Nasalance norms in the speech of greek normal adults: Linguistic, phonetic, gender effects and crosslinguistic comparisons

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ABSTRACT

Normative nasalance scores were obtained for 80 monolingual adult speakers of Greek. The effects of gender, type of linguistic material and phonological ccontext on nasalance scores were examined. Finally, crosslinguistic comparisons were made based on the existing literature. Subjects read aloud syllables, sentences and passages, consisting of nasal, oral and oral/nasal context. In contrast with other languages, the results did not reveal any gender differences. Different nasalance scores were obtained a) for syllables versus sentences and passages, b) for different phonological categories, comparing among vowels and among nasals. Also, velar contexts yielded higher nasalance. Finally, the crosslinguistic comparison of Greek with other languages and dialects revealed that Greek has lower nasalance scores. The nasalance results have clinical utility for the diagnosis and management of adults with resonance disorders caused by velar insufficiency or dysfunction. The impact of language characteristics on speech production demands for appropriate nasality/orality is discussed.

1. INTRODUCTION

A valuable method for the assessment of nasality in speech is to obtain objective, reliable acoustic measures of nasality rather than listener judgements of it (Haapanen 1991[1]; Anderson 1996[2]; Whitehill, 2001[3]). Such measures can be made via the nasometer (Fletcher και Bishop, 1973[4]; Kay Elemetrics, 1994[5]), a microcomputer-based device which uses two microphones to sample the nasal and oral acoustic energy respectively. Several studies report nasalance scores for various languages and dialects, such as English (Hutchinson et al., 1978[6]; Seaver et al., 1991[7]; Vallino-Napoli & Montgomery, 1997[8]; Litzaw & Dalston, 1992[9]; Kavanagh, Fee, Kalinowski, Doyle & Leeper, 1994[10]), Spanish (Nichols, 1999[11]), Flemish (Van Liedre, Wuyts, De Bodt, Van Cauwenberge, 2001[12]), Finnish (Haapanen, 1991), Puerto-Rican Spanish (Anderson, 1996), Cantonese (Whitehill, 2001), Danish (Van de Weijer & Slis, 1991[13]), Canadian English and Canadian French (Leeper, Rochet & MacKay 1992[14]; Kavanagh et al. 1994). Van Liedre (2001) compared the nasalance scores among three different languages and concluded that English and Spanish have higher nasalance scores than Flemish (Van Liedre, 2001). Moreover, several studies have reported gender differences in nasalance scores but their results are inconsistent with respect to which gender yields higher nasalance scores. A few studies indicated that women have higher nasalance scores than men (Hutchinson et al., 1978; Seaver et al., 1991; Vallino-Napoli & Montgomery, 1997). A contrary finding was obtained by Fletcher (1978). At last, other research studies failed to find any differences among the nasalance scores of men and women (Litzaw & Dalston, 1992; Kavanagh et al., 1994). The purposes of the present study were: a) to obtain nasalance norms for Greek, b) to examine nasalance scores as a function of gender, linguistic and phonemic context and c) to draw crosslinguistic comparisons.

2. METHODS

Subjects

80 monolingual Greek adults, 40 men aged 18-32 years old and 40 women aged 18-34 years old, all members of the student community of TEI Patras. The speakers originated from various locations of Greece. Subjects had no history of hearing, speech and language problems. At the date of their participation to his study all were screened for speech, language and hearing acuity in the speech and hearing laboratory of TEI Patras. The hearing screenings included both tone audiometry and tympanometry tests.

Materials

The testing materials consisted of

- 12 syllable types (8 oral and 4 nasals), each uttered in repetition, (see SNAP test, MacKay & Kummer, 1994[15]).
- 5 sentence groups, composed from velars, sibilants, bilabials, alveolars and nasals, respectively. Each group contained 5 sentences.
- 3 texts, i.e. oral, nasal and balanced (oral and nasal sounds in representative ratios for Greek).

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A frequency analysis of oral and nasal phonemes found in greek written text (12 pages from a popular novel) was conducted prior to the development of the text materials. The constructed balanced text contained representative rations of oral and nasal sounds of Greek. The oral and nasal texts contained higher percentages of oral and nasal sounds, respectively, compared to the ones found in the representative written Greek sample.

The selected oral/nasal frequencies as well as their representative frequencies in written Greek are listed in Table 1.

The data was analyzed via the Nasometer 6200 Kay Elemetrics.

Table 1: Constructed vs. natural text frequencies (in parenthesis) of oral and nasal sounds in Greek. The constructed frequencies were used for material development, i.e. oral, nasal and balanced texts.

STIMULUS MATERIAL	Nasal sounds	Oral sounds
Nasal text	23,10% (8,10%)	
Oral text		99,30% (91,80%)
Balanced text	8,60% (8,10%)	91,30% (91,80%)

Subjects were instructed to utter the written material in their normal speaking rate and volume.

3. RESULTS

The means, standard deviations and variation coefficients of nasalance scores were calculated for each subject and type of linguistic/phonetic material. A one-way Manova was used to detect statistically significant effects of gender, type of linguistic material (syllables, sentences, text) and phonemic/phonetic context on nasalance scores. Specific effects were tested via pairwise comparisons, using the Bonferoni correction for post-hoc analysis. Finally, t-tests with a Cohran & Cox correction for uneven and non-uniform samples were used to examine crosslinguistic comparisons.

Nasalance of oral versus nasal sounds

A comparison of nasalance in oral versus nasal material was initially conducted in order to validate nasometric values (Table 2).

Table 2: Nasalance (%) in oral vs. nasal sounds of Greek.

STIMULUS MATERIAL	oral	nasal
syllables	16,23	66,63
sentences	12,80	42,01
text	12,43	42,34

Pairwise comparisons revealed that the oral-nasal differences were statistically significant for syllables $F(1,77) = 744,99$, $p< 0,00000$, sentences $F(1,77) = 18,635$, $p< 0,00005$ and text $F(1,77) = 2294,19$, $p< 0,00000$.

Nasalance as a function of gender

Gender comparisons of nasalance were made for each type of linguistic material and for nasal and oral versions separately. For men vs. women respectively, the nasalance means were 66,32% vs. 66,99% for nasal syllables, 53,20% vs. 42,35% for nasal sentences and 53,07% vs. 42,29% for nasal text. Despite the lower nasalance in the speech of women than men, differences were not statistically significant (nasal syllables: $F\{1,77\} = 0,0322$, $p< 0.858$; nasal sentences: $F\{1,77\} = 0,0428$, $p< 0,837$; Nasal text: $F\{1,77\} = 0,0279$, $p< 0,869$). As for the oral material, for men vs. women respectively, the nasalance means were 15,78% vs. 16,67% for oral syllables, 12,34% vs. 13,25% for oral sentences and 12,04% vs. 13,13% for oral text. No statistically significant differences for oral material were found as a function of gender (oral syllables: $F\{1,77\} = 0,1633$, $p< 0,687$; oral sentences: $F\{1,77\} = 0,428$, $p< 0,515$; oral text: $F\{1,77\} = 0,8257$, $p< 0,366$).

Group Nasalance in Greek

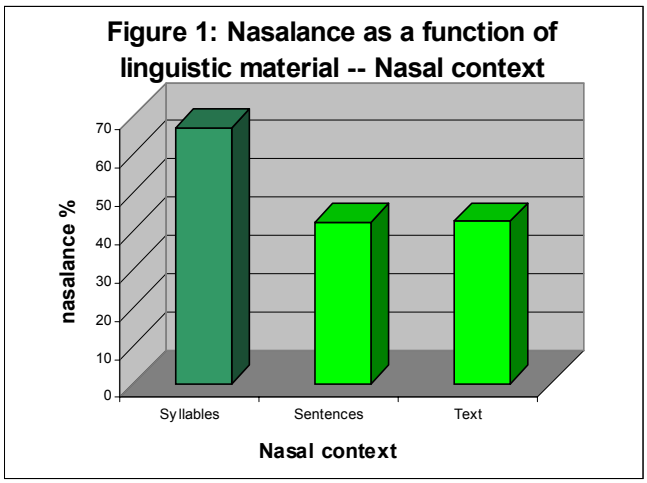
Since nasalance did not differ as a function of gender, data for the balanced (oral/nasal) text was pooled over in order to derive an overall representative nasalance score for Greek (Table 3).

Table 3: Mean, standard deviation and coefficient of variation for nasalance in Greek adult speakers.

	Nasalance
Mean	25,50%
S.d.	5,38
cosin	0,21

Effects of linguistic material

Three types of linguistic material, syllables, sentences and text, were compared with respect to nasalance scores, separately for oral and nasal stimulus materials. Figure 1 shows the mean nasalance scores for nasal syllables, nasal sentences and nasal text. Nasal syllables yielded a statistically significant higher nasalance (66,63%) than sentences (42,01%), i.e. $F(1,66) = 2941,9$, $p< 0,00000$, and text (42,34%), i.e. $F(1,66) = 2917,6$, $p< 0,00000$. Nasal sentences and nasal text yielded very similar nasalance. A comparison among types of linguistic material for oral context yielded similar results with respect to nasalance, i.e. oral syllables had higher nasalance (16,23%) than oral sentences (12,8 %) and oral text (12,43%). This difference was also statistically significant (syllables vs. sentences: $F(1,66) = 148,78$, $p<.0,00000$; syllables vs. text: $F(1,66) = 159,67$, $p<0,00000$.



Phonemic differences

Figure 2 compared the nasalance scores for two nasal consonants, /m/ and /n/ embedded in syllables. The vowel context was /i/ and /a/. The nasal /n/ yielded a statistically significant higher nasalance score than /m/, i.e. F (1,66) = 50,67, p< 0,0000.

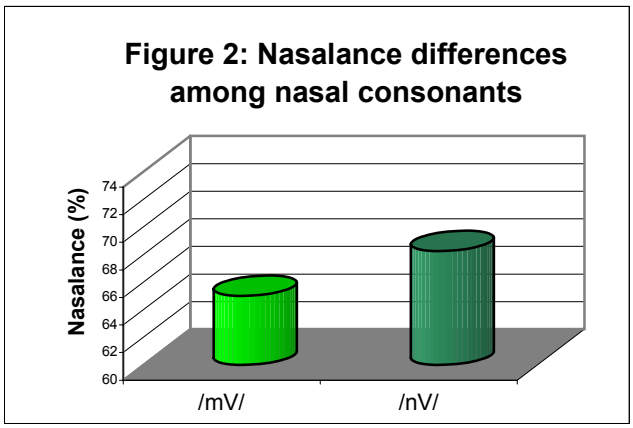
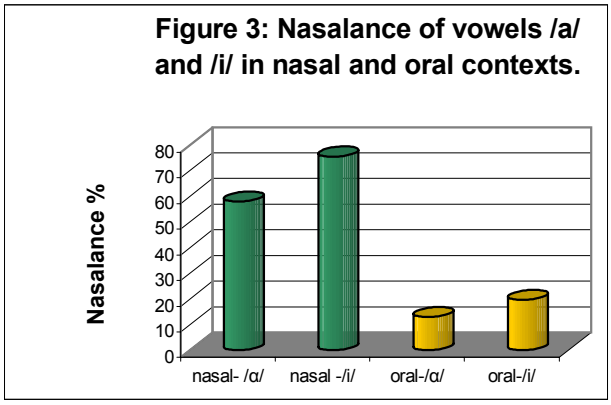
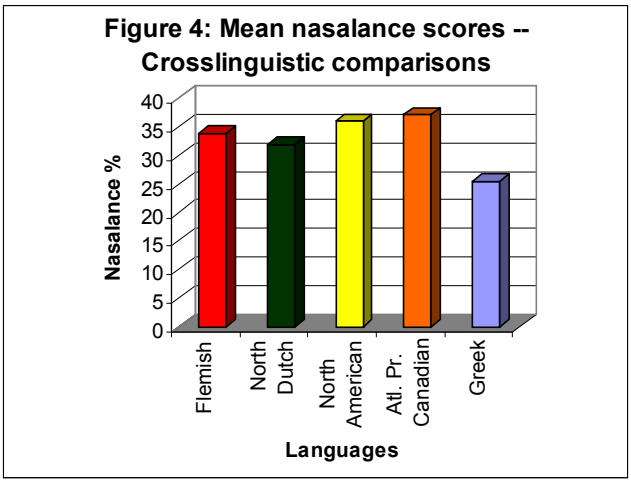


Figure 3 compared the nasalance scores among vowels /i/ and /a/, appearing in nasal and oral consonant contexts respectively. The results indicated higher nasalance values for /i/ than /a/ which were statistically significant for both oral (F{1,77} = 14,19, p< 0,0003) and nasal (F {1,77}= 949,29, p< 0,00000) consonant contexts.



Crosslinguistic comparison

A crosslinguistic comparison of group mean nasalance scores was conducted, comparing Greek with Finnish (Haapanen, 1991), Flemish (Lierde, Wuyts, De Bodt, & Van Cauwenberge 2001) Spanish (Anderson, 1996), Cantonese (Whitehill, 2001, Canadian French (Leeper et al., 1992; Kavanagh et al., 1994), Danish (Van de Weijer & Slis, 1991) and Mid-Atlantic American English (Litzaw & Dalston, 1992). Moreover, a statistical comparison among some languages (Finnish, Spanish, Cantonese) was made based on the reported standard deviations, using two-way t-tests with Cohran & Cox correction. For nasal stimulus materials, statistically significant lower nasalance scores were found for Greek compared to Finnish (t = -11,93, p< 0,05), Spanish (t = -10,88, p< 0,05) and Cantonese ((t= -9,03, p< 0,05), where subjects were matched for gender. For balanced (oral/nasal) stimulus materials, statistically significant lower nasalance scores were obtained for Greek compared to Finnish (t= -8,76, p<0, 05), Spanish (t = -7,66, p< 0,05) and Cantonese (t = -8,95, p< 0,05). Figure 4 shows the mean group nasalance scores for Greek, Flemish, Northern Dutch, Atl. Pr. Canadian and North American English, as derived from balanced (oral/nasal) text. As indicated, Greek shows lower nasalance than all other languages examined.



4. CONCLUSIONS

The lack of objective tools for the assessment of velopharyngeal dysfunction in the greek population formed a strong incentive for undertaking this study. The main purpose was to obtain nasometric values for normal adult speakers of Greek. Nasalance (%), a measure derived from the analysis of speech via the nasometer, is an objective measure of nasality, based on the oral and nasal acoustic energy emitted during speech. The sample used consisted of yound adults originating from various regions of Greece, aged 18-34 years old. Hence, these results are considered representative of the greek population with respect to geographical location, but they have limited

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validity for older greek adults. Future studies should focus on validating the obtained norms for the older greek adult population.

Similarly to other studies (Haapanen 1991; Anderson 1996; Whitehill, 2001), good internal validity was obtained for nasometric measures since oral stimulus materials yielded significantly lower nasalance scores than nasal stimulus materials.

In contrast with most of the examined languages (e.q. Hutchinson et al., 1978; Seaver et al., 1991; Vallino-Napoli & Montgomery, 1997), no gender differences were found in Greek with respect to acoustic nasality, that is, nasalance scores. It can be concluded that uniform test protocols can be developed without taking into account gender differences.

The examination of nasalance as a function of linguistic material revealed that the type of stimuli used may significantly affect the obtained scores. Thus, caution should be exersised before generalizing conclusions to different linguistic structures.

Another interesting finding was that phonological context affects nasalance scores. The vowel results indicated that /i/ is more nasal than /a/, a finding consistent with previous studies conducted in English (Bell-Berti, 1980[16]; Bell-Berti, Baer, Harris & Niimi, 1979[17]). The present findings provide a crosslinguistic validation of vowel differences on nasality. Also, different nasalance scores were obtained among nasal consonants. The higher nasalance for /n/ than /m/ can be accounted for by pressure differences which are magnified as the size of the occluded oral cavity decreases.

At last, the lower nasalance scores of Greek compared to other languages is a finding that needs to be further explored in future studies in order to find out whether it stems from decreased frequencies of nasal compared to oral sounds or from phoneme-specific language constraints. An important clinical implication is that greek speech places greater demands on the function of the velopharyngeal system than other languages. Therefore, individuals with velopharyngeal insufficiency face greater difficulties in obtaining acceptable orality/nasality standards. Consequently, higher constraints are placed in therapeutic and/or surgical intervention (i.e. cleft palate). It would be useful to back these data with perceptual findings before attempting to draw definite conclusions on the above clinical issues.

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