ceiling, (iii) max. 10 formants and 3000 Hz ceiling. For each setting and formant, a mean value of estimates was obtained. Then, based on a visual inspection of spectra and an auditory perception, we manually chose the most appropriate values (from the estimates proposed by the three settings) not containing nasal formants, F1 with f_0 merging and other typical estimation errors. In most scenarios, the first two values of the method (i) agreed best with our manual inspection of /ɪ, ɛ, a/ vowels and the first and the third value of the method (ii) performed well with /o, u/ vowels. However, in many situations, this was not a rule. Nasal context, creeky-voice, different f_0 and spectral composition of the voice played a significant role. Hence, the manual evaluation was necessary.

2.4 Statistical analysis

For the statistical analysis, we excluded the phonemes in foreign words such as the names of French or foreign cities, unpronounced and semi-pronounced phones (annotated manually in brackets, e.g., typically the vowel /o/ in the Czech word 'protože'), the Czech conjunction /a/ (meaning "and" in English) longer than 150 ms being considered as a hesitation (cf. Rubovičová, 2014).

The data were analysed in R (R Core Team, 2019) using the packages *lme4* (Bates, Mächler, Bolker & Walker, 2015), *dplyr* (Wickham, François, Henry & Müller, 2020), *rPraat* (Bořil & Skarnitzl, 2016), *ggplot2* (Wickham, 2016), and *emmeans* (Lenth, 2021). For the study of vowels and /ɦ/ and /x/, we first counted the number of their occurrences by speaker, recording session and task, see Table 6. Groups with less than 4 occurrences were excluded from the study (/ɦ/ in RT of all speakers, /ɦ/ in SS of the speaker LS3, and /ɛː/, /oː/, /uː/ in both tasks).

In order to examine the differences in the acoustic properties of vowels, /ɦ/ and /x/ across the three recording sessions for each speaker separately, we performed a set of linear regression models with the interaction between two fixed effects for each studied acoustic property and phoneme. The fixed effects were the recording session (hereafter time) with three levels (1st recording = A0, 2nd recording = A1, 3rd recording = A2) and task (two levels: RT and SS). We analysed the relationship between the recording session and the given acoustic property: *lm*(*value ~ time∗task, data*). Visual inspection of residual plots did not reveal any obvious deviations from homoscedasticity or normality. The comparison of estimated means across levels of the effects was carried out with the package *emmeans* on the full model with the interaction. The significance level of 0.05 with Bonferroni correction for 4 speakers was $\alpha = 0.0125$.

For the study of the final schwa, we counted the number of occurrences by speaker and recording session in SS. During the manual annotation, we did not observe any occurrence in RT, which corresponds to the results of Hévrová (2021). Thus, the final schwa was not analysed in RT.

Table 6: Number of occurrences of analysed phonemes by speaker and task.

	Reading task (RT)				Semi-spontaneous speech (SS)			
	LS1	LS3	LS4	LS5	LS1	LS3	LS4	LS5
/ɦ/	–	–	–	–	21	–	17	26
/x/	22	19	19	17	22	29	18	25
/a/	113	113	106	110	205	272	218	189
/aː/	30	28	29	29	68	70	78	54
/ɛ/	152	154	156	155	327	347	384	301
/ɪ/	79	80	82	83	142	225	173	177
/iː/	64	58	62	62	99	99	99	61
/o/	108	106	107	106	216	284	234	218
/u/	42	43	44	44	47	89	71	67

3. Results

3.1 Spectral moments in /ɦ/ and /x/

The analysis of the four spectral moments (*COG,* standard deviation, skewness and kurtosis) of /ɦ/ in SS for the three speakers (see Figure 1) showed a significant difference

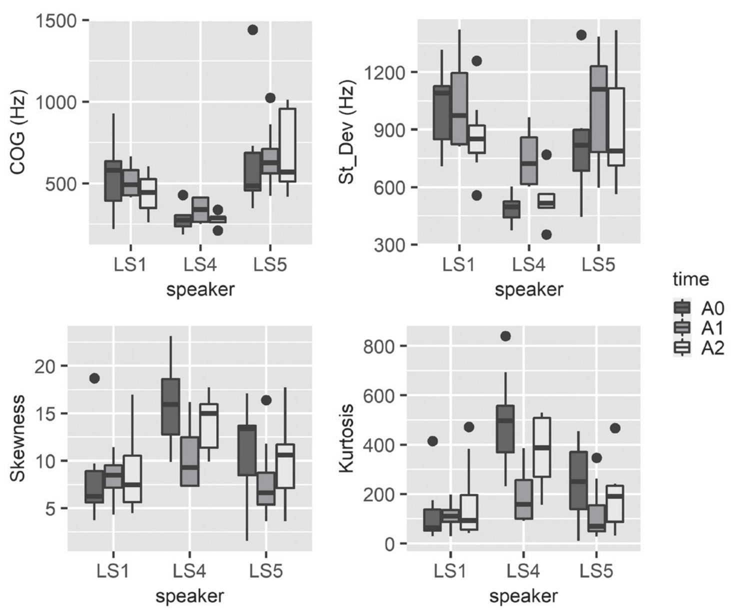

Figure 1: *COG*, standard deviation, skewness and kurtosis of /ɦ/ in semi-spontaneous speech (SS).

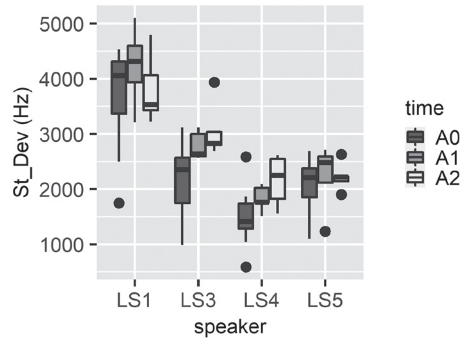

Figure 2: Standard deviation of /x/ in reading task (RT).

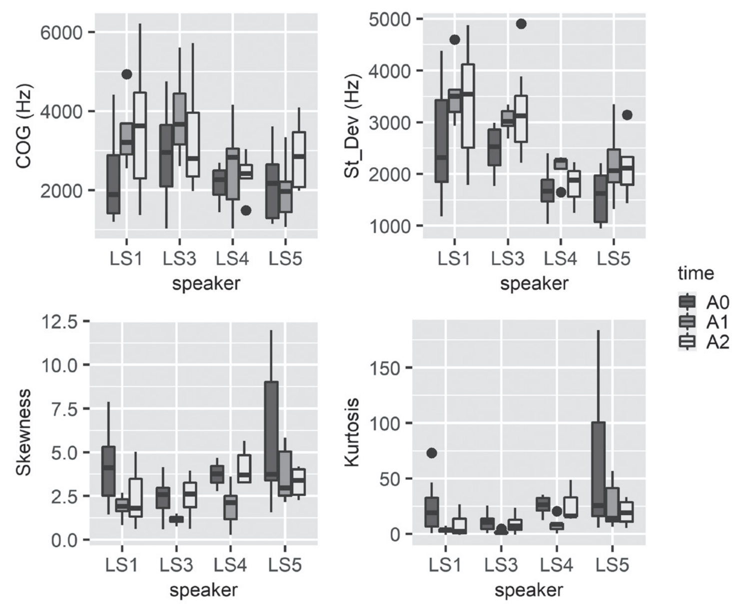

Figure 3: *COG*, standard deviation, skewness and kurtosis of /x/ in semi-spontaneous speech (SS).

in the standard deviation between the first and the second recording session (A1 – A0) of LS4 speaker, estimate: 264.3 Hz (SE = 76.8 Hz, DF = 14, $p = 0.0104$), where SE is the standard error, and DF denotes degrees of freedom.

The analysis of /x/ in RT did not reveal any significant difference in the four spectral moments due to the Bonferroni correction, although there is an indicated upward trend over time in the standard deviation (depicted in the Figure 2).

The analysis of /x/ in SS of all speakers (see Figure 3) lead to a significant difference in skewness between the second and third recording session (A2 – A1) of LS4, estimate: 2.20 (SE = 0.614, DF = 15, $p = 0.0071$).

3.2 F1 and F2 in vowels

Distributions of F1 and F2 formant values during three recording sessions are depicted in Figure 4. All significant shifts between two time moments are summarised in Table 7. In RT, the most frequent are shifts in /a, aː/ where a significant shift in one of the formants is present in all speakers. In contrast, shifts are rare in the remaining vowels in RT. In SS, significant shifts across all analysed vocals /a, aː, ɛ, ɪ, o, u/ are more frequent. In relation to Figure 4, the individuality of each speakers is notable. Please also see Table 9 in the Discussion and conclusions section for a different way of illustrating the significant shifts found.

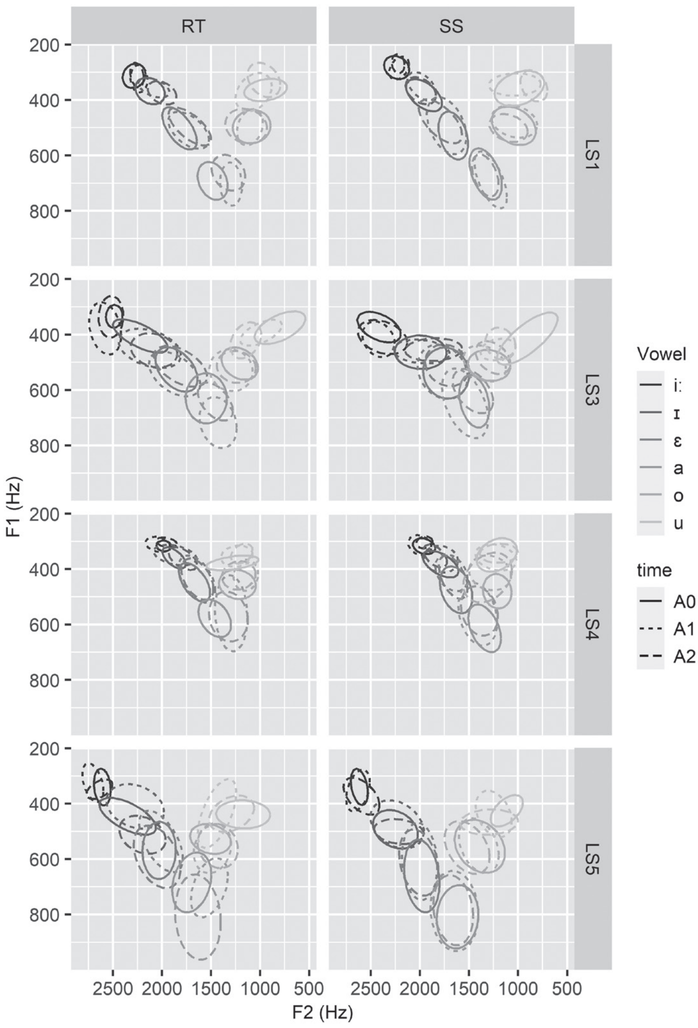

Figure 4: Formant values (50%) of vowels in reading task (RT) and semi-spontaneous speech (SS). From top-left to top-right (following the v-shape): /iː, ɪ, ɛ, a, o, u/.

Table 7: Significant shifts in formant values of vowels in reading task and semi-spontaneous speech (SE = standard error, DF = degrees of freedom).

Vowel	Task	Speaker	Formant	Sessions	Estimate (Hz)	SE (Hz)	DF	p-value
/a/	RT	LS3	F1	A1 – A0	78.8	20.9	110	0.0008
				A2 – A1	–61.8	17.7	110	0.0020
		LS5	F1	A2 – A0	111.1	30.9	107	0.0014
				A2 – A1	84.5	27.4	107	0.0073
		LS1	F2	A1 – A0	–165.3	39.5	110	0.0002
				A2 – A0	–134.5	37.3	110	0.0014
		LS4	F2	A1 – A0	–164.1	44.6	103	0.0011
				A2 – A0	–144.9	42.0	103	0.0024
	SS	LS3	F1	A2 – A1	–44.4	15.3	269	0.0115
		LS4	F1	A1 – A0	–45.9	14.8	215	0.0064
				A2 – A0	–61.3	15.7	215	0.0004
/aː/	RT	LS1	F1	A2 – A0	–62.6	17.2	27	0.0031
				A2 – A1	–65.7	17.2	27	0.0020
		LS3	F1	A2 – A1	–93.7	27.9	25	0.0069
/ɛ/	RT	LS5	F1	A2 – A1	65.6	19.8	152	0.0033
	SS	LS1	F1	A2 – A0	–43.6	12.7	324	0.0019
		LS4	F1	A1 – A0	–56.5	10.8	381	<0.0001
		LS1	F2	A2 – A0	117.5	26.6	324	<0.0001
/ɪ/	RT	LS5	F1	A2 – A0	70.7	20.9	80	0.0031
				A2 – A1	102.0	18.1	80	<0.0001
	SS	LS4	F1	A2 – A0	–26.0	8.56	170	0.0079
		LS3	F2	A2 – A0	–143.4	44.8	222	0.0045
/o/	RT	LS4	F1	A1 – A0	–40.6	13.7	104	0.0103
	SS	LS4	F1	A2 – A1	78.2	26.4	231	0.0094
			F2	A2 – A0	186.6	36.9	231	<0.0001
		LS5	F2	A2 – A0	112.9	37.6	215	0.0083
/u/	RT	LS3	F2	A2 – A0	347.0	75.5	40	0.0001
	SS	LS3	F2	A1 – A0	297.9	62.4	76	<0.0001
				A2 – A0	302.2	62.4	76	<0.0001
		LS5	F2	A2 – A0	217.0	65.3	64	0.0042

3.3 Final schwa

Table 8 shows the number of occurrences of final schwa per speaker and recording session. Speaker LS4 did not use any final schwa at all. Speakers LS1 and LS3 also did not use any final schwa in the first recording (A0, close to the day of arrival to Toulouse), but later (A2), the final schwa can be found in their speech. Speaker LS5 produced final schwas more often overall, even during the first recording (A0); however, we should note this was recorded 21 days after arriving in Toulouse and in fact, it is actually closer in meaning to A1. Due to the low counts obtained overall, we decided not to conduct a statistical analysis.

Table 8: Number of occurrences of final schwa per speaker and recording session in SS.

	A0	A1	A2
LS1	0	0	1
LS3	0	2	2
LS4	0	0	0
LS5	6	1	6

4. Discussion and conclusions

Our first hypothesis predicted a drift in spectral moments of /ɦ/ and /x/, use of a final schwa in semi-spontaneous speech (SS) and formant shifts of vowels. Table 9 summarises all significant drifts in specific acoustic parameters between two different recording sessions.

We observed the drift in spectral moments of /ɦ/ and /x/ in SS of only one speaker, the obvious drawback is the lack of data to analyse here (see Table 6). The significant drift of the standard deviation of /ɦ/ (between the first and the second recording session, A1 – A0) cannot be judged as assimilation nor dissimilation because /ɦ/ does not exist in French. However, a similar increase of the standard deviation towards the Czech /x/ values in L1 production of late Czech-French bilinguals was found in Hévrová (2021). The significant drift in the skewness of /x/ (between the second and the third recording session, A2 – A1) can be considered as a return back to its original value (A0). Although not statistical significant, the decrease in skewness of /x/between A1 – A0 is also in conformity with findings in Hévrová (2021). We may summarise these observations into two hypotheses: (i) when the phonetic drift/attrition occurs in /ɦ/ and /x/ of Czechs in France, /ɦ/ may be directed towards the spectral moments of Czech /x/, and /x/ may move away from the values of spectral moments of Czech /x/; (ii) the phonetic drift is not linear in time, i.e., some characteristics may evolve in one direction over time with varying speed, and others may also revert later.

Concerning the vowels, we found the drift in F1 of /aː/ as predicted but only for two speakers in RT. However, we also found a drift in F1 or F2 of /a/ for all speakers in RT and an F1 drift for two speakers in SS. We can presume that the lower number of /aː/ items compared to /a/ could influence the lower significant findings in the case of /aː/. We predicted the drift in F1 and F2 of /ɛ/, and we found F1 drift for one speaker in RT and with two other speakers in SS where one of them also had a drift in F2. We also predicted the drift in F1 and F2 of /ɛː/, but this was not analysed concerning a few /ɛː/ occurrences in both tasks. The predicted drift in F1 and F2 of /ɪ/ was found significant also only in a few cases. In addition, we found some drifts in /o/ and /u/ vowels.

Hence, we may conclude that our first hypothesis was only partially confirmed: the drift appeared in the predicted phonemes but not for all speakers in all phonemes.

The second hypothesis predicted variance in type and amount of the drift among speakers. We summarised all significant drifts in Table 9 for this reason.

We classified the drift of vowels in Table 9 concerning the reference values of Czech and French vowels found in the literature referred to in the caption of Table 2. Assimilation stands for getting closer to the French vowels' values, dissimilation means moving away from the French vowels, and by returning back (not considered as a drift), we mean a movement towards the original value of A0. Although the variety of significant findings across speakers in Table 9 is apparent, we can observe a joint behaviour of drift trends in several cases. In RT, /a/ dissimilates in its F1 (two speakers) and its F2 (two other speakers) while it assimilates in its F1 in SS (two speakers). The /ɛ/ of two speakers assimilates in SS (in F1, or in both F1 and F2), and the /o/ and /u/ dissimilate in their F2 in SS (two speakers). However, as Table 9 shows, the vowels of the speakers often did not drift at the same time: e.g., in RT, the /a/ dissimilates in its F1 between the first and the second recording session of LS3 while in the case of LS5, the similar behaviour is between the second and the third recording session. In SS, it assimilates between the second and the third recording session of LS3 and between the first and the second recording session of LS4. This observation seems to support our second hypothesis of the inter-speaker variance, mainly the assumption of SLM-r that many factors varying across speakers (that means not only the time of L2 immersion) influence together L2 sound production and consequently, the time in which the interactions between L1 and L2 phonetic categories start to occur may vary from speaker to speaker.

Table 9: Significant drifts. Note: A1 – A0 = light grey, A2 – A1 = grey, A2 – A0 = dark grey, N = not analysed, Nd = not determined, A = assimilation, D = dissimilation, B = return back.

	/ɦ/	/x/	/a/				/aː/		/ɛ/		/ɪ/			/o/		/u/	
	SD	skew.	F1		F2		F1		F1	F2	F1		F2	F1	F2	F2	
Reading task (RT)																	
LS1	N				D	D	A	A									
LS3	N		D	B			B									D	
LS4	N				D	D								A			
LS5	N		D	D					B		D	D					
Semi-spontaneous speech (SS)																	
LS1									A	A							
LS3	N		A										D			D	D
LS4	Nd	B	A	A					A		A			B	D		
LS5															D	D	

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