Cross-linguistic transfer of phonological assimilation in early and late bilinguals

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Abstract

Bilinguals show linguistic transfer effects at several processing levels. Focusing on phonology, we investigate the transfer of optional assimilation rules during speech production. Specifically, we examine to what extent bilinguals apply their native assimilation rule and/or fail to apply an L2 assimilation rule in their L2 speech. Both early and advanced late English-French bilinguals read a short French text. Using a speech recognizer with specific pronunciation variants, we found that the late bilinguals showed evidence for transfer of place assimilation, as well as a reduction in the amount of voicing assimilation compared to that of native French controls. The early bilinguals did not differ from the French controls in terms of place assimilation, but their voicing assimilation rate was intermediate between those of the French controls and the late bilinguals.

Keywords: speech production; cross-linguistic transfer; bilingualism; phonology; assimilation; French; English

Introduction

Bilinguals simultaneously and unconsciously activate their two languages (for review, see Kroll & de Groot, 2005), leading to linguistic transfer effects at several processing levels, including the phonological one (e.g., Colomé, 2001; Rodriguez-Fornells et al., 2005). Here, we focus on bilinguals' transfer of phonological rules during speech production. The hallmark of speech in a second language is the presence of a foreign accent (for review, see Flege & Bohn, 2021), and part of such an accent is the transfer of *obligatory* rules from the native (L1) to a second (L2) language. For instance, Polish final obstruent devoicing is present in the L2 English of many native Polish speakers (Flege & Dravidian, 1984). As to *optional* rules, virtually no previous research has investigated their cross-language transfer. We know of only one small study showing that among two native Hungarian L2 English speakers, one tended to apply the Hungarian voicing assimilation rule when speaking English (Altenberg & Vago, 1983). Moreover, to the best of our knowledge no study has yet examined whether bilinguals apply optional rules of their L2 to the same extent as native speakers of that language do.

We aim to shed more light on the cross-linguistic transfer of optional rules. As even simultaneous bilinguals can have a perceptible accent in at least one of their languages (Kupisch et al., 2014, Chang & Yao, 2016; Lloyd-Smith, Einfeldt & Kupisch, 2020), we consider both late and early bilinguals.

Our case study concerns English-French bilinguals speaking French. English has place assimilation, by which a word-final coronal stop or nasal consonant can adopt the place of articulation of a following stop or nasal consonant. For instance, *ten peas* can be pronounced *te[m] peas*. French has no productive place assimilation rule; rather, it has voicing assimilation, by which a word-final obstruent can adopt the voicing feature of a following word-initial obstruent. For instance, *œuf blanc* 'white egg' can be pronounced *œu[v] blanc* (voicing change), and *club chic* 'stylish club' can be pronounced *clu[p] chic* (devoicing change). Using a reading task, we compare the application of both these rules in the French speech of early and late English-French bilinguals to that of native French speakers. English has no voicing assimilation rule applying across words, but in this language word-final voiced obstruents tend to be phonetically voiceless (Davidson, 2016). We therefore also examine potential differences in voicing assimilation rates as a function of type of change (devoicing vs. voicing).

Experiment

Materials

We constructed a short, child-friendly[1], story in French, containing 25 two-word phrases with an assimilation context: nine for voicing assimilation (e.g. *douze portes* /du**z**pɔʁt/ 'twelve doors'), eight for place assimilation (e.g. *liquide mauve* /liki**dm**ov/ 'purple liquid'), and eight for both (e.g.

[1] At the outset of this study we were especially interested in recording bilingual parents reading the story to their young child, to examine the assimilations that children growing up in bilingual families are exposed to. Yet, data collection had to start during the 2020 pandemic lockdown in Paris. At that time, families of young children were particularly overwhelmed by the situation, being with their children at home all day. We therefore decided to recruit any participant who was willing to make a recording and send it to us via e-mail. We continued in the same way when collecting data in a second batch, in 2023.

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petite boîte /pətit**b**wat/ 'small box').[2] The complete list is in the Appendix. Among all the 17 contexts for voicing assimilation, nine concerned a possible devoicing change, and eight a possible voicing change. Among the eight place assimilation contexts, half had an oral target consonant and half a nasal one. None of the 25 phrases contained a prosodic boundary that would make assimilation unlikely.

Procedure

All communication was carried out via email. In written instructions, participants were asked to read the story once to familiarize themselves with it and then to record themselves on their cellphone while reading it out loud, as if they were speaking to a child, yet avoiding over-articulating or speaking overly slowly. Upon reception of their recording, they were sent a link to a short online questionnaire with biographical and language background questions.

Participants

Fifty-three English-French bilingual adults participated. Nineteen of them (12 women; mean age: 30; range: 20-57) were early bilinguals, and 34 (28 women; mean age: 47; range: 20-76) were advanced late bilinguals. In addition, 30 native French controls (16 women; mean age: 35; range: 22-70) also participated. One additional native French participant was excluded from the analyses, because they produced 82% of the target consonants with a following schwa, which cancels out the context for assimilation.

Most of the early bilinguals had one native-French speaking and one native-English speaking parent and had been exposed to both languages from birth, and none of them had started learning either French or English after age 4. At the time of the recording, nine of them lived in the UK or the US, the remaining ten lived in Paris, France. The late bilinguals were native speakers of English and advanced learners of French. They had started learning French between the ages of 8 and 24 (mean: 13). Twenty-three of them lived in France, the remaining 11 in the UK or the US.

All bilinguals estimated their oral proficiency in French on a scale of 1 to 7. These estimations were higher for the early than the late bilinguals (early: M=6.68; SD=0.48; late: M=5.82; SD=1.09; t=3.27, p<.002). In addition, 15 native French speakers listened to the first six sentences (i.e., approximately 15 to 20 seconds) of all the bilingual recordings, presented in random order, and rated their accent on a scale from 1 (French-nativelike) to 5 (very strong English accent). A mixed-effects model with fixed factor Group and a random structure composed of intercepts for Recording and Rater and a within-Rater slope for Group revealed that the early bilinguals were rated as more native-like than the late bilinguals (early: M=1.38, SE=0.16; late: M=3.13, SD=0.23; β=0.88, SE=0.13, t=6.94, $\chi^2(1)$=48.2, p<.0001).

[2] We had planned eight contexts in all three conditions, but discovered an additional one for voicing assimilation after most of the recordings had been made.

Finally, the native French controls had all learned English in school, but they were all born and lived in France and none of them had an English-speaking parent. We refer to these control participants as 'native French', despite the fact that most of the early bilinguals had been exposed to French from birth as well.

Results

Data coding An automatic speech recognition (ASR) system was used to align the audio with its orthographic transcription via a pronunciation lexicon in forced alignment mode (Adda-Decker & Lamel, 1999). That is, the system had no choice regarding the word sequence to be matched with the audio signal (whence forced alignment); however, it was free to choose the best matching pronunciation among the proposed variants. To assess assimilation, the lexicon contained pronunciation variants. Examples of the relevant variants for target words in the three assimilation contexts are shown in (1). Note that besides the canonical and the assimilated pronunciations, a pronunciation with the target consonant being followed by a schwa was also present.

(1) Pronunciation variants of sample target words
   a. context for voicing assimilation:
      douze *portes* 'twelve doors'
      [duz] – [dus] – [duzə]
   b. context for place assimilation:
      lune *bossue* 'hunchback moon'
      [lyn] – [lym] – [lynə]
   c. context for both voicing and place assimilation:
      pirate *barbu* 'bearded pirate'
      [piʁat] – [piʁad] – [piʁap] – [piʁab] – [piʁatə]

The alignment provided the chosen pronunciation variant along with time codes of all individual segments.

Analyses We excluded 161 tokens (7.8%), most of them (71%) due to the presence of a bit of silence (on average 193 ms) between the target segment and the beginning of the next word, the others due to mispronunciations, hesitations, and the like. The late bilinguals had the highest percentage of missing tokens (13.9%), followed by the native French (3.6%) and the early bilinguals (3.5%). The results for the remaining dataset (N=1914) are shown in Table 1.

We analyzed these data in logistic mixed-effects models in the R environment (R Core Team, 2014), using the *lme4* package (Bates et al., 2015). All factors were contrast-coded, and the random structures were the maximal ones allowing for convergence and avoiding overfitting (as indicated by lme4's singular fit warning). The *bobyqa* optimizer (Powell, 2009) was used if it helped obtaining model convergence. The Anova function in the *Car* package (Fox & Weisberg, 2009 was used to establish statistical significance, and post-

Table 1: Production patterns for the three groups of participants as a function of assimilation context; standard errors are shown in parentheses.

	% Canonical	% Assimilated			% Schwa
		voicing	*place*	*both*	
Late bilinguals (N=34)					
voicing	70.07 (2.77)	18.61 (2.36)	NA	NA	11.31 (1.92)
place	75.81 (2.72)	NA	10.48 (1.95)	NA	13.71 (2.19)
both	60.95 (3.37)	9.05 (1.98)	14.76 (2.45)	1.43 (0.82)	13.81 (2.39)
Early bilinguals (N=19)					
voicing	53.53 (3.84)	38.24 (3.74)	NA	NA	8.24 (2.11)
place	89.73 (2.52)	NA	3.42 (1.51)	NA	6.85 (2.10)
both	65.49 (4.00)	24.65 (3.63)	4.93 (1.82)	0.70 (0.70)	4.23 (1.69)
Native French (N=30)					
voicing	34.87 (2.96)	49.43 (3.10)	NA	NA	15.71 (2.26)
place	89.83 (1.97)	NA	3.39 (1.18)	NA	6.78 (1.64)
both	49.78 (3.33)	25.55 (2.90)	6.17 (1.60)	5.29 (1.49)	13.22 (2.25)

hoc analyses with corrections for multiple comparison were run in the *emmeans* package (Lenth, 2016).

First, we analyzed the tokens in which the target segment was followed by a schwa, which eliminates the context for assimilation. There were 211 such tokens (11%). A model with fixed factor Group and a random structure composed of intercepts for Participant and Item revealed no effect of Group (early bilinguals: β=-0.56, SE=0.26, z=-2.15; late bilinguals: β=0.29, SE=0.22, z=1.35; native French: β=0.27, SE=0.22, z=1.20; $\chi^2(2)=4.62$, p=.1).

Next, we focused on the Canonical and Assimilated tokens (N=1703). Figure 1 (next page) shows the assimilation rates within this set for the phrases with the context for one (A) or both (B) assimilation rules; for the latter, the left and right panels show single and double assimilations respectively. We analyzed these data in three separate mixed-effects models. The first two models, i.e. the models for the tokens with a single detected assimilation (Figure 1A and left panel of Figure 1B), contained the fixed factors Group, Context, and its interaction, and random intercepts for Participant and Item. To account for the fact that assimilation is more likely to occur at higher speech rates, we took the mean segment duration in the target words as a proxy for speech rate, and added it as a covariate.[3] Thus, the overall structure of these models was as shown in (2).

(2) Assimilation ~ Group × Context + Duration + (1 | Item) + (1 | Participant)

The model for the phrases presenting a context for either voicing or place assimilation (Figure 1A) revealed an effect of Context (β=-1.28, SE=0.19, z=-6.88, $\chi^2(1)=47.3$, p<.0001), with overall more voicing than place assimilation, and a Group × Context interaction (Early:Place: β=-0.27, SE=0.18, z=-1.49; $\chi^2(2)=16.7$, p<.0003; Late:Place: β=0.93, SE=0.14, z=6.81; Native:Place: β=-0.67, SE=0.16, z=-4.21; $\chi^2(2)=52.3$, p<.0001). Post-hoc analyses revealed that the native French controls and the early but not the late bilinguals had higher rates of voicing than of place assimilation (native French: β=3.89, SE=0.49, z=7.95; p<.0001; early bilinguals: β=3.09, SE=0.57, z=5.45; p<.0001; late bilinguals: β=0.69, SE=0.40, z=1.74; p=.08). Furthermore, in the context for voicing assimilation, the native French had higher assimilation rates than both the early bilinguals (β=0.77, SE=0.24, z=3.26; p<.004) and the late bilinguals (β=1.79, SE=0.24, z=7.45; p<.0001), and the early bilinguals had higher rates than the late bilinguals (β=1.02, SE=0.25, z=4.09; p<.0002); in the context for place assimilation, the late bilinguals had higher assimilation rates than both the early bilinguals (β=1.37, SE=0.51, z=2.72; p<.02) and the native French (β=1.41, SE=0.42, z = 3.33; p < .003), but there was no difference between the latter two (|z|<1).

The model for the phrases presenting a context for both voicing and place assimilation (left panel of Figure 1B) likewise revealed an effect of Context (β=-0.52, SE=0.11, z=-4.97; $\chi^2(2)=24.7$, p<.0001), with overall more voicing than place assimilation, and a Group × Context interaction (Early:Place: β=-0.44, SE=0.16, z=-2.69; Late:Place: β=0.82,

[3] These mean durations were on average 98 ms for the late bilinguals, 84 ms for the early bilinguals, and 79 ms for the native French. A linear model with the factor Group revealed a significant effect of Group (F(2,80)=24.0, p<.0001); the mean segment durations in the target words were longer for the late bilinguals than for the early bilinguals (β=14.5, SE=3.33, t=4.36; p<.0002) and the native French (β=19.5, SE=2.91, t=6.70; p<.0001), while there was no difference between these mean durations for the latter two groups (p>.1). Using as a covariate the duration of the entire recording (means: 90 sec for the late bilinguals and 75 sec for both the early bilinguals and the native French) instead of mean duration of segments in the target words does not change the reported results.

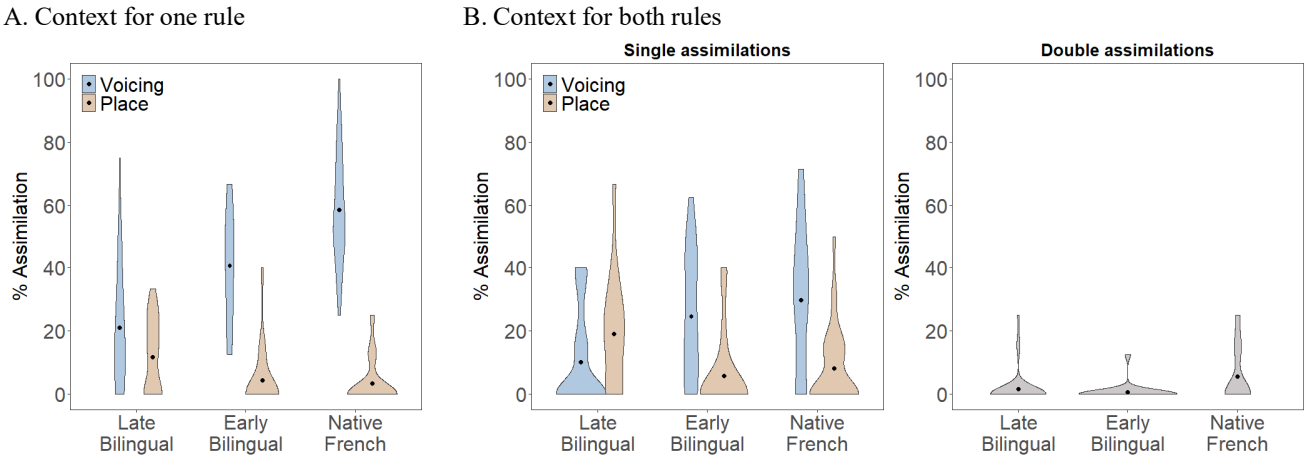

Figure 1: Violin plots of % assimilation. A: phrases with the context for either voicing or place assimilation. B: phrases with the context for both rules, with single assimilations in the left panel and double assimilations in the right panel. The black dots indicate mean values.

SE=0.14, z=5.85; Native:Place: β=-0.38, SE=0.14, z=-2.69; $\chi^2(2)$=35.0, p<.0001). Post-hoc analyses revealed that the early bilinguals and the native French controls had higher rates of voicing than of place assimilation (early bilinguals: β=1.93, SE=0.44, z=4.40; p<.0001; native French: β=1.81, SE=0.33, z=5.54; p<.0001), while the late bilinguals showed a non-significant pattern in the opposite direction, with numerically more place than voicing assimilations (β=-0.59, SE=0.32, z=-1.86; p=.06). Furthermore, the late bilinguals had lower voicing assimilation rates than both the early bilinguals (β=-1.15, SE=0.32, z=-3.55; p<.002) and the native French (β=-1.43, SE=0.30, z=-4.78; p<.0001), while there was no difference between the latter two (β=0.29, SE=0.27, z=-1.09; p>.1); conversely place assimilation rates for the late bilinguals were *higher* than for both the early bilinguals (β=1.38, SE=0.44, z=3.12; p<.006) and the native French (β=0.96, SE=0.35, z=2.77; p<.02), while there was again no difference between the latter two (|z|<1).

Finally, the data from the right panel of Figure 1B (application of both rules) were submitted to a model with the fixed factor Group, a covariate for Duration, and random intercepts for Participant and Item. The model revealed no significant effect, but a trend for Duration (β=-36.0, SE=20.1; z=-1.79; $\chi^2(1)$=3.21, p=.07), such that shorter mean durations of segments in the target word corresponded to higher assimilation rates.

Figure 2 shows the rates of voicing assimilation in all phrases presenting the context for this rule (alone or with that for place assimilation), split by type of change, i.e. voicing or devoicing. These data were submitted to a model with fixed factors Group, Voice change, and their interaction, and random intercepts for Participant and Item. The model revealed an effect of Group (late bilinguals: β=-1.04, SE=0.15, z=-7.10; early bilinguals: β=0.18, SE=0.15, z=1.23; native French: β=0.86, SE=0.14; z=6.34; $\chi^2(2)$=62.9, p<.0001), as well as a Group × Voice change interaction (Early:Devoicing: β=0.30, SE=0.11, z=2.59; Late:Devoicing: β=-0.14, SE=0.11, z=-1.32; Native: Devoicing: β=-0.15, SE=0.10, z=-1.55; $\chi^2(2)$=6.79, p<.04).

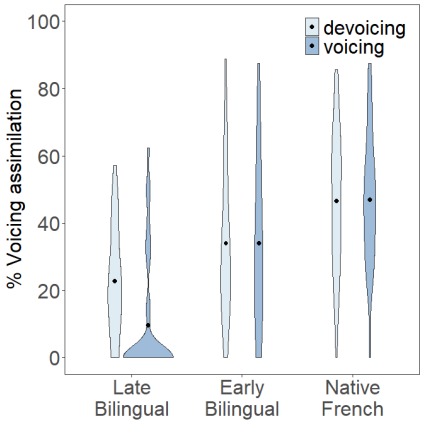

Figure 2: Violin plots of % voicing assimilation as a function of voicing change type. The black dots indicate mean values.

Post-hoc analyses of the Group effect showed overall less voicing assimilation by the late bilinguals than by the other two groups (early bilinguals: β=-1.22, SE=0.26; z=-4.67, p<.0001; native French: β=-1.90, SE=0.24; z=-7.91, p<.0001), and less voicing assimilation by the early bilinguals than by the native French (β=-0.67, SE=0.24; z=-2.78, p<.02). Post-hoc analyses of the interaction showed that in both contexts, late bilinguals showed less voicing assimilation than the other two groups (*devoicing context*: early bilinguals: β=-0.78, SE=0.31; z=-2.56, p<.03; native

French: β=-1.45, SE=0.28; z=-5.17, p<.0001; *voicing context*: early bilinguals: β=-1.66, SE=0.35; z=-4.75, p<.0001; native French: β=-2.34, SE=0.32; z=-7.25, p<.0001), and early bilinguals showed numerically less voicing assimilation than the native French (*devoicing context*: β=-0.66, SE=0.30; z=-2.20, p=.07; *voicing context*: β=-0.69, SE=0.29; z=-2.33, p=.05). Furthermore, while the late bilinguals showed numerically more voicing assimilation in the devoicing than in the voicing context (β=0.78, SE=0.50; z=1.56, p>.1), the early bilinguals and the native French showed very similar assimilation rates (early bilinguals: β=-0.10, SE=0.48; |z|<1; native French: β=-0.11, SE=0.45; |z|<1).

Finally, we examined whether the bilingual participants' assimilation rates were correlated with their global accent. Figure 3 shows the individual rates of voicing assimilation (top) and place assimilation (bottom) (computed over all trials presenting the relevant context and in which the speaker did not produce a schwa) as a function of mean accent rating.

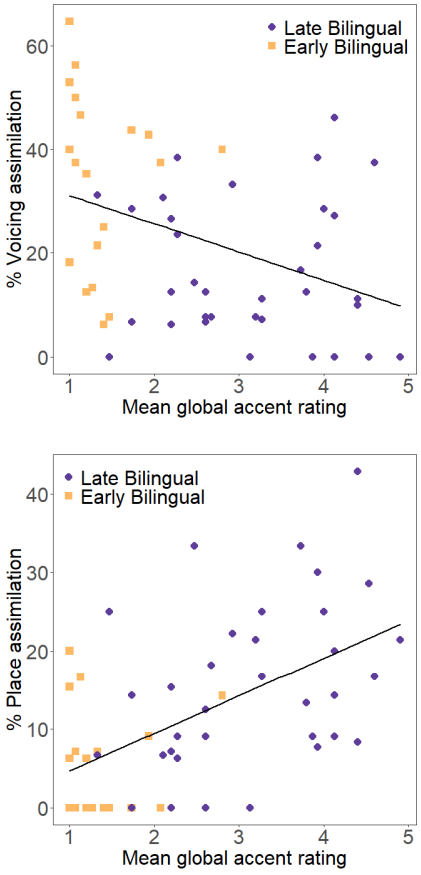

Figure 3: Mean % voicing (top) and place (bottom) assimilation as a function of mean global accent rating (1=native French accent; 5=very strong English accent).

[4] For the curious reader: the mean global accent ratings were indeed higher for the subgroup without assimilations ($mean_{with}$=2.99; $mean_{without}$=2.19; F(51)=6.14, p<.02).

Global accent was correlated negatively with voicing assimilation (F(1,51)=8.93, adjusted R^2=.13, p<.005) and positively with place assimilation (F(1,51)=21.5, adjusted R^2=.28, p<.0001). It should be noted that the part of the recordings that was presented to the native French listeners contained three contexts for voicing assimilation and one for place assimilation. Twenty-eight out of the 53 bilinguals had produced at least one of the three possible voicing assimilations, making it in principle possible that the native listeners were sensitive to this aspect for the purposes of their ratings.[4] Yet, there was only one speaker who had applied place assimilation (a late bilingual, whose foreign accent had a mean rating of 2.47); therefore, the presence vs absence of place assimilation cannot be a factor accounting for differences in the ratings, and the correlation between these ratings and the place assimilation rates is robust.

Discussion

The results can be summarized as follows. First, for phrases with the context for either voicing or place assimilation, the native French controls performed are as expected: they showed large amounts of voicing assimilation and very little place assimilation. As to the late bilinguals, their place assimilation rates were higher than that of the native French controls and their voicing assimilation rates lower. As to the early bilinguals, they did not differ from the native French in terms of place assimilation, but their voicing assimilation rates were intermediate between those of the native French and the late bilinguals. Second, for phrases with the context for both rules, there was no difference between the three groups in the subset of tokens where both rules were applied. In the subset of tokens where only one rule was applied we observed reduced voicing assimilation rates in all three groups. As a result, late bilinguals applied numerically more place than voicing assimilation. The native French and the early bilinguals, by contrast, still showed significantly more voicing than place assimilation, although in both groups this difference was smaller than in the context for either one or the other rule; in addition, the two groups no longer differed in terms of voicing assimilation rates. Third, concerning voicing assimilation, the early bilinguals and the native French showed equal amounts of voicing changes (e.g. /f/ → [v] in *neuf boîtes* 'nine boxes') and devoicing changes (e.g. /z/ → [s] in *douze portes* 'twelve doors'), but the late bilinguals showed a trend towards more devoicing than voicing changes. For both types of change, late bilinguals showed less voicing assimilation than the other two groups, and early bilinguals showed numerically less voicing assimilation than the native French. Finally, the bilinguals' global English accent – as rated by a group of native French listeners – was correlated negatively with voicing assimilation and positively with place assimilation rates.

Overall, we thus found clear evidence of L1-to-L2 transfer in the late bilinguals: They showed both less voicing

assimilation and more place assimilation than the native French controls. In addition, the numerical pattern of voicing vs. devoicing changes in the context of voicing assimilation suggests a potential influence from English, in that contrary to the native French they may apply more devoicing than voicing changes, in accordance with the tendency in English of word-final voiced obstruents to be phonetically voiceless (Davidson, 2016).[5] We also found evidence of transfer in the early bilinguals, but only to the extent that they did not reach native-like amounts of voicing assimilation.

All three groups showed low percentages of double assimilations, but numerically the native French group stood out. This is unexpected since French has no place assimilation, but possibly related to a higher speech rate in this group. That is, there may be more coarticulation in the native French tokens, leading the ASR system to choose the label of the following word-initial consonant, which by design differs from the target consonant in both voicing and place of articulation.

As to the correlations between global accent and assimilation rates in the bilinguals, the one for place assimilation is especially interesting. Not only does this correlation have the largest slope, it is also unaffected by collinearity, since there was only one token of place assimilation in the entire input to the native French raters. Thus, transfer of a native assimilation rule goes hand-in-hand with the presence of an L2-accent.

One peculiar aspect of the results concerns the voicing assimilation rates in the context where it is the only rule that can apply compared to the context where both rules can apply. All three groups show less voicing assimilation in the latter. This difference seems especially puzzling for the native French, for whom in the absence of a French place assimilation rule the two conditions are strictly equivalent. We tentatively argue that the difference is nothing but a consequence of the fact that there are relatively few items overall (i.e., 17 that can undergo voicing assimilation), which are not controlled for a host of factors, including frequency (of the target word itself, of the following word, as well as of the bigram), part of speech, and position within the sentence. It is thus unsurprising that there is a lot of variability in assimilation rates across items. For instance, no native French speaker produced voicing assimilation in *grande couleuvre* 'big grass-snake', but – discarding those who produced a schwa – 83% did so in *village calme* 'quiet village'.

The mean global voicing assimilation rate of the native French speakers (i.e. the percentage of voicing assimilations computed over the dataset including schwa productions) is 41%, which stands out high compared to a previous study of voicing assimilation in French journalistic speech, which reported a rate of 22% (Adda-Decker & Hallé, 2007). This difference is likely due to the more formal style of the corpus in the latter study, which is described as consisting of 'rather clearly articulated speech'. One may also wonder about the residual presence of place assimilation in the native French speakers' productions, with a global mean of 7%. A closer looks at the data shows that they applied this process practically only to nasal targets (e.g. /n/ → [m] in *lune bossue* 'hunchback moon'), not to oral ones (e.g. /t/ → [p] in *planète magique* 'magical planet'). They thus differ from the late bilinguals, who applied the two changes more evenly. (The early bilinguals pattern with the native French in this respect.) More research is necessary to examine a possible tendency of French /n/ to assimilate to a following labial.

To conclude, focusing on English-French bilinguals and native French controls, we analyzed recordings that were made by participants on their cellphones at home. The audio quality was surprisingly good, enabling us to show for the first time robust evidence for L1-to-L2 transfer of optional phonological rules in late and – to a certain extent – early bilinguals. It would be interesting to examine the role of factors such as country of residence and amount of use of L2 for the extent of this transfer. Another individual factor that is worth investigating is inhibitory control; we would expect that bilinguals with higher control are better at suppressing activation of their L2 phonology and hence perform more similarly to L1 speakers. Finally, as bilinguals can show the influence of L2 phonetic categories in their L1 speech (e.g., Sancier & Fowler, 1997; de Leeuw, Schmid & Mennen, 2010), future research could also investigate if there is L2-to-L1 transfer of phonological rules.

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Appendix

Items (two-word phrases presenting the context for one or both assimilation rules):

Voicing: *crabe sacré* (sacred crab), *crabe sera* (crabe will be), *douze portes* (twelve doors), *grosse dame* (large woman), *lac gelé* (frozen lake), *neuf boîtes* (nine boxes), *perruque verte* (green wig), *vague chaude* (warm wave), *village calme* (quiet village)

Place: *Capitaine Bayard* (Captain Bayard), *cette maison* (this house), *devienne pleine* (becomes full), *liquide mauve* (purple liquid), *lune bossue* (hunchback moon), *planète magique* (magical planet), *tornade maudite* (cursed storm), *une pouliche* (a filly horse)

Both: *grande couleuvre* (big grass-snake), *grande patience* (great patience), *grotte glacée* (frozen cave), *limonade parfaite* (perfect lemonade), *petite boîte* (small box), *pirate barbu* (bearded pirate), *salade croustillante* (crisp salad), *squelettes gluants* (slimy skeletons)

[5] Alternatively, such a result may be due to a failure to produce voiced obstruents with the typical French prevoicing. In either case the asymmetry would be due to influence from their native language.

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