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Reshaping the Vowel System: An Index of Phonetic Innovation in Canadian English

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Abstract
This paper examines two current sound changes in Canadian English (CE): the Canadian Shift (CS) and the fronting of back-upgliding vowels. Among the changes involved in the CS is the retraction of the TRAP vowel from its initial position in the low-front quadrant of the vowel space to a new position in the low-central region. Among the changes affecting the back-upgliding vowels is a forward shift in the nuclear position of the GOOSE vowel, traditionally a back vowel, whose main allophones are now located in the high-front quadrant. Thus, TRAP is shifting backwards and GOOSE is shifting forwards. These changes are demonstrated with an apparent-time analysis of the speech of 60 speakers from two age groups in three cities: Vancouver, Montreal and Halifax. The relative positions of TRAP and GOOSE in F2 space are expressed as an Index of Phonetic Innovation (IPI), calculated as the mean F2 of GOOSE subtracted from the mean F2 of TRAP. Positive IPI values, with TRAP still further forward than GOOSE, reflect comparatively conservative vowel systems, which tend to have a trapezoidal shape, with two low corners: one in the front, at TRAP, and one in the back, at the LOT vowel. Negative IPI values, with GOOSE further forward than TRAP, reflect comparatively innovative vowel systems, which tend to have a triangular shape, with retracted and lowered TRAP as the bottom corner of an inverted triangle, and LOT located on its rear side. Multivariate statistical analysis of a larger sample of 86 younger speakers from every region of Canada finds that both region and speaker sex have significant effects on the IPI. The most innovative vowel systems tend to be found among women in the most urbanized regions of Canada, particularly the metropolitan areas focused on Toronto and Vancouver, while the most conservative vowel systems tend to be found among men in the less urbanized regions, especially the Prairies and Atlantic Canada. These types are illustrated with detailed analyses of individual speakers from Montreal and Toronto.

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Charles Boberg*

1 Two Active Sound Changes in Canadian English (CE)

The *Atlas of North American English* (Labov, Ash and Boberg 2006) identified two active sound changes in Canadian English (CE): the Canadian Shift (CS) and the fronting of /uw/. These are shown together in Figure 1.

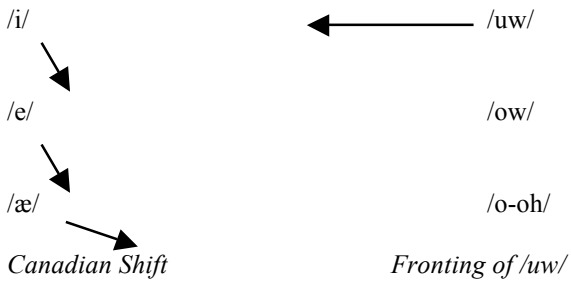

Figure 1: The Canadian Shift and the fronting of /uw/ in CE.

The Canadian Shift (CS) was first identified as a connected set of changes by Clarke, Elms & Youssef (1995). It involves the lowering and retraction of the short front vowels /i/, /e/ and /æ/ (the KIT, DRESS and TRAP lexical sets of Wells 1982) in response to low-back merger of /o/ and /oh/ (LOT and THOUGHT). The *Atlas* finds this to be the most diagnostic characteristic of CE, supporting the clearest separation of CE from neighboring American English dialects. To this extent, the CS can be seen as a divergent change, enlarging the phonetic distance between CE and American varieties, though some elements of the shift have also been observed in U.S. dialects. By contrast, the *Atlas* reported fronting of /uw/ (in the GOOSE set) to be active in most of North America, including Canada, where it is comparatively advanced. While in the American Midland and South fronting of /uw/ is one of three parallel shifts that affect the back-upgliding vowels as a set (/uw, ow, aw/, or GOOSE, GOAT and MOUTH), in Canada the fronting is largely restricted to /uw/; the articulation of /ow/ in most CE speech remains relatively conservative, with a nucleus not significantly displaced from its original position on the upper-mid-back periphery of the vowel space. Though this wide discrepancy between the positions of /uw/ and /ow/ is a distinctive characteristic of CE, the fronting of /uw/ itself can therefore be seen as a convergent change, making CE sound more like several U.S. dialects.

In CE, the combined effect of these changes is a reversal of the relative positions of /uw/ and /æ/ in the front-back or F2 dimension of the vowel space, as illustrated in Figure 2:

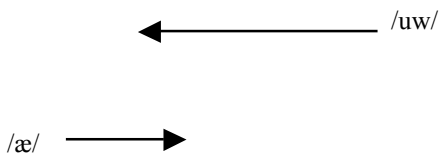

Figure 2: The reversal of /uw/ and /æ/ in CE.

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Whereas in traditional English phonology /uw/ is labeled a back vowel and /æ/ a front vowel, in contemporary CE the main distribution of allophones of /æ/ is now further back than the main distribution of allophones of /uw/. The *Phonetics of Canadian English* (*PCE*) project at McGill University, most recently reported in Boberg (2010), shows that this reversal is helping to reshape the CE vowel system and is correlated with social factors in ways that fit standard models of the social mechanism of sound change, especially with respect to age and sex. It also shows regional differentiation that allows us to point to some regions of Canada as being more phonetically innovative than others. This paper presents a new analysis of these data, slightly different from but reaching the same conclusions as that in Boberg (2010).

The sociolinguistic characteristics of the reversal of /uw/ and /æ/ are easier to examine if we express it as a single value, derived by subtracting the mean second-formant (F2) value of /uw/, normally the backer vowel with the lower F2 value, from that of /æ/, normally the fronter vowel with the higher value. This operation produces an Index of Phonetic Innovation (IPI) in CE, expressed in Hz, as shown in Figure 3.

$$F2\ (æ) - F2\ (uw)$$

Figure 3: An Index of Phonetic Innovation (IPI) in CE.

Positive values of the IPI (where F2 (æ) > F2 (uw)) are conservative, indicating the traditional orientation of the two vowels, with /æ/ in front of /uw/; negative IPI values (where F2 (æ) < F2 (uw)) are innovative, with /uw/ having advanced and /æ/ having retracted far enough that they have crossed one another in the front-back dimension of phonetic space.

2 *Phonetics of Canadian English* (*PCE*) Data on the IPI

The PCE project is an acoustic study of regional differentiation in the phonetics of CE, carried out by the author at McGill University from 1999 to 2005. It involved recorded sociolinguistic interviews with a large sample of native-English-speaking McGill undergraduate students from all regions of North America. To these were later added a smaller sample of older speakers, born in or before 1965, in three widely separated cities: Vancouver, Montreal and Halifax (the Montreal speakers were part of a larger study, the *Phonetics of Montreal English*, reported in Boberg 2004 and 2010; a comparison of the Vancouver and Halifax samples was first presented by Sadlier-Brown and Tamminga 2008, who interviewed the older speakers in those cities). Apparent-time analyses of changes in progress reported in this paper are therefore based on a comparison of the Vancouver, Montreal and Halifax sub-samples of the PCE project with the older sample just mentioned. The demographic characteristics of this sample are shown in Table 1. Regardless of age, all interviews were conducted in an identical fashion. They included demographic information, a word list and spontaneous conversation between the subjects and their interviewers, who were also McGill students. The recorded speech was digitized and analyzed acoustically using Kay Elemetrics' CSL 4400 program. This paper reports on the results of the analysis of the word list portion of the interviews, which comprised 145 simple, mostly monosyllabic words per person, featuring all of the vowels of English in a representative range of allophonic environments. Measurements of the first and second formants were taken at a single point in the vowel nucleus, representing either the maximal value of F1 or a point of inflection in F2, in either case indicating the maximal approximation of the articulators toward the target quality of the vowel in question. The formant data were then normalized using the additive point system of Nearey 1978, categorized by the vowel they contained in order to calculate mean formant values for each vowel for each speaker, and subjected to statistical analysis using SPSS (for further methodological details, see Boberg 2008 or 2010:143–146, 199–202, 225).

City	Older (≤1965)		Younger (>1965)		TOTAL
	F	M	F	M	
Vancouver	4	2	4	4	14
Montreal	13	6	8	5	32
Halifax	6	2	3	3	14
TOTAL	23	10	15	12	60

Table 1: Sample for analysis of age differences: *PCE* participants from Vancouver and Halifax and British-origin *PME* participants from Montreal, by age (birth year) and sex (F = female; M = male).

3 Apparent-time Analysis of the CS and Fronting of Back Vowels

An apparent-time analysis of changes in progress in the vowel productions of the sample in Table 1 began with a MANCOVA of the effects of age and region on the set of phonetic measures implicated in each process: for the CS, this was the F1 and F2 of all of the short vowels (those of the KIT, DRESS, TRAP, LOT, STRUT and FOOT lexical sets of Wells 1982); for the fronting of the nuclei of back-upgliding vowels, this was the F1 and F2 of the vowels /uw, ow, aw/ (GOOSE, GOAT and MOUTH (*mouth* is a bad keyword for CE, since /aw/ before voiceless fricatives is subject to Canadian Raising; the /aw/ tokens analyzed here were all in non-raising environments). The main effect of age revealed by the MANCOVA is shown in Table 2, along with an indication of whether age was found to co-vary with region. The main effect of region on the CS is not a concern of this paper, though the effect of region on the IPI is examined below; for the effect of region on the CS *per se* see Boberg (2008, 2010).

Process/set	*Dependent measures*	*Effect of age*	*Co-variation with region?*
Canadian Shift	F1/F2 of short vowels	YES: F = 3.183 (12 df); $p = 0.003$	YES: F = 1.658 (24 df) $p = 0.052$
Position of back-upgliding vowels /Vw/	F1/F2 of /uw, ow, aw/	YES: F = 3.392 (6 df); $p = 0.008$	YES: F = 1.875 (12 df) $p = 0.049$

Table 2: Effects of age (birth year) on sets of phonetic measures from Vancouver, Montreal and Halifax: results of MANCOVA.

Table 2 indicates that the two age groups examined here do differ significantly in their productions of short and long back-upgliding vowels. An apparent-time analysis of this generational difference therefore suggests that, at least in Vancouver, Montreal and Halifax, the CS and the fronting of back-upgliding vowels are active changes in progress, a view that confirms the findings of Labov, Ash and Boberg (2006) in these respects and of Boberg (2005) in Montreal. Table 2 also indicates that these changes show co-variation with region, implying that they may display different stages, rates or trajectories of change in the three cities examined here (for studies of the CS in particular Canadian regions, see Sadlier-Brown 2010 for Vancouver; Hagiwara 2006 for Winnipeg; Hoffman 2010 and Roeder and Jarmasz 2009 for Toronto; Boberg 2005 for Montreal and D'Arcy 2005 for St. John's.)

The more specific effects of age on these general processes can be seen in Table 3, which presents the results of tests of between-subjects effects, showing the significance of the age effect for individual phonetic measures (measures that showed no significant effect of age are not listed). From this analysis it appears that all three short front vowels, as well as /u/ (FOOT), are affected by lowering (higher F1 means among younger speakers), while /e/ and /æ/ (DRESS and TRAP), as well as /u/, are affected by retraction or backing (lower F2 means among younger speakers). Of the vowels assumed to be involved in the CS, therefore, /i/ (KIT) shows only lowering (and then only at a marginally significant level), while /e/ and /æ/ show both lowering and retraction, implying a diagonal trajectory of shift, downward and inward (in the case of /æ/, the effect of age on F1 is only marginally significant, suggesting that the primary development, at least at this stage in the

change, is retraction). Crucially, /o/ (LOT), whose merger with /oh/ (THOUGHT) in CE has been proposed as the initiating condition for the CS (Clarke, Elms and Youssef 1995:212), shows no effect of age, suggesting that the position of this vowel is diachronically stable, as might be expected of an initiating condition.

Among the back-upgliding vowels, only /uw/ and /ow/ show movement in apparent time; the unraised distribution of /aw/ is stable. For GOOSE and GOAT, younger speakers have higher F2 measures, indicating advancement or fronting in apparent time. Despite what was said above about the relatively conservative status of CE /ow/, these data show this vowel to be advancing as rapidly as /uw/, though starting over 400 Hz further back. Table 3 suggests that the wide discrepancy between fronted /uw/ and conservative /ow/ that distinguished CE in the past may be narrowing, as /ow/ slowly shifts away from the rear periphery of the vowel space toward a more central articulation. As it does so, the vowel is also opening to some extent, dropping 36 Hz between the two groups; by contrast, the trajectory of /uw/ is unidirectional, involving only advancement, with no significant lowering.

Measure	*F*	*Sig.*	*O mean*	*O s.d.*	*Y mean*	*Y s.d.*	*Diff.*
F1 (i)	3.527	0.066	539	9	563	9	24
F1 (e)	9.845	0.003	694	10	735	9	41
F1 (æ)	2.871	0.097	838	18	879	17	41
F1 (u)	7.471	0.009	546	10	582	9	36
F2 (e)	7.987	0.007	1969	22	1885	20	84
F2 (æ)	13.423	0.001	1802	18	1710	17	92
F2 (u)	7.490	0.009	1233	20	1308	19	75
F1 (ow)	7.987	0.007	571	9	607	9	36
F2 (ow)	13.633	0.001	1173	22	1286	21	113
F2 (uw)	7.348	0.009	1606	34	1732	32	126

Table 3: Significant effects of age (birth year) on phonetic measures from Vancouver, Montreal and Halifax ($p \leq 0.10$ @ 1 df): results of tests of between-subjects effects, with means and standard deviations for each age group and age difference (all in Hz). Older (O) group born in or before 1965; younger (Y) born after 1965.

Generational differences in the articulation of the vowels involved in the CS and in back-vowel fronting are shown graphically in Figure 4. Note that the black squares, indicating the means for the younger group, are mostly lowered and centralized with respect to the white diamonds, indicating the means for the older group. The graph clearly shows lowering and retraction of KIT, DRESS and TRAP; centralization and lowering of FOOT and GOAT; and fronting of GOOSE. The mean positions of /iy/ (FLEECE) and /o/ (LOT) and of the pre-lateral allophones of /uw/ (GOOSE, i.e. *cool*, *pool* and *tool*), which do not participate in the fronting of /uw/, are also shown, as 'x' symbols, in order to indicate the outlines of the vowel space. An inspection of Table 3 and Figure 4 shows that the mean F2 positions of /uw/ and /æ/ have indeed been reversed among younger speakers: while among older speakers /uw/ has a mean F2 of about 1600 Hz, almost 200 Hz less than the mean F2 of /æ/ (about 1800 Hz), among younger speakers the mean F2 of /uw/ as increased to 1732 Hz, which is 22 Hz greater than the mean F2 of /æ/, which has decreased to 1710 Hz. This produces a positive IPI for the older speakers and a negative IPI for the younger group. Whereas the white diamonds representing /uw/ and /æ/ in Figure 4 have the conventional orientation, the black squares representing these vowels are more or less directly aligned in the front-back dimension.

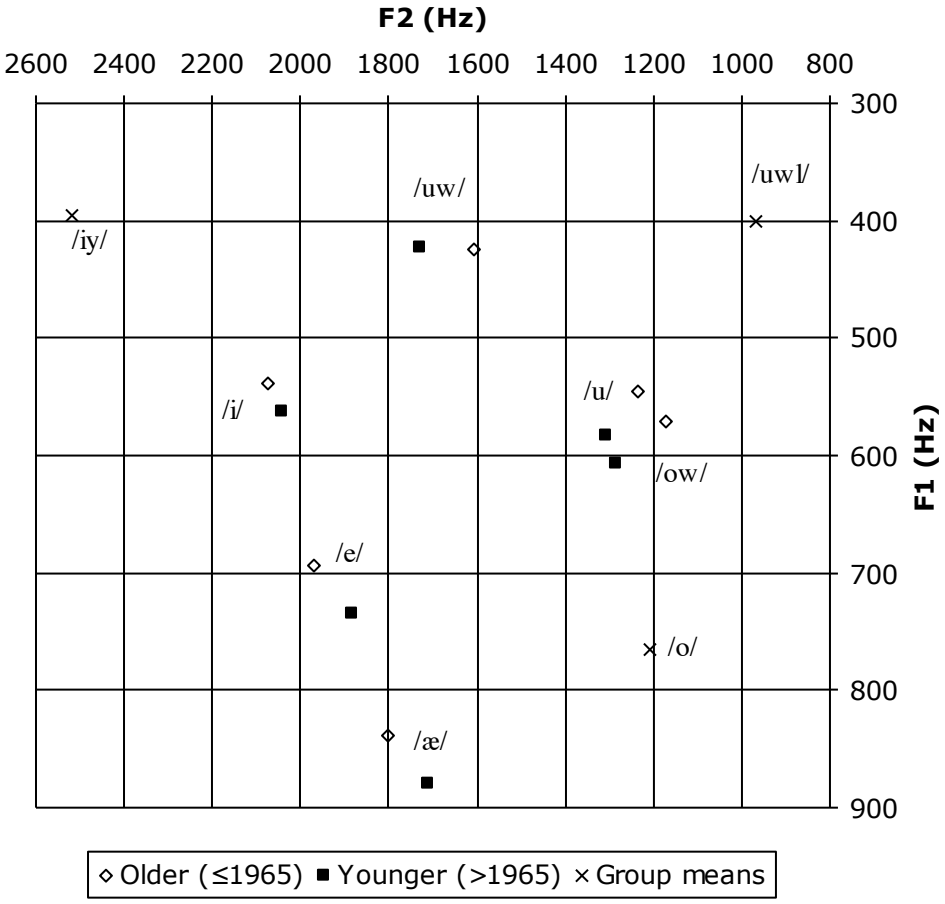

Figure 4: Age differences in *PCE* data: graph of data from Table 3 (a reproduction of Fig. 5.3 from Boberg 2010:230).

4 Region and Sex Effects on the IPI

Now that the reversal of /uw/ and /æ/ in younger CE has been demonstrated, it remains to be seen whether the IPI exhibits correlations with non-linguistic factors that might illuminate our sociolinguistic understanding of this change in progress. In order to examine more closely the effect of region on the IPI, data from the older speakers will be set aside and the analysis will resort to the larger set of more socially uniform but regionally diverse data from 86 younger speakers representing all of the regions of Canada. Table 4 shows partial results from a MANCOVA (fully reported in Boberg 2010:199–213) of the effect of region on the same set of phonetic measures as was analyzed above, plus the IPI, defined above as the difference between the mean F2 measures of /æ/ and /uw/. The MANCOVA found that region does have a significant effect on the IPI, as was suggested by the co-variation statistics in Table 2 above. Table 5 gives the mean IPI value for eight regions, from west to east: British Columbia, the Prairies, Southern Ontario, Greater Toronto, Eastern Ontario, Quebec, the Maritimes and Newfoundland. The range of values is considerable. On the strongly positive end, indicating conservative systems with /uw/ still well behind /æ/, we find Newfoundland as the most extreme region, then the Prairies and the Maritimes sharing a more moderately conservative status. Quebec (essentially the English-speaking community of Montreal) is of intermediate status, shows the vowels more or less directly aligned, with only 22 Hz difference between their means. On the innovative side we find British Columbia, Greater Toronto and Eastern Ontario, in the moderate range, and Southern Ontario at the extreme end, with /uw/ 241 Hz further forward than /æ/. This distribution suggests that phonetic innovation in CE is

led by Canada's most urbanized regions, particularly those focused on Greater Toronto and Vancouver, Canada's largest English-speaking cities, and resisted (or at least not as quickly adopted) by the less densely urbanized regions on the Prairies and in Atlantic Canada.

Measure	*F*	*df*	*Sig.*
F2(æ) – F2(uw)	2.491	7	0.026

Table 4: Tests of between-subjects effects of region on /æ/-/uw/ reversal.

Measure	*BC*	*PR*	*SO*	*TO*	*EO*	*QC*	*MT*	*NL*
n	12	15	7	8	9	13	16	6
mean IPI	-100	113	-241	-110	-95	-22	99	230

Table 5: Regional means (in Hz) for IPI, or /æ/-/uw/ reversal (F2(æ) – F2(uw)).

While the PCE sample of 86 undergraduate students is comparatively uniform in its social characteristics, it does include a mixture of 51 female and 35 male students, which supports an analysis of the effect of sex on the IPI and its component measures. This is shown in Table 6, which again presents tests of between-subjects effects from a MANCOVA fully reported in Boberg 2010. The table indicates that sex has a significant effect on the advancement or F2 position of /æ/ and /uw/, both singly and combined as the IPI. In every case, given the trajectory of change identified in the age analysis above, it appears that female students are more innovative, as a group, than male students. The female mean F2 is 65 Hz lower for /æ/, indicating a more retracted vowel, but 98 Hz higher for /uw/, indicating a more fronted vowel. The combined effect of these differences is that the female students have a negative mean IPI of -59 Hz, which is moderately innovative, while the male students have a positive mean IPI of 104 Hz, which is moderately conservative. Phonetic innovation in CE therefore appears to be led not only by the most urbanized regions but also by women, a finding that conforms to the expectation of Labov (1990) that women will lead most changes in progress. From this it might be hypothesized that the most phonetically innovative examples of modern CE will be heard from young women in Vancouver and Toronto, while the most conservative will be heard from older men on the Prairies or in Atlantic Canada, a proposition that could be more fully explored in future research.

Measure	*F*	*Sig.*	*F mean*	*F s.d.*	*M mean*	*M s.d.*	*Diff.*
F2(æ)	9.339	0.003	1701	95	1766	86	65
F2(uw)	6.165	0.016	1760	180	1662	210	98
IPI	10.212	0.002	-59	227	104	257	163

Table 6: Tests of between-subjects effects of sex on /æ/-/uw/ reversal.

5 Examples from Individual Speakers

In order to exemplify the general social patterns identified in the previous section, and to look in greater detail at the distribution of individual tokens of the vowels involved in the IPI, the vowel systems of two individual speakers are presented here. They have been selected to represent the range of variation between the conservative and innovative types hypothesized above. The conservative end is represented in Figure 5, by a Montreal English-speaker of Irish-Canadian ethnicity born in 1920, whose IPI is 395 Hz, a strongly positive value. The innovative end is represented in Figure 6, by a female student from Toronto, born in 1979, whose IPI is -319 Hz, a strongly negative value. In both charts, tokens of /uw/ (GOOSE) are represented by white circles, while tokens of /æ/ (TRAP) are shown with black squares; the means of other vowels discussed above are labeled with x's.

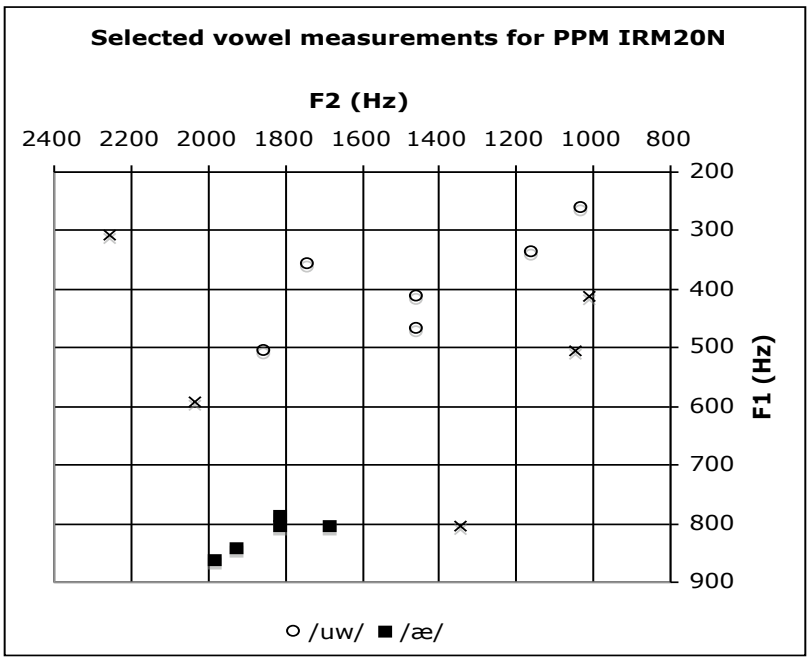

Figure 5: An Irish-origin Montreal man born in 1920 (IPI = 395 Hz).

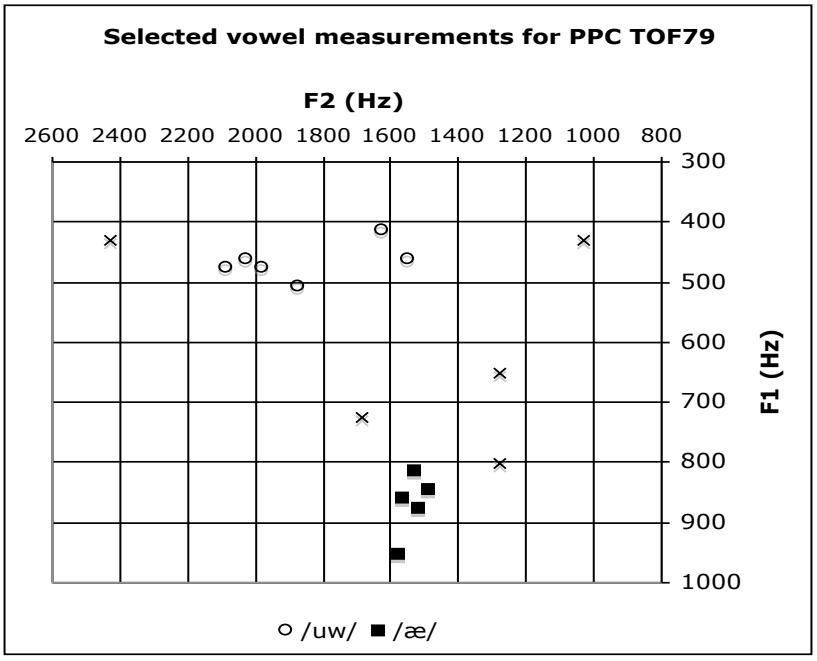

Figure 6: A Toronto woman born in 1979 (IPI = -319 Hz).

The older Montreal man in Figure 5, about 80 years old when he was recorded, does display moderate fronting of /uw/: pre-consonantal post-coronal tokens, such as *soon* and *tooth*, have shifted to a central value of 1500 Hz, while word-final post-coronal tokens, such as *do* and *too*, have shifted well into the high-front quadrant of the vowel space, directly above /æ/. The remainder the /uw/ set, however, remains in high-back position: *boots* and *food*, with preceding labials, have not shifted significantly beyond the conservative position of the pre-lateral allophones, which

are found at 1000 Hz. At this apparently medial stage in the change, fronting of /uw/ shows strong phonetic conditioning. Abstracting away from the range of allophonic variation, the mean F2 value of the main distribution of /uw/ is still in the high-back quadrant, somewhat behind the midline of 1500 Hz. By contrast, /æ/, based on the tokens *bad*, *sack*, *sad*, *sat* and *tap*, is still firmly in the low-front quadrant, with relatively little apparent retraction, leaving an open space in the low-central region of the vowel space between low-front /æ/ and low-back /o/ (LOT). This arrangement produces a strongly positive IPI value and is associated with an essentially trapezoidal vowel system, with clearly defined front and back corners on its lower margin. Also noteworthy in this conservative system are the mean positions of /ow/ (GOAT), which has not shifted significantly inward from the rear periphery, and of /e/ (DRESS), which remains on the front periphery connecting /iy/ (FLEECE) and /æ/: as with /æ/, there is no evidence of the CS having begun to operate on the front vowel sub-system of this speaker.

The younger Toronto woman in Figure 6 demonstrates a remarkably different system, in which the combined forces of back-vowel fronting and the CS have produced an essentially triangular vowel space, with a single low corner formed by a strongly shifted /æ/. The mean of this vowel is now between 1500 and 1600 Hz, a central value. Moreover, /æ/ has dropped below the position of /o/, which is in a similar position for the two speakers; in the older speaker's system, /o/ formed the rear lower angle of the vowel trapezoid, while in the younger system, the lowering and retraction of /æ/ causes /o/ to lie on the rear side of an inverted triangle, the line between /æ/ and /uwl/, the pre-lateral allophone of /uw/. In the upper range of the younger vowel space, even the post-labial tokens of /uw/ have shifted to a central position, while all of the post-coronal tokens (*do*, *soon*, *too*, *tooth*), regardless of the presence of a following consonant, have completed their shift into the high-front quadrant, behind /iy/. Only the pre-lateral tokens remain in high-back position; with this one exception, phonetic conditioning plays a smaller role in this later stage of the change, as it reaches completion. For this speaker, the mean F2 value of the main distribution of /uw/ has shifted across the mid-line of the vowel system into the high-front quadrant; combined with the retracted position of /æ/, now well behind /uw/, this produces a strongly negative IPI. The advanced stage of back-vowel fronting and the CS can also be observed in the mid vowels: compared with the older man's means, this woman's /ow/ has shifted over 200 Hz further forward while her /e/ has shifted over 300 Hz further back; these movements further contribute to the emerging triangular character of the modern CE vowel system. This reshaping is shown in abstract form in Figure 7.

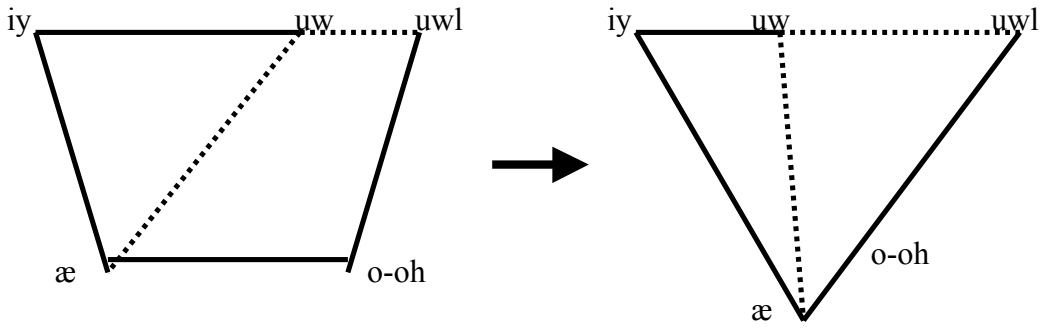

Figure 7: An abstract conception of reshaping of CE vowel system.

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