THE EFFECT OF VOWEL HEIGHT ON PATTERNS OF ASSIMILATION NASALITY IN FRENCH & ENGLISH

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ABSTRACT

Assimilation nasality patterns for French and English vowels were studied as subjects (15F;15E) spoke them in CVC, NVN, NVC, and CVN contexts. Corresponding oral and nasal acoustical signals were transduced by a Nasometer, stored separately on FM tape, low-pass filtered and digitized. The vowel portion of each digitized signal was isolated, converted to rms values, and the degree of nasalance established by comparing rms amplitudes of corresponding oral and nasal data across the vowel's duration. High vowels in both languages exhibited a higher degree of assimilation nasality than lower vowels, although for a given vowel height, French exhibited less assimilation nasality than English.

1. INTRODUCTION

The assimilation of nasality onto vowels spoken in the context of nasal consonants has been documented by research using various methods (aeromechanical, acoustical, biomechanical, perceptual). Furthermore, it has been suggested that differences in degree of assimilation nasality exist among vowels as a function of tongue height. The research reported here used acoustical analog recording and digital analysis techniques to quantify and compare assimilation nasality patterns in French and English as a function of vowel height.

2. PROCEDURES

2.1. Subjects/Speech Sample

Subjects were 30 young adults, 15 native speakers of Standard French and 15 of Canadian English, with normal hearing, voice qualities and articulation patterns. They read aloud words in which English vowels /i, I, ɛ, a, u/ and French /i, ɛ, a, u, y/ were embedded in the contexts CVC, NVC, CVN and NVN, where V= one of the target vowels, C= a non-nasal obstruent and N= /m/ or /n/. Each word was produced as the terminal item in a carrier phrase, e.g.,"A half keen"; or "Neuf quines."

2.2. Data Collection/Analysis

The oral and nasal acoustical signals corresponding to subjects' productions of the test words were transduced separately by means of a Kay Elemetrics Nasometer 6200. The Nasometer microphone signals were recorded simultaneously on separate channels of an FM tape recorder, low-pass filtered at 4.8 kHz and digitized at 10 kHz via CSpeech [5]. The vowel portion of the oral and nasal component of each digitized signal was isolated, converted to an rms value, and the degree of nasalance computed by comparing rms amplitudes of corresponding oral and nasal data across the duration of the vowel in 5 ms steps, according to the formula: % nasalance = nasal rms/(nasal + oral rms) x 100. Data analysis focussed on three dependent measures: 1) degree of nasal resonance, using 0.5, or 50% nasalance as an arbitrary threshold, 2) percentage (%) of the vowel with nasalance values above 0.5, and 3) absolute duration (msec) of the vowel with nasalance above 0.5.

3. RESULTS

3.1. CVC data, French & English

Figure 1 depicts the percentage of CVC cases without significant nasalance (i.e., <0.5). In the majority of cases, nasalance levels did not exceed the arbitrary threshold of 0.5, although the number of cases in which this was true was smaller for /i/ in both languages.

3.2. NVN data, French & English

Figure 2a graphs the percentage of NVN cases where nasalance was above the criterion of 0.5 at both ends of the vowel (including cases where it dipped below 0.5 in the middle). Figure 2b displays only those cases where the entire duration of the vowel exhibited nasalance levels above 0.5. Both languages show a noticeable difference between /i/ and /a/, with /i/ exhibiting a higher sustained nasalance level throughout the vowel's duration. In French, more clearly than in English, /u/ occupies an intermediate position between /i/ and /a/ with respect to this phenomenon.

3.3. NVC data, French & English

Figures 3a and b illustrate the patterns of carry-over nasalization in the NVC context for /i, u, ɛ and a/ in French and English. A larger percentage of the vowel exhibits the carry-over effects of the preceding nasal consonant when the vowel is high than when it is low, and the percentage of the vowel exhibiting the nasal consonant's influence is roughly the same in French and in English (3a). The absolute durations of the nasalized portions are shorter, however, in French (3b).

3.4. CVN data, French & English

Figures 4a & b illustrate the percentages and absolute durations of the French and English target vowels that are nasalized in anticipation of the final nasal in the CVN context. High vowels /i/ and /u/ tend to exhibit anticipatory nasalance levels greater than 0.5 across a larger percentage of their durations compared to mid or low vowels in both languages, though French always reveals less anticipatory nasalization than English for the vowels considered.

3.5. NVC data, English

Figures 5a & b compare carry-over nasalization patterns among English vowels /i, u, I, ɛ, a/. The carry-over effects of the initial nasal consonant influence a larger portion of the high vowels than of the others, and the effect is consistent whether one considers the percentage of vowel nasalized (5a), or the absolute duration of the nasalized segment (5b).

3.6. CVN data, English

Figures 6a & b compare anticipatory nasalization patterns among the English vowels. As in the NVC context, the high vowels exhibit more influence of the nasal consonant than the other vowels. A comparison of the proportional carry-over and anticipatory data for the English vowels (5a & 6a) reveals that, except in the case of /i/ where the proportions of the vowel nasalized are comparable in both the NVC and CVN contexts, for the other vowels the amount of nasalization is greater in the anticipatory situation.

3.7. NVC data, French

Figures 7a & b compare carry-over nasalization patterns among French vowels /i, y, u, ɛ, a/. The patterns for these vowels are similar to those for English with respect to vowel height: The initial nasal consonant influences a larger portion of the high vowels than of the others, and the effect is consistent for the percentage of the vowel nasalized (7a) and the absolute duration of the nasalized segment (7b).

3.8. CVN data, French

Figures 8a & b compare anticipatory nasalization patterns among the French vowels. As in the NVC context, the high vowels exhibit more influence of the nasal consonant than the other vowels. When the French carry-over and anticipatory patterns for percentage of the vowel nasalized are compared (7a & 8a), the low vowels exhibit about the same amounts of carry-over and anticipatory nasalization. The high vowels, on the other hand, exhibit more carry-over than anticipatory nasalization effects.

4. SUMMARY/DISCUSSION

4.1. For these 30 subjects in the contexts examined, French always exhibited less assimilation nasality than English. This was true for all vowels considered and for the NVC and CVN contexts. These results support the validity of Delattre's pedogogical recommendation to English speakers of French that they prevent premature anticipation of the nasal consonant in the CVN context in order not to nasalize the vowel [3]. These data do not, however, support Delattre's assertion that French vowels followed by a nasal consonant remain oral throughout their duration.

4.2. The degree of vowel nasalization in a nasal consonant context varied with the height of the vowel. High vowels exhibited more assimilation nasality than low vowels. This correlation is very systematic in the French vowel data; it also applies to the English vowel data, although less systematically. The apparent contradiction between these results and those of Clumeck [1] may be related to his use of the term "nasalized" to describe articulatory gestures of the velum, and the fact that the biomechanical behavior of the velopharynx cannot be assumed to be monotonically related either to the perception of nasal resonance or to the acoustical consequences of nasal coupling during speech production. The perception or measurement of nasal resonance is ultimately a function of the relative acoustical impedances of the oral and nasal cavities, as well as the formant frequency values of the vowel in question. The spectral envelopes of /i/ and /u/ are markedly affected by small nasal coupling, whereas vowels with a more open tract configuration are much less affected by small degrees of coupling [2]. This is consistent with listeners' judgements that the amount of nasal coupling necessary for the perceptual identification of nasalization was almost three times as much for low vowels as for high ones [4].

5. CONCLUSIONS

5.1. The difference in the degree of nasalance between French and English may be related to the fact that English does not have phonemic nasal vowels and therefore can "tolerate" higher levels of assimilation nasality.

5.2. The higher levels and longer durations of assimilation nasality observed for the high vowels in both French and English are related to the acoustical impedance of the vocal tract for the production of these vowels. There is no obvious articulatory or physiological reason for the earlier lowering of the velum observed by Clumeck [1] for low vowels in the CVN context. It may simply be that such lowering does not have an undesirable acoustical effect, and does not lead to excessive perceptible nasalization of these vowels. Later lowering of the velum for high vowels, however, may ensure that their spectral envelopes are not too drastically affected by extraneous nasal resonance.

5.3. Further research on assimilation nasality is recommended by means of simultaneous multidimensional sampling methods that could consider biomechanical, perceptual and acoustical parameters of vowel production without losing sight of the phonemic characteristics of the languages sampled.

6. REFERENCES

[1] CLUMECK, H. (1976), "Patterns of soft palate movement in six languages" *Journal of Phonetics 4*, 337-351.

[2] CURTIS, J. (1968), in "*Cleft Palate and Communication,*" D. Spriestersbach & D. Sherman (eds.) New York: Academic.

[3] DELATTRE, P. (1951) "A l'usage des étudiants anglo-américains" 2nd ed. *Principes de Phonétique Française*, Middlebury, VT: Middlebury College.

[4] HOUSE, A. and STEVENS, K. (1956) "Analog studies of the nasalization of vowels" *Journal of Speech & Hearing Disorders 21*, 218-232.

[5] MILENKOVIC, P. (1990) Department of Electrical & Computer Engineering, University of Wisconsin, Madison, WI 53705 U.S.A.

FIGURE 1: % /CVC/ CASES WITHOUT SIGNIFICANT NASALANCE (<0.5)

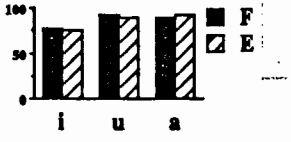

FIGURE 2a: % /NVN/ CASES WITH NASALANCE >0.5 AT BOTH ENDS

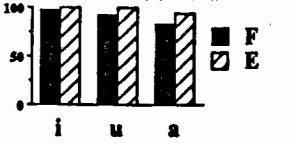

FIGURE 2b: % /NVN/ CASES WITH NASALANCE >0.5 OVERALL

FIGURE 3a: /NVC/ FRENCH & ENGLISH PERCENTAGE OF VOWEL NASALIZED

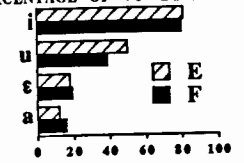

FIGURE 3b: /NVC/ FRENCH & ENGLISH DURATION OF NASALIZATION (MSEC)

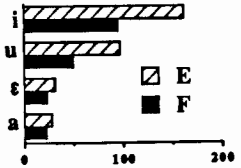

FIGURE 4a: /CVN/ FRENCH & ENGLISH PERCENTAGE OF VOWEL NASALIZED

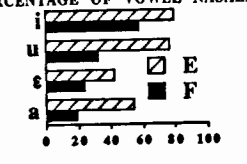

FIGURE 4b: /CVN/ FRENCH & ENGLISH DURATION OF NASALIZATION (MSEC)

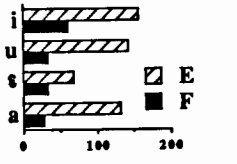

FIGURE 5a: /NVC/ ENGLISH PERCENTAGE OF VOWEL NASALIZED

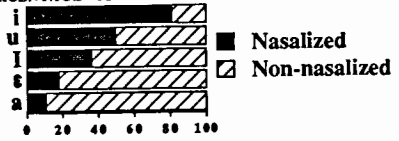

FIGURE 5b: /NVC/ ENGLISH DURATION OF NASALIZATION (MSEC)

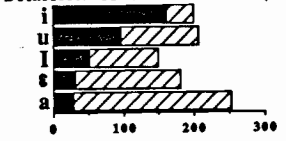

FIGURE 6a: /CVN/ ENGLISH PERCENTAGE OF VOWEL NASALIZED

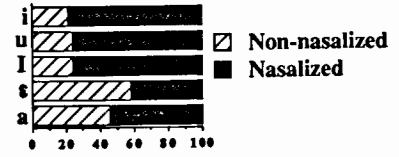

FIGURE 6b: /CVN/ ENGLISH DURATION OF NASALIZATION (MSEC)

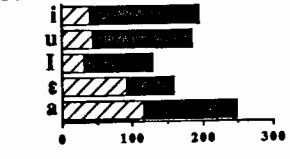

FIGURE 7a: /NVC/ FRENCH PERCENTAGE OF VOWEL NASALIZED

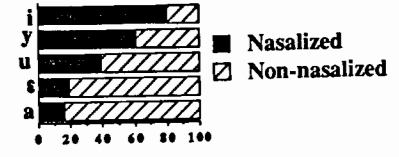

FIGURE 7b: /NVC/ FRENCH DURATION OF NASALIZATION (MSEC)

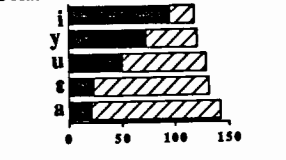

FIGURE 8a: /CVN/ FRENCH PERCENTAGE OF VOWEL NASALIZED

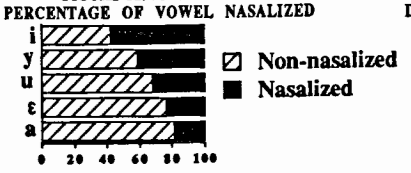

FIGURE 8b: /CVN/ FRENCH DURATION OF NASALIZATION (MSEC)