Production and contrastiveness of Canadian Raising in Metro-Detroit English

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ABSTRACT

This study leverages cultural expectations of rhyming patterns to study Canadian Raising in Metro-Detroit English. This feature has been found in a variety of phonetic contexts and is suggested to be only marginally contrastive. In the first experiment, I examine baseline production using a sentence-reading task and find raising in a variety of contexts with notable inter-speaker variation. The second experiment uses a novel poetry paradigm to test contrastiveness of [aɪ] and [ʌi]. Results show general accommodation in vowel duration and backness, but not vowel height. However, vowel height does appear to be affected by context in a small number of productions. These findings suggest that the two vowels are indeed marginally contrastive in Metro-Detroit English. This paper studies the spread and contrastiveness of Canadian Raising, and has implications for a new paradigm for studying phonetic contrasts.

Keywords: Canadian Raising, phonetic contrasts, context, phonetic accommodation

1. INTRODUCTION

Canadian Raising is a well-studied phonetic phenomenon in which /aɪ/ in Standard American English splits into [aɪ] and [ʌi] in some dialects [11]. Despite its name, this has been found to occur in a variety of geographic areas, including the U.S. state of Michigan [3,13]. Though this shift in pronunciation was originally suggested to happen only before voiceless consonants, further work has found that it occurs in a number of other phonetic environments, such as before [ɾ], [d], and [g] [20]. Furthermore, speakers of the same dialect have differing intuitions about which words are and are not raised.

Significant variation in Canadian Raising has led many researchers to conclude that it is a *marginally contrastive* phenomenon [7,8]. This is because the two diphthongs are neither consistently produced nor perceived as separate by speakers of a single dialect, despite most speakers having intuitions that the two sounds are distinct. Conclusions about contrastiveness have largely come from studies that generalize over inter-speaker variation in perception

and production of the contrast. However, it may be informative to also examine phonology at the individual level.

Though we often speak of contrastiveness at the dialectal level, it is possible that individuals may vary in their own phonologies. Indeed, variation in speaker intuition about which words are produced with [aɪ] vs. [ʌi] has been reported in many of the previously cited sources. It may be that individual speakers are consistent in their own productions, but the phenomenon appears marginally contrastive at the dialectal level because of speaker differences. Thus, this study is interested in whether speakers are consistent in their production patterns of Canadian Raising. Consistency would support a stronger contrast than has been found at the dialectal level, while inconsistency would support previous findings of marginality.

The poetry paradigm used here relies largely on phonetic accommodation and imitation. Phonetic accommodation refers to changes in production based on social factors. Research has found that changes in interlocutor or context can affect many facets of speech, including word pronunciation, speech rate, and pitch [5,12]. I suggest that poems are a certain type of context, where learned cultural expectations may influence production. As noted by Trudgill [19], this accommodation is restrained by phonology— accommodation would not be expected if it would cause a shift from one phonological category to another. Thus, if two words (one typically [aɪ], the other [ʌi]) are expected to rhyme in a poem, the poetry context may cause the speaker to accommodate by assimilating the second sound toward the first. Accommodation here would suggest a marginal contrast in the mind of the speaker.

Beyond contextual expectations, this elicitation method may also call on phonetic imitation. It has been proposed that word representation is episodic or relies on exemplars; recent and long-term phonetic information is stored in memory [6,16]. Studies show that this stored information can then affect production: for both consonants and vowels, phonetic production can be altered by previous speech [4,14]. It is noted that this imitation occurs at the phoneme level and is constrained by phonological categories. Though most studies have examined imitation of another speaker's productions, there is some evidence that speakers

may imitate features of their own speech [17]. From this, we may expect that the combination of contextual expectations and phonetic imitation may cause variability in the production of [aɪ] and [ʌi] when they are paired together in a rhyme.

If the two sounds in question are indeed marginally contrastive, we would expect that (for [aɪ]-[ʌi] rhymes) an [ʌi] produced at the end of the first line of a poem would differ from one produced at the end of the second line. This is because the first production does not have the context of a previous rhyming word. The second production, however, occurs after [aɪ] has already been produced and the speaker is expecting the two words to rhyme. If the two sounds are fully contrastive, then we would not expect to see any changes in production between when a word is ordered first or second in a poem.

In this study, I expect that speaker productions of [aɪ]/[ʌi] for a given word will vary depending on location in a rhyme, due to phonetic accommodation and imitation. Specifically, it is expected that typically-raised words like *writer* will have a lowered production (closer to [aɪ]) when in the second line of a rhyme. This is because speakers are likely exposed to Standard English, which only uses [aɪ], so these productions may be somewhat acceptable. In contrast, typically-unraised words like *higher* are unlikely to ever be heard as [ʌi], so accommodation in this direction is not as expected.

2. METHODS

This study includes two production experiments. Experiment 1 employed a sentence-reading task to test baseline raising patterns and Experiment 2 used a poetry paradigm to examine production in rhyming contexts. Both experiments were self-paced, where the participant clicked to make the next sentence or the next line of the poem appear. The second experiment consisted of two parts. The first was a familiar poem reading, in which participants read 16 couplets (mostly from nursery rhymes) aloud. This was to familiarize them with the rhyme scheme and prime them to expect rhyming. The second was a novel poem-reading task, where they read unfamiliar couplets with [aɪ]-[ʌi] paired rhymes.

2.1. Stimuli

The stimuli consisted of the 26 target words shown in Table 1, which were categorized as either Predicted Raised (PR) or Predicted Unraised (PU) based on previous literature and experimenter intuitions as a speaker of the dialect [9,13].

For Experiment 1, each word was read in isolation and in a carrier sentence. An additional 72 filler items were used, and the list was pseudo-randomized.

Table 1: Raising categorization of target words.

Predicted Raised (PR)	Predicted Unraised (PU)	
biter	buyer	higher
fire	divided	liars
hire	flier	provided
invited	flyer	rider
sighted	fryer	shyer
spiders	glided	sider
whiter	gliders	sliding
writing	guiding	slider
	hiders	wider

For Experiment 2, each PR word occurred in two poems: once at the end of the first line and once at the end of the second line. Both times it was paired in a rhyme with a PU word. In dialects without Canadian raising, each of these matches would create perfect rhymes; for the speakers in this study, a rhyming mismatch was intended for each pair. This created a total of 16 target poems, which were pseudo-randomized with 130 filler poems that did not include the target diphthongs.

2.2. Participants and procedure

Ten participants (8F,2M, aged 18-65) were recruited for this study. All participants were native English speakers born and raised in the Metro-Detroit area. Participants were paid $5 upon study completion.

For each participant, Experiment 1 and Experiment 2 (in that order) were completed in one day, in a quiet location. Recordings were created using a Zoom H4N Pro portable recorder and an AKG C 520 head-mounted microphone at 44.1kHz.

Participants were instructed to read the text aloud in a normal speaking voice. They were told to click through PowerPoint slides containing the stimuli at their own pace and to not advance until they had completely finished reading the text. At the end of the session, participants completed a background language questionnaire.

2.3. Statistical analysis

Recordings were manually annotated in Praat [2], using markers such as intensity and formant transitions [15]. For each target word, five measures were taken: duration, F1 at nucleus, F2 at nucleus, F1 at offglide, and F2 at offglide (see [8]). The vowel nucleus refers to the point of maximum F1, and the offglide refers to the point of maximum F2. In order to account for gender differences in frequency, resulting formant values were centered

and scaled for each individual speaker prior to statistical analysis.

For each experiment, a linear mixed-effects regression was run in R [18] using the package *lme4* [1] for each individual measure and p-values were obtained using Satterthwaite Approximations from *lmerTest* [10]. In Experiment 1, Gender and Predicted Raising were used as fixed effects with Speaker as a random effect. In Experiment 2, Gender, Predicted Raising, Order, and the interaction between Predicted Raising and Order were used as fixed effects, and Speaker as a random effect. Beyond these models, non-raised vowels in the PR condition in the baseline experiment were located by searching for outliers 2.5 standard deviations from the mean of F1 at nucleus in the PR condition for each speaker, then removed. Data visualizations were created using *ggplot* [21].

3. RESULTS

3.1. Experiment 1

A linear mixed-effects model found a significant effect of raising on duration ($\beta=0.22$, SE=0.13, $p<0.001$), F1 at nucleus ($\beta=1.49$, SE=0.11, $p<0.001$), F1 at offglide ($\beta=1.01$, SE=0.122, $p<0.001$), F2 at offglide ($\beta=-0.35$, SE=0.12, $p<0.01$). No significant effect of raising on F2 at nucleus ($\beta=0.24$, SE=0.11, $p=0.09$). In each regression, gender was not a significant predictor.

As expected, the PU condition overall was predicted by longer duration, higher F1 at nucleus and offglide, and lower F2 at offglide. It was also expected that gender would not be significant, as normalized scores were used in each regression. Difference in F1 at nucleus is shown in Figure 1.

Figure 1: Experiment 1, normalized F1 at nucleus
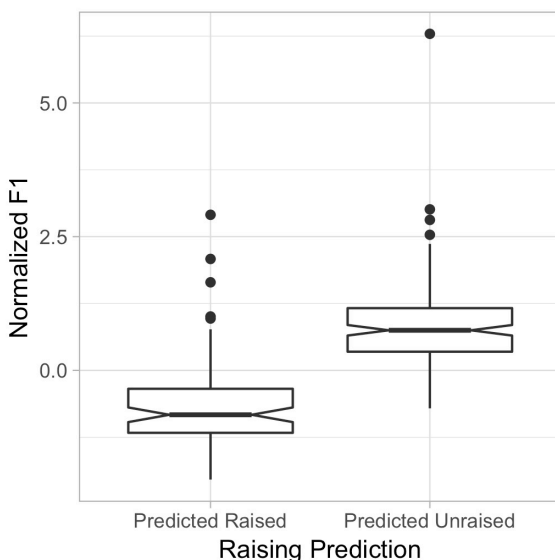
As seen in the first figure, there are notable outliers in the PR condition. A total of 7 outliers were found: *hire* for 6 speakers and *fire* for one speaker.

3.2. Experiment 2

The model for duration found a significant effect of Predicted Raising ($\beta=2.8\text{e-}02$, SE=3.5e-03, $p<0.001$), and Predicted Raising*Order ($\beta=-1.9\text{e-}02$, SE=4.9e-03, $p<0.001$). F1 at nucleus was significantly predicted only by Predicted Raising ($\beta=1.27$, SE=0.1, $p<0.001$). F2 at nucleus showed a significant effect of Predicted Raising ($\beta=0.63$, SE=0.14, $p<0.001$), Order ($\beta=0.36$, SE=0.2, $p<0.5$), and Predicted Raising*Order ($\beta=-0.58$, SE=0.2, $p<0.01$). Regression for F1 at offglide found a significant predictor only in Predicted Raising ($\beta=0.64$, SE=0.13, $p<0.001$). All other predictors were not significant ($p>0.05$).

As with the first experiment, statistical results show that PU words were overall longer than PR, and had higher F1 and lower F2. Differences between first and second order only significantly predicted the F2 value at nucleus. The interaction between Predicted Raising and Order significantly predicted differences in duration and F2 at nucleus, indicating that duration and F2 at nucleus for the PR and PU categories were affected differently by a change in order.

4. DISCUSSION

The results from Experiment 1 show that Canadian Raising is present in Metro-Detroit English roughly as expected, based on raising predictions. Production of raising can be quantified here with duration, F1 at nucleus and offglide, and F2 at offglide. Though the broad patterns are as expected, several outliers were discovered. These outliers were the words *hire* and *fire*, which were predicted to be raised (PR), but had F1 at nucleus values closer to the PU condition. Notably, neither of these words have diphthongs in the traditionally-described context for Canadian Raising (prior to a voiceless consonant). This may suggest that diphthongs are less likely to be raised in non-traditional contexts. Additionally, as these outliers only existed for some of the speakers, we can conclude that there is indeed inter-speaker variation in Canadian Raising.

Experiment 2 again found that words in the PR and PU categories generally behaved as expected in regard to duration, F1, and F2. Order was found to affect only F2 at nucleus, indicating that when a word occurs second in a poem, it is more fronted than when it occurs first. In studying the interaction between Order and Predicted Raising, it was found that for duration and F2 at nucleus, words in PR vs.

PU were affected differently by order. For both measures, the second order production was shifted toward the word it rhymed with (e.g. the [ʌi] in an [aɪ]-[ʌi] rhyme was produced as more fronted and with a longer duration than the [ʌi] in an [ʌi]-[aɪ] rhyme). These shifts in production suggest that the poetry context does provoke accommodation for duration and F2 measures.

Though Canadian Raising is often correlated with duration and F2, the main indicator is vowel height (F1 at nucleus). This measure was *only* significantly predicted by Predicted Raising, indicating that there was no global effect of order on vowel height, and that PR and PU words did not vary by order (as we might expect, if they accommodate toward one another). This lack of effect suggests that there was no phonetic accommodation in vowel height for the target words. Assuming that rhyming contexts can influence production through socio-contextual awareness of poetic conventions and phonetic imitation, we might then conclude that a lack of accommodation points to the sounds [aɪ] and [ʌi] as being distinct phonemes with a strong contrast.

However, when examining individual data, there is evidence that this phonetic contrast is not so concrete. Figure 2 shows one speaker's productions of *wire* and its rhymes (*flier-wire*, *wire-buyer*) in the second experiment.

Figure 2: One speaker's productions of *wire* (PR, black) in Experiment 2, shown with its paired rhymes *flier* (PU, grey circle) and *buyer* (PU, grey triangle).
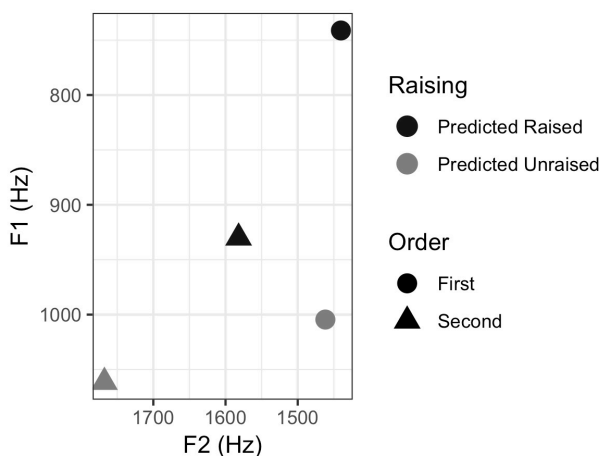
In this graph, we can observe potential accommodation in terms of F1 (vowel height). Overall, when a word is at the end of the first line (ordered first), it tends to have a lower F1 than when a word is at the end of the second line (ordered second). However, the frequency difference between first and second order for the PR condition is 189 Hz, which is much greater than the PU difference of 57 Hz. In terms of vowel height, this speaker seems to show accommodation of PR *wire* toward PU *flier*, but no accommodation of PU *buyer* toward PR *wire*.

Such patterns can be observed in a handful of the data, roughly 10 sets of productions across 5 speakers. As in Figure 2, most of these patterns are with PR words instead of PU words, in line with earlier predictions. These shifts suggest that though an individual speaker has intuitions and tendencies for certain productions of Canadian Raising, the distinction between [aɪ] and [ʌi] is at least somewhat malleable. This individual malleability aligns with previous conclusions at the dialectal level that the phenomenon is only marginally contrastive.

5. CONCLUSIONS

This study finds that Canadian Raising is present in Metro-Detroit English in a variety of phonetic contexts with notable inter-speaker variation for non-traditionally raised words. In order to examine contrastiveness of these sounds at the level of individual phonology, a novel poetry paradigm was introduced. This task relies on learned expectations of poetry structure and phonetic imitation to induce phonetic accommodation between [aɪ] and [ʌi]. There is broad evidence of accommodation for duration and F2, but not for F1, which is the most prominent feature of Canadian Raising. However, further inspection of the data shows potential accommodation for vowel height in a handful of instances. These results support the account that [aɪ] and [ʌi] are marginally contrastive sounds.

Future work remains, such as examining general phonetic patterns in poetry contexts to ensure that the observed shifts in production are in fact due to accommodation. The paradigm created for this study can also be employed to test other marginal contrasts or mergers (e.g. testing contrastiveness of *cot-caught* vowels for speakers who do not have a complete merger/split). This study gives an overview of the phenomenon of Canadian Raising in the Metro-Detroit area, and offers insight into its marginal contrastiveness using a novel poetry paradigm.

6. ACKNOWLEDGEMENT

7. REFERENCES

[1] Bates, D., Maechler, M., Bolker, B., Walker, S. 2015. Fitting linear mixed-effects models using lme4. Journal of Statistical Software 67(1), 1-48.

[2] Boersma, P., Weenink, D. 2018. Praat: doing phonetics by computer, version 6.035, www.praat.org [computer program].

[3] Dailey-O'Cain, J. 1997. Canadian raising in a midwestern US city. *Language Variation and Change*, *9*(1), 107-120.

[4] Delvaux, V., & Soquet, A. 2007. The influence of ambient speech on adult speech productions through unintentional imitation. *Phonetica*, *64*(2-3), 145-173.

[5] Giles, H., Coupland, J., & Coupland, N. (Eds.). 1991. *Contexts of accommodation*. New York: Cambridge University Press.

[6] Goldinger, S. D. 1998. Echoes of echoes? An episodic theory of lexical access. *Psychological review*, 105(2), 251.

[7] Hall, K. C. 2013. A typology of intermediate phonological relationships. *The Linguistic Review*, 30(2), 215-275.

[8] Hualde, J. I., Luchkina, T., & Eager, C. D. 2017. Canadian Raising in Chicagoland: The production and perception of a marginal contrast. *Journal of Phonetics*, *65*, 15-44.

[9] Kilbury, J. 1983. Talking about phonemics: Centralized diphthongs in a Chicago-area idiolect. *Essays in Honor of Charles F. Hockett*, 336-341.

[10] Kuznetsova A., Brockhoff, P.B., Christensen R.H.B. 2017. lmerTest Package: Tests in Linear Mixed Effects Models. Journal of Statistical Software, 82(13): 1-26.

[11] Labov, W. 1963. The social motivation of a sound change. *Word*, 19(3), 273-309.

[12] Labov, W. 1972. The isolation of contextual styles. *Sociolinguistic patterns*, 70, 100.

[13] Milroy, J. 1996. Variation in /ai/ in Northern British English, with comments on Canadian Raising. *University of Pennsylvania Working Papers in Linguistics*, *3*(1), 16.

[14] Nielsen, K. 2011. Specificity and abstractness of VOT imitation. *Journal of Phonetics*, 39(2), 132-142.

[15] Peterson, G. E., Lehiste, L. 1960. Duration of syllable nuclei in English. *J. Acoust. Soc. Am*. 32, 693–703.

[16] Pierrehumbert, J. B. 2001. Exemplar dynamics: Word frequency, lenition and contrast. *Typological studies in language*, 45, 137-158.

[17] Purcell, D. W., & Munhall, K. G. 2006. Compensation following real-time manipulation of formants in isolated vowels. *The Journal of the Acoustical Society of America*, *119*(4), 2288-2297.

[18] R Core Team. 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

[19] Trudgill, P. 1986. *Dialects in contact*. Blackwell.

[20] Vance, T. J. 1987. "Canadian Raising" in some dialects of the northern United States. *American Speech*, *62*(3), 195-210.

[21] Wickham, H. 2016. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York