The role of experience in L2 contrast perception: Perceptual confusability of French vowels by French L2 listeners

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Motivation

- Hall & Hume (2013) tested vowel confusability among native speakers of Parisian French
  - Would vowel confusability patterns be consistent with known phonological patterns of French?
    - For example, allophonic sounds should be more confusable than contrastive ones
- Results from perception experiment found confusability to reflect phonological patterns well
  - The interchangeable front rounded mid-vowels had the highest degree of confusability
Present research

- How would L2 French listeners perform in such a confusability experiment?
- Already have their own difficulties in perception
  - Gottfried, 1984; Levy & Strange, 2008
- In what ways is the confusability of French vowels by L2 listeners similar or different to that of native speakers (NS)?
- What is the role of experience in the extent to which an L2 listener can become more native-like in perception?
Methods

- At its core, a vowel identification task
- Fairly faithful to Hall & Hume's (2013) experiment with native speakers
- Modified in consideration of L2 participants
- Stimuli come from a native speaker of a different variety of French: Quebec French (vs. H&H's European French)
Stimuli

- French pseudowords in the form \([aC_1VC_2a]\)
- Consonants were from the set of \([b], [d], [g]\)
  - Always two distinct consonants from the set
- Middle vowel was one of fifteen French vowels \([u \ y \ e \ ɛ \ ɔ \ o \ ɔ̃ \ i \ ə \ a \ ë \ ã \ œ̃ \ ũ\]) or absent completely*
  - \([ə]\) refers to the vowel referred to as French schwa or e-muet
  - Same vowels as H&H, with the addition of the fourth nasal vowel \([œ̃]\)
- *Test also included stimuli with the English rhoticized schwa \([ɚ]\) in the V position, results not discussed here
• Nasal vowels not shown
• [œ] is not as centralized as depicted
  ○ In the vicinity of [ø] and [œ]
• Corresponding pairs of low-mid and high-mid vowels prone to complementary distribution (high-mid in open syllable, low-mid in closed), but not absolute
Stimuli

- Resulted in 102 unique pseudowords
  - 6 consonant environments x 17 vowels
- Recorded by a native female speaker of Quebec French
  - Given examples of each vowel from real words (also recorded)
    - E.g., *nid* ([ni], 'nest') for [i] pseudowords
  - Pseudowords written in orthographic French at the end of a carrier phrase:
    - *Il voit cet abiga* ('He sees this *abiga*')
- Other examples: *abida, adouga, aguéda, adba*
Listeners presented a permanent grid of 15 model French words written in plain text.

For each pseudoword, listeners clicked the model word containing the vowel sound that most closely matched the middle vowel of the pseudoword.

- If they believed there was no vowel in that position, they were told to click a box labeled 'XX'.

Example: For the pseudoword *abiga* (V = [i]), the intended response would be *nid* ([ni])
<table>
<thead>
<tr>
<th>nous</th>
<th>nu</th>
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<th>lait</th>
<th>beau</th>
<th>sotte</th>
<th>deux</th>
<th>œuf</th>
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<tbody>
<tr>
<td>nid</td>
<td>ne</td>
<td>ma</td>
<td>bain</td>
<td>brun</td>
<td>bon</td>
<td>blanc</td>
<td>XX</td>
</tr>
</tbody>
</table>
Procedure

- **Familiarization activities**
  - Participants listened to the speaker produce all of the model words, could listen multiple times
    - Encouraged but not forced to repeat the word aloud
  - Practice activity with the grid: listened to model words and matched them to the grid
    - Had to correctly identify all 15 model words twice before moving on to test phase

- **Test phase**
  - Two blocks of the 102 pseudowords = 204 tokens per listener
    - Randomized order
    - Self-paced
Participants

- 25 French L2 listeners, all native speakers of American English
  - 22 F, 3 M
  - Mean age = 23 years
  - Most university students or recent graduates

- Self-rated proficiency and description of French experience
  - Beginner (n = 1)
  - Early intermediate (n = 3)
  - Late intermediate (n = 11)
  - Advanced (n = 9)
  - Near-native (n = 1)

- Slightly over half had studied abroad in France
  - None noted any specific experience with Quebec French

- Ten participants reported having taken a course in French phonetics or pronunciation
## Overall Results: Confusion Matrix

Confusion matrix of all participants’ responses in each vowel category, expressed as a percentage for all tokens of a given vowel stimulus. Each row adds up to 100%. The bolded cells show the percentage of responses matching the intended response for each category.

| Intended Response | [u]  | [y]  | [e]  | [ε]  | [ɔ]  | [o]  | [œ]  | [i]  | [ə]  | [a]  | [ɛ]  | [œ]  | [ɔ]  | [ā]  | XX  |
|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| [u]               | 66.6 | 19.4 | 1.3  | 7.6  | 1.7  | 1    | 0.4  | 2    | 1    | 1    | 1    | 1    | 1    | 1    | 1   |
| [y]               | 10.1 | 81.6 | 0.3  | 0.4  | 5    | 0.7  | 0.3  | 1.7  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3 |
| [e]               | 72.8 | 20.8 | 0.6  | 2.1  | 2    | 0.3  | 1.3  | 0.3  | 1.3  | 0.3  | 1.3  | 0.3  | 1.3  | 0.3  | 0.3 |
| [ɛ]               | 66.8 | 30.2 | 1.9  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7 |
| [ɔ]               | 0.3  | 1.3  | 0.3  | 0.7  | 12.5 | 35.7 | 12.2 | 5.2  | 20.6 | 2    | 3.5  | 4.9  | 0.7  | 0.7  | 0.7 |
| [o]               | 1    | 2    | 10   | 67.1 | 3.9  | 1    | 1.3  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7 |
| [œ]               | 5.6  | 4.2  | 2    | 3    | 33.7 | 15.5 | 26.1 | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7 |
| [œ]               | 4.3  | 4    | 0.3  | 0.7  | 1    | 3.3  | 26.9 | 15.3 | 33.3 | 0.3  | 0.3  | 5.6  | 1    | 3.6  | 1   |
| [i]               | 0.3  | 99.3 | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3 |
| [ə]               | 1    | 4.6  | 1.7  | 0.6  | 2    | 2    | 24.6 | 15.2 | 40.9 | 2    | 0.7  | 2    | 0.7  | 0.7  | 1   |
| [a]               | 0.4  | 3.4  | 3.2  | 0.4  | 1    | 5.7  | 75.1 | 4.6  | 0.4  | 3.4  | 2.4  | 0.4  | 3.4  | 2.4  | 0.4 |
| [ɛ]               | 0.3  | 9    | 10.8 | 0.4  | 1.7  | 1.4  | 17.1 | 75.1 | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7  | 0.7 |
| [œ]               | 0.3  | 1.3  | 2    | 3.9  | 1    | 3.6  | 7.5  | 4.6  | 2.7  | 11.3 | 38.8 | 11.6 | 3.7  | 3.7  | 3.7 |
| [œ]               | 0.3  | 2    | 2.1  | 0.3  | 0.3  | 0.3  | 2.7  | 77.5 | 14.4 | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3 |
| [œ]               | 2    | 2.3  | 1.4  | 0.4  | 4.1  | 4.9  | 12.9 | 40.2 | 30.9 | 1    | 30.9 | 1    | 30.9 | 1    | 30.9|
| [œ]               | 1    | 0.3  | 1    | 5    | 1.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3  | 0.3 |
Overall Trends

- Overall accuracy: 56%
  - vs. 73% for H&H native speakers (NS)
  - Responses by L2 listeners generally include a wider set of vowels

- Similarities with native speakers
  - Ceiling performance for [i]
    - 99.3% accuracy for L2, 100% for NS
  - High accuracy for [y]
    - 81.6% accuracy for L2, 99% for NS
  - But misidentification of [u] as [y]
    - 19.4% of [u] tokens identified as [y] for L2, 13% for NS
Results: Same Confusions?

- NS were the least accurate with set of mid-front rounded vowels [œ], [ø], [ɘ]
  - 25%, 27%, and 37% accuracy respectively
  - Incorrect responses distributed between other two vowels
- L2 also inaccurate with these vowels
  - 15.3%, 33.7%, and 40.9% accuracy respectively
  - Incorrect responses strongly favored other two vowels in the set, but almost all choices selected for all three vowels
Results: Same Confusions?

- But: L2 were least accurate with vowel [ɔ]
  - 12.5% accuracy vs. 52% for NS (worst after mid-front rounded)
  - Identified by L2 as [o] (35.7%), [ə] (20.6%), [ø] (12.2%)
  - Identified by NS largely as [ɔ] (32%)

- No other major confusions among NS
  - All other vowels above 70% accuracy
  - Symmetric confusion between [e]-[ɛ]
    - [e] with 71% accuracy, identified as [ɛ] for 27% of tokens
    - [ɛ] with 73% accuracy, identified as [e] for 23% of tokens

- Many more confusions among L2
Results: L2 Difficulties

- Overwhelming tendency to identify low-mid vowels as high-mid
  - [ɛ] with 30.2% accuracy, identified as [e] for 66.8% of tokens
  - [œ] with 15.3% accuracy, identified as [ø] for 26.9.7% of tokens
  - [ɔ] with 12.5% accuracy, identified as [ø] for 35.7% of tokens

- Patterned (mostly) similarly to NS for identification of high-mid vowels
  - [e] with 72.8% accuracy, identified as [ɛ] for 20.8% of tokens
  - [o] with 67.1% accuracy, identified as [ɔ] for 10% of tokens
    - L2 also identified [ɔ] as [ɔ̃] for 12% of tokens, NS did not at all
  - [ø] with 33.7% accuracy, confusions with [ø] and [ɛ]
Results: L2 Difficulties

- Confusions amongst nasal vowels
  - Unlike NS, sometimes identified nasal vowels as oral vowels
  - NS had slight tendency to identify [ã] as [ĩ] (12%)
  - L2 had overwhelming tendency to do so
    - [ã] with 30.0% accuracy, identified as [ĩ] for 40.2% of tokens and [œ] for 13% of tokens
- Nasal vowel [œ] also posed much difficulty (38.8%)
  - Confused for [ɐ] (11.3%) and [ĩ] (11.6%)
    - Infrequently [ã] (3.7%)
  - Also confused for oral [œ] (7.5%) and absent vowel (7.6%)
Results: L2 Triumph!

- L2 listeners outperformed NS in the absent vowel category
  - 90% for L2 vs. 78% for NS
  - For both, [ə] the most frequently chosen incorrect response
    - 5% for L2 vs. 11% for NS
- Confusion reflects alternation of schwa with zero
- Possible difference in schwa duration between two speakers/sets of stimuli
  - Shorter schwa might be more confusably with zero
What factors had an impact on vowel identification accuracy?

- French proficiency
  - 3 groups: Beginner+Early Intermediate vs. Late Intermediate vs. Advanced+Near-native
    - One-way ANOVA (p = 0.045)
  - Or 2 groups: Beginner+EI+LI vs. Advanced+NN
    - Group averages 53.1% vs. 62.7%
    - T-test (p = 0.032)

- The upper group (which included 5 graduate students of French) was much more native-like than the L2 listeners overall for the [u]-[y] distinction
  - 90% accuracy for [y], 79.9% for [u]

- But: still overidentified [ã] as [ᵻ] and [œ̃] (41.7% correct)
What factors had an impact on vowel identification accuracy?

- **Study abroad (SA)**
  - 2 groups: Participants with study abroad experience vs. those without
    - Of those with experience, split between LI and Adv/NN
  - **Average accuracy:**
    - 62.2% with SA, 48.5% without
  - **T-test:** $p < 0.001$
- **SA ranged from weeks to 5 years; most were at least several months**
What factors had an impact on vowel identification accuracy?

- Phonetics/pronunciation courses
  - 2 groups: Participants who had taken such a course vs. those who had not
    - Of those who had, also split between LI and Adv/NN
  - Average accuracy:
    - 65.0% with SA, 51.2% without
  - T-test: p < 0.001

- Problem: Lots of overlap between participants with study abroad experience and those having taken a phonetics course
What factors had an impact on vowel identification accuracy?

- **Phonetics vs. Study Abroad**
  - 2 groups: Participants who had only studied abroad vs. those who had studied abroad and taken a phonetics course
    - Again, split between LI and Adv/NN
  - Average accuracy:
    - 57.5% with only SA, 66.0% with both
  - T-test: $p = 0.039$

- Shows importance of metalinguistic awareness

- Illustration: considering only LI listeners, accuracy for $\text{[oe]}$ was 69.7% for those with the course experience vs. 27.2% without
Conclusions

- For L2 listeners, French vowel confusability reveals less about French phonological structure and more about their difficulty perceiving some French sounds.
- With increased experience, an L2 listener's confusions may become more native-like.
  - But are still influenced by their first language experience.
- Further research can work to investigate in what ways various types of language experience (e.g., engagement with native speakers or explicit study) are most beneficial to L2 listeners.


Confusion Matrix from Hall & Hume (2013)

TABLE 1. Identification accuracy for French vowels. Correct responses (i.e., stimuli) are in rows; given responses in columns. The vowel ‘e’ designates French “schwa.” Numbers are the percentage of each given response that was provided for each stimulus, with row totals adding up to 100%. The diagonal in bold represents the percentages of correct responses. Numbers enclosed in dashed lines indicate responses to tense/lax counterpart vowels. A response of ‘??’ indicates that participants responded by clicking outside of one of the given response choices (which was erroneously recorded as an actual response, but occurred only 4 times in 2400 trials).

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<tr>
<th>Given Response</th>
<th>∅</th>
<th>‘e’</th>
<th>[ø]</th>
<th>[œ]</th>
<th>[e]</th>
<th>[ɛ]</th>
<th>[o]</th>
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<th>[ʊ]</th>
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