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CHARACTERISTICS OF NASALANCE IN CANADIAN SPEAKERS OF ENGLISH AND FRENCH

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ABSTRACT

This investigation was designed to evaluate, instrumentally (Nasometer), the relative amount of oral and nasal acoustic energy (in percent nasalance) displayed in the speech of 1751 Canadian speakers of English and French from several regions of the country. Results of the investigation indicate that there were significant differences among the data for two of the three passages assessed in English and French, indicating different levels of nasalance could be expected in production by normal speakers of various ages. In addition, there were differences in nasalance values for regions of the country and ages of the participants. For several of the passages, there were gender differences with female speakers demonstrating slightly greater nasalance values for certain age groups, languages, and regions of the country. These normative nasalance data in both languages are discussed in terms of the different nature of nasal phonemes (consonants and vowels) in the two languages, the articulatory component of each language, and the characteristics of the Nasometer itself.

I. INTRODUCTION

Dialects differ from one another in their phonetics, phonology, morphology, syntax, and lexicon. Dialect variation is studied for purely descriptive ends, for what it may demonstrate theoretically about language, for what it may show about social history and movement of peoples, as well as for many other reasons [1].

Dialect variation has special importance for the speech-language pathologist. A clinician has to be aware of regional or social dialect characteristics in order to avoid diagnosing those characteristics as symptoms of a disorder of speech or language. A related area concerns standardized tests that are used diagnostically in the field of Speech-Language Pathology. The norms for those tests may assume certain dialect characteristics. It is possible that a particular score on a standardized test may fall outside the clinically normal range if the standard dialect is assumed as the normal referent, even though that score may be clinically normal for a speaker within a region where a non-standard dialect is spoken. In any case where this situation may occur, dialect description is of more than passing interest.

Velopharyngeal function, which controls the oral-nasal dimension of speech, is an area of interest because of the frequency of its impairment within the population. As a result, a number of methods are used to assess velopharyngeal function [2], either by directly viewing it (e.g., with videoflouroscopy or nasendoscopy) or by inferring the functional competence of the velopharyngeal mechanism from aeromechanical or acoustical measurements (e.g., by means of pressure/flow or accelerometry) [3]. The recent commercial availability of the Nasometer (Kay Elemetrics Corporation, Pine Brook, New Jersey, U.S.A.) has provided a relatively simple, noninvasive means of assessing or inferring velopharyngeal function acoustically. This computer-based device dynamically monitors the ratio of nasally-emitted sound energy to the sum of nasally and orally-emitted (i.e., total) sound energy in speech. The resultant value, termed "nasalance," may be averaged over a time period corresponding to a particular utterance. For clinical purposes, the mean percent nasalance for a given utterance is compared to norms for the same utterance.

It is apparent that a subject's nasalance score is determined by the phonetic composition of the utterance, the functioning of the velopharyngeal mechanism, and, theoretically at least, the dialect of the speaker. In clinical use, the examiner controls for phonetic composition by using standard test passages (e.g., the Zoo, Rainbow and Nasal Sentence passages for English). The nasalance score, therefore, should be an indicator of the functional condition of the velopharyngeal mechanism [4]. However, the contribution of dialect is unknown until it is directly investigated. Only recently has the question of variance in nasalance across dialects been addressed in selected regional varieties of English [5].

To our knowledge, no norms or test passages existed for nasometric assessment in any dialect of Canada's other official language, French. Thus, the objective of the present study was to establish Canadian nasometric norms in both English and French on standard reading passages.

II. METHOD

2.1 Subjects

Seventeen hundred and fifty-one native speakers of English and French (1356 English, 395 French), including 754 female and 602 male speakers of English, and 216 female and 179 male speakers of French served as subjects. The speakers were arbitrarily subdivided into six age groups (i.e., 7-12; 13-19; 20-44; 45-64; 65-84; 85+ years) for comparative purposes. [As data collection for this project is ongoing toward an ultimate goal of several thousand subjects, the sample of 1751 represented by the data reported here is characterized by unequal numbers of French and English speakers within and across regions and age groups.] All speakers for whom data are included were judged by the investigators or self reported to have normal speech, language and hearing.

2.2 Instrumentation

Three Kay Elemetrics Nasometers (model 6200) connected to separate AT computers were used to collect the nasalance data. The oral and nasal acoustic components of each subject's speech while reading aloud were sensed with microphones on either side of a sound separator that rested on the person's upper lip. The resultant signal was filtered and digitized by custom electronic modules and then measured for nasalance by the computer and accompanying software (Kay Elemetrics, Version 1.7). Calibration methods and instructions to subjects were standardized across recording centres according to the Nasometer manufacturer's specifications and to the examiners' satisfaction considering the language samples being obtained and the age of the speakers. Subjects were recorded in either the Humanosphere Centre of Science North, Sudbury, Ontario, The National Museum of Science and Technology, Ottawa, Ontario, or the Department of Speech Pathology and Audiology at the University of Alberta, Edmonton.

2.3 Reading Passages

The French passages were specifically designed to correlate with the English passages already in use by other researchers for development of a normative data base in North America (i.e., the Zoo, Rainbow and Nasal Sentence passages). French Passage #1 (La Peur du Tigre, comparable to the Zoo Passage in English) contained no nasal consonants; French Passage #2 (Le Petit Prince, comparable to the Rainbow Passage in English) contained 13.75% nasal consonants; French Passage #3 (Blanche Neige, comparable to the Nasal Sentences in English) contained 28% nasal elements. Each subject read aloud the three passages in his/her native language, and the data obtained from the Nasometer for each reading were stored on computer for later statistical analyses.

III. RESULTS

3.1 Nasalance Scores

<u>Zoo and French #1 Passages</u>

Table 1 contains the means and standard deviations of the nasalance scores derived from the readings of the Zoo and French #1 passages. These data are presented according to geographical region and gender of the speaker.

The analysis of variance (ANOV) using scores from the three regional speech patterns and two languages resulted in a significant difference by region [(F2, 1716) = 11.66; p < .0001] and age [(F5, 1716) = 5.09; p < .0001]. There were no significant differences in nasalance scores for the languages used (Zoo/French #1). There were no interaction effects.

Post-hoc comparisons for regional contrasts revealed significant differences (p=.05) between the Ottawa and Alberta and Alberta and Sudbury nasalance scores on the passages containing no nasal consonants (Zoo and French #1). Further post-hoc analyses for age effects were calculated (see Table 2). The younger groups (7-12; 13-19) differed significantly (p=.05) from the older age groups (65-84; 85+) for the Zoo and French #1 passages.

<u>Rainbow and French #2 Passages</u>

Table 1 contains the means and standard deviations of the nasalance scores derived from the readings of the Rainbow and French #2 Passages. These data are presented according to geographical region and gender of the speaker.

An ANOV using scores from the three regional speech patterns and two languages resulted in significant differences by language [(F1, 1717) = 38.10; p<.0001], by gender [(F1, 1717) = 8.35; p < .004], by age [(F5, 1717) = 4.67; p < .0003], and by region of the country [(F2, 1717) = 11.30; p < .0001].

The post-hoc analyses indicated (see Table 2) that the French #2 Passage had significantly (p = .05) lower nasalance scores that its English counterpart, the Rainbow Passage. Post-hoc analyses also confirmed that females had significantly (p = .05) greater nasalance scores than males within each language. With respect to the age factor, the younger age group (7-12 years) had significantly lower (p = .05) nasalance scores than the two older groups (65-84; 85+ years) on post-hoc testing. In addition, the data obtained from subjects in the Alberta region exhibited significantly lower (p = .05) nasalance scores than those obtained from either the Ottawa or Sudbury regions. There were also significant interactions between language and region, gender and age, and age and region.

<u>Nasal Sentences and French #3 Passages</u>

The information in Table 1 contains the means and standard deviations of the nasalance scores from the readings of the Nasal Sentences and French #3 Passages. These data are presented according to geographical region and gender of the speaker.

The ANOV using scores from the three regional speech patterns and two languages resulted in significant differences by language [(F1, 1706) = 326.1; p < .0001], by gender [(F1, 1706) = 4.21; p < .004], by age [(F5, 1706) = 3.41; p = .004], and by region [(F2, 1706) = 11.05; p = .0001].

Post-hoc analyses (see Table 2) indicated that there was a significant difference (p=.05) between the two passages, with the English Nasal Sentences exhibiting 25-30% more nasalance than the French #3 Passage. Females (in both languages) demonstrated significantly greater (p=.05) nasalance values than males. There was also a significant difference (p=.05) between the nasalance scores of the younger age groups (7-12; 13-19) and the older age groups (65-84; 85+). In addition, data from the Alberta region demonstrated significantly (p=.05) lower nasalance scores than those obtained from either of the other two regions, particularly for the French #3 Passage readings.

Table 1. Means and standard deviations of nasalance scores (%) of the three regions studied for males and females in English and French.

		Passages			
Region	Gender	Zoo Mean	SD	French #1 Mean	SD
Alberta	M	11.2	4.7	10.0	3.9
	F	10.4	3.9	9.8	3.3
N = 163			N = 43		
Ottawa	M	14.5	5.7	15.6	5.8
	F	13.6	5.1	16.1	6.6
N = 451			N = 236		
Sudbury	M	13.6	9.2	15.2	8.5
	F	14.2	8.0	14.4	6.4
N = 742			N = 116		
		Rainbow		French #2	
Alberta	M	31.6	5.3	24.3	3.5
	F	33.4	2.8	24.3	4.0
Ottawa	M	33.3	6.2	29.4	7.4
	F	35.6	6.4	31.0	7.0
Sudbury	M	34.0	9.8	28.9	7.1
	F	37.2	10.0	28.7	5.9
		Nasal Sentences		French #3	
Alberta	M	59.7	7.0	32.5	4.6
	F	62.6	4.5	30.0	4.8
Ottawa	M	62.2	7.6	39.1	9.1
	F	62.5	7.9	42.2	8.4
Sudbury	M	61.5	9.4	37.0	9.4
	F	63.7	9.2	38.4	8.8

Table 2. Means and standard deviations of nasalance scoress (%) for English and French Passages by age and gender.

Passage	Gender	Age Group	Mean	SD
Zoo	M	7-12	11.6	5.3
	F	7-12	11.2	4.7
French #1	M	7-12	12.3	4.3
	F	7-12	12.4	5.4
Zoo	M	13-19	11.1	5.3
	F	13-19	11.3	5.4
French #1	M	13-19	10.8	4.0
	F	13-19	11.9	6.5
Zoo	M	20-44	13.0	6.6
	F	20-44	13.1	6.3
French #1	M	20-44	15.8	8.7
	F	20-44	16.1	6.9
Zoo	M	45-64	12.9	6.0
	F	45-64	14.0	6.4
French #1	M	45-64	16.4	5.4
	F	45-64	15.0	3.6
Zoo	M	65-84	16.1	6.8
	F	65-84	14.4	6.5
French #1	M	65-84	19.2	7.3
	F	65-84	13.3	8.9
Zoo	M	85+	17.4	0.0
	F	85+	12.7	0.0
French #1	M	85+	15.5	8.7
	F	85+	16.7	2.7
Rainbow	M	7-12	31.6	6.8
	F	7-12	32.7	5.0
French #2	M	7-12	26.3	5.8
	F	7-12	26.4	5.2
Rainbow	M	13-19	32.7	5.1
	F	13-19	34.0	5.5
French #2	M	13-19	25.8	4.7
	F	13-19	27.2	5.9
Rainbow	M	20-44	33.7	6.1
	F	20-44	35.7	6.3
French #2	M	20-44	28.2	5.8
	F	20-44	31.6	6.9
Rainbow	M	45-64	32.4	5.7
	F	45-64	36.9	5.5
French #2	M	45-64	31.5	5.4
	F	45-64	32.0	5.5
Rainbow	M	65-84	34.1	15.1
	F	65-84	37.0	8.0
French #2	M	65-84	34.5	8.8
	F	65-84	25.3	11.8
Rainbow	M	85+	33.5	0.0
	F	85+	37.6	0.0
French #2	M	85+	27.6	12.5
	F	85+	31.2	4.7
Nasal Sentences	M	7-12	60.8	8.2
	F	7-12	62.0	6.9
French #3	M	7-12	34.3	7.5
	F	7-12	35.3	6.0
Nasal Sentences	M	13-19	61.3	7.7
	F	13-19	62.1	7.0
French #3	M	13-19	35.5	5.9
	F	13-19	36.8	9.8
Nasal Sentences	M	20-44	61.7	7.5
	F	20-44	63.1	7.6
French #3	M	20-44	37.8	7.7
	F	20-44	41.4	7.2
Nasal Sentences	M	45-64	59.7	7.1
	F	45-64	65.1	7.1
French #3	M	45-64	38.9	5.7
	F	45-64	42.5	7.4
Nasal Sentences	M	65-84	61.6	10.8
	F	65-84	64.9	7.4
French #3	M	65-84	45.3	11.0
	F	65-84	35.7	7.4
Nasal Sentences	M	85+	64.4	0.0
	F	85+	55.4	0.0
French #3	M	85+	36.0	16.4
	F	85+	40.0	9.0

IV. DISCUSSION

This study was designed to obtain normative information on nasalance in dialects of English and French spoken in Canada by male and female subjects representing a wide range of ages and several regions of the country.

In general, the results of the present investigation suggest that while the French passages were designed to be comparable to the English in percent nasal components, there were differences between French and English in the average overall percent nasalance recorded for two of the three passages. French passages #2 and #3 exhibited lower overall nasalance compared to their English counterparts (the Rainbow Passage and the Nasal Sentences, respectively), despite an attempt to match the proportionate number of nasal phonemes in the passages in the two languages. For example, the nasal passage in French (#3) was constructed to have 28% nasal elements, but on average, French-speaking subjects demonstrated 37% nasalance on this passage compared to the 62% nasalance exhibited by English speakers for the Nasal Sentences. Several hypotheses are advanced to explain this difference. The first relates to the different nature of nasal phonemes in English and French. The balance of nasals between equivalent passages in the two languages was based on the number of nasal phonemes in each passage. In English, nasal consonants are the only nasal phonemes; segments incidentally nasalized by coarticulation were not counted in the total, as they are not phonological nasals. In French, nasal consonants and phonologically nasalized vowels were counted as nasal phonemes; again, incidentally nasalized segments were not counted. Thus, French passages #2 and #3 contained proportionately as many nasal consonants and nasal vowels as the corresponding English passages contained nasal consonants alone.

The Nasometer functions by comparing, dynamically, the amplitude of the nasally-emitted acoustic energy to the sum of the nasally- and orally-emitted acoustic energy. That is, the nasalance score is not a measure of the absolute acoustic energy emitted from the nose, but rather is the proportion of the total acoustic energy emitted that is passed from the nose. Thus, a nasal consonant, whose component of orally-emitted acoustic energy is very low, typically obtains a considerably higher nasalance score that does a nasal vowel for which the orally-emitted component is proportionately much higher. Because all nasal phonemes in English are consonants, but a large proportion of the nasal phonemes in French are vowels, the nasalance score in French can be expected to be lower overall for balanced passages. To the extent that this explains the difference in scores between the two languages for the passages that contain nasal phonemes in this research, the lower nasalance score in French does not necessarily correspond to a lower overall amount of acoustic energy emitted nasally by French speakers.

The second hypothesis relates to the fact that nasalization of vowels is phonologically distinctive in French but not in English. Thus, it may be expected that speakers normally will exercise greater care in the production of features whose inaccurate realizations may lead to perceptual ambiguity. Therefore, control of nasality in vocalic and semivocalic segments may be expected to be more precise in spoken French than in spoken English. [6]

The third consideration is that dialects may vary in nasalance, as Seaver, et al. [5] have found in English. That is, the aperture of the velopharyngeal port, at least in segments other than plosives and high-pressure fricatives and affricates, may be in part a matter of articulatory set typical of a particular dialect. In a similar way, this aspect of articulatory set may be characteristic of a given language. It is not unreasonable to hypothesize that English generally may have a greater degree of velopharyngeal port opening (and therefore nasal coupling) in the neighborhood of nasal segments as a matter of habitual production (articulatory set) than does French. Support for this hypothesis in the present study is seen in the equivalency of the nasalance scores for the Zoo and French #1 passages which have no nasal elements in their construction. Both passages give nasalance values that are comparable and may be used by clinicians to assess English- or French-speaking individuals who have or are suspected of having velopharyngeal inadequacy.

Differences reported here in nasalance values for the English and French passages according to gender are generally consistent with other research. Lower nasalance scores for males also have been reported by Seaver, et al. [5], Fletcher [7], and Hutchinson, Robinson, Nerbonne [8]. Several explanations may account for this result. First, it has been reported that females demonstrate a greater degree of nasal airflow [9] during the production of high pressure consonants than males. Second, given reports that females have slightly different pharyngeal configurations (e.g., greater length and greater anteroposterior dimensions [10]), there may be differences in the active velopharyngeal closure patterns of females and males [11]. A third explanation may be related to the filter characteristics of the Nasometer. Its band-pass filter, 300 Hz wide and centered at 500 Hz, may pass female voices more effectively (nasalance-wise) than male voices. The acoustic consequences of varying pharyngeal sizes and differences in "source-filter" characteristics may interact to provide "real" differences in nasalization characteristics between genders. Alternatively, there may be artifactual differences related to the filter characteristics of the Nasometer that favor males (i.e., less nasalance).

The present data suggest that separate norms for males and females should be employed when evaluating nasalization in individuals. Further, our results contraindicate the use of adult normative data when interpreting nasalance scores for children using the French and English passages employed here. Finally, further research concerning the effects of regional dialects on nasalance scores in French and English in Canada appears warranted. The differences in nasalance scores reported here within and between standard spoken samples of the two official languages of Canada suggest that regional norms need to be established to interpret nasalance information accurately with respect to velopharyngeal function in spoken French and English. For example, the present data may be interpreted to suggest that dialects of French spoken in regions in close proximity to Québec may have more nasalization than those spoken in enclaves more distant or more affiliated with English or other languages.

In conclusion, we believe that the use of the normative data associated with the standard passages in English and French used in this research will aid speech-language pathologists and speech scientists in differentiating normal from abnormal velopharyngeal function. Further research is necessary on a larger sample of subjects of both genders and all ages who exhibit dialectal variations in both languages.

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