Original Article

Access this article online
Website: www.jclpca.org
DOI: 10.4103/jclpca.jclpca_33_20
Quick Response Code:

Influence of native language on Nasalance values in Kannada and Malayalam speakers

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ABSTRACT

Introduction: Nasalance values vary across languages. Therefore, establishing separate normative values of nasalance for each language and studying their influence on each other becomes important for the assessment and management of persons with resonance disorders. So the present study aimed at comparing the nasalance values of vowels, unvoiced syllables, and voiced syllables between native Kannada speakers and native Malayalam speakers. The present study also compared the nasalance values of meaningful words, oral sentences, and nasal sentences (for both English and Kannada languages) between native Kannada speakers and native Malayalam speakers. **Materials and Methods:** Twelve native Kannada speakers and 12 native Malayalam speakers (age range – 18–23 years) served as participants. The test stimuli included a standardized set of meaningful words, oral sentences, and nasal sentences in both English and Kannada, vowels, unvoiced syllables, and voiced syllables. The data were recorded and the values were obtained from the Nasometer. **Results:** The results revealed a higher nasalance value for Malayalam speakers (/a/-29,i/-45.41,u/-19.50, unvoiced syllables-16.96, voiced syllables-21.63, words-22.71, oral sentences-21.40, and nasal sentences-60.15) than for Kannada speakers (/a/-14.90,i/-32.60,u/-10.50, unvoiced syllables-11.59, voiced syllables-16.99, words-15.83, oral sentences-13.62, and nasal sentences-56.18) across all the stimuli considered. However, a statistically significant difference was found only on vowels. **Conclusions:** The present study indicated that in bilingual or trilingual speakers, there is an effect of native language on the Nasalance Values of second and/or third language.

Key words: Bilingual, linguistic influence, nasalance, normal, resonance, trilingual

INTRODUCTION

Resonance is the modification of sound that is generated by the vocal cords which is determined by the size and shape of the cavities of the vocal tract and the function of the velopharyngeal valve.[1] It provides quality for the speech sound and consists of an adequate balance between oral and nasal resonance.[1] During the production of oral sounds, the the velopharyngeal port is closed separating the nasal cavity from the oral cavity.[2] There are many disorders with velopharyngeal port dysfunction resulting in the nasalization of non-nasal sounds (especially, individuals with a history of the cleft palate). However, some amount of nasalization is also present in normal speech and it varies across languages.[3-5] In some languages like Malayalam, a certain degree of oronasal opening is appreciable.[6]

The standard protocol of measuring nasalance in India includes both subjective and objective. In subjective, perceptual analysis is used which is considered as gold standard. Here, a general conversation and repetition of the standardized set of stimuli are recorded. Using a standard set of protocol, like Henningsson's protocol,[7] the recorded speech samples are analyzed to identify the degree of nasalance. Perceptual rating of severity of nasalization is one of the difficult tasks as the quality of the perceptual judgments of the listeners depends on the experience and skillful training in the field of cleft lip and palate (CLP) diagnostics.[8] However, this method carries inherent limitations where the finer degrees of speech variations are difficult to assess.

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Cite this article as: Girish KS, Pushpavathi M, Satish HV. Influence of native language on Nasalance values in Kannada and Malayalam speakers. J Cleft Lip Palate Craniofac Anomal 2021;8:111-8.

Submission: 29.09.2020 **Revision:** 13.12.2020
Acceptance: 07.01.2021 **Web Publication:** 07.06.2021

Both speakers, and listener variables, may influence the speech ratings.[8] Therefore, subjective assessments are supplemented by objective assessments to measure the estimation of nasalance in persons with CLP, which supports and verifies perceptual ratings. Hence, instrumental evaluations play a major role in evaluating hypernasality in individuals with a history of CLP.

Instruments commonly used for the measurement of nasalance are Nasometer (Kay Elemetrics, Lincoln Park, NJ, USA), Nasal View (Tiger DRS), and Oro-Nasal system (Glottal Enterprises Inc., Syracuse, NY). Currently, Nasometer is the widely used objective assessment tool for measuring nasalance and it is widely used for diagnosing resonance disorders and in research.[9] It is a microphone-computer based system used for measuring nasalance values, which comprises a headgear mounted with a directional microphone on either side of the sound-separator plate. It measures the nasalance values in percentage by calculating the ratio of the acoustic signal collected at the nasal microphone to the acoustic signal collected at the oral as well as nasal microphone, i.e., nasalance = nasal signal/(oral signal + nasal signal) × 100.[10] Different stimuli have been developed to assess nasalance in different languages like Kannada, Tamil, Malayalam etc., by various authors. Most of the time, both subjective and objective methods are used to find the corelation to establish an appropriate normative.

Researchers have opined that nasalance is influenced by many factors like vowel type,[11] length, and type of stimuli, the context of the speech sound, and rate of the speech.[12,13] Previous investigations have showed that nasalance values increases as the vowel height increases[14-16] and the nasalance values were more for voiced syllables than unvoiced syllables.[14]

Similarly, several studies have investigated nasalance values across different languages. The investigations reported no significant differences in the nasalance values of Spanish speakers when compared with English speakers.[3] Similar results were found between Flemish, North Dutch, and Canadian speakers.[17] In contrast, several studies have revealed a significant cross-linguistic difference in nasalance values[17,18] which necessities the development of normative nasalance values in different Indian languages across different stimuli helping in the evaluation and management of persons with resonance disorders.

In the Indian context, the influence of Kannada, Malayalam, and Hindi on the nasalance values of English was investigated. The participants included 30 normal adult females in the age range between 17 and 35 years in each group (Kannada, Malayalam, and Hindi). The participants in each group had the respective native language as their first language and all the participants had English as their second language. The procedure included reading of a standardized zoo passage and it was recorded using Nasometer. The results revealed that the nasalance value for English was higher in Hindi (25.37 ± 7.19) and Malayalam (24.73 ± 7.99) speakers than in Kannada speakers (19.53 ± 7.56).[4] A similar study revealed a significantly higher nasalance values for English in native Malayalam speakers (22.33 ± 1.67) than in native Tamil speakers (14.20 ± 1.19).[5] These studies highlight the importance of the native language, which needs to be taken into account during assessing and planning intervention for persons with resonance disorders.

In India, there are 22 scheduled languages and 100 non-scheduled languages (includes English also) according to the eighth amendment of the Indian constitution.[19] Kannada and Malayalam are scheduled and widely spoken regional Dravidian languages of South Asia. Kannada is spoken in the state of Karnataka, located in the south-western subcontinent of India with approximately 37 million speakers[20] which include 28.44% of bilinguals and 12.15% of trilinguals.[19] Malayalam is spoken in the state of Kerala and also in the Lakshadweep Islands of the southwest coast of India with approximately 35 million speakers[21] which includes 28.75% of bilinguals and 16.60% of trilinguals.[19] There are 9.82% of Kannada-English bilinguals and 21.24% of Malayalam-English bilinguals in India; 0.13% and 0.07% of native Kannada speakers use Malayalam as their second and third language respectively; 1.45% and 0.29% of native Malayalam speakers use Kannada as their second and third language respectively.[19]

Though there are several regional languages in India, English is typically taught as a second language.[22,23] As nasalance varies across languages, it is very much necessary to know the influence of the native language on English, which is a second language for most of the Indians. This investigation helps speech-language pathologists in evaluating the efficacy of therapy in English and to compare the results of English speakers across clinical settings. In addition to the clinical implications from the comparisons of nasalance values across different languages, there is a theoretical benefit as they facilitate our understanding of the influence of linguistic factors on the nasalance measurements. Also, there is a dearth of studies investigating the effect

of native Indian languages on nasalance values of a second/third language across different types of stimuli.

The present study aimed to compare nasalance values in English and Kannada language between Kannada-English bilingual speakers and Malayalam-English-Kannada trilingual speakers. The objectives of the present study are: (1) Comparison of the Nasalance values of vowels (/a/,/i/,and/u/), unvoiced syllables (/pa/,/ṭa/, and/ka/), and voiced syllables (/ba/,/ḍa/,and/ga/) of native Kannada speakers with native Malayalam speakers; (2) Comparison of the Nasalance values of meaningful English words, oral sentences, and nasal sentences of native Kannada speakers with native Malayalam speakers. (3) Comparison of the Nasalance values of meaningful Kannada words, oral sentences, and nasal sentences of native Kannada speakers with native Malayalam speakers.

MATERIALS AND METHODS

The following methodology was used to compare nasalance values in English and Kannada language between native Kannada speakers and native Malayalam speakers.

Research design

The performance of the two groups was considered in all the objectives of the present study, hence Standard Group Comparison was employed.

Participants

A total of 12 native Kannada speakers and 12 native Malayalam speakers within the age range of 18–23 years, served as participants. The participants were selected based on convenience and purposive sampling methods so all the participants considered were females. All the native Kannada speakers had English as their second language, whereas, all the native Malayalam speakers had English as their second language and Kannada as their third language. All the participants had at least 15 years of exposure to English and Malayalam speakers had at least 4 years of exposure to Kannada (regional language). All the participants had normal hearing sensitivity with normal speech, language, and mental abilities. Participants had no signs of cold/cough/upper respiratory tract infection at the time of data recording. All the participants had normal velopharyngeal functioning, which was confirmed by the Plastic Surgeon. Hearing impairment, speech-language, and cognitive problems were ruled out through an informal assessment by a Speech-Language Pathologist. Also, written consent was taken from all the participants.

Ethical consideration

The present study followed all the ethical guidelines given by Basavaraj and Venkatesan and written consent was taken from all the participants.[24]

Test materials

The test stimuli included vowels, unvoiced syllables, voiced syllables, meaningful oral words, oral sentences, and nasal sentences [Appendix 1]. There were three vowels, three unvoiced syllables, and three voiced syllables which were the same for both English and Kannada stimuli.[25] Whereas, there were six meaningful oral words,[26] five oral sentences, and five nasal sentences (Unit for Structural Oro-Facial Anomalies, All India Institute of Speech and Hearing) in the English stimuli as well as six meaningful oral words,[27,28] five oral sentences, and five nasal sentences in the Kannada stimuli.[29] The oral stimuli were loaded with oral pressure consonants and the nasal stimuli were loaded with nasal consonants.

Procedure

Speech stimuli (English as well as Kannada) were recorded using Nasometer in a quiet room environment. Before recording, the Nasometer (Model 6450, Key Elemetrics) was calibrated according to the manufacturer's instructions. Each participant was seated comfortably on a chair and the headgear was positioned such that the Nasometer separation plate was firmly placed against the upper lip, perpendicular to the plane of the nasal septum, as shown in Figure 1.

Both native Kannada speakers and native Malayalam speakers were instructed to repeat the English stimuli followed by Kannada stimuli in their comfortable pitch and loudness. The inter-stimuli gap was 2 s for vowels, syllables, and bi-syllabic words; 3 s for oral, nasal, and oro-nasal sentences. The speech samples were recorded using the Nasometer application and were saved in the ".nsp" format for further analysis. In this application, the cursors on the screen were set from onset to the offset of the stimulus and the mean nasalance values were noted [Figure 2].

Statistical analysis

The obtained nasalance values were subjected to statistical computation using IBM Statistical Package Social Sciences software (International Business Machines Corporation, Armonk, New York). Shapiro–Wilk test of normality was applied to check the normality, which revealed a non-normal distribution of the data ($P < 0.05$). Hence, the Mann–Whitney *U*-test

was carried out to check for a significant difference in the nasalance values across native Kannada and Malayalam speakers.

RESULTS

The mean and standard deviation of the nasalance values for vowels, unvoiced syllables, voiced syllables, oral sentences, and nasal sentences for native Kannada and Malayalam speakers are tabulated under the following sub-sections.

Comparison of the nasalance values of vowels, unvoiced syllables, and voiced syllables between native Kannada speakers and native Malayalam speakers

The mean nasalance values for vowels, unvoiced and voiced syllables of native Kannada and Malayalam speakers were compared to get the normative nasalance value in both the languages. The mean and standard deviation values are tabulated [Table 1].

The results revealed a higher nasalance value in native Malayalam speakers than native Kannada speakers. Mann-Whitney U test revealed a statistically significant difference in vowels (/a/: [$Z = 3.174$; $P = 0.002$];/i/: [$Z = 2.277$; $P = 0.023$];/u/: [$Z = 2.447$; $P = 0.014$]) but not in unvoiced ($Z = 1.683$; $P = 0.92$) and voiced syllables ($Z = 1.123$; $P = 0.262$).

Comparison of the nasalance values of meaningful English words, oral sentences, and nasal sentences between native Kannada speakers and native Malayalam speakers

The mean nasalance values for meaningful English words, oral sentences, and nasal sentences of native Kannada and Malayalam speakers were compared to investigate the effect of native language on English (second language). The mean and standard deviation values are tabulated [Table 2].

The results revealed a higher nasalance value in native Malayalam speakers than native Kannada speakers. Mann–Whitney *U*-test revealed a statistically significant difference in meaningful words ($Z = 2.078$; $P = 0.38$) and oral sentences ($Z = 2.309$; $P = 0.21$), but not in nasal sentences ($Z = 1.881$; $P = 0.60$).

Comparison of the nasalance values of meaningful Kannada words, oral sentences, and nasal sentences between native Kannada speakers and native Malayalam speakers

The mean nasalance values for meaningful Kannada words, oral sentences, and nasal sentences of native Kannada and Malayalam speakers were compared to investigate the effect of native language on Kannada (third language for native Malayalam speakers). The mean and standard deviation values are tabulated [Table 3].

Figure 1: Participant seated for the nasometer recording of speech samples

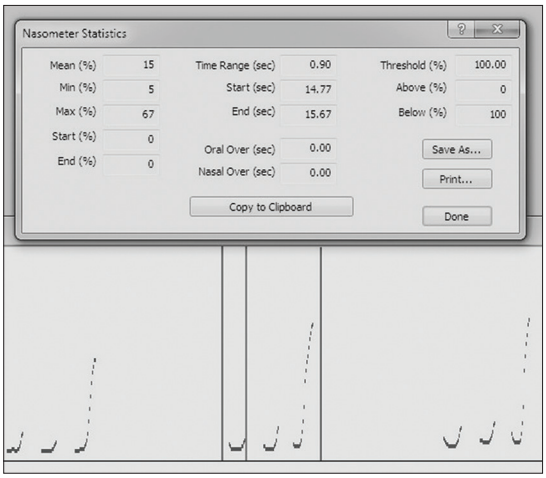

Figure 2: Stimulus selection for nasalance values extraction

Table 1: Average mean and standard deviation values of vowels across native Kannada and native Malayalam speakers

Subjects	Mean±SD				
	/a/	/i/	/u/	Unvoiced syllables	Voiced syllables
Native Kannada speaker	14.90±7.34	32.60±14.10	10.50±5.98	11.59±6.22	16.99±7.58
Native Malayalam speaker	29±8.65	45.41±12.15	19.50±9.52	16.96±8.25	21.63±9.80

*SD: Standard deviation

Table 2: Average mean and standard deviation values of meaningful English words, oral sentences, and nasal sentences across groups

Subjects	Mean±SD		
	Words	Oral sentences	Nasal sentences
Native Kannada speaker	15.83±7.59	13.62±6.36	56.18±5.44
Native Malayalam speaker	22.71±5.90	21.40±6.64	60.15±4.71

*SD: Standard deviation

Table 3: Average mean and standard deviation values of meaningful Kannada words, oral sentences, and nasal sentences across groups

Subjects	Mean±SD		
	Words	Oral sentences	Nasal sentences
Native Kannada speaker	16.70±8.27	15.22±5.73	54.68±6.74
Native Malayalam speaker	27.59±8.18	20.03±7.53	60.53±5.45

*SD: Standard deviation

The results revealed a higher nasalance value in native Malayalam speakers than native Kannada speakers. Mann–Whitney *U*-test revealed a statistically significant difference in meaningful words ($Z = 2.703$; $P = 0.007$) but not in oral sentences ($Z = 1.584$; $P = 0.113$), and nasal sentences ($Z = 1.880$; $P = 0.60$).

DISCUSSION

The present study compared and analyzed the nasalance values of various stimuli between Kannada and Malayalam speakers to know the influence of native language on the nasalance values. The results are discussed under the following sub-sections.

Comparison of the nasalance values of vowels, unvoiced syllables, and voiced syllables of native Kannada speakers with native Malayalam speakers

Native Malayalam speakers had higher nasalance values than native Kannada speakers in all the vowels, unvoiced syllables, and voiced syllables [Table 1]. This might be due to the influence of the "inherent nasal quality" of the language[4] with Malayalam having a greater number of nasal consonants.[12] Malayalam has six nasal consonants (/ŋ/,/ɲ/,/ɳ/,/n̪/,/m/, and/n/)[30] where all of them are prevalently used,[6,31] whereas Kannada has five nasal consonants, out of which only three nasal consonants are commonly used. Although native Malayalam speakers had higher nasalance values than native Kannada speakers, significant differences were found only in vowels which might be because of the smaller sample size considered.

Across the vowels,ihad the highest nasalance values anduhad the lowest nasalance values in all the participants. This might be because of the tongue position, placed high in the oral cavity during the production of high vowels resulting in the smaller oral cavity, reduced oral intensity, increased nasal intensity when compared to low vowels production.[32] The results of the present study are in agreement with the findings of the previous study who also found significantly higher nasalance values for high vowels than for low/neutral vowels.[15,16]

Concerning unvoiced and voiced syllables, the latter has more nasalance values. This can be because the nasalance values are vowel dependent where the vibration of palatal structures during the production of vowels and other voiced phonemes transfers acoustic energy to the nasal cavity.[33] This result is in consonance with the results of a previous study that reported higher nasalance values for voiced syllables than unvoiced syllables.[14]

Comparison of the nasalance values of meaningful English words, oral sentences, and nasal sentences of native Kannada speakers with native Malayalam speakers

The comparison of the nasalance values for English stimuli between native Kannada speakers and native Malayalam speakers revealed an increased average mean nasalance values for the latter. This might be due to the effect of the native language on the second language. Native Malayalam speakers usually pronounceaase after voiced stops and after/r/,[34] leading to an increase in the nasalance values, as the mid-front vowele is more nasalized than low front vowel /a/.[35] Furthermore, native Malayalam speakers tend to pronounce voiceless stops in the intervocalic position as voiced stops.[34] This might be another reason for the increase in nasalance values, as voiced syllables are more nasalized than unvoiced syllables, which was shown in the earlier results of the present study. The intrinsic characteristics of the velopharyngeal closure

vary based on the phonemic features of that language.[4] Hence, these characteristics of the native language might have influenced the articulatory characteristics of the second/third language. Furthermore, a comparison of the nasalance values of English stimuli revealed a statistically significant difference in meaningful words and oral sentences, but not in nasal sentences which might be because of the smaller sample size.

Comparison of the nasalance values of meaningful Kannada words, oral sentences, and nasal sentences of native Kannada speakers with native Malayalam speakers

The comparison of the nasalance values of Kannada stimuli between native Kannada speakers with native Malayalam speakers also revealed an increased average mean nasalance values for the latter. Again, this might be because of the "inherent nasal quality" and phonemic characteristics of Malayalam language as discussed earlier.[4] However, a statistically significant difference was not found in oral sentences and nasal sentences. This supports the findings of a previous study, which did not report any effect of the native language on the nasalance values.[3] However, in the present study, the authors opine that a significant difference would have been obtained with a larger sample size.

In India, majority of the population are regional native-language and English bilinguals. The present study shows the influence of the native language on nasalance values on second/third language. Hence, the stimuli to assess nasalance should include both native as well as a second/third language. This will provide a clear indication of how much the nasality is affecting the intelligibility of speech. This information in turn will help to develop an appropriate intervention plan with apposite stimuli to reduce hypernasality and improve intelligibility in speech of children with repaired CLP.

CONCLUSIONS

The present study showed that there is an effect of native language on the nasalance values of second/third languages. Hence, the native language has to be taken into account while assessing and planning intervention for persons with resonance disorders. It is very much necessary to have normative nasalance values in English concerning specific regional languages. However, the results of the present study must be validated by replicating a similar study on a larger sample size including both male and female speakers across different age ranges, and the reliability of the instrument needs to be carried out.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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APPENDIX 1

1. **Vowels:**/a/,/i/and/u/
2. **Unvoiced syllables:**/pa/,/ʈa/, and/ka/
3. **Voiced syllables:**/ba/,/ɖa/, and/ga/

English

1. Words: desk, garage, bottle, sugar, cloud, and sleep

2. Oral sentences:

Betty bought butter
Baby ate food
Papa brought a doll
Suzy likes her school
They go to the ball park

3. **Nasal Sentences:**

Mama made lemon jam
Mommy made dinner
Monkey is hanging in the tree
Mama made some muffins
Neil saw a robin in a nest

Kannada

1. Words:/ka: ge/,/t̪aʈ̪e/,/kappe/,/ɖabbi/,/ʃarʈu/, and/su:ʤi/

2. Oral sentences:

/ka: ge ka: lu kappu/
/gi:t̪a be: ga ho: gu/
/appa paʈa t̪a/
/ba: lu t̪abala ba: risu/
/beɖa ka:ɖ̪ige oɖ̪i̪da/

3. **Nasal Sentences:**

/manu a: nejannu noɖ̪i̪da/
/navi: na manejin̪da ban̪danu/
/na: nu a: nejannu noɖ̪i̪de/
/manga maneja me: li̪de/
/ma: ma: manʤa̪din̪da ban̪danu/