NORMATIVE NASALANCE VALUE IN HINDI LANGUAGE

Register No. 07SLP014

A dissertation submitted in part fulfillment for the degree of
M.Sc., (Speech Language Pathology)
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ALL INDIA INSTITUTE OF SPEECH AND HEARING,
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MYSORE – 570006.
MAY – 2009


Dedicated to the
lord almighty &
my beloved
parents..!

CERTIFICATE

This to certify that this dissertation entitled **"NORMATIVE NASALANCE VALUE IN HINDI LANGUAGE"** is the bonafide work in part fulfillment for the degree of Masters in Science (Speech Language Pathology) of the student (Register No. 07SLP014). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for award of any other diploma or degree.

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This is to certify that this dissertation entitled **"NORMATIVE NASALANCE VALUE IN HINDI LANGUAGE"** has been prepared under my supervision and guidance.

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DECLARATION

This dissertation entitled **"NORMATIVE NASALANCE VALUE IN HINDI LANGUAGE"** is the result of my own study under the guidance of Dr M. Pushpavathi, Reader & HOD, Dept of Clinical Services, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any university for any other Diploma or Degree.

Place – Mysore **Reg. No. 07SLP014**

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"A help rendered in hour of need
Though small is greater than the world
It is gainer's worth and pleasure
It gives me a sense of pride to thank all..!! "

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“ वक्रतुण्ड महाकाय सुर्यकोटि सम प्रभः
निरविघ्नम कुरु मे देव सर्व कार्येषु सर्वदा ”

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CHAPTER - I

INTRODUCTION

Speech refers to the processes associated with the production and perception of sounds used in spoken language. Speech is a unique, complex, dynamic motor activity through which we express our thoughts and respond to and control our environment. “Speech is the form of communication in which the transmission of information takes place by means of speech waves which are in the form of acoustic energy. The speech waveforms are a result of interaction of one or more source with the vocal tract filter system” (Fant, 1960). Human expresses thoughts, feelings and ideas orally to one another through a series of complex movements that alter and mold the basic tone created by voice into specific, decodable sounds. Speech is produced by precisely coordinated muscles actions in the head, neck, chest and abdomen. Speech development is a gradual process that requires years of practice. During this process, a child learns to regulate these muscles to produce understandable speech.

The number of nasal sounds in that language as well as frequency of occurrence of nasal sounds may be an important factor. Among the Indian languages, Hindi is one of the languages which have got more nasal resonance than other language. Hindi language has six nasal consonants all of which are presently used (bilabial, alveolar, palatal, retroflex and velar). In addition to these nasal sounds, nasalization of vowels is also highly prevalent which may account for increased nasal resonance.

Speech disorders may arise from deficits related to the form and or function of the respiratory, phonatory, resonatory, and/or articulatory mechanisms. Clients with cleft palate, velopharyngeal inadequacy/insufficiency, dysarthric patients present with resonance disorders. Nasalization may be defined as the existence of significant communication between the nasal cavity and the rest of vocal tract. Two of the most characteristic clinical components of resonance disorders are hypernasality and nasal emission. Hypernasality may be defined as the presence of excessive nasal resonance during the production of vowels or vowel-like consonants. Nasal emission deals with the presence of turbulent noise production during the production of high pressure consonants. This turbulent noise is often detected as an audible "puff" of air emitted via nostrils.

Nasality is a perceptual attribute whose detection requires the judgment of a listener (Moll, 1964; McWilliams et al. 1981,; Haapanen, 1991a).Traditionally, the presence of speech characteristics such as hypernasality and nasal emission has been documented by way of perceptual judgments. Perceptual judgments have been and will be continued to be used in the clinical setting because of the apparent face validity of these judgments (Dalston, 1997). However, perceptual judgment scale has a number of significant drawbacks. First, the ability to accurately and consistently judge the presence of hypernasality and nasal emission is related to factors such as the degree of experience the clinician has with patients presenting with resonance-based disorders and with the skills of the clinician to identify the aforementioned characteristics. The accurate perception of various speech characteristics has an element of finesse that is not necessarily something that is easily taught or learned. These drawbacks mean that the

inexperienced clinician or the clinician who does not have a fine ear by which various speech characteristics may be discerned will be at a disadvantage when faced with the patient presenting with a resonance-based disorder. Second, even for those clinicians who may be able to accurately perceive the presence of certain speech characteristics, it is often difficult to gauge the difference between various degrees of the presenting speech characteristics.

Many clinicians are able to discern the presence of severe speech deficits, but have much more difficulty in detecting those disorders which may be mild or borderline or which may exist between mild and severe judgments. In these cases, it may be that only severe cases are identified for treatment. In addition, the changes in resonance which may accompany treatment may not be accurately detected or objectively noted by the clinician. Third, reliability of judgments, particularly between clinicians, is often weak on anything but the simplest type of judgment scale. Therefore, information passed from clinician to clinician may have very little meaning unless the clinicians have had a great deal of similarity in their respective training, experience and ability to perceive the speech characteristics which define the patient's disorder.

In an effort to address the limitations of perceptual judgments by themselves, numerous methods of objectively measuring various aspects of speech disorder have been developed. In the area of resonance disorders, a number of methods have been developed to objectively evaluate the characteristics of hypernasality and nasal emission. One of the stronger objective assessment methods of the nasal speech signal is through the

measurement of nasalance. Nasalance has been defined as the ratio of nasal (n) to oral (o) sound pressure level and is commonly derived via the following formula:

$$\text{Nasalance} = \{\text{Nasal(n)} / \text{Nasal(n)} + \text{Oral(o)}\} \times 100$$

The measurement of nasalance has often been described as a useful measure in the assessment of excessive nasal resonance in speech, particularly since it may be derived through non-invasive and fairly simple instrumental means.

Nasometer, an instrument that has been used for the assessment of nasalance was developed by Kay Elemetrics in 1987. This system is comprised of headgear (oral and nasal microphone and a separate plate), filtering hardware, and computer software for the display of nasalance (over time or as a summary static for a given speech sample). The Nasometer was designed primarily for the assessment of hypernasality and includes hardware for the analog filtering of the acoustic signals using a 300 Hz bandwidth filter with a center frequency of 500 Hz. The analog speech signal is sampled at 120 Hz and nasalance is computed from the DC component of the signal. The instrument has been used for the assessment, rehabilitation and for the research purposes.

Tiger Electronics Inc. (Seattle, WA) has developed a system known as NasalView based on the work of Awan (1996; 1997). The NasalView system is reported to be highly beneficial in the identification of resonance based disorders which have hypernasality and

nasal emission as key characteristics. NasalView assesses the nasality of speech by measuring the acoustic output from both nasal and oral cavity by using two microphones, separated by an acoustic shield that rests on the upper lip, which is mounted on a head set which gives appropriate position for the microphones. Additionally it is a personal computer based device that can be easily installed and can measure the nasality at any point of the sample.

A common diagnostic task entails having the patient read or repeat a series of standard passages which contain varying degrees of nasal consonants. Passages such as the *zoo passage* (0% nasal consonants), the *rainbow passage* (11% nasal consonants), and the *nasal sentences* (35% nasal consonants) have been used in the testing the NasalView system and preliminary norms have been derived for different ages and genders. By having a patient read or repeat these passages using the NasalView system, one can objectively determine if the patient has significantly increased or decreased (in the case of hyponasality) nasalance in comparison to a representative peer group.

The measurements of mean nasalance and other summary statistics can be used to support perceptual judgments regarding resonance-based speech disorders as well as determine the degree of resonance disruption (i.e. mild, moderate, or severe in nature). The objective data provided via the NasalView system can be used to document pre-and post-therapy change in the patients speech production. The Nasal View system also provides the benefit of record, playback, and storage of speech samples that may be used

in perceptual analysis and to relate pre/post therapy change in computed nasalance with actual speech samples.

The identification and objective measurement of characteristics such as hypernasality and nasal emission may be greatly enhanced through the use of computer analysis systems such as NasalView. In addition, the treatment of resonance- based disorders is improved by the addition of real-time feedback which allows therapy to be conducted in a novel and intriguing fashion.

In clients with velopharyngeal dysfunction, accurate assessment of the disorder is critical. Hence in order to select the treatment, the need for reliable, objective measures of speech nasality with high levels of content validity was largely met with NasalView instrument. It employs non-invasive measurement techniques and can be used easily in outside medical set ups. Its validity has generally shown high levels of correspondence between listener's judgments of speech nasality and the nasalance measures made by devices.

Need for the study

A need for a reliable, objective measure of speech nasality with high level of content validity largely met with the NasalView system to address the limitations of perceptual judgment in the area of assessment of resonance disorders. Studies have shown that nasalance of normal speech is sensitive to the phonetic composition of the speech stimuli, native language, regional dialect, age and gender. There are limited data

concerning nasalance values in Indian languages. This makes the strong need for the establishment of regional norms as there are very few standardized normal nasalance values for normal speakers in Indian languages.

Aims of the study:

- To develop normative data on nasalance for adults across gender and nasalance deviation in Hindi language for oral and nasal sentences and paragraphs.
- To study the effect of stimuli differences on nasalance value across gender.
- To study the effect of gender differences on nasalance value across stimuli.

CHAPTER - II

REVIEW OF LITERATURE

Over the years, various objective methods have been developed for assessing the nasality. These methods can be classified as direct and indirect methods. Direct objective methods such as Nasendoscopy and Videofluroscopy are widely used to evaluate the velopharyngeal dysfunction, which has greater reliability. However, Nasendoscopy is invasive and videofluroscopy exposes clients to radiation. Additionally, these techniques must be conducted in medical settings and thus are not always available to speech language pathologists.

There are various acoustic and aerodynamic techniques, developed to measure the nasalance (Fletcher et al., 1989 and Warren et al.. 1993). TONAR (The Oral to Nasal Air Pressure Ratio) is one among them. This instrument involves positioning two microphones (one to pick up the oral energy) separated by a wooden plate. This method has got several limitations, like the positioning of the microphones, the quality of the separating chamber and calibration of the equipment. This technique is not a real time analyzer and the use of this instrument for analyzing in running speech was not well accepted due to the above limitation.

Assessment of nasality disorder in speech is traditionally proved to be difficult perceptual task for speech pathologists. Perceptual ratings of speech nasality are susceptible to many problems that influence the results. Children with velopharyngeal

inadequacy are suggested for speech therapy as a treatment option. Hence an accurate assessment of the nasality is critical, as this provides valuable information for the suitable treatment. Hence use of instrumentation has become an important part of the assessment and treatment of individuals with velopharyngeal dysfunction.

To assess and study nasalization and disorders of nasalization, speech language pathologist and otorhinolaryngologists relay on a combination of direct and indirect assessment procedures (Shiprintzen & Bardach, 1995). Direct methods of visualization of the velopharyngeal valve include multi view Video fluoroscopy and Nasopharyngoscopy, where as indirect or non-visualizing procedures are illustrated by the mirror test and aerodynamic and acoustic investigations (Van Lierde et al., 2001).

Speech language pathologist prefers the indirect method, since it is a noninvasive method and does not require additionally the medical professional support. Moreover the action of the velopharyngeal mechanism is not easily observed visually. In addition the acoustic effects of improper velar action are sometimes difficult to monitor visually. Therefore, there is a need in the field of speech pathology for convenient and reliable systems to monitor velar action during speech, both to give the clinician a measure of such action and to provide a means of feedback for the person trying to improve velar control.

Several methods have been reported to assess nasality by using instruments. Following are some of the methods that are used:

- Measuring the low frequency, primarily subsonic and including zero frequency, components of the airflow through the nose or nose and mouth simultaneously, often with measure of the intra oral pressure.
- Accelerometer is one of the instrument, which is placed (vibration detector) on the nose to detect the sound passing through the nose.
- Measuring the sound (acoustic pressure waveform) emitted from the nose and mouth respectively with microphones placed above and below the barrier, analyzing the acoustic properties of the radiated speech to detect the acoustic properties associated with nasalization (Baken, 1987).

But the above-mentioned equipments and methods had limitations due to lack of proper calibration of the equipment, standardization of procedure and lack of normative data.

Nasalance is a commonly used measure that allows the speech-language pathologist to validate and quantify a perceptual assessment. Nasalization can be measured in different units. e.g. nasality (subjective), nasalance ratio and nasalance (objective). Fletcher et al. (1974) have coined the term nasalance to describe various measures of the balance between the acoustic energy at the nares, (An) and Ao can be expressed as a simple ratio, An/Ao to yield a measure that can be referred to as a nasalance ratio (NR) or it can be expressed as a percentage. AN/Ao+An to yield a

measure that can be referred to as % Nasalance (% N). Each measure contains the same information, but with a different scale. Recent measurements of nasalance have been reported in the % nasalance form.

The nasalance score is calculated as a ratio of the nasal sound pressure level to the combined nasal and oral sound pressure level (Fletcher, 1978). There are some instruments like Nasometer, NasalView and Oronasal system which are being use to obtain nasalance value for normal as well as disordered individuals in all population.

NasalView (Awan, 1997) is a new PC-based system for the computerized measurement of nasalance (Tiger Electronics, Seattle, WA). NasalView provides mean, minimum and maximum nasalance values (in percentage) for different stimuli like syllable, sentences and paragraphs i.e. oral, nasal and oro-nasal. The sampled sound signal or signal selections can be played back and edited with the NasalView program. Oscillograms of the nasal and oral signal and a nasalance curve are displayed together with nasalance statistics so that speech segments can be identified accurately and the envelope of the nasalance curve over time can be related to particular sounds. NasalView is widely being used to establish normative data across age, gender, dialect and stimuli by different authors.

Very few studies have been conducted to establish normative data across gender and across stimuli using NasalView system and there is no published study done in Indian language to establish normative nasalance value and to measure the effect of nasalance across gender and across stimuli using NasalView system.

Authors such as Awan, S. N. (1998, 2001), Bressmann, T., Sader, R., Whitehill, T. L., Awan, S. N., Zeilhofer, H., Horch, H., (2000); Awan, S., Daniel, Z. H., & Jordan, R.G. (2001); Bressmann, T. (2005); Bressmann T., Klaiman, P., Fischbach, S. (2006); Kuttner C, Schonweiler R, Seeberger B, Dempf, Lisson J, Ptok M. (2003); Ravindran, T. D. (2009) conducted the following studies focused on establishing normative data for normal adults and to compare the obtained nasalance value across stimuli, across gender, across patient with cleft lip and palate and normal population and across different instruments using NasalView system.

Awan, S. (1998) conducted a study to find the nasalance across two instruments i.e. Nasometer and NasalView and to measure the effect of mean nasalance across stimuli Total 181 subjects were considered for the study, among which 161 were children and 20 were male and female adults (age range 18-30 years). Three common passages i.e. Zoo passage (oral paragraph), Rainbow passage (oro-nasal paragraph) and Nasal Sentence (nasal paragraph) were used as stimuli. Results revealed that mean nasalance values (in percentage) obtained by NasalView system were as; nasal paragraph (48.44%), Rainbow passage (34.19 %), Zoo passage (24.67 %) for normal adult subjects. Author reported that, nasalance values obtained with the NasalView tend to be higher for oral stimuli and lower for nasal stimuli, compare with the mean nasalance values obtained using Nasometer. Author concluded that NasalView system appears effectively to separate varying degrees of nasal speech and although actual nasalance values differ from those of the Nasometer, NasalView provides high levels of both validity and reliability in its ability to measure RMS nasalance.

Bressmann et al. (2000) evaluated two new simple measures derived from mean nasalance data i.e. the nasalance distance (range between maximum and minimum nasalance) and the nasalance ratio (minimum nasalance divided by maximum nasalance) for nasal and non-nasal stimuli using NasalView instrument. They studied 133 patients with cleft lip and palate (87 male and 46 female) including normal adults and children. Authors regrouped the subjects according to their resonance into three groups i.e. group I consisted of 34 patients with normal nasal resonance, group II consisted of 51 patients with hypernasality and group III consisted of 48 patients with marked hypernasality. Oral and nasal acoustic measurements were made using the NasalView system. Nasalance distance and nasalance ratio were calculated for five non-nasal and three nasal sentences from the modified Heidelberg Rhinophonia Assessment Form. Results revealed that subjects with normal resonance (group I) exhibited mean nasalance of 1.59 % for oral sentences (which is lower than group II and III) and 6.19 % for nasal sentences (which is higher than group II and III). Authors reported that, patients with normal resonance could be distinguished from patients with marked hypernasality with measures of nasalance distance and nasalance ratio. Hence, concluded that the two new measurements are valuable in routine clinical examinations. Nasalance distance and ratio derived from sentence stimuli are two useful and easily applicable measures that can be used to supplement the nasalance mean value. Also, authors reported that lower values for nasalance distance and nasalance ratio were obtained when the measures were used to differentiate normal from all hypernasal speakers.

Awan, S. Daniel, Z. H., Jordan, R. G. (2001) established a preliminary normative data for both children and adults. Data was collected from total 255 subject among them 203 were children and 52 were adult subjects (29 females and 23 males) using NasalView instrument. Authors considered 29 normal subjects without any communication impairment and had no history of clefting or velopharyngeal incompetence/insufficiency and no complaint of upper respiratory infection and/or nasal congestion. To assess varying degrees of normal nasal resonance, subjects were asked to read the following three passages while wearing the Nasal View headgear. The Zoo Passage (Fletcher, 1972), Rainbow Passage (Fairbanks, 1960) and Nasal Sentences (Fletcher, 1972). For those very young subjects (ages 5 to 6 years) who had difficulty reading the three passages, subjects asked to repeat the following: The first two sentences of the Zoo Passage; the 2nd sentence of the Rainbow Passage and the first sentence of the Nasal Sentence. The authors reported that mean nasalance exhibited by female subjects was 26.71 % and mean nasalance exhibited by male subjects is 26.02 % for oral paragraph (Zoo Passage). Similarly, mean nasalance exhibited by female subjects was 51.18 % and mean nasalance exhibited by male subjects was 50.81% for nasal paragraph (Nasal Sentences). Although authors have not mentioned about nasalance difference across gender but the results revealed that significant difference was not evident across gender.

Awan, S. (2001) conducted a study to explore the effect of age and gender on measures of RMS. Author selected 181 subjects between the ages of 5 and 14 yrs. He compared the nasalance value in a group of 40 adult (20 males and 20 females between the ages of 18-30 yrs). The subjects were asked to read three passages i.e. Zoo Passage,

Rainbow Passage and Nasal Sentences. Speech samples were also included in this analysis (total *n* = 201 subjects). Subjects were divided into six age groups and nasalance values were compared across gender, across age group and across stimuli. Authors reported that mean nasalance values obtained for mal and female subjects from three passages i.e. Nasal Passage, Rainbow Passage, Zoo Passage were 46.68% (6.19), 32.95% (4.86), 23.39% (3.66) respectively. Results revealed that significant difference was not evident between males and females in terms of RMS nasalance at any age group, whereas a significant difference was evident across stimuli.

Kuttner, C. et al. (2003) conducted a study to measure the normal nasalance for the German language using NasalView system. A total of fifty normal subjects (eleven to twenty years) were taken as subjects. The tone material used comprised the vowels /a:/ , /e:/, /i:/, /o:/,/u:/, the sentences S (1): "This chocolate I very tasty." and "Call my mummy Mimmi." and the text, passages of LT (1): "Northwind and the sun", LT (2) : "A child's birthday Party" and LT (3): "A famous song". Result obtained were as mean nasalance for the vowels was 35.9% (8.4) ; for S1 (containing no nasal consonants) 24.9 % (5.3) and for S2 (with many nasal sounds) 69.6 % (5.5). the results for the text passages were 42.1 % (4.2) for LT (1), 36.9 % (4.3) for LT (2) and 38.2 % (4.4) for LT3. reslts revealed that the mean nasalance value obtained by nasal stimuli was higher than mean nasalance obtained by oral stimuli.Authors concluded that there is significant difference across stimuli.

Bressman, T. (2005) conducted a study to compare the three instruments Nasometer, NasalView and Oronasal system. He compared nasalance value across three

passages i.e. Zoo Passage, Rainbow Passage and Nasal Sentences. Author also compared the nasalance value across oral and nasal stimuli. He studied 76 normal adult subjects including 51 female and 25 male in the age range of 20 to 55 years with mean age 26.5 years. Results depicted that mean nasalance was 21.2% for oral sentences, 56.9 % for nasal sentences, 34.72 % for oro-nasal sentences using NasalView instrument. Also, author found that mean nasalance for text passages i.e. Zoo Passage, Rainbow Passage and Nasal Sentences was 21.1%, 35.2 % and 55.47 % respectively using NasalView instrument. Results showed that the Nasometer had the lowest nasalance scores for the nonnasal Zoo Passage. The NasalView had the highest nasalance scores for the phonetically balanced Rainbow Passage. The OroNasal system had the lowest nasalance scores for the Nasal Sentences. The nasalance distance was largest for the Nasometer and smallest for the OroNasal System. Over 90% of the recordings were within 4% to 6% nasalance for most materials recorded with the Nasometer and the NasalView and within 7% to 9% for materials recorded with the OroNasal system. There were significant differences between the complete Zoo Passage and the Nasal Sentences and the individual sentences from these passages for the Nasometer and the OroNasal System.

Bressmann, T. et al. (2006) conducted a study to compare the nasalance values obtained by fifty normal subjects (Thirty-one female and nineteen male) with age range 23 to 44 years and nineteen hypernasal patients with cleft palate (Eight female and 11 male) with age range 11 to 19 years. There mean nasalance were measured across three instruments i.e. the Nasometer, the NasalView and the OroNasal system. Two passages were taken as material i.e. Zoo passage (oral paragraph) and Nasal Sentence (nasal

paragraph). Authors reported that mean nasalance exhibited by fifty normal subjects (male and female combined group) on NasalView instrument was 21.09 % for oral passage and 55.74 % for the nasal paragraph. On the other hand, mean nasalance exhibited by eight subjects with cleft palate with hypernasality was 25.72 % for oral paragraph and 47.55 % for nasal paragraph. Subjects with cleft palate with moderate hypernasality exhibited mean nasalance of 27.71 % for oral paragraph and 50.21 % for nasal paragraph using NasalView instrument. Authors concluded that mean nasalance value exhibited by cleft palate patient with hypernasality (mild or moderate) is higher than mean nasalance exhibited by normal subjects for both oral as well as nasal paragraph. Their results revealed the significant difference in mean nasalance across stimuli. They conclude that the nasalance scores from the Nasometer, the NasalView and the Oronasal system are not interchangeable and that nasalance magnitudes from the three systems cannot be compared directly.

Ravindran, T. D. (2009) conducted a study to establish the normative nasalance values in Malyalam language, using NasalView system, and to investigate the effect of mean nasalance values across gender and across stimuli. Fifty adult males and females in the age range of 18-35 years were taken as subjects. The stimulus materials included Nasal sentences, oral sentences, nasal paragraph and oral paragraph in Malayalam language. Results depict that the mean nasalance values obtained by male subjects were 21.64 % for oral sentences, 21.35 % for oral paragraph, 51.19 % for nasal sentences, and 5.43 % for nasal paragraph. Female subjects exhibited mean nasalance value of 24.78 % for oral sentence, 23.05 % for oral paragraph, 57.54% for nasal sentences and 56.92% for nasal paragraph. A significant difference was evident for nasal stimuli across gender

whereas significant difference was not evident for oral stimuli across gender. Significant difference ($p < 0.005$) was evident across oral stimuli and across nasal stimuli for both female and male subjects i.e. within gender groups. There was a significant difference ($p > 0.001$) across nasal and oral stimuli. Author concluded that mean nasalance value exhibited by female subject is higher as compared to mean nasalance exhibited by male subjects across oral and nasal stimuli.

The above studies have explored the relationship of nasalance value across gender and stimuli. The present study is an attempt to develop the normative data for the assessment of nasalance in Hindi language in adults and to compare the nasalance value across gender and stimuli.

CHAPTER - III

METHOD

Subjects

One hundred normal Hindi speaking adults participated in the present study. Each subject was evaluated by an experienced speech and language pathologist to assess oral structure and function. Normal speech and language ability were also evaluated informally during five- minute conversation. Background information regarding hearing ability and other medical history was collected. Adults with normal speech and language ability, normal hearing and normal orofacial structure and function were considered for the study. All the participants were native speakers of Hindi language.

Subjects were divided into two groups. First group consist of 50 females in the age range of 18-35 years and second group was consisted of 50 males in the age range of 18-35 years. Table 1 depicts the subjects' details.

Gender	Age range (Mean age)	No. of subjects
Male	18-35 years (26.5years)	50
Female	18-35 years (26.5years)	50
Total		100

Table 1: Subjects details

Stimuli

Two sets of stimuli were prepared by an experienced speech language pathologist whose mother tongue is Hindi. One set consisted of oral sentences, which had predominantly oral consonants and the other set was nasal sentences which consisted of predominantly nasal sentences. Each category consisted of ten sentences. Sentences were made simple, short, easy to remember and meaningful. The sentences selected were ranged in length from three to four words (five to six syllables). The paragraphs were ranged in length from six to seven sentences.

Two sets are :

Set-1 : Ten Nasal and Ten oral sentences of equal length (five to six syllables)

Set-2 : Nasal and oral paragraph containing 6 sentences each.

Procedure

Phase 1: To find the content validity of the stimulus materials, sentences were given for the content judgment to ten speech language pathologists who were native speakers of Hindi language and had at least one year experience in the field. Judges were asked to read the instructions given in the rating sheet carefully before rating. Ten sentences and two paragraphs were given to them in each category (oral and nasal) in the form of a rating sheet, where they were asked to rate the sentence and paragraph. . A five point rating sheet was used where, rating of '0' indicated fully oral or no nasality and '4' indicated highly nasalized for both the categories. Most appropriate five sentences in

each category out of ten sentences were selected on the basis of rating given by judges. The five point rating sheet is provided in the Appendix-I and stimuli material is provided in the Appendix III

Instrumentation

The Nasal View system is a PC/Windows-based system which provides for the recording of high resolution speech signals using windows-compatible sound cards (sampling at up to 4410 Hz at 8 or 16 bits of resolution). The hardware components found in the Nasal View system include headgear and a portable custom dual-channel pre-amplification unit. The key component of the headgear is a rigid plate constructed of 5mm thick styrene straps. The sound separator plate is suspended from a Jackson Model 170 headgear (Jackson Products, Belmont, MI) by styrene straps. The sound separation characteristics of this plate are augmented by the addition of a light weight acoustic barrier material. (Fig 1.a)

Fig 1 (a.): Headgear Unit

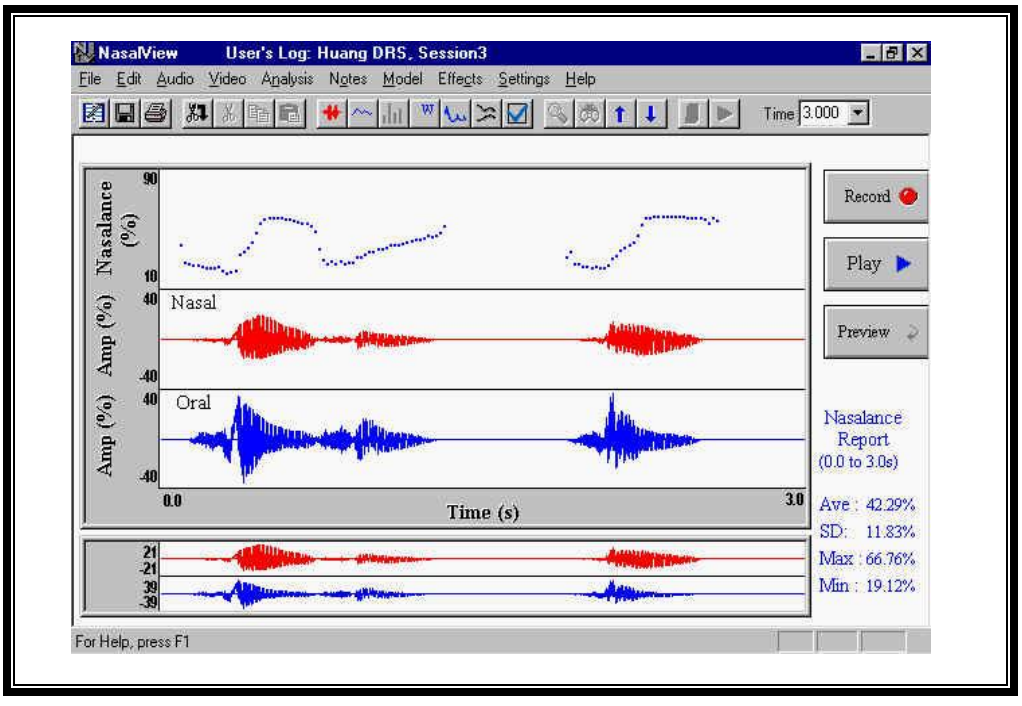

Fig 1 (b.): Waveform of Oral and Nasal Stimuli

Fig (c.): Computer based NasalView system with headgear

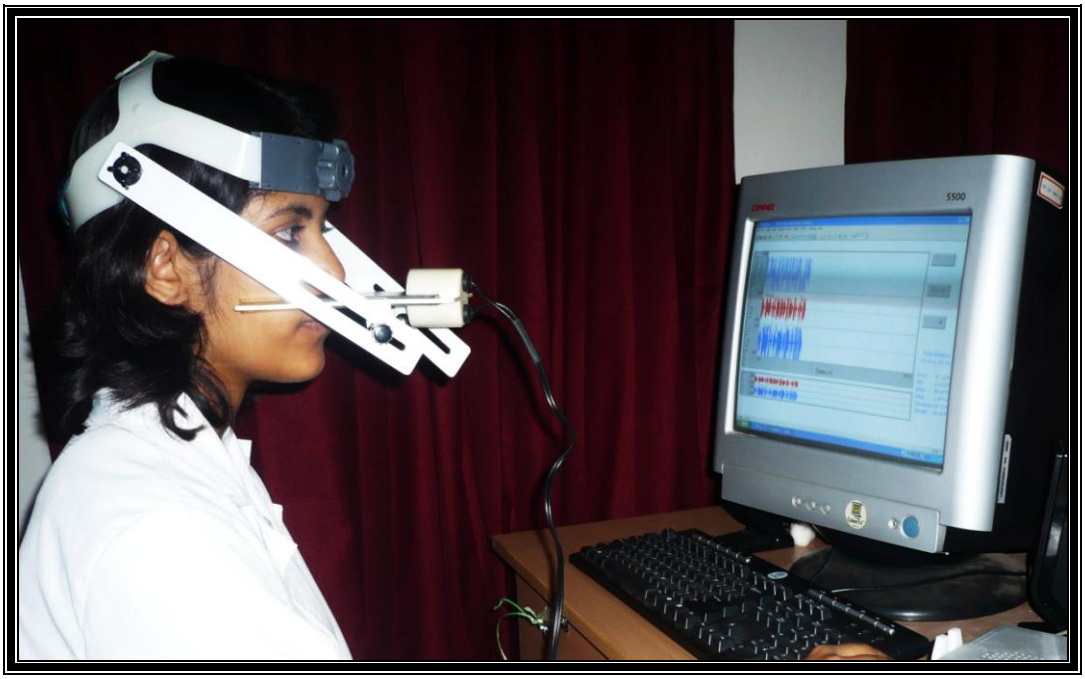

Fig 1 (d.): Subject undergoing NasalView assessment.

The outputs from each microphone are preamplified using a custom-made dual-channel amplification system. The amplification unit also contains a tone-generator circuit and speaker by which calibration of the Nasal View microphones may be achieved. During the calibration process, a software routine makes any necessary adjustments to left (nasal) and right (oral) channel recording amplitudes to ensure that each channel is equally sensitive to detected sound pressure levels. Finally, the outputs from the amplification unit are then fed to the right (nasal) and left (oral) line input channels of a soundblaster16 or compatible A-to-D/ D-to-A card. The soundblaster16 board allows for two channels recording at sampling rates up to 44 KHz; all filtering actions necessary for effective A-to-D conversion are built into the soundblaster16 board.

Because the full frequency range (as limited by the selected sampling rate) of the nasal and oral acoustic signals are captured for data analysis by the NasalView system, playback capability of both oral and nasal sound signals and a full array of analysis techniques is made possible.. The measurement of hypernasality and nasal emission may be calculated on either a nasalance scale (0% to 100%) or using the Nasal Index.

Data Collection

The NasalView was setup in a suitable quite recording room. The instrument was calibrated prior to the experiment based on the instructions provided in the manual. The speech sample was recorded individually. After selecting the subjects they were seated comfortably, and the nasal view head set was placed on subjects head (Fig 1 (c)). The position of the nasal view head set was adjusted and secured firmly in accordance with

the manufacturer's instructions. Once the nasal view headset correctly positioned, subjects were asked to read the stimuli if he/she is a literate. In case of non literate, they were asked to repeat the speech stimuli after the speech pathologist for a reliable output.

Data Analysis

Data was obtained for the two sets of stimuli including five sentences and two paragraphs for both categories (oral and nasal). The data files for all speech samples were subjected to a screening process to ensure that no inaccurate data were included in calculations of population mean. Once the data files have been screened for the entire subject, the mean, maximum, minimum nasalance for each stimulus in each set were calculated. Mean value of each stimulus were correlated with perceptual judgments. Using the nasal view statistical function, these scores were recorded in a separate sheet form suitable for subsequent statistical analysis using "SPSS" program software (Version- 16.0) package.

Statistical Analysis

Four types of tests i.e. descriptive analysis, mixed ANOVA (Analysis Of Variance), independent t-test, paired t-test were administered to perform the statistic analysis. Mixed ANOVA was used to study the effect of type, nasality and gender on nasalance value, independent t-test was used to measure the effect of gender on nasalance value, paired t-test was used to find the effect of stimuli on nasalance value and to compare the nasalance value within and across stimuli.

CHAPTER - IV

RESULTS

The present study was aimed to develop normative data of nasalance values in Hindi language for oral and nasal sentences and oral and nasal paragraphs for adults using NasalView (version 4). The study is also aimed to find the effect of gender on nasalance values across stimuli. The data was analyzed for adult subjects using descriptive statistics, mixed ANOVA, independent t-test, paired t-test and using SPSS software (version-16.0) package.

I. Effect of Stimuli on Nasalance Value in Females

a. Oral Sentences and Oral Paragraph

The following table depicts average of mean, minimum and maximum nasalance value of female subjects across oral sentences and oral paragraph. The nasalance mean for oral sentences was 22.58 % with the range from 6.56 % of minimum to 65.55 % of maximum. Similarly, nasalance mean obtained for oral paragraph was 22.23 % with the range from 4.0 % of minimum to 85.22 % of maximum.

Stimuli	Mean (S.D)	Min. (S.D)	Max. (S.D)
Oral sentences	22.58 (4.61)	6.56 (1.65)	65.55 (8.42)
Oral paragraph	22.23 (4.33)	4.00 (2.13)	85.22 (6.71)

Table 2: Mean Nasalance Value in female (in percentage) across Oral Stimuli.

b. Nasal Sentences and Nasal Paragraph

The following table depicts average of mean, minimum and maximum nasalance value of female subjects across nasal sentences and nasal paragraph. It shows that nasalance mean for nasal sentences were 50.41 % with the range from of 11.31% of minimum to 87.80% of maximum. Similarly, nasalance mean for nasal paragraph was 49.74 % with the range from 6.29% of minimum to 90.02% of maximum.

Stimuli	Mean (S.D)	Min (S.D)	Max (S.D)
Nasal sentences	50.41 (3.94)	11.31 (2.56)	87.80 (4.62)
Nasal paragraph	49.74 (4.55)	6.29 (2.90)	90.02 (4.38)

Table 3: Mean Nasalance Value in female (in percentage) across Nasal Stimuli

II. Effect of Stimuli on Nasalance Value in Males

c. Oral Sentences and Oral Paragraph

The following table depicts average of mean, minimum and maximum nasalance values of male subjects across oral sentences and oral paragraph. It shows that nasalance value obtained for oral sentences was 22.48 % with the range from 6.51% of minimum to 62.83% of maximum. Similarly, nasalance values obtained for oral paragraph was 21.59% with the range from 3.46 % of minimum to 83.22 % of maximum.

Stimuli	Mean (S.D)	Min. (S.D)	Max. (S.D)
Oral sentences	22.48 (4.79)	6.51 (1.78)	62.83 (11.40)
Oral paragraph	21.59 (4.85)	3.46 (1.23)	83.22 (8.45)

Table 4: Mean Nasalance Value in male (in percentage) across Oral Stimuli

d. Nasal Sentences and Nasal Paragraph

The following table depicts average of mean, minimum and maximum nasalance values of male subjects across nasal sentences and nasal paragraph. It shows that mean nasalance value obtained for Nasal sentences was 47.03 % with the range from 9.75% of minimum to 85.74 % of maximum. Similarly, mean nasalance value obtained for nasal Paragraph was 46.84 with the range from 5.59% of minimum to 88.30 % of maximum.

Stimuli	Mean (S.D)	Min. (S.D)	Max. (S.D)
Nasal sentences	47.03 (4.86)	9.75 (2.52)	85.74 (6.37)
Nasal paragraph	46.84 (5.23)	5.59 (2.14)	88.30 (5.58)

Table 5: Mean nasalance value in male (in percentage) across Nasal Stimuli.

III. Interaction effect of gender, nasality and type of stimuli on nasalance value

Mixed ANOVA was done to study the main and interaction effects of gender, nasality and type of stimuli. The following table 6 shows the results of mixed ANOVA.

Effects and interactions	F (1,98)
Main effect of type	4.960 *
Main effect of nasality	3256.008 * * *
Main effect of gender	5.571 *
Interaction between type and nasality	0.192
Interaction between nasality and gender	8.992 * *
Interaction between type and gender	0.003
Interaction among type, gender and nasality	1.337

* Significant at 0.05 level

* * Significant at 0.01 level

* * * Significant at 0.001 level

Table 6: Interaction effects of gender, nasality and type of stimuli on nasalance value

Above table (6) depicts the significant difference ($p < 0.005$) across gender and significant difference ($p < 0.01$) across stimuli (nasal and oral). Also, significant difference ($p < 0.001$) was evident across type of stimuli (sentences and paragraph). Since there was significant interaction between gender, nasality and type of stimuli, following analysis were done to study these interaction in detail. Independent t- test was done to compare mean nasalance of combined group (male and female) across stimuli.

Following table (7) shows results of independent t-test.

Nasality across type of stimuli	t (98)
Oral sentences	3.814 * * *
Oral paragraph	0.114
Nasal sentences	2.948 * *
Nasal paragraph	0.697

* * Significant at 0.01 level

* * * Significant at 0.001 level

Table 7: Effect of stimuli on mean nasalance across gender

Above table depicts that the significant difference present across nasality (i.e. oral stimuli and nasal stimuli) on mean nasalance for combined group. It also shows that significant difference across type of stimuli was not found (i.e. sentence and paragraph) on mean nasalance male and female subjects.

Using Paired t-test, comparison of mean nasalance for oral and nasal stimuli for sentences and paragraphs across gender was done. Following table 8 depicts the result of paired t-test.

Gender	Pairs compared	t (49)
Female	NS – OS	55.032*
	NP- OP	40.145 *
	NS - NP	1.401
	OS - OP	0.752
Male	NS- OS	30.787 *
	NP - OP	29.655 *
	NS - NP	0.469
	OS- OP	1.906

* Significant at 0.05 level

Table 8: Comparison of Mean Nasalance Value across gender and stimuli.

Above table depict the significant difference across nasal and oral sentences and nasal and oral paragraph for both the genders, whereas significant difference was not evident across nasal sentences and paragraph and oral sentences and paragraph.

III. Effect of Gender on Nasalance Value: Oral Stimuli

e.) Nasalance Value for the Oral Sentences across Gender.

The present study also aimed at comparing the nasalance values across stimuli and gender. The following table depicts mean, minimum and maximum nasalance values for oral sentences across gender. Descriptive analysis was done to find the mean and standard deviation for the oral sentences across gender. It shows that both female and male subjects exhibited approximately same mean nasalance value i.e.22.58 % for females and 22.48 % for males. Independent t-test was done to find the significant

difference and the results indicated that significant difference was not evident across gender.

GENDER	Mean (S.D)	Min (S.D)	Max (S.D)
Male	22.48 (4.79)	6.51 (1.78)	62.83 (11.40)
Female	22.58 (4.61)	6.56 (1.65)	65.55 (8.42)

Table 9 Mean Nasalance Value (in percentage) for oral sentences

f.) Mean Nasalance Value for the Oral Paragraph across Gender.

The following table depicts the mean, minimum and maximum nasalance values for oral paragraph across gender. Descriptive analysis was done to find out the mean and standard deviation for the oral paragraph across gender. It shows that female subjects exhibited mean nasalance of 22.23 % which is approximately similar to the mean nasalance exhibited by male subjects i.e. 21.59 %. Independent t-test was used to find the significant difference and the results indicated that significant difference was not evident for the oral paragraph across gender.

Gender	Mean (S.D)	Min (S.D)	Max(S.D)
Male	21.59 (4.85)	3.46 (1.23)	83.22 (8.45)
Female	22.23 (4.33)	4.00 (2.13)	85.22 (6.71)

Table 10: Mean Nasalance values (in percentage) for oral paragraph across gender.

The following figure depicts that the mean nasalance value obtained for oral sentences and oral paragraphs. Here, OS stands for oral sentences and OP stands for oral paragraph.

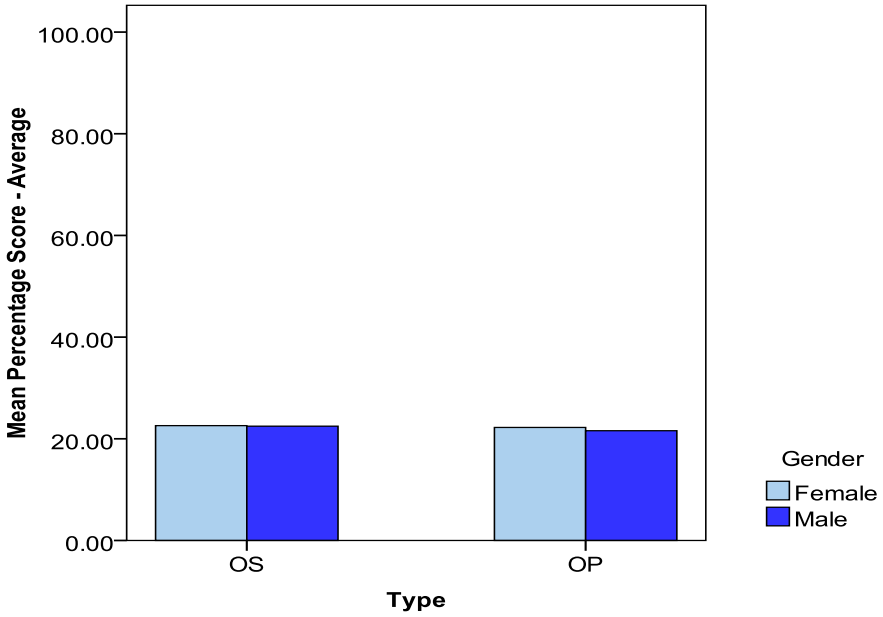

Fig 2: Nasalance Value for Oral sentence and oral paragraph across gender.

IV. Effect of Gender on Nasalance Value: Nasal Stimuli

g.) Mean Nasalance value for the Nasal sentences across gender.

The following table depicts the mean, minimum and maximum nasalance values for nasal sentences across gender. Descriptive analysis was done to find out the mean and standard deviation for the nasal sentences across gender. It shows that female subjects exhibited higher mean nasalance value i.e. 50.41 % compared to mean nasalance value obtained by male subjects i.e. 47.03 % for nasal sentences. Similarly, female subjects exhibited higher minimum nasalance value i.e. 11.31 % as compared to minimum nasalance value obtained by male subjects i.e. 9.75 %. Maximum nasalance value

obtained by female subjects was 87.80 % which is higher than maximum nasalance value obtained by male subjects i.e.85.74 % for nasal sentences. Independent t-test was done to find the significant difference across gender and the results revealed significant difference was evident.

GENDER	Mean (S.D)	Min(S.D)	Max(S.D)
Male	47.03 (4.86)	9.75 (2.52)	85.74 (6.37)
Female	50.41 (3.94)	11.31 (2.56)	87.80 (4.62)

Table 11: Mean Nasalance values for Nasal Sentences across Gender

h.) Mean Nasalance Value for the Nasal paragraph across Gender.

The following table depicts the mean, minimum and maximum nasalance value for nasal paragraph across gender. Descriptive analysis was done to find out the mean and standard deviation for the nasal paragraph across gender. It shows that female subjects exhibited higher mean nasalance Value for nasal paragraph i.e. 49.74% as compared to mean nasalance values obtained by male subjects i.e. 46.84 %. Female subjects exhibited higher minimum as well as maximum nasalance values i.e. 6.29 % and 90.02 % respectively as compared to minimum and maximum nasalance values obtained by male subjects i.e. 5.59 % and 88.30 % respectively. Independent t-test was used to find the significant difference across the two groups. The results revealed a significant difference for the nasal paragraph across gender.

Gender	Mean (S.D)	Min (S.D)	Max (S.D)
Male	46.84 (5.23)	5.59 (2.14)	88.30 (5.58)
Female	49.74 (4.55)	6.29 (2.90)	90.02 (4.38)

Table 12: Nasalance values for nasal paragraph across gender

The following figures depict the mean nasalance value obtained for nasal sentences and nasal paragraphs.

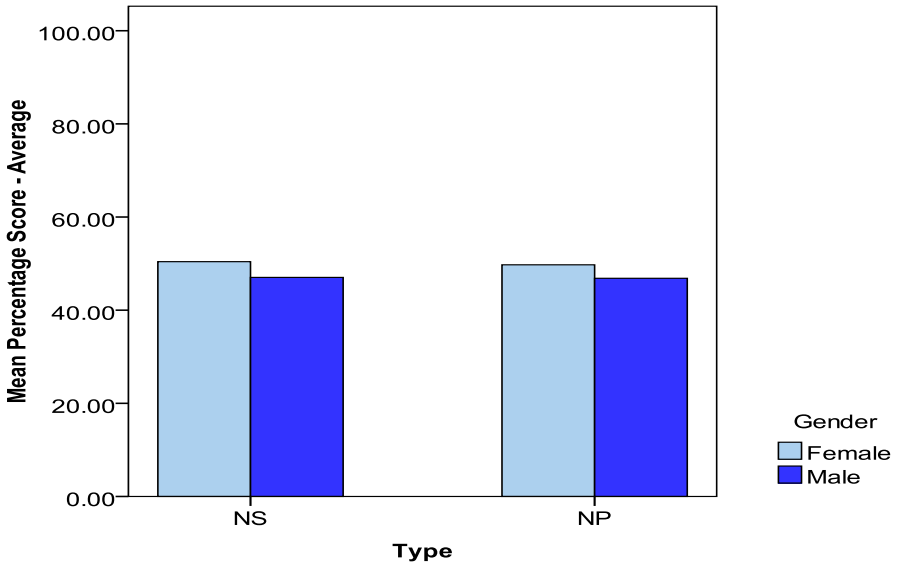

Fig 3: Nasalance Value for Nasal sentence and Nasal paragraph across gender.

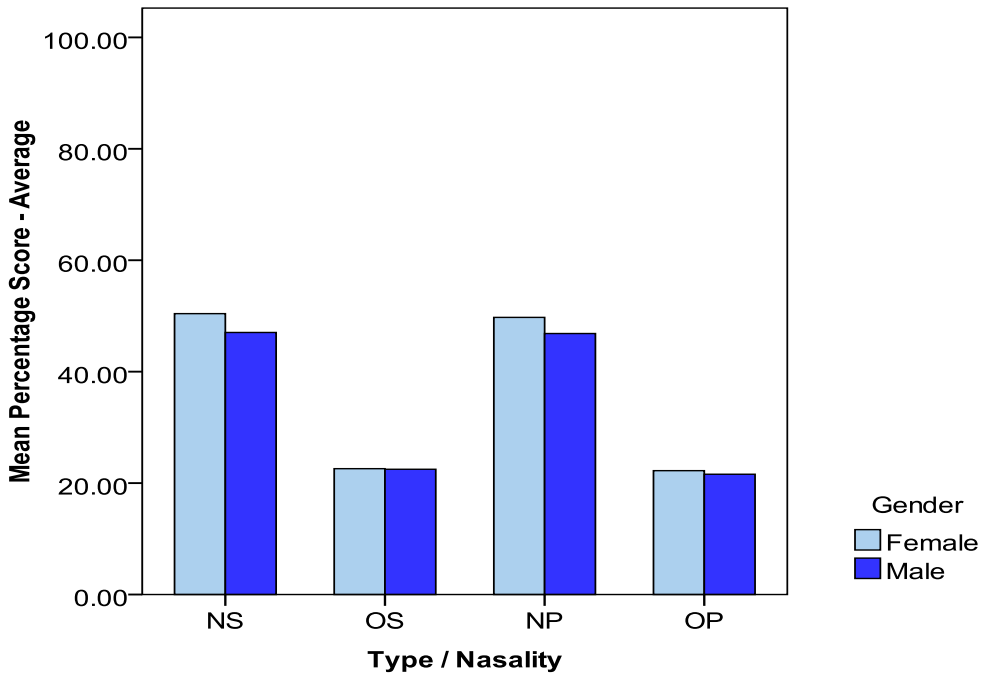

Figure 4: Mean Nasalance Values across gender and across stimuli

In conclusion, above figure 4 depicts the mean nasalance values obtained across gender and stimuli. It shows that female subjects exhibited higher nasalance than male subjects for nasal sentences as well as for nasal paragraphs. On the other hand, male and female subjects exhibited approximately same nasalance for oral sentences as well as for oral paragraph. The nasalance value obtained was approximately same for oral stimuli across gender but significantly differ for nasal stimuli. Also, it shows that nasal sentences having more nasalance value than oral sentences. Similarly, nasalance value obtained for nasal paragraphs showed more nasalance as compare to oral paragraph.

Following figures (5) and (6) depicting the maximum and minimum nasalance value respectively, obtained by normal adult subjects for oral and nasal stimuli.

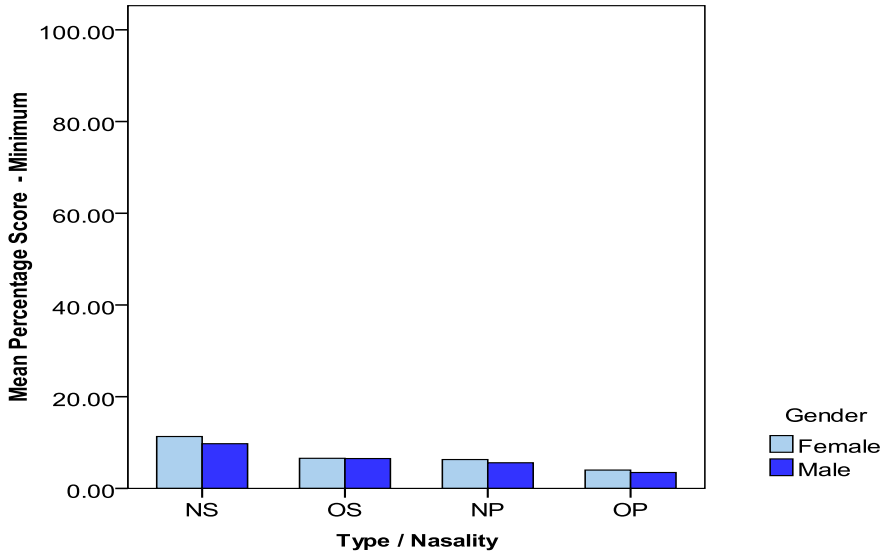

Figure 5: Minimum Nasalance Values across Gender for oral and nasal sentences and paragraphs.

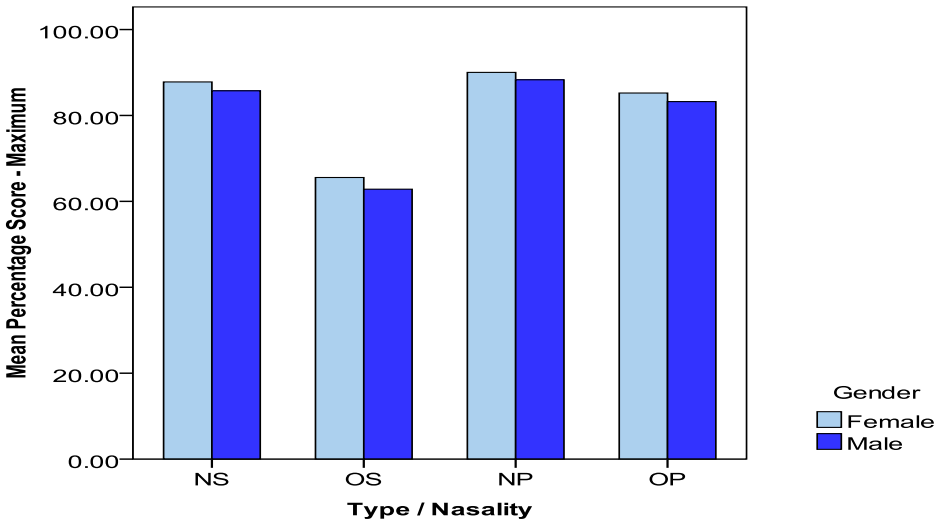

Figure 6: Maximum nasalance value across gender for oral and nasal sentences and paragraph.

CHAPTER - V

DISCUSSION

The primary aim of the study was to establish normative nasalance values for Hindi speaking male and female adult subjects for selected nasal and oral sentences and nasal and oral paragraph using NasalView (version-4) software. The summary of the normative data for Hindi speaking female and male adults is shown in table (13). The reported normative nasalance data provide important reference information for the assessment of nasality disorders in adults. Speech pathologist can measure the nasality for the diagnosis and effect of a specific therapy approach and the plastic surgeon can evaluate the effect of different surgical techniques.

Stimuli	Gender	Mean (S.D)	Min (S.D)	Max (S.D)
Oral Sentences	Male	22.48 (4.79)	6.51 (1.78)	62.83 (11.40)
	Female	22.58 (4.61)	6.56 (1.65)	65.55 (8.42)
Oral paragraph	Male	21.59 (4.85)	3.46 (1.23)	83.22 (8.45)
	Female	22.23 (4.33)	4.00 (2.13)	85.22 (6.71)
Nasal sentences	Male	47.03 (4.86)	9.75 (2.52)	85.74 (6.37)
	Female	50.41 (3.94)	11.31 (2.56)	87.80 (4.62)
Nasal paragraph	Male	46.84 (5.23)	5.59 (2.14)	88.30 (5.58)
	Female	49.74 (4.55)	6.29 (2.90)	90.02 (4.38)

Table 13: Normative Mean Nasalance Value across gender and across stimuli

Very few studies have been done to develop a normative data and for measuring nasalance value across gender and across stimuli using NasalView instrument. There is no published Indian study on NasalView to establish normative data. Hence, the present study was aimed to establish normative data on nasalance value across gender and stimuli in Hindi speaking adults

I Nasalance Value across Gender

Result of the present study shows that the mean nasalance value exhibited by female subjects was 22.58 (4.61) for oral sentences and 22.23% (4.33) for oral paragraph and mean nasalance exhibited by male subjects was 47.03 (4.86) for oral sentences and 21.59 % (4.85) for oral paragraph. It also shows that mean nasalance exhibited by female subjects for nasal sentences was 50.41 (3.94) and 49.74 % (4.55) for nasal paragraph. Similarly, mean nasalance exhibited by male subjects was 47.03 (4.86) for nasal sentences and 46.84 % (5.23) for nasal paragraph. A significant difference was evident across gender in adults.

This difference may be attributed to the basic structural and functional differences between genders. The resonance of voice is influenced by the size, shape, and surface of the intraglottal and supraglottal resonating structures and cavities (Shprintzen and Bardach, 1995). The mechanism for velopharyngeal valving has been found to be different for men and women. Mckerns and Bzoch (1970) suggested that velar length is greater in men, the height of elevation is greater and the inferior point or contact is most

usually above palatal plane. In the female similar results are not found. The other finding that supports the present result is the acoustic transmission of palate. As the age increases, the sympathetic transfer of acoustic energy from oral cavity to the nasal cavity also increases in females (Hoit et al., 1994).

In the present study it has been found that females had higher nasalance value in both categories of stimuli. The result can also be attributed to increased respiratory effort and increased nasal cross-sectional area in female. (Seaver et al., 1991; Fletcher,1978; Hutchinson,1978).

The results also partially support the findings of Awan, S. (2001) who investigated the nasalance value of normal children and adult subjects using Nasal View to find out the age and gender effects on measures of RMS nasalance. Results shows that though no significant differences in RMS nasalance were observed between males and females at any age level, the female subjects were observed to produce adult levels of RMS nasalance at a younger age than the male subjects. These authors reported that this observation may be due to earlier facial skeletal and nasopharyngeal maturation in females as compared to males. Cephalometric data regarding the horizontal depth of the nasal cavity for various ages changes which is gradual but continuous growth in face height and width from 5years to 12± 15 years in males and two years earlier in females. In addition, nose width and height were fully developed in females by age 12 and in males by age14± 15 (Farkas *et al*., 1992). The authors reported lower levels of nasalance for all the three passages (Zoo, Rainbow and Nasal Sentences) for adults. His study

indicated a trend for increases in measured RMS nasalance for all the three passages with age and gender. Studies have reported that there is an increase in mean cross-sectional area of the nasal cavity from six years of age (Warren *et al.*, 1990) and there is an overall increases in nasopharyngeal height and volume (Bergland, 1963).

Data from Athanasiou *et al.* (1992) show that cephalometric ratios corresponding to measures of the facial skeleton demonstrate a progressive increase in absolute dimension during the period of 6 to 15 years in both males and females. It may be that the overall result of these aforementioned anatomical changes (in addition to the possible effects of atrophy of adenoid tissue) is a decrease in measured nasal resistance to airflow (Principato and Wolf, 1985) and, therefore, increases in the ratio of nasal to oral sound pressure level as observed in this study.

Also in the current study, female and male speakers age range was 18 to 35 years with 17 year interval exhibited no differences for stimuli containing no nasal sounds (oral stimuli). It is possible that a wider age range exaggerates the influence of variables associated with aging, including morphological and neuroanatomical changes, on sex differences in nasalance score. The sex difference in nasalance score variation in Hutchinson et al.'s (1978) study might be caused, not only by the higher ages of subjects, but also by the much wider age range of subjects, compared with the current study and Van Doorn and Purcell's (1998) study. These results may indicate that not only age but also range of age of subject speakers must be taken into consideration for the purpose of establishing normative nasalance data.

Similar results were obtained by Jay Kumar, T. (2005) who conducted a study to establish normative data for Nasometer in Kannada language. Fifty normal children and fifty normal adults were taken as subject (twenty five male and twenty five female in both the groups). Result of this study supports the findings of the present study. Author reported a significant difference across gender for both children and adult. author concluded that this difference across gender could be due to physiological and structural differences related to the velopharyngeal closure.

A similar study done by Ravindran, T. D. (2009), aimed to establish normative nasalance value in Malayalam language for adults and to study the effect of gender differences on nasalance value using NasalView system. Five oral and five nasal sentences and an oral and nasal paragraph was used as stimulus material to study the effect of stimuli on nasalance value. Results showed the similar finding as found in the present study. Author reported a significant difference across gender and across stimuli. Results revealed that females exhibit higher mean nasalance value as compared to males and the mean nasalance obtained from nasal stimuli is higher as compared to oral stimuli within gender. Author concluded that this is due to anatomical and physiological differences related to velopharyngeal closure across gender.

The results of the present study do not support the findings of Awan S.N et.al. (2001), who conducted a study to develop preliminary normative data for NasalView instrument and authors reported that mean nasalance exhibited by female subjects and male subjects are approximately same for oral paragraph (Zoo Passage) as well as for

nasal paragraph (Nasal Sentences) which reveals no significant difference across gender A result of their study does not reveal a significant difference across gender.

II Nasalance across Stimuli

The second aim of the present study was to compare the nasalance value across stimuli. Results of the present study revealed that a significant difference across mean nasalance obtained from oral and nasal sentences. It also shows that mean nasalance value obtained for nasal sentences is higher i.e. 48.72 % (4.72) than the mean nasalance obtained from oral sentences i.e. 22.53 % (4.67) exhibited by combined group (male and female). Similarly, a significant difference was evident between mean nasalance obtained from nasal and oral paragraph. It shows that mean nasalance obtained from nasal paragraph was higher i.e. 48.29 % (5.09) than oral paragraph i.e. 21.91 % (4.59).

Results from the present study also indicates that, the mean nasalance obtained for oral sentences and oral paragraph were approximately same i.e. 22.53% (4.67) and 21.91% (4.59) for oral sentences and oral paragraph respectively exhibited by combined group. Similarly mean nasalance exhibited by male subjects for nasal sentences and nasal paragraph is found to be approximately same i.e. 48.72% (4.72) and 48.29% (4.67) respectively and significant difference was not evident across oral sentence and oral paragraph and across nasal sentence and nasal paragraph. The reason could be attributed to the characteristics phonetic structure of the nasal and oral stimuli. As , the production of nasal stimuli induces transfer of acoustic energy into nasal cavity through open velopharyngeal port which is picked up by the microphone of the NasalView.

So far, studies concerned for normative data and of nasalance measurements have made use of mean values from group studies. The mean nasalance from a text word, sentence, or text passage is the most direct measure provided by instruments such as the Nasometer or the NasalView. However, there is considerable interspeaker variability across subjects' mean values of nasalance across stimuli. Bressmann et al., (1998a), reported that the mean values of the 45 patients with perceptually normal nasal resonance had a range from 19.5% to 35% nasalance for the nonnasal sentence "Peter spielt auf der Straße" ("Peter is playing in the street"). For the 27 patients with severe hypernasality, the mean values for the same sentence ranged from 23% to 64.6% nasalance. The variability in normal nasalance values may be attributed to individual variation as well as dialectal aspects of speech (Seaver et al., 1991). Because of this variability, it may be difficult to interpret nasalance mean values. For example, subjects with perceptually normal speech and resonance might present with abnormal nasalance scores, while on the other hand, patients who are clearly hypernasal based on perceptual judgment might well be within the normal range of mean nasalance.

Other variables affecting nasalance scores have been studied, such as stimulus length (Watterson et al., 1999) and morphological differences across speakers (Williams et al., 1992; Haapanen et al., 1996). Watterson et al. (1999) reported that stimuli of both 17 syllables and 6 syllables achieved high criterion validity, indicating that they could be substituted for the longer 44-syllable Zoo passage. Although the Kitsutsuki passage is relatively short in comparison with the Zoo passage, it is possible that the length of the Kitsutsuki passage (27 syllables) does not affect normative data.

Results of the present study are supports the finding of Bressmann et.al, (2000), who conducted a study to find the relationship between nasalance ratio for nasal and nonnasal sentences using NasalView instrument. Results form their study reveals that there is a significant difference present across stimuli. Mean nasalance obtained from nasal sentences showed higher values than oral sentences which supports the results obtained from the present study.

Awan, S., Daniel, Z. H. (2001) conducted a study to develop preliminary normative data for NasalView instrument using three passages i.e. Zoo passage, Rainbow passage and Nasal sentences. Authors reported that mean nasalance exhibited by female subjects and male subjects are approximately same for oral paragraph (Zoo Passage), oro-nasal paragraph (Rainbow Passage) as well as for nasal paragraph (Nasal Sentences) which reveals a significant difference across stimuli. This could be attributed to the reason that these reports were made on the basis of English or languages with similar phonological characteristics to English.

Similar results were obtained from study done by Tim Bressman (2005), which revealed that there is a significant difference present across three passages i.e. Zoo Passage, Rainbow Passage, and Nasal Sentences i.e. mean nasalance obtained from oral and nasal sentences, whereas there is no significant difference present within stimuli i.e. mean nasalance obtained from oral sentences and oral paragraph and mean nasalance obtained from nasal sentences and nasal paragraph.

A similar study done by Ravindran, T. D. (2009), showed that there is a significant difference across stimuli in adult Malayalam speakers across gender. The

author conducted the study to establish normative nasalance value in Malayalam language for adults and to study the effect of gender differences and type of stimuli on nasalance value using NasalView system. Author reported that a significant difference was evident across oral and nasal stimuli. Results showed the similar finding as found in the present study. result revealed that the mean nasalance obtained from nasal stimuli is higher as compared to oral stimuli within gender. author concluded that this difference could be attributed to difference in characteristic phonetic structure of the nasal and oral stimuli.

Awan, S. (2001) conducted a study on normal subjects using Nasal View to find out the age and gender effects on measures of RMS nasalance. The author reported lower levels of nasalance for all the three passages (Zoo, Rainbow and Nasal Sentences) for adults. His study indicated a trend for increases in measured RMS nasalance for all the three passages with age and gender. Studies have reported that there is an increases in mean cross-sectional area of the nasal cavity from six years of age (Warren *et al.*,1990) and there is an overall increases in nasopharyngeal height and volume (Bergland, 1963).

Williams et al. (1992) examined whether changes in nasalance scores might occur after adenoidectomy, tonsillectomy, or adenotonsillectomy. The results suggested that there was a significant increase in nasalance following tonsillectomy or adenotonsillectomy, whereas there was no significant change following adenoidectomy. They speculated that nasalance scores may be more closely related to the size of the nasopharyngeal airway than to the actual adenoid volume.

Haapanen et al. (1996) examined the relationship between cephalometric craniofacial dimensions and speech performance in thirty young adult patients with cleft palate . They measured various cephalometric dimensions reflecting vertical facial height and sagittal nasopharyngeal length to compare with the speech data. They indicated that sagittal bony nasopharyngeal depth is significantly related to speech impairment.

These studies above imply that the maxillofacial morphology, especially in the midfacial region including the velopharynx, may affect nasalance score variation. Therefore, it is essential that the differences in craniofacial morphology, which is variable in association with race or age, are taken into consideration for the purpose of establishing normative nasasalance data for nasalance score.

There is great difference in craniofacial morphology between the Mongolian and the Caucasian (Singh et al., 1998; Zeng et al., 1998). Singh et al. (1998) examined whether there is a difference in craniofacial morphology in subjects of diverse ethnic origin using lateral cephalograms of 142 Korean and European-American children. They concluded that Korean children have a smaller anterior cranial base and midfacial dimensions than European-American children. If oral and nasal acoustic impedance is affected by relative discrepancies between oral and nasal morphology, a relatively smaller vertical dimension of the midface might result in decreased nasal acoustic energy, which may lead to a decrease in nasalance

III Clinical Interpretation of Normative Data

Establishing the nasalance values for clinically significant abnormalities is important in many areas of medical epidemiology. It can be approached from a clinical or statistical perspective (Baker and Rose, 1984). Initially clinical perspective had been widely used Dalston et al. (1991a, 1993) who used clinical rather than statistical approach. Perceptual ratings on a numerical scale were predetermined to be clinically significant at a particular value. Then, nasalance scores for nasalance were set as those that give the best over all correct prediction of the presence or absence of abnormal nasality.

Regardless of the methodology differences that have led to the development of cut off scores, it is quite clear that cut off values determines that there are some speakers whose resonance is judged to be normal and who have abnormal resonance. Following Table 14 shows cut off values for normal adult male and female.

Stimuli	Female	Male
Oral sentence	13.36-31.18	12.90-32.06
Oral paragraph	13.57-30.89	11.89-31.29
Nasal sentence	42.53-58.29	37.31-56.75
Nasal paragraph	40.64-58.84	36.38-57.30

Table 14: Cut off values for across gender and stimuli

The significant difference was evident across gender in adults. This difference may be attributed to basic structural and functional differences across gender. An adult female has difference in size, shape and resonating cavity of vocal system than an adult male. This difference might lead to show significantly high mean nasalance value exhibited by female subjects as compare to male subjects.

The possible reason could be the underlying anatomical and physiological differences related to velopharyngeal closure across gender. But the present study does not support the findings of Trindade et al., 1997; Van Doorn & Purcell, 1998; Sweeney et al., 2004, who reported no significant difference across gender.

Overall the present study adds to the body of evidence that there are gender and stimuli differences in nasalance values. Clinically the normative data reported in the present study may help to identify and treating individuals with resonance disorders.

CHAPTER - VI

SUMMARY AND CONCLUSION

Nasalance is a commonly used measure that allows the speech-language pathologist to validate and quantify a perceptual assessment. The nasalance score is calculated as a ratio of the nasal sound pressure level to the combined nasal and oral sound pressure level (Fletcher, 1978). There are some instruments like Nasometer, NasalView and Oronasal system which are being use to obtain nasalance value for normal as well as disordered individuals in all population.

NasalView (Awan, 1997) is a new PC-based system for the computerized measurement of nasalance (Tiger Electronics, Seattle, WA). NasalView provides mean, minimum and maximum nasalance values (in percentage) for different stimuli like syllable, sentences and paragraphs i.e. oral, nasal and oro-nasal. The sampled sound signal or signal selections can be played back and edited with the NasalView program. Oscillograms of the nasal and oral signal and a nasalance curve are displayed together with nasalance statistics so that speech segments can be identified accurately and the envelope of the nasalance curve over time can be related to particular sounds. NasalView is widely being used to establish normative data across age, gender, dialect and stimuli by several authors.

The present study primarily aimed to establish normative data for Hindi speaking male and female adults. The subjects for the study considered were one hundred normal

subjects with normal oral structure and functions. All the participants were native speakers of Hindi language. Subjects were divided into two groups. First group consisted of fifty females and the second group consisted of fifty male adults. Both group had equal number of males and females. For the purpose of the stimuli, an experienced post graduate speech and language pathologists whose mother tongue was Hindi prepared two sets of Hindi sentences and paragraphs. Ten sentences and two paragraphs were given to them in each category and were provided with a five point rating sheet to rate for each sentence and paragraphs i.e. oral and nasal (rating sheet provided in Appendix- I). Most appropriate five sentences in each category out of ten were selected on the basis of rating given by judges. The material and scoring sheet is provided in the Appendix-II. The Nasal View (version 4) was used to for the data collection. The instrument was calibrated prior to the data collection. Nasal View head gear was placed on the subjects head. Once the head set is positioned properly, the subjects were instructed to read or repeat sentences. After the completion of each speech sample, the nasalance trace was stored on computer file for latest analysis. The data was analyzed for adults (male and female separately) using descriptive statistics, independent t-test, mixed ANOVA and paired t-test using SPSS software version 16.0 package.

The present study aimed to develop normative data for Hindi speaking male and female adults by obtaining nasalance value across gender and across stimuli. Following table (12) shows the mean normative nasalance values with the range of minimum nasalance value to the maximum nasalance value for adults across gender and across stimuli.

Stimuli	Gender	Mean (S.D)	Min (S.D)	Max (S.D)
Oral Sentences	Male	22.48 (4.79)	6.51 (1.78)	62.83 (11.40)
	Female	22.58 (4.61)	6.56 (1.65)	65.55 (8.42)
Oral paragraph	Male	21.59 (4.85)	3.46 (1.23)	83.22 (8.45)
	Female	22.23 (4.33)	4.00 (2.13)	85.22 (6.71)
Nasal sentences	Male	47.03 (4.86)	9.75 (2.52)	85.74 (6.37)
	Female	50.41 (3.94)	11.31 (2.56)	87.80 (4.62)
Nasal paragraph	Male	46.84 (5.23)	5.59 (2.14)	88.30 (5.58)
	Female	49.74 (4.55)	6.29 (2.90)	90.02 (4.38)

Table 15: Normative mean nasalance value across gender and across stimuli

The mean nasalance value exhibited by normal adult male and female subjects for oral sentences was 22.48 % (4.79) and 22.58 % (4.61) respectively. The mean nasalance value exhibited by male and female subjects for oral paragraph was 21.59 % (4.85) and 22.23% (4.33) respectively. The mean nasalance values exhibited by adult male and female subjects for nasal sentences were 47.03% (4.86) and 50.41% (3.94) respectively. The mean nasalance value exhibited by male and female subject for nasal paragraph was 46.84% (5.23) and 49.74 (4.55) respectively. A significant difference was evident across gender and across stimuli.

This difference may be attributed to the basic structural and functional differences across genders. The resonance of voice is influenced by the size, shape, and surface of the intraglottal and supraglottal resonating structures and cavities (Shprintzen and Bardach,

1995). The mechanism for velopharyngeal valving has been found to be different for men and women. Mckerns and Bzoch (1970) suggested that velar length is greater in men, the height of elevation is greater and the inferior point or contact is most usually above palatal plane. In the female similar results are not found. The other finding that supports the present result is the acoustic transmission of palate. As the age increases, the sympathetic transfer of acoustic energy from oral cavity to the nasal cavity also increases in females (Hoit et al., 1994). It has been found that females had higher nasalance value in both categories of stimuli. The result can also be attributed to increased respiratory effort and increased nasal cross-sectional area in female. (Seaver et al.,1991; Van Lierde et al., Fletcher,1978; Hutchinson,1978).

Results from Bressmann et.al, (2000) study reveals that there is a significant difference present across stimuli. Mean nasalance value obtained for nasal sentences showed higher values than oral sentences which support the results obtained from the present study. Awan, S., Daniel, H. (2001) conducted a study to develop preliminary normative data for NasalView instrument using three passages i.e. Zoo passage, Rainbow passage and Nasal sentences. Authors reported that mean nasalance exhibited by female subjects and male subjects are approximately same for oral paragraph (Zoo Passage), oro-nasal paragraph (Rainbow Passage) as well as for nasal paragraph (Nasal Sentences) which reveals a significant difference across stimuli. This could be attributed to the reason that these reports were made on the basis of English or languages with similar phonological characteristics to English.

The possible reason for these gender differences on nasalance value could be underlying anatomical and physiological differences related to velopharyngeal closure across gender. Additionally, some studies demonstrated that there are gender differences in vocal fold vibration pattern (Oates and Dacakis, 1997)

Overall the present study adds to the body of evidence that there are gender differences in nasalance values. Clinically the normative data reported in the present study may help to identify and treating individuals with resonance disorders.

Limitations of the Present Study:

- Limited age range of subjects were considered.
- Limited number of subjects.
- The dialect variation in Hindi language was not controlled .

Future directions:

- Normative data need to develop for other age range and geriatric population.

- Normative nasalance value across dialect variation in Hindi language and other Indian languages needs to be investigated.

- Vowel differences and effect of length of stimuli on nasalance scores may also be considered.

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APPENDIX

Oral and Nasal stimuli were prepared by a post graduate speech and language pathologist whose native language is Hindi. These oral and nasal stimuli were given to ten experienced speech and language pathologists in the form of five point rating sheet for the perceptual rating of nasalance. Five oral and nasal sentences and an oral and nasal paragraph were selected according to their ratings.

Appendix I consists of a sample of ten oral sentences, ten nasal sentences, an oral paragraph and a nasal paragraph provided in a five point rating sheet.

Appendix II consists of a sample of perceptual nasalance rating given by an experienced speech and language pathologist whose native language is Hindi.

Appendix III consists of the five oral and five nasal sentences, an oral paragraph and a nasal paragraph selected from the ratings given by ten experienced speech language pathologists. These oral and nasal sentences and paragraphs were used as a stimuli material in the study to develop normative nasalance value in Hindi language, which can be further use for the assessment of nasalance in Hindi speaking adults using NasalView instrument.

APPENDIX - I

FIVE POINT RATING SHEET

INSTRUCTIONS

- Please read the instructions carefully.
- Fill your details in the space provided.
- Please read the sentences and paragraphs given properly and mark a tick to the corresponding sentence/ paragraph on rating sheet according to the points 0 to 4.
- Please give remark, if required to change or modify the mentioned sentences and paragraph.
- Suggestions are invited.

Here, five points 0 to 4 indicates:

0- fully oral or no nasality
1-oral with slight nasal
2-equally oral or nasal
3- nasal with slight oral
4- highly nasalized or no oral

Name :

Age/sex

Qualification :

No. of year experienced :

Overall remark/ suggestion about stimuli :

Signature: Date:

APPENDIX- I

1. SENTENCES

a.) ORAL SENTENCES IPA

1. रवि बाजार गया
2. यह घर है
3. गीता पढ्ती है
4. शीला खुश है
5. सीता जाती है

b.) NASAL SENTENCES

1. मैने आम मागा
2. मै मकान लूगा
3. नानी अगूर देगी
4. नाना नानी आएगे
5. मा नही मानी

2. PARAGRAPHS

c.) ORAL PARAGRAPH

एक प्यासा कौआ था वह जल के लिए इधर उधर भटक रहा था तभी उसे एक घडा दिखाई दिया घडा थोडे ही जल से भरा था उसे एक तरकीब सूझी, वह पास पडे पत्थर ले आया और घडे के भीतर डाळ दिए इससे जल ऊपर आ गया कौआ जल पीकर उड गया

d.) NASAL PARAGRAPH

नीना मीना बहने है वे नाना नानी से मिलने उनके मकान जाऐगी वहा नौ दिन रहेगी नानी उन्हे आम देगी, नाना उन्हे मैना कि कहानी सुनाएगे नीना मीना नाना सग मेले मे जाऐगी नानी मन्दिर जाऐगी व वहा नन्द किशन के नमन मे मग्न होगी

APPENDIX- II

FIVE POINT RATING SHEET

INSTRUCTIONS

- Please read the instructions carefully.
- Fill your details in the space provided.
- Please read the sentences and paragraphs given properly and mark a tick to the corresponding sentence/ paragraph on rating sheet according to the points 0 to 4.
- Please give remark, if required to change or modify the mentioned sentences and paragraph.
- Suggestions are invited.

Here, five points 0 to 4 indicates:

0- fully oral or no nasality
1-oral with slight nasal
2-equally oral or nasal
3- nasal with slight oral
4- highly nasalized or no oral

Name : Pooja Dayal
Age/sex 23yrs/ Female
Qualification : M Sc. (SLP)
No. of year experienced : 6years

Overall remark/ suggestion about stimuli :
Oral sentences and paragraphs are sharing complete oral components nasal sentences & Paragraph requires little modification.

Signature: Pooja Date: 11/11/08

S. no	1. SENTENCES	IPA	Rating					Remark / suggestion
	a.) ORAL		0	1	2	3	4	
1	रवि बाजार गया	/ɾəvɪ/badʒar/gəjə/	✓					
2	पेड बडा है	/peɖ/ /bəɖa/ /hɛ/	✓					
3	यह घर है	/jəh/ /gʰər/ /hɛ/	✓					
4	गीता पढ्ती है	/gitaˌ/ /pəɖʰˌi/ /hɛ/	✓					
5	आप कैसे हो	/ap/ /kɛse/ /ho/	✓					
6	यह थरमुस है	/jəh/ /θərməs/ /hɛ/		✓				can change to words like: जीपर, कोलर
7	चार टमाटर दो	/ʧar/ /ʈəmaʈər/ /do/		✓				some nasal component is coming. change it
8	शीला खुश है	/ʃila/ /kʰuʃ/ /hɛ/	✓					
9	सीता जाती है	/siˌtaˌ/ /ʤaˌtˌi/ /hɛ/	✓					
10	शोभा सोती है	/ʃobʰa/ /ʃoˌtˌi/ /hɛ/	✓					
	b.) NASAL							
1	मैंनें आम माँगा	/mɛ̃ne/ /am/ /mãga/					✓	
2	मैं मक़ान लूगा	/mɛ/ /məkan/ /lũga/				✓		oral component is coming
3	मामी आमँ लेंगी	/mami/ /am/ /lẽgi/					✓	
4	माँ नहीं मानी	/mã/ /nəhĩ/ /mani/					✓	
5	नाना नानी आएगें	/nana/ /nani/ /ɛ̃ge/					✓	
6	नमन गाना सुनेगा	/nəmən/ /gana/ /sunega/			✓			change to - नमन ने गाना सुना
7	यहाँ जाँच होंगी	/jəhã/ /ʤãʧ/ /hõgi/				✓		
8	,नानी अँगुर देंगी	/nani/ /ãguɾ/ /dẽgi/					✓	
9	वे न मिलेगें	/ve/ /nə/ /mɛ̃ɛ̃ge/			✓			
10	जंगल मे मंगल	/ʤə̃gal/ /me/ /mə̃gal/			✓			This showing equally oral and nasal.

PARAGRAPHS	Rating				
	0	1	2	3	4
c.) ORAL PARAGRAPH एक प्यासा कौआ था।वह जल के लिए इधर उधर भटक रहा था। तभी उसे एक घडा दिखाई दिया घडा थोडे ही जल से भरा था। उसे एक तकीब सूझी, वह पास पडे पत्थर ले आया और घडे के भीतर डाळ दिए इससे जल उपर आ गया कौआ जल पीकर उड गया /ekl /pjasal /kɔal /ɔal /vɔhl /dʒal/ /kel /liʲel /ɪʃʰɔrl /uʃʰɔrl /bʰɔtɔkl /rɔhal /ɔal /ʧabʰil /usel /ekl /gʰɔɗal /rɔɪkʰail /rɔial /gʰɔɗal /ɔɑdel /hel /dʒal/ /sel /bʰɔral /ɔal /usel /ekl /ʧarkibl /sudʒhil /vɔhl /pasl /pɔɗel /pɔɔɔrl /lel /ajɑv/ɪɔl /gʰɔɗel /kel /bʰiʧɔrl /ɗal/ /ajel /isel/dʒal/ /upɔrl /al /gʒjal /kɔal /dʒal /pikɔrl /ud /gʒjal	✓				
d.) NASAL PARAGRAPH नीना मीना बहनें हैं।वे नाना नानी से मिलने उनके मकान जाऐंगी।वहाँ नौं दिन रहेंगी नानी उन्हें आम देंगी, नाना उन्हें मैना कि कहानी सुनाएँगें।नीना मीना नाना सँग मेले मे जाऐगीं नानी मन्दिर जाऐंगी व वहाँ नन्द किशन के नमन में मग्न होंगीं। /nina-/mina /bɔhnel /hɛ̃ /vel /nanal /nanil /sel /milnel /unkel /makan/ /dʒɑ̃egi/ /vɔhal /nɔ/ /rɔini /rɔhẽgi/ /nanil /unhel /am/ /rɔẽgi/ /nanal /unhel /mɔɛ̃nal /kil /kahanil /sunɑ̃egel /nina/ /mina/ /nanal /sɔ̃gl /mel/ /mɛ̃l /dʒɑ̃egi/ /nanil /mɔ̃ɔɔɪ/ /dʒɑ̃egi/ /vɔl /vɔhal /mɔ̃ɔɔl /kijɔnl /kel /nɔmɔn/ /mɛ̃l /magnl /hõgil				✓	

REMARK/SUGGESTION: Oral paragraph is showing full oral components but nasal paragraph is having slight oral component with more nasality.

APPENDIX - III

1. SENTENCES

a.) ORAL SENTENCES	IPA
1. रवि बाजार गया।	/ɾəvɪ/ /badʒaɾ/ /gəja/
2. यह घर है।	/jəh/ /gʰəɾ/ /hɛ/
3. गीता पढ़ती है।	/gi̥ta/ /pəɽʰt̪i̥/ /hɛ/
4. शीला खुश है।	/ʃila/ /kʰuʃ/ /hɛ/
5. सीता जाती है।	/si̥ta/ /dʒat̪i̥/ /hɛ/

b.) NASAL SENTENCES	
1. मैंने आम माँगा।	/mɛ̃ne/ /a:m/ /mã:ga/
2. मैं मकान लूँगा।	/mɛ̃/ /məkan/ /lũga:/
3. नानी अँगूर देंगी।	/nani̥/ /ə̃gur/ /de̞:gi̥/
4. नाना नानी आएँगें।	/nana/ /nani̥/ /a:e̞ge/
5. मैं नहीं मानीं।	/mã:/ /nəhi:/ /ma:ni/

2. PARAGRAPHS

c.) ORAL PARAGRAPH

एक प्यासा कौआ था। वह जल के लिए इधर उधर भटक रहा था। तभी उसे एक घडा दिखाई दिया घडा। थोडे ही जल से भरा था। उसे एक तरकीब सूझी, वह पास पडे पत्थर ले आया और घडे के भीतर डाळ दिए।इससे जल ऊपर आ गया।कौआ जल पीकर उड गया

|ekI |pjaːsal |kɔal |ϑal |vəh| |dʒəll |kel |llɪel |ɪɗʱərI |uɗʱərI |bʱətəkI |rəhal |ϑal |təbʱi'l |usel |ekI |gʱəɗal |ʂikhail |ʂɪal |gʱəɗal |ϑoɗel |hel |dʒəll |sel |bʱəral |ϑal |Usel |ekI |tʰərkib| |sudʒʱi'l |vəhl |pasI |pəɗel |pəϑərI |llel |ajal |ɔrI |gʱəɗel |kel |bʱi'tʰərI |ɗall |ʂɪel |liše| |dʒəll |upərI |al |gəjal |kɔal |dʒəll |pikərI |uɗI |gəja|

d.) NASAL PARAGRAPH

नीना मीना बहनें हैं।वे नाना नानी से मिलने उनके मकान जाऐगीं।वहाँ नौं दिन रहेंगीं नानी उन्हें आम देगीं, नाना उन्हें मैंना कि कहानी सुनाएगें।नीना मीना नाना संग मेले में जाऐंगी नानी मन्दिर जाऐंगी व वहाँ नन्द किशन के नमन में मग्न होंगी।

|nĩnal-|mĩnal |bəhne| |hɛ̃| |ve| |nanal |nanil |se| |milne| |Unke| |məkan| |dʒɑ̃:gi| |vəhɑ̃:| |hɔ| |ʂini |rəhẽgi| |nanil |Unhe| |ami |ʂẽgi| |nanal |unhe| |mɛ̃nal |ki| |kəhani| |sunɑ̃ge| |nĩnal-|mĩnal |nanal |sɔ̃gI |mele| |mel |dʒɑ̃gi| |nanil |mɔ̃ʂɪrI |dʒɑ̃gi| |vo| |vəhɑ̃| |nəɳɗ| |kiʃən| |ke| |nəmən| |mẽ| |məgən| |hõgi:|