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Asymmetry in French speech-in-noise perception: the effects of native dialect and cross-dialectal exposure

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Abstract: Research has shown that speakers' native production patterns can change after living in adulthood in a region where a second dialect (D2) of their native language is spoken, yet relatively little is known about how speech perception changes after postadolescent D2 exposure. This study explores this topic by examining how varying degrees of exposure to Quebec French and Hexagonal French affect comprehension of speech in these dialects. A speech-in-noise perception experiment was conducted among mobile and nonmobile speakers of Quebec and Hexagonal French to test the competing effects of native dialect and D2 exposure on cross-dialectal speech perception. Results show an own-dialect advantage for all groups in their comprehension of speech in noise, though this advantage is smaller for the mobile groups, particularly for the mobile Hexagonal French listeners. An effect of D2 exposure on D2 perception is also revealed for the mobile Hexagonal listeners but not for the Québécois listeners, indicating an asymmetry in cross-dialectal perception. These findings suggest that, while phonological representations for the native dialect remain robust, processing of D2 speech can improve after extended, postadolescent exposure to this dialect. Furthermore, the extent of this adaptation may be modulated by mobile listeners' prior experience with this dialect.

Keywords: speaker mobility; speech-in-noise perception; second dialect acquisition; cross-dialectal exposure; spoken French

1 Introduction

Individuals are remarkably adept at understanding speech despite the enormous amount of variability across accents and listening contexts. For instance, adult listeners are able to adapt to phonetic variation in speech to accurately comprehend accents with which they have little familiarity (e.g., Adank et al. 2009; Bradlow and Bent 2008; Brown et al. 2020) or even no familiarity at all (see Banai and Lavie 2020; Samuel and Kraljic 2009). Nonetheless, the ease and accuracy with which listeners are able to comprehend accented speech is known to vary depending on their experience with a given accent. For example, listeners typically show an advantage in processing speech in a local or native dialect versus in a nonlocal, regional dialect (e.g., Impe et al. 2008; Labov and Ash 1997; Smith et al. 2014; Wright and Souza 2012). Dialect prestige has also been shown to influence speech perception such that listeners are typically better at processing speech in prestigious, standard accents due to their increased exposure to these varieties (e.g., Clopper and Bradlow 2008; Dufour et al. 2007, 2019; Floccia et al. 2006; Sumner and Kataoka 2013; Sumner and Samuel 2009). Such findings align with exemplar-based theories of speech perception which posit that frequent exposure to a particular variety strengthens links between dialectal variants and phonological representations, resulting in easier and more accurate processing of speech in this variety (see Clopper 2014).

One question that remains underexplored, however, is to what extent the perception of accented speech can change across the lifespan. Although limited, existing research on this topic suggests that social and developmental factors can affect the perception of accented speech in adulthood (see Cristia et al. 2012), therefore

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challenging theories that propose limited plasticity in the speech perception system in postadolescence (see Werker and Hensch 2015). Additional evidence for this claim comes from research showing that perceptual adaptation can occur after individuals move in adulthood to a region where a different dialect of their native language is spoken, as part of "second dialect acquisition" (see Nycz 2015; Siegel 2010). However, compared to the body of research on changes to production in second dialect acquisition, research on perceptual change in this context is sparse. Moreover, the few studies that have examined this topic have yielded mixed results: while some studies indicate that long-term, postadolescent exposure to a second dialect (D2) can improve processing of this D2 (Bowie 2000; Scott and Cutler 1984; Voeten 2021; Walker 2018), others have shown little effect of D2 exposure on speech processing (Evans and Iverson 2007; Kunkel et al. 2023; Ziliak 2012). Given the limited research on this aspect of second dialect acquisition, the factors driving and constraining perceptual adaptation in this context remain unclear. Research on perceptual change in second dialect acquisition, together with studies on perceptual attrition among second language speakers (e.g., Ahn et al. 2017; Celata and Cancila 2010; de Leeuw et al. 2023), offers valuable insights for theories of how previously internalized linguistic systems may change across the lifespan (see Sankoff 2018).

This study explores this topic by examining perceptual adaptation among geographically mobile French speakers using a speech-in-noise intelligibility experiment. Assessing listeners' ability to comprehend speech in adverse (vs. quiet) listening conditions not only mirrors often noisy, real-world environments but also introduces greater variability into the perception process, allowing for nuanced effects of speaker- and listener-related factors on speech comprehension to be revealed. Two previous studies have used speech-in-noise experiments to investigate perceptual adaptation in second dialect contexts. In Evans and Iverson (2007), British English university students who relocated from the north of England to the south participated in a speech-in-noise experiment in which they heard sentences produced by both Northern and Southern British English speakers. Although an own-dialect perceptual advantage was found (such that listeners generally showed better comprehension for Northern vs. Southern British English speech), listeners did not show improved comprehension of D2 Southern British English despite their increased exposure to this dialect. More recently, Walker (2018) tested the comprehensibility of American and British English speech in noise among Americans living in the UK, Britons living in the US, and two nonmobile groups of Americans and Britons. Results showed that mobile listeners demonstrated higher overall accuracy in their comprehension of D2 speech in noise compared to the nonmobile listeners. Crucially, however, all groups (both mobile and nonmobile) showed better comprehension accuracy for speech in their first dialect (D1) than in a D2. This suggests that while long-term D2 exposure can lead to improved comprehension of D2 speech, it does not result in a weakened ability to comprehend D1 speech. This finding therefore provides evidence against D1 perceptual attrition in postadolescent second dialect acquisition, thus supporting a view of this process as additive rather than replacive (see Siegel 2010: 66–70).

The current study builds on the work of Walker (2018) by investigating how D2 exposure to Quebec French and Hexagonal French (i.e., the French of continental France) affects cross-dialectal comprehension of speech in these dialects. French presents a particularly interesting context for examining second dialect acquisition given the marked differences in global prestige between Hexagonal and Quebec French. French has traditionally been viewed as a strictly monocentric language, with Hexagonal French (and particularly Parisian French) being considered the sole standard variety throughout the Francophone world (see Oakes 2021). While the second half of the twentieth century saw a shift towards an increased acceptance of a standard Quebec French norm (e.g., Chalier 2019), this variety has still been shown to be evaluated by French speakers as possessing less overt prestige compared to Hexagonal French (e.g., Kircher 2012). This cross-dialectal disparity in prestige is also reflected in the amount of exposure that French speakers receive to Hexagonal and Quebec French transnationally. Not only has standard Hexagonal French (or *français de référence*) traditionally served as the pedagogical target in Quebec schools (see Lebrun 2007), but French media have long shown a relatively strong presence in Quebec (Martineau et al. 2022: 108). In contrast, the presence of Quebec French in France is relatively limited (Mauchand and Pell 2022). This situation of asymmetrical D2 exposure is thus predicted to result in a *perceptual* asymmetry in the intelligibility of Hexagonal and Quebec French among speakers of these dialects. This general prediction is tested by comparing the perceptual capacities of mobile speakers of Hexagonal and Quebec French to nonmobile (i.e., sedentary) speakers of these dialects, thereby assessing the competing influences of D1 background and D2 exposure on cross-dialectal speech comprehension. Building on the findings discussed above, four hypotheses were tested in the following confirmatory analysis:

H1: All listener groups will show an own-dialect advantage in cross-dialectal speech-in-noise comprehension.

H2: Due to asymmetrical cross-national exposure, D1 Québécois listeners will show better comprehension of Hexagonal French speech in noise than D1 French listeners will in their comprehension of Quebec French.

H3: Mobile French and Québécois listeners, having had more direct exposure to D2 speech, will exhibit better comprehension of D2 speech in noise compared to nonmobile listeners of the same D1.

H4: Mobile French listeners will show greater perceptual change than the mobile Québécois listeners, as the latter are likely to have had more exposure to Hexagonal French prior to moving than the French listeners had to Quebec French.

2 Methods

2.1 Participants

Seventy-nine native speakers of either Hexagonal or Quebec French were recruited as participants across four groups (55 women, 23 men, 1 other):
– native Hexagonal French speakers born, raised, and living in France (nonmobile French listeners)
– native Hexagonal French speakers born and raised in France but living in Quebec (mobile French listeners)
– native Quebec French speakers born, raised, and living in Quebec (nonmobile Québécois listeners)
– native Quebec French speakers born and raised in Quebec but living in France (mobile Québécois listeners)

All nonmobile participants reported never having spent more than six months outside their home country, while all mobile participants reported having moved to a D2 region after the age of 18 and having lived in this D2 region for at least one year. Although the mobile French and mobile Québécois participants had similar distributions in age of mobility, the average length of residence in a D2 region among the mobile Québécois listeners (mean = 10.3 years) was more than double that of the mobile French listeners (mean = 4.6 years), as shown in Table 1.

Table 1: Descriptive statistics for participants' demographic information (in years).

	Nonmobile Hexagonal French (*n* = 19)	**Mobile Hexagonal French (*n* = 25)**	**Mobile Quebec French (*n* = 12)**	**Nonmobile Quebec French (*n* = 23)**
Age	Mean = 30.7 SD = 7.2 median = 30.5 Range = 22:47	Mean = 34.8 SD = 8.3 median = 34 Range = 23:57	Mean = 41.3 SD = 12.1 median = 40 Range = 28:67	Mean = 28.6 SD = 7.4 median = 26.5 Range = 22:50
Age of mobility	–	Mean = 30.3 SD = 8.3 median = 28 Range = 18:55	Mean = 31 SD = 7 median = 28 Range = 24:48	–
Length of residence	–	Mean = 4.6 SD = 2.6 median = 4 Range = 2:11	Mean = 10.3 SD = 9.9 median = 12 Range = 1:29	–

2.2 Stimuli

Stimuli came from the French Hearing in Noise Test (HINT), a sentence list based on the BKB British English list (Bench et al. 1979) adapted specifically for use with adult Canadian Francophone populations (Vaillancourt et al. 2005). Sentences in the HINT are highly semantically predictable, normed for intelligibility, are five to seven syllables in length, and contain two to five content words each (i.e., keywords). A subset of 64 HINT sentences was selected for use in this study, with care taken to exclude sentences containing lexical items specific to Quebec French (e.g., *tuque* 'beanie'). All sentences contained 2–4 phonetic contexts differing between Quebec and Hexagonal French. These included contexts of Quebec French features such as the assibilation of /t/ and /d/ before high front vowels (e.g., *fondu* [fɔ̃dzy] 'melted'), the laxing of high vowels in closed syllables (e.g., *vite* [vɪt] 'quickly'), and the diphthongization of long vowels (e.g., *fête* [fa͡ɛt] 'party'; see Reinke and Ostiguy 2016: 41–43, 53–61).

Eight native French speakers (4 Québécois; 4 French) were recruited to record the stimuli for this experiment. Speakers were balanced for gender across the two dialect groups and were all between the ages of 20 and 32 (Quebec French mean = 27 years, Hexagonal French mean = 27.25 years). Recordings were made remotely using the phone application Awesome Voice Recorder X (AVR; Newkline Co. 2022), which has been shown to be a viable option for making high-quality recordings remotely (see Zhang et al. 2021). To maximally ensure consistency across stimuli, speakers recorded in a quiet room using the same settings on AVR (44.1 kHz sampling rate, stereo, M4A file format, 128 kbps) on the same device type (iPhone).

All recorded sentences were converted to mono format and intensity normalized to 72 dB. Pilot testing was conducted to determine the optimal speech-to-noise ratio to avoid ceiling effects in sentence intelligibility (see, e.g., McCloy et al. 2015). Three native Hexagonal French speakers (not otherwise involved in the experiment) provided comprehension accuracy measures for a subset of 40 HINT sentences, consisting of four sets of 10 sentences each mixed at a different speech-to-noise ratio (−4 dB, −5 dB, −6 dB, and −7 dB). A −7 dB speech-to-noise ratio was selected for use as this ratio was found to yield an overall accuracy rate around 50 %, a rate comparable to those in past speech-in-noise studies (e.g., Clopper and Bradlow 2008; Vaughn 2019; Walker 2018).[1] Following Walker (2018), a 900 ms leader of silence was inserted before the onset of each sentence using a Praat script from Daidone (2018). Next, another Praat script (Winn 2023) was used to generate a 3,100 ms span of speech-shaped noise at an intensity of 79 dB, derived from the long-term average spectral properties of all sentences. This noise was then mixed uniformly with each sentence and, finally, a 500 ms leader of silence was added before the speech-shaped noise.

2.3 Procedure

This experiment was conducted remotely on Gorilla (Anwyl-Irvine et al. 2020). Although online testing necessarily introduces more variation into the data compared to in-person testing, recent research has shown the two settings to yield comparable results in speech-in-noise experiments (e.g., Bent et al. 2023). Nonetheless, to mitigate noise in the data, all participants were instructed to complete the experiment in a quiet room using headphones or earphones. Participants were told that the goal of this study was to assess their ability to understand speech in poor listening conditions, and that they would hear sentences produced by native French speakers.

After completing four practice rounds, participants proceeded to the main part of the experiment in which they heard each of the 64 sentences in individual trials. Although all participants heard the same unique sentences produced by the same speakers, each participant heard the sentences in a different randomized order. In each trial, participants were shown a fixation cross in the center of their screen while hearing the sentence embedded in noise, followed by a prompt to repeat aloud what they had heard. Verbal responses were collected as they require less time and cognitive effort than typed responses (see Baese-Berk et al. 2023).[2] Participants were

1 This speech-to-noise ratio is lower (i.e., noisier) than what has been used in past speech-in-noise experiments (e.g., −4 dB in Walker 2018), perhaps indicating that the French HINT sentences are inherently more comprehensible than similar English-language sentences sets.

2 See Baese-Berk et al. (2023: 70–71) for a discussion of potential disadvantages arising from the analysis of verbal responses in speech-in-noise experiments.

instructed to repeat any parts of the sentence that they understood and to say *quelque chose* 'something' for words or sentences that were incomprehensible. Verbal responses were recorded using the Audio Recording zone in Gorilla. After each recording, participants clicked a button to proceed to the next trial.

2.4 Analyses

After excluding recordings that did not contain speech (n = 126), participants' responses (n = 4,930) were manually transcribed and scored for accuracy using an R script adapted from a previous script written by Abby Walker. An accuracy rate (calculated as a proportion out of 1) was derived for each sentence based on the number of predetermined keywords correctly repeated relative to the total number of keywords. Keywords included all content words (nouns, lexical verbs, adjectives, adverbs, and prepositions)[3] and excluded function words (articles, pronouns, conjunctions, auxiliary verbs). Recorded words that showed homophony with target keywords, as determined by the surrounding grammatical and semantic context, were scored as correct. These included singular/plural alternations (e.g., *cochon* [kɔʃɔ̃] 'pig' and *cochons* [kɔʃɔ̃] 'pigs') and verbs with homophonous inflectional variations (e.g., *trouves* [tʁuv] 'find (2nd person singular)' and *trouvent* [tʁuv] 'find (3rd person plural)'). Two sentences and four participants with accuracy scores falling more than 2 standard deviations outside their respective group means were excluded from the raw data, leaving 4,536 sentences for further analysis. Because the data were highly skewed due to a prevalence of sentences with a proportional accuracy rate of either 0 or 1, data were centered to improve their normality. Following Walker (2018), accuracy scores were centered twice: first on mean accuracy per sentence (to normalize for differences in intelligibility across sentences) and then again on mean accuracy per participant (to account for variance in accuracy across participants), with the first centered score serving as input for the second.

To draw inferences about the magnitude and direction of dialect effects on listeners' comprehension accuracy, a Bayesian linear mixed-effects regression model was fit to the data using the brms package (Bürkner 2017) in R Studio (R Core Team 2024).[4] This model included the twice-centered accuracy rate as the outcome variable and fixed effects for D1 (Hexagonal vs. Quebec French), mobility (nonmobile vs. mobile), and speaker dialect (Hexagonal vs. Quebec French), along with two- and three-way interactions between these predictors. For ease of interpretation, all fixed effects were contrast coded as −0.5 and 0.5. Because variation across sentences and participants was already accounted for in the centering process, the random effects structure for this model included only a by-participant random intercept and slope for speaker dialect:

$$\text{brm}\left(\text{centered accuracy} \sim \text{D1} \times \text{mobility} \times \text{speaker dialect} + \left(1 + \text{speaker dialect} \,\middle|\, \text{participant}\right)\right)$$

Weakly informative priors were specified for this model, with Normal (0, 1) priors assigned to the slopes of fixed effects, the model intercept, and the standard deviation of random effects. The regression model was estimated using Markov chain Monte Carlo sampling with four chains, each consisting of 8,000 iterations. Half of these iterations were discarded as warm-ups, leaving 16,000 posterior samples for inference. All R-hat values were equal to 1.00, indicating successful convergence of all effects (Vasishth et al. 2018). The stimuli, data, and analysis script for this study are available at the following OSF repository: https://osf.io/z8khg/?view_only=931370800d4e4afd9b6d553cdca0bf8d.

3 Results

Figure 1 shows the centered accuracy results for each participant group by speaker dialect. In this plot, the closer a group's bars are to each other on either side of the zero point on the y-axis, the more similar their comprehension

3 Instances of *de* found in prepositional phrases (e.g., *pleine de linge* 'full of laundry') were included as keywords, whereas those in partitive constructions (e.g., *du chocolat chaud* '(some) hot chocolate') were not.

4 See Vasishth et al. (2018) for a discussion of the pros and cons of Bayesian versus frequentist statistical analyses.

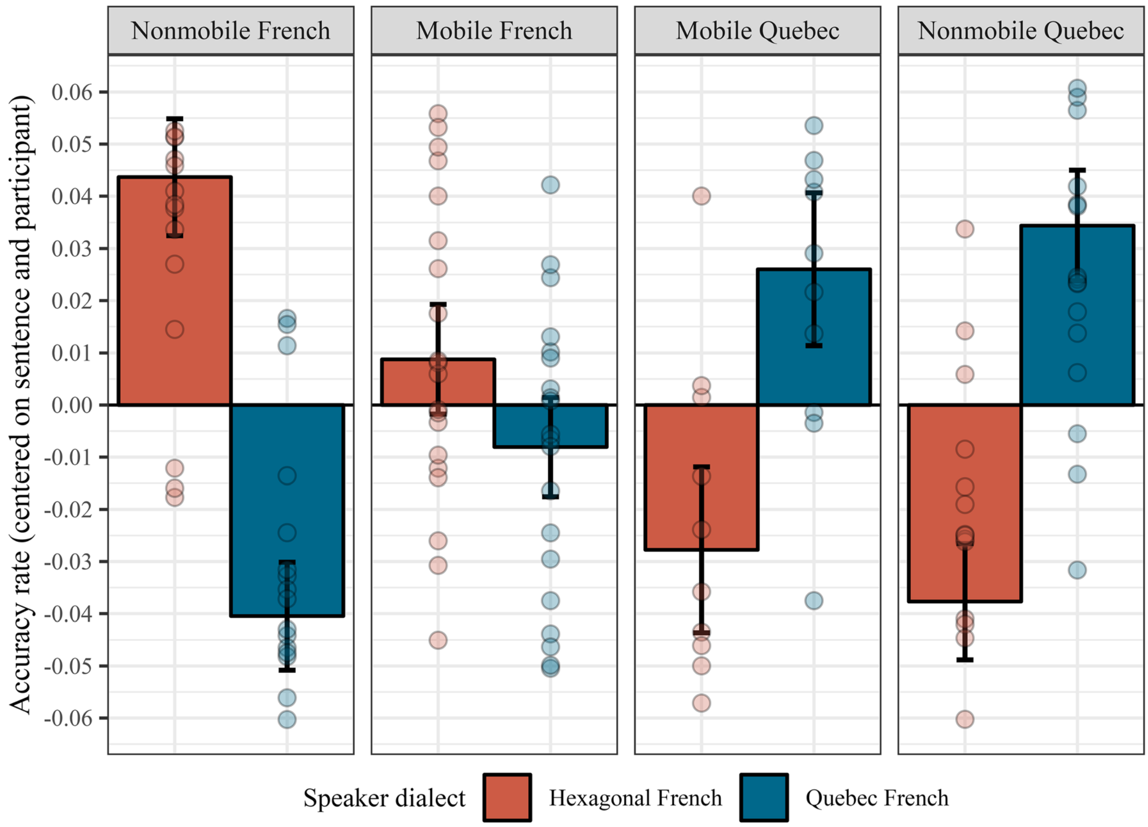

Figure 1: Accuracy rates by listener group and speaker accent, centered on the mean proportion of correct keywords per sentence and per participant. Jitter points represent individual participant means per speaker dialect, with error bars indicating standard error.

accuracy for Hexagonal versus Quebec speech in noise. Results show that all groups exhibited a D1 advantage in perception, although the extent of this advantage varies across groups. Comparing across the D1 French groups (i.e., the nonmobile and mobile French participants), a notably smaller D1 advantage is observed for the mobile French listeners than for the nonmobile French listeners. A similar pattern is found between the D1 Québécois groups, such that the mobile Quebec French listeners show a relatively smaller D1 advantage compared to the nonmobile Quebec French listeners. However, the difference in magnitude between the D1 French groups is larger than that between the D1 Québécois groups, indicating that the effect of mobility on participants' perception varies by D1. Lastly, comparing the two nonmobile groups, the nonmobile Québécois listeners show a slightly smaller D1 advantage relative to the nonmobile French listeners. Together, these results point to an interaction between D1 and mobility in participants' cross-dialectal speech comprehension.

Table 2 shows the results of the Bayesian linear regression model conducted to statistically assess this interaction. First, regarding the effect of native dialect, a two-way interaction was found between D1 and speaker dialect. The coefficient for this interaction (estimate = 0.11) had a 95 % credible interval (CI) which did not overlap

Table 2: Results from interaction terms in the Bayesian linear regression model.

Interaction term	Estimate	Estimated error	95 % Credible interval (CI)
D1: Speaker dialect	0.11	0.02	[0.08, 0.15]
D1: Mobility	−0.00	0.02	[−0.03, 0.03]
Mobility: Speaker dialect	−0.02	0.02	[−0.06, 0.01]
D1: Mobility: Speaker dialect	−0.09	0.04	[−0.16, −0.01]

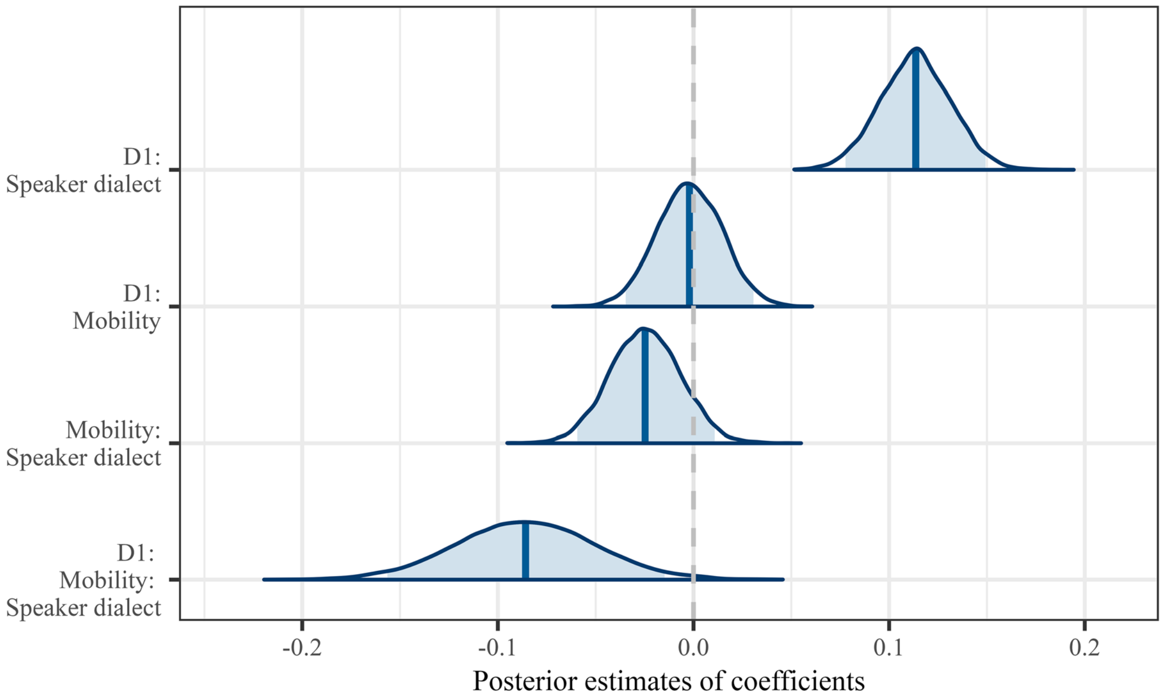

Figure 2: Posterior distributions from the linear regression model for interactions between D1, mobility, and speaker dialect. The light blue areas show the 95 % CI and the dark blue vertical bars show the median of the posterior distribution for each parameter in the model.

with zero ([0.08, 0.15]), indicating a meaningful effect of D1 on the perception of Quebec French versus Hexagonal French speech in noise. In contrast, no statistical evidence was found for an effect of mobility in interaction with D1 (estimate = –0.00, 95 % CI: [–0.03, 0.03]) nor with speaker dialect (estimate = –0.02, 95 % CI: [–0.06, 0.01]). However, a meaningful three-way interaction between D1, mobility, and speaker dialect was observed (estimate = –0.09, 95 % CI: [–0.16, –0.01]), suggesting the combined influence of these factors to account for variance in perceptual accuracy across participant groups. Figure 2 visualizes the posterior distributions of these interaction terms.

To further investigate the effects within this three-way interaction, two post hoc pairwise comparisons were conducted using the emmeans package in R (Lenth 2023). The first comparison estimated the difference in comprehension accuracy of Quebec versus Hexagonal French speech in noise for each participant group. Results from this analysis (shown in Table 3) revealed that, across all groups, only the mobile French listeners did not show a meaningful difference in accuracy between Quebec and Hexagonal French (estimate = –0.016, 95 % CI: [–0.047, 0.012]), thus aligning with the small D1 advantage observed for this group in Figure 1.

The second post hoc comparison estimated the difference in comprehension accuracy across the four participant groups for each speaker dialect separately. As shown in Table 4, a meaningful difference was found between the nonmobile and mobile French participants in their perception of both Hexagonal French (estimate = 0.034, 95 % CI: [0.004, 0.066]) and Quebec French speech in noise (estimate = –0.032, 95 % CI:

Table 3: Results from the first pairwise comparison. Model syntax: emmeans(model, ~ speaker dialect | D1 × mobility).

Pairwise comparison	Estimate	Lower HPD	Upper HPD
Nonmobile French	–0.084	–0.117	–0.050
Mobile French	–0.016	–0.047	0.012
Mobile Québécois	0.053	0.010	0.098
Nonmobile Québécois	0.072	0.042	0.103

Table 4: Results from the second pairwise comparison. Model syntax: emmeans(model, ~ D1 × mobility | speaker dialect).

Speaker dialect: Hexagonal French			
Pairwise comparison	**Estimate**	**Lower HPD**	**Upper HPD**
Nonmobile Québécois–nonmobile French	−0.081	−0.113	−0.049
Nonmobile Québécois–mobile Québécois	−0.009	−0.047	0.028
Nonmobile Québécois–mobile French	−0.046	−0.075	−0.015
Nonmobile French–mobile Québécois	0.064	0.030	0.099
Nonmobile French–mobile French	0.034	0.004	0.066
Mobile Québécois–mobile French	−0.036	−0.074	−0.000
Speaker dialect: Quebec French			
Pairwise comparison	**Estimate**	**Lower HPD**	**Upper HPD**
Nonmobile Québécois–nonmobile French	0.075	0.043	0.105
Nonmobile Québécois–mobile Québécois	0.008	−0.028	0.044
Nonmobile Québécois–mobile French	0.042	0.014	0.072
Nonmobile French–mobile Québécois	−0.066	−0.104	−0.028
Nonmobile French–mobile French	−0.032	−0.063	−0.003
Mobile Québécois–mobile French	0.034	−0.001	0.070

[−0.063, −0.003]). However, no statistical difference was found between the nonmobile and mobile Québécois groups in their perception of Hexagonal French (estimate = −0.009, 95 % CI: [−0.047, 0.028]) or Quebec French speech in noise (estimate = 0.008, 95 % CI: [−0.028, 0.044]).

Comparing across listeners of different D1s, the nonmobile French group was found to differ in perception from the nonmobile and mobile Québécois groups across both speaker dialects. Similarly, the nonmobile Québécois group differed from the nonmobile and mobile French groups for both speaker dialects. When comparing the two mobile groups, the mobile French and mobile Québécois groups differed in their perception of Hexagonal French speech in noise. In contrast, no meaningful difference was found between these groups in their perception of Quebec French speech in noise (estimate = 0.034, 95 % CI: [−0.001, 0.070]), suggesting that these groups had relatively similar comprehension accuracy for this dialect.

4 Discussion and conclusions

This study aimed to examine how French speakers' D1 background and D2 exposure influence their cross-dialectal perception of Quebec and Hexagonal French. The overarching hypothesis of this investigation was that a perceptual asymmetry would emerge in listeners' ability to comprehend these dialects in adverse listening conditions, reflecting the asymmetrical presence and prestige of these dialects cross-nationally. Consistent with Hypothesis 1, all listener groups demonstrated an own-dialect advantage in their comprehension of cross-dialectal speech in noise, such that D1 Québécois listeners were better at comprehending Quebec French speech in noise and D1 French listeners were better at comprehending Hexagonal French speech. This finding aligns with numerous past studies showing listeners to possess processing benefits in the comprehension of D1 speech (e.g., Clopper and Wagner 2019; Evans and Iverson 2007; Smith et al. 2014; Walker 2018). In keeping with Walker (2018), these results also indicate that mobile listeners maintain a D1 advantage in perception even after extensive exposure to a D2. Theoretically, these findings support the idea that acquiring a D1 involves the formation of dense and robustly encoded phonological representations for this dialect (see Clopper 2014).

Hypothesis 2 predicted that a perceptual asymmetry would also extend to listeners' perception of D2 speech. Specifically, it was predicted that D1 Québécois listeners would show better comprehension of Hexagonal French speech in noise than D1 French listeners would in their comprehension of Quebec French, given the asymmetrical, transnational prestige and prominence of Hexagonal French. This would be reflected in D1 Québécois listeners demonstrating relatively high comprehension accuracy for Hexagonal French speech in noise. Overall, however, this hypothesis was not upheld. While the nonmobile Québécois group showed slightly less of a D1 advantage (i.e., more similarity in their processing of Quebec vs. Hexagonal French) compared to the nonmobile French group, both nonmobile groups showed relatively strong perceptual advantages for D1 speech and disadvantages for D2 speech. A possible explanation for this result is linked to the contemporary view of Quebec French and Hexagonal French as possessing separate, endonormative French standards (see Pöll 2017). As mentioned in the introduction, there has been growing acceptance of a spoken Quebec French norm since the 1970s, leading to a decline in the presence of Hexagonal French norms in certain contexts, such as in broadcast media (e.g., Chalier 2019). Moreover, while a spoken norm resembling Hexagonal French (i.e., *le français international*) still holds some influence in formal and institutional spheres (see Bigot and Papen 2013), Quebec French speakers are undoubtedly exposed to their native variety primarily in vernacular contexts. Thus, while the prestige of Hexagonal French may make it more prevalent in Quebec compared to the presence of Quebec French in France, its restriction to particular linguistic domains may mean that Quebec French speakers do not have strong representations for this variety. As most studies on cross-dialectal intelligibility have focused on regional varieties within a nation possessing a single standard variety (e.g., Clopper and Bradlow 2008; Dufour et al. 2007, 2019; Sumner and Samuel 2009), future research on intelligibility across transnational varieties with distinct norms (e.g., Walker 2018) will be crucial for understanding the interplay between global prestige and cross-dialectal exposure.

Regarding the effect of D2 exposure on speech-in-noise perception, Hypothesis 3 posited that mobile listeners would show more accurate comprehension of D2 speech in noise compared to nonmobile listeners of the same D1. This hypothesis was only partially supported: while both mobile listener groups showed smaller differences in their perceptual accuracy of D1 versus D2 speech compared to the nonmobile listeners, only the mobile French group differed statistically from their corresponding nonmobile group. The lack of statistical difference between the mobile French and mobile Québécois listeners in their comprehension of Quebec French speech further suggests a facilitatory effect of D2 exposure on perception among the mobile French group. This result crucially supports the claim that long-term ambient exposure to a D2 can lead to improved perception of this dialect (Bowie 2000; Scott and Cutler 1984; Voeten 2021; Walker 2018). More generally, this finding provides evidence that the speech perception system remains malleable even into adulthood (Cristia et al. 2012). Nevertheless, the fact that the mobile French listeners still showed a perceptual advantage for their D1, albeit a small one, suggests that long-term ambient D2 exposure does not result in native-like abilities to process a D2. Rather, these findings suggest that D2 exposure results in "intermediate" perceptual capacities between those of native D1 and D2 speakers (see Siegel 2010: 57–59). Thus, while individuals with extensive D2 input can become "fluent listeners" of a D2, developing perceptual abilities superior to those without comparable D2 input (see Sumner and Samuel 2009), their ability to process this D2 is still likely to fall short of that of native D2 speakers. For this reason, the notion that second dialect acquisition involves structural change to the native phonology, as proposed by studies framing this as a replacive rather than an additive process (e.g., Chambers 1992; Payne 1976; Trudgill 1986), seems unlikely. Moreover, the lack of evidence for a decline in mobile listeners' D1 speech comprehension runs counter to studies showing postadolescent L1 perceptual attrition in immersive second language contexts (e.g., Celata and Cancila 2010), potentially suggesting that second dialect acquisition and second language acquisition engender distinct types of changes to the native phonology.

Importantly, the observed effect of mobility on cross-dialectal comprehension was found to vary by D1 between the mobile and nonmobile groups. As predicted by Hypothesis 4, a greater difference in comprehension accuracy was found between the D1 French groups than between the D1 Québécois groups. This result is somewhat surprising considering that the length of residence of the mobile Québécois listeners was, on average, twice as long as that of the mobile French listeners (see Table 1). A possible explanation for this finding may again relate to the asymmetrical D2 exposure between the Québécois and French groups. Mobile French listeners likely had less exposure to Quebec French prior to moving abroad than mobile Québécois listeners had to Hexagonal French. As a result, representations for Quebec French may have been less robust than those that mobile Québécois listeners had for Hexagonal French. Compared to the mobile Québécois listeners, the mobile French listeners may have therefore undergone more extensive attunement of their D2 perceptual capacities to accurately comprehend Quebec French speech. This suggests that the amount of D2 exposure listeners receive in their D1 region may modulate the degree to which their perception changes after moving to a D2 region. Testing this hypothesis among mobile speakers of other languages that show asymmetries in mutual intelligibility across varieties (see Gooskens and van Heuven 2021) would help verify this claim.

In conclusion, this study has shown that, while listeners' ability to comprehend their native dialect remains robust across the lifespan, some change can occur to the perceptual system due to long-term, ambient D2 exposure in adulthood. Furthermore, the extent of such change in second dialect acquisition may be influenced by the global presence and prestige of a dialect and, consequently, by listeners' stored representations for this dialect. This study underscores the need for further research on perceptual change in second dialect acquisition to better understand the nature of individual linguistic change across the lifespan.

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Appendix

Subset of 64 French HINT sentences included in speech-in-noise experiment (from Vaillancourt et al. 2005). Non-keywords are shown in parentheses. "Audio file" refers to the unique identifier accompanying each stimulus in the OSF repository.

Speaker	Audio file	Sentence	Translation
QF1	00007	*(Ce) musicien joue (du) piano*	This musician plays the piano
QF1	00010	*(Cette) histoire (est) triste*	This story is sad
QF1	00014	*(Elle) écoute (la) radio*	She listens to the radio
QF1	00042	*(Il) (ne) faut (pas) manger vite*	You must not eat quickly
QF1	00045	*(Il) voyage dans l'espace*	He travels in space
QF1	00082	*(Le) bûcheron coupe (du) bois*	The lumberjack cuts wood
QF1	00085	*(Le) chien dormait dehors*	The dog was sleeping outside
QF1	00113	*(Le) chocolat (a) fondu*	The chocolate melted
QF2	00008	*(Cette) dame aime (se) faire bronzer*	The woman likes to tan
QF2	00017	*(Elle) nage dans (la) rivière*	She swims in the river
QF2	00037	*(Il) mange (sa) soupe*	He eats his soup
QF2	00042	*(Il) vit dans (la) jungle*	He lives in the jungle
QF2	00051	*(Je) bois (du) chocolat chaud*	I drink hot chocolate
QF2	00072	*(La) mère berce (son) enfant*	The mother rocks her child
QF2	00102	*(Ma) mère range (la) vaisselle*	My mother puts away the dishes
QF2	00116	*(Son) frère ramasse (les) poubelles*	My brother collects the garbage
QF3	00008	*(Ces) champignons (sont) bruns*	The mushrooms are brown
QF3	00023	*(Elle) prend (un) bain chaud*	She is taking a warm bath
QF3	00047	*(Ils) bâtissent (une) école*	They are building a school
QF3	00054	*(Je) vais m'asseoir sur (ce) banc*	I am going to sit on this bench
QF3	00059	*L'écureuil grimpe dans l'arbre*	The squirrel is climbing the tree
QF3	00080	*(La) valise (est) pleine de linge*	The suitcase is full of laundry
QF3	00110	*(Notre) fille (se) marie demain*	Our daughter is getting married tomorrow
QF3	00120	*Tout (le) monde (est) en classe*	Every one is in class
QF4	00011	*(Les) choux poussent dans (le) jardin*	The cabbages grow in the garden
QF4	00018	*(Le) lapin ronge (une) carotte*	The rabbit gnaws on a carrot
QF4	00030	*(Elle) saute sur (le) trampoline*	She is jumping on the trampoline
QF4	00032	*(Il) (est) parti (à) (la) pêche*	He went fishing
QF4	00039	*L'éléphant (a) (une) longue trompe*	The elephant has a long trunk

(continued)

Speaker	Audio file	Sentence	Translation
QF4	00048	*(Ils) (ont) trouvé (un) sapin*	They found a fir tree
QF4	00057	*(Sa) mère fait (une) tarte*	Her mother is making a tart
QF4	00119	*(Le) fromage sent mauvais*	The cheese smells bad
HF1	00019	*(Elle) prend soin de (sa) mère*	She takes care of her mother
HF1	00034	*(Il) (est) professeur d'histoire*	He is a history professor
HF1	00038	*(Il) mange (un) morceau de tarte*	He eats a piece of tart
HF1	00055	*(Le) marchand vend (des) bonbons*	The shopkeeper sells candy
HF1	00074	*(Elle) pointe du doigt*	She is pointing her finger
HF1	00093	*(Le) petit garçon chante bien*	The little boy sings well
HF1	00099	*(Les) oiseaux chantent dans l'arbre*	The birds sing in the tree
HF1	00119	*(Tu) (as) caché (mon) jouet*	You hid my toy
HF2	00005	*(Ce) garçon pédale très vite*	The boy pedals very quickly
HF2	00037	*(J'ai) fait cuire (du) poisson*	I cooked fish
HF2	00069	*(La) cuisine (est) grande*	The kitchen is big
HF2	00070	*(La) fenêtre (est) ouverte*	The window is open
HF2	00079	*(La) vache mange (du) foin*	The cow is eating hay
HF2	00100	*(Les) livres (sont) tous bien rangés*	The books are neatly arranged
HF2	00105	*Maman (a) fait cuire (une) dinde*	Mom cooked a turkey
HF2	00112	*Papa tirait (le) chariot*	Daddy pulled the wagon
HF3	00015	*(Il) (a) compté jusqu'à dix*	He counted to ten
HF3	00017	*(La) petite fille cherche (sa) bague*	The little girl is looking for her ring
HF3	00026	*(Ma) tante fait (de) (la) couture*	My aunt sews
HF3	00035	*(Il) mange avec (une) fourchette*	He eats with a fork
HF3	00043	*(Les) tulipes (sont) jolies*	The tulips are pretty
HF3	00091	*(La) salle (était) vide*	The room was empty
HF3	00092	*Tous (les) chats (sont) gris*	All the cats are gray
HF3	00117	*(Le) cochon joue dans (la) boue*	The pig is playing in the mud
HF4	00001	*(C'est) (une) perle rare*	It is a rare pearl
HF4	00003	*(Ce) chemin mène (au) village*	This path leads to the village
HF4	00056	*L'oiseau (est) sur (une) branche*	The bird is on a branch
HF4	00118	*(Le) chèvre mangeait (de) l'herbe*	The goat ate grass
HF4	00089	*(Le) facteur apporte (une) lettre*	The mailman delivers a letter
HF4	00109	*L'argent (est) à (la) banque*	The money is at the bank
HF4	00115	*(Ses) yeux sont remplis de larmes*	His eyes are filled with tears
HF4	00118	*Tous (les) poissons vivent dans l'eau*	All fish live in water

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