CROSS-LANGUAGE VARIATION IN THE VOWELS OF FEMALE AND MALE SPEAKERS

Caroline Henton
Voice Processing Corp., 1 Main St., Cambridge, MA 02109, U.S.A.

ABSTRACT

After normalization, females' vowel spaces are uniformly larger than are males' spaces. Cross-language data indicate that female speakers produce more explicit vowels than do male speakers. It is particularly in the F1 dimension that the females' vowel quadrilaterals extend beyond the males'. It may be inferred that female speakers articulate vowels with a more open mouth. Acoustic and sociophonetic reasons for such behaviour are explored.

INTRODUCTION

Normalized acoustic data from seven languages and dialects indicate that female speakers produce vowels in a manner that is more phonetically explicit than that of male speakers. Against a background of acoustic ignoral of female-male differences, or sociolinguistic and dialectological inference, it is interesting to ask why it is that females are more 'open-mouthed' than are males, cf. [2],[4],[8]. Can we expect that speakers with a higher F0 automatically have a larger vowel space? Are females making a greater effort to keep vowels distinct, which might potentially contribute to greater intelligibility? Or do females over-articulate, avoiding reduced or centralized forms, as a result of social expectations to be 'guardians', and the overt wish to speak a prestigious variety of the language, see [8,9]?

Data from three English dialects will also be presented, showing that female speakers are not uniform in their behaviour: some females merge vowels more often than do males, while other female populations appear to differentiate the same vowels more systematically. The perceived social prestige of an accent is offered as one explanation for these disparate directions of change. Implications in speech technology, in terms of sex-differentiated recognition algorithms, and improved sex-specific speech synthesis (hypo- and hyper-articulation) will also be discussed.

CROSS-LANGUAGE DATA

Data from six phonetic studies are presented in Figure 1. Vowels are plotted in the F1-F2 space, with formants converted to the Bark scale. Data were normalized for perceptual comparison on a single referential system, by subtracting 1 Bark from the female values (1 Bark might equally well have been added to the male values). Motivations for this auditory normalization appear in [1], [6].

Details about the experimental collection methods for the languages and dialects appear in Henton, [4] and [6]. Languages illustrated in Figure 1 are (a) British English, Received Pronunciation (RP); (b) British English, Modified Northern (MN); (c) General American English; (d) French oral vowels; (e) Swedish long vowels; (f) Standard Dutch vowels. Vowels were also studied in Utrecht Dutch. From the series of plots, a pattern can be detected. In all cases, the females' vowel spaces are larger, more peripheral than those of the males, and particularly so in the F1 dimension.

DISCUSSION

Clear enunciation is a trait that has been associated consistently with female speech (see, *inter alia*, Kramer, [7]). This could mean several things phonetically. Firstly, women may 'over-articulate', i.e., they may use fewer grammatical and phonetic weak forms. From acoustic phonetic data it is impossible to observe grammatical hyper-articulation, since vowel measurements are most commonly obtained from word-lists or citation forms. It is nevertheless possible to speculate that women may produce phonetic hyperarticulation. Secondly, women may use the periphery of the articulatory space, compared with men whose vowels might be closer to the centre. In general, females' articulatory gestures appear to be more extreme across languages, and this greater articulation is achieved with the degree of jaw openness.

Both Labov [8] and Goldstein [2] have implied that, when possible, females will adopt a more 'open-mouthed' articulatory posture than will males. Labov [1990, p.219] returned to this theme more recently and observed that in some of the earlier literature research indicated that females were actively increasing the dispersion of the vowel system, by raising the peripheral tense vowels in Detroit English; whereas the male speakers exhibited shifts in the opposite direction, causing them to be more 'close-mouthed'. This tendency was also noticed tangentially for Swedish by Sundberg [10].

There is a possible connection between females' 'open-mouthedness' and the two principles of sexual differentiation in speech that Labov [8] invoked. Labov's first principle is that, "In stable sociolinguistic stratification, men use a higher frequency of non-standard forms than women" [1990, p. 205]. Linked to this principle is the fact that, "in (the) stable situations...women appear to be more conservative and favor variants with overt social prestige, whereas men do the reverse" [1990, p. 206]. There are a plethora of studies of various variables (notably the alternation of velar/alveolar nasal in "-ing/-in" in British, American and Australian English; the realizations of the interdental fricatives in English, and the various realizations of /s/ in Latin American and Peninsular Spanish) which all indicate that men use significantly more stigmatized forms than do women.

Any parallel between non-standard grammatical or lexical forms and the acoustic realizations of vowels has not, to my knowledge, been investigated explicitly, but would be worthwhile. Given that women can only exhibit their conservative or prestige-seeking behaviour when the opportunity arises, it does not seem unreasonable to assume that women in the phonetic studies were aware that they had been selected as speakers of a standard variety of the language; in the closely controlled environment of recording citation forms n a laboratory setting they would do their best to produce those standard and prestige forms that they had consciously or unconsciously come to guard.

The second principle proposed by Labov (ibid.) is that, "in change from below, women are most often the innovators." It is not possible to observe 'change from below' in the acoustic data here; in the one case where change might be said to have occurred - in the British English speech of the Modified Northerners (MN) - change has come from above, with the MN speakers changing their accents in the direction of the more prestigious RP.

Turning to the second of Labov's suppositions in his first principle above, namely that males' vowels are closer to the centre of a given vowel space, we may review data for two vowels in three dialects of English. The vowels are schwa and caret, which occur sequentially in an RP pronunciation of the word "above". Both are non-peripheral vowels. Using data from British English RP and MN, and West Coast American English, Henton [5] showed that in all three accents, the variability of the females' realizations of these vowels was significantly greater than that of the males. It was particularly in the F1 dimension that the females varied so widely, as could be seen in the coefficient of variation values. Furthermore, in West Coast American English, the male speakers centralized caret so much that, to all intents and purposes, they have only have one central non-rhotic vowel (schwa).

CONCLUSIONS

There is a regularity in the production of vowels across four languages, or seven dialects. Female speakers produced more open-mouthed variants of vowels than do males. If greater articulatory distinction may be equated with standard or prestige forms, then women can again be seen as guardians of the standard. Patricia Kuhl (personal communication) has indicated in her studies of cross-linguistic utterances by American English and by Swedish mothers to infants that the mothers tend to over-articulate, produce 'clearer' tokens when talking to babies than when talking to other adults (cf. Labov's reflections on the role of women in child-care, [1990, p.219].

To attribute linguistic change to one simple variable is dangerous. The exploration of these data invites an explicit investigation of whether women articulate more distinctively than men do. It has been suggested that re-plotting the current cross-language data on a

logarithmic scale would enable articulatory inferences to be made more appropriately than the Bark scale allows. A log. scale would probably render more conservative differences, but if (as is to be expected) the female-male differences remain, then the argument for females being more 'open-mouthed' would be all the more robust. Such a re-plotting will be presented in due course.

APPLICATIONS

Far from female speech being a "tongueless slobber" (Henry James, 1906), it seems that females make a greater to keep vowels more distinct than males do. With further data, it might be possible to determine empirically whether female speakers are more potentially more intelligible because of their greater differentiation of the peripheral vowels. For speech synthesis research this might imply that the F1 parameters of vowels in female speech need to be adjusted by a greater amount than might be expected by comparison to males' open vowel values. Intelligibility in speech synthesis has already reached asymptote, but increasing F1 would also add to the naturalness of the female voices. In speech recognition research it was assumed for many years that women were more difficult to recognize. The reasons given for such bias were nebulous, usually phrased in such terms as 'women's speech is so much more musical' or 'it's so variable'. Several facts militate against these sexist assumption: first, women's speech is not necessarily more intonationally variable (see [3]); second, current speech recognition techniques commonly dispense with any prosodic information; and third, women's vowels at least are more distinct than are mens'. Resistance has not lain in the technology, but rather been perpetuated by an androcentric scientific heritage focussing on males' speech alone. Most cogently, it has transpired that at least in English women's speech is generally *easier to recognize* than mens' speech.

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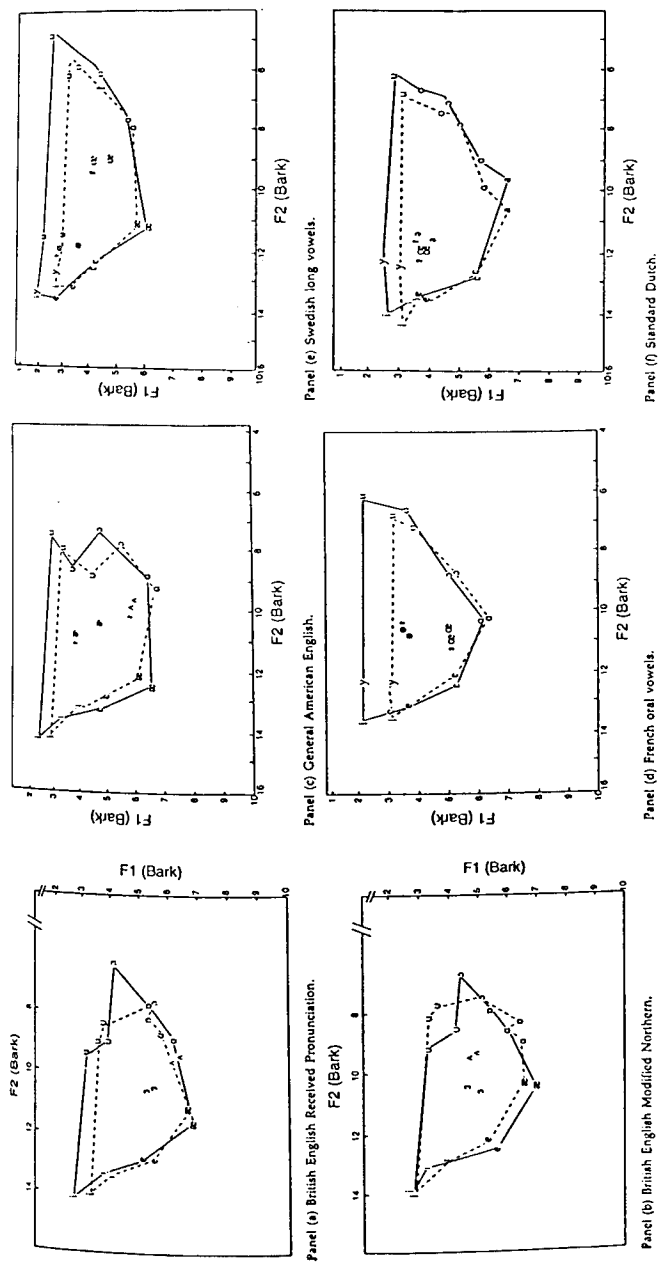

Figure 1 Mean formant values of vowels in each of six languages and dialects, plotted in a Bark-scaled F1-F2 space. Females' peripheral vowels are joined by a solid line, males' peripheral vowels by a dashed line. Panel (a) shows British English Received Pronunciation (RP); Panel (b) shows British English Modified Northern (MN); Panel (c) shows General American English; Panel (d) shows French oral vowels; Panel (e) shows Swedish long vowels; Panel (f) shows Standard Dutch vowels.