**PROJECT PROPOSAL**

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| **Part –A** | | |
| **1.0** | **Title of the Project** | **Validation of Nasality Severity Index** |
| **Area of Research :** | Speech Language Pathology |
| **1.1** | **Principal Investigator:** | **Dr. A. Navya** |
| **1.2** | **Principal Co-Investigator(s):** | **Dr. M. Pushpavathi & Dr. M.S.Vasanthalakshmi** |
| **1.4** | **Collaborating Institution** | Not Applicable |
| **1.5** | **Total Grants Required**  **(in figures and in words)** | Rs. 5,23,000/- (Five lakhs twenty three thousand rupees only) |
| **1.6** | **Duration of the Project** | 12 months |

**2.0. Project Summary**

Cleft lip and palate (CLP) is a congenital abnormality due to incomplete fusion of tissue during the development of face and upper lip in the gestational period. These children undergo surgical intervention for the closure of the cleft. Even after surgical intervention, the children with CLP do exhibit hypernasality, nasal emissions, and compensatory articulatory errors secondary to velopharyngeal dysfunction (VPD). The evaluation of speech in CLP can be performed using subjective and objective methods. Even though the perceptual evaluation is considered as a gold standard, it is influenced by various factors. Hence researchers developed nasality severity index, which can provide the objective information about the perceived nasality. The study by Navya and Pushpavathi (2016) developed nasality severity index, however the validation of the index is performed only by considering 5 subjects in to each group. Hence, the current study aimed to validate the nasality severity index equations developed by Navya and Pushpavathi (2016). The four equations considered for validation are as follows.

NSI (1) = -3.10 - 0.01(a)+0.01(b)+0.07(c)-0.01(d)-0.04(e) 0.01(f) + 0.06(g) +0.02(h) +0.02(i) -0.03(j) - 0.12(k) + 0.52(l) + 0.04(m) - 0.02(n) - 0.04(o) + 0.03(p)- 0.01(q) + 0.02(r) - 0.01(s) + 0.02(t) - 0.01(u) + 0.03(v) + 0.02(w) + 0.09(x) - 0.07(y) - 0.01(z) + 2.95(z1).

NSI (2) = 1.46 - 0.02(a) + 0.02(b) + 0.01(c) + 0.15(d) -0.11(e)-0.10(f)-0.02(g)- 0.01(h)-0.30 (i)+0.03(j)+0.07(k)-0.17(l)+0.11(m)+0.02(n) 0.01(o) + 0.04(p) + 0.05(q) + 0.01(r) - 0.007(s) + 0.04(t) - 0.03(u) - 0.001(v) - 0.05(w) + 0.14(x) -.18(y) + 0.16(z) - 6.93(z1).

\*Note: a=/a/1000Hz, b = /a/1587Hz, c = /i/1000Hz, d = /i/1259, e = /i/1587, f = /i/3174, g = /p/ 396, h = /p/500, i = /p/793, j = /p/1000, k = /p/1259, l = /p/1587, m = /p/2000, n = /p/2519, o = /p/3174, p = /p/4000, q = /t/396, r = /t/500, s = /t/793, t = /t/100, u = /t/2519, v = M\_nasla, w = M\_nasli, x = M\_O, y = M\_N, z = M\_ON, z1 = M\_NR.

NSI (3) = -2.39 + 0.02(M\_Nasli) - 0.02(M\_ON) - 0.04(M\_NDS) + 4.75(M\_NRS) + 0.01 (T396).

NSI (4) = 3.63 + 0.03(M\_Nasli) - 0.12(M\_ON) + 0.09(M\_NDS) + 3.64(M\_NRS)- 0.05 (T396).

\*Note: M\_Nasla = Mean nasalance of vowel /a/, M\_Nasli = Mean nasalance of vowel /i/, M\_ON = Mean nasalance of oronasal sentences, M\_NDS = Mean of nasalance distance, M\_NRS = Mean of nasalance ratio, M\_N = Mean of nasal sentences, T396 = One third octave spectral amplitudes for /i/ in /tip/.

The study will include 60 children with repaired cleft lip and palate (RCLP) and typically developing children (TDC). They will be grouped based on the perceived nasality using 4 point standardized rating scale. The nasalance and one third octave spectral amplitude measures will be evaluated for all the children. The stimulus considered for subjective and objective measures will be spontaneous speech, oral, nasal, oronasal sentences, vowels /a/, /i/, /pit/, and /tip/. The nasalance measures will be performed by using Nasometer 6400 and one third octave spectral amplitude measures will be evaluated by using MATLAB software. The appropriate statistical methods will be used to validate the nasality severity index equations.

**3.0 Introduction**

**3.1 Definition of the problem**

The speech of individuals with CLP is primarily characterized by abnormalities in resonance characteristics of vocal tract. This is a direct result of unoperated cleft / fistula and/or velopharyngeal dysfunction. The individual with velopharyngeal dysfunction (VPD) exhibits abnormal closure of velopharyngeal port during the speech production. The objective evaluation of nasality has led to the development of various measures. A recent study by Navya and Pushpavathi (2016) developed nasality severity index which was validated by considering only 5 children under each group. Hence, the current study is planned to validate the equation by considering more number of children under each group so that it can be used widely on daily basis in the clinics.

**Aim**

The aim of the present study is to validate the nasality severity index (NSI) developed by Navya and Pushpavathi (2016) for Kannada speaking children with repaired cleft lip and palate. The equations are given below.

NSI (1) = -3.10 - 0.01(a)+0.01(b)+0.07(c)-0.01(d)-0.04(e) 0.01(f) + 0.06(g) +0.02(h) +0.02(i) -0.03(j) - 0.12(k) + 0.52(l) + 0.04(m) - 0.02(n) - 0.04(o) + 0.03(p)- 0.01(q) + 0.02(r) - 0.01(s) + 0.02(t) - 0.01(u) + 0.03(v) + 0.02(w) + 0.09(x) - 0.07(y) - 0.01(z) + 2.95(z1).

NSI (2) = 1.46 - 0.02(a) + 0.02(b) + 0.01(c) + 0.15(d) -0.11(e)-0.10(f)-0.02(g)- 0.01(h)-0.30(i)+0.03(j)+0.07(k)-0.17(l)+0.11(m)+0.02(n) 0.01(o) + 0.04(p) + 0.05(q) + 0.01(r) - 0.007(s) + 0.04(t) - 0.03(u) - 0.001(v) - 0.05(w) + 0.14(x) -.18(y) + 0.16(z) - 6.93(z1).

NSI (3) = -2.39 + 0.02(M\_Nasli) - 0.02(M\_ON) - 0.04(M\_NDS) + 4.75(M\_NRS) + 0.01 (T396).

NSI (4) = 3.63 + 0.03(M\_Nasli) - 0.12(M\_ON) + 0.09(M\_NDS) + 3.64(M\_NRS)- 0.05 (T396).

**3.2 Objectives of the Study:** The following objectives were considered in the study.

* Classification of children with RCLP based on perceptual evaluation of nasality using the standardized perceptual rating scale.
* To estimate nasality severity index for all the four equations in children with RCLP and typically developing children (TDC).
* Correlation of estimated nasality severity index with the perceived nasality in children with RCLP and TDC.

**3.3 Review of status of research and development in the subject**

To have consensus across the measures of nasality a multidimensional diagnostic measure with high sensitivity and specificity is required. An attempt was made by Van Lierde, Wuyts, Bonte, and Cauwenberge (2007) to construct an equation based on Glatzel test, maximum duration time, and nasalance measures derived from children with CLP in the age range of 4-12 years. The results indicated an index “Nasality Severity Index = - 60.69 - (3.24x percent of oral text) – (13.39 x Glatzel value /a/) + (0.244 x maximum duration time (seconds) - (0.558 x % /a/) + (3.38 x % oronasal text)”. Their study concluded that nasality severity index with sensitivity and specificity of 88% and 95% respectively can be used in the evaluation process of speech in children with CLP.

However, overcoming the advantages of the NSI equation, some limitations are also reported. This index is based on Dutch language and cannot be generalized universally. Another limitation is that only 5 variables (nasalance percent of oral text, Glatzel value of /a/, maximum duration time (seconds), nasalance % of /a/, nasalance percent of oronasal text) were considered for evaluation and to further formulate the index. The review of literature has also revealed that there are other potential acoustic (nasalance distance, nasalance ratio, voice low tone to high tone ratio, 1/3rd octave analysis, jitter, and shimmer) and aerodynamic variables (sub glottal pressure, mean airflow rate, & laryngeal airway resistance) that can be used to differentiate individuals with hypernasality from normals. The study has not included equal number of participants based on severity of hypernasality. Hence they could not derive any cut-off values with respect to the severity of hypernasality exhibited as there were limited numbers of children with CLP under each degree of perceived nasality. Therefore, the study only correlated the NSI values with the perceived nasality and commented on trend observed across the groups.

Another study by Navya and Pushpavathi (2016) constructed nasality severity index based on measures of perceptual evaluation, nasalance values and one third octave spectra analysis. The study included 33 children with mild hypernasality, 34 with moderate to severe hypernasality and 35 age and gender matched typically developing children. Based on discriminant function analysis four equations to calculate nasality severity index was developed. The equation included 27 variables based on one third octave spectral analysis and nasalance measures. There were two discrimination functions such as NSI (1) and NSI (2). If the cutoff score based on NSI (1) was below -1.21 indicates controls group and above is hypernasal group. Based on equation derived from NSI (2) mild hypernasal group were indicated with score below -0.18 and above this are considered as moderate to severe hypernasal group. The percentage of predicted group member ship was 100 %, 95.7 %, and 91.7 % for normal, mild and moderate to severe hypernasal groups respectively. The equations are as shown below.

NSI (1) = -3.10 - 0.01(a)+0.01(b)+0.07(c)-0.01(d)-0.04(e) 0.01(f) + 0.06(g) +0.02(h) +0.02(i) -0.03(j) - 0.12(k) + 0.52(l) + 0.04(m) - 0.02(n) - 0.04(o) + 0.03(p)- 0.01(q) + 0.02(r) - 0.01(s) + 0.02(t) - 0.01(u) + 0.03(v) + 0.02(w) + 0.09(x) - 0.07(y) - 0.01(z) + 2.95(z1).

NSI (2) = 1.46 - 0.02(a) + 0.02(b) + 0.01(c) + 0.15(d) -0.11(e)-0.10(f)-0.02(g)- 0.01(h)-0.30(i)+0.03(j)+0.07(k)-0.17(l)+0.11(m)+0.02(n) 0.01(o) + 0.04(p) + 0.05(q) + 0.01(r) - 0.007(s) + 0.04(t) - 0.03(u) - 0.001(v) - 0.05(w) + 0.14(x) -.18(y) + 0.16(z) - 6.93(z1).

\*Note: a=/a/1000Hz, b = /a/1587Hz, c = /i/1000Hz, d = /i/1259, e = /i/1587, f = /i/3174, g = /p/396, h = /p/500, i = /p/793, j = /p/1000, k = /p/1259, l = /p/1587, m = /p/2000, n = /p/2519, o = /p/3174, p = /p/4000, q = /t/396, r = /t/500, s = /t/793, t = /t/100, u = /t/2519, v = M\_nasla, w = M\_nasli, x = M\_O, y = M\_N, z = M\_ON, z1 = M\_NR.

To check the validity of the index fifteen children with RCLP and TDC five in each group were included and verified the group membership by calculating the NSI. The results indicated 100%, 60% and 80% correct identification of the predicted group membership on control, mild and moderate to severe hypernasal groups. To formulate an index with less number of variables to ease of use of index so that this can be used clinically on daily basis. Another statistical method called as step wise discriminant analysis was used. The equation included 5 parameters based on nasalance values and one third octave spectra analysis.

NSI (3) = -2.39 + 0.02(M\_Nasli) - 0.02(M\_ON) - 0.04(M\_NDS) + 4.75(M\_NRS) + 0.01 (T396).

NSI (4) = 3.63 + 0.03(M\_Nasli) - 0.12(M\_ON) + 0.09(M\_NDS) + 3.64(M\_NRS)- 0.05 (T396).

\*Note: M\_Nasla = Mean nasalance of vowel /a/, M\_Nasli = Mean nasalance of vowel /i/, M\_ON = Mean nasalance of oronasal sentences, M\_NDS = Mean of nasalance distance, M\_NRS = Mean of nasalance ratio, M\_N = Mean of nasal sentences, T396 = One third octave spectral amplitudes for /i/ in /tip/.

Based on functions derived using this method, if the NSI (3) value is more than -0.85 it indicates hypernasal group and participants exhibiting less than -0.85 are considered as TDC. If the NSI (4) value is less than 1.29 indicates moderate to severe hypernasal group and exceeding this indicates mild hypernasal group. Among NSI (3) and NSI (4), the groups are significantly differentiated for 86.9% based on NSI (3) and 13.1 % based on NSI (4). The validity of the index indicated 100%, 40% and 60% correct identification of the predicted group membership on TDC, mild hypernasal and moderate to severe hypernasal groups.

**3.4 International and national status**

The study would enhance the data base for the use of the instruments for objectively analyzing nasality and correlating with perceived nasality. The study would enhance the ease of communicating the objective findings across various centers and multidisciplinary professionals. The findings would also add to the existing literature worldwide and particularly in developing countries.

**3.5 Importance of the proposed project in the context of current status**

Evaluation of hypernasality is skill based task. Hence developing an index which is amalgamation of objective measures can increase the accuracy of diagnosing severity of hypernasality. The most commonly used objective measure is nasalance. The studies on correlation of nasalance measures with perceived nasality provided ambiguous results. Hence, another objective measure based on one third octave spectral amplitudes are calculated which is potentially correlating with perceived nasality. Based on these two measures nasality severity index is developed. However, the validation of the index is not performed on larger children with RCLP. So the findings of the current study can have direct clinical implications if the nasality severity index has good validity in analyzing nasality.

**4.0 Work Plan**

**4.1 Method**

**Participants**

The study includes both subjective and objective measures of nasality in children with RCLP. Based on the inclusion and exclusion criteria, the present study will consider 60 Kannada speaking children where 40 are children with RCLP and 20 are typically developing children in the age range of five to twelve years. Based on perceived nasality children will be divided in to three groups (normal nasality, mild hypernasality, moderate to severe hypernasality) 20 in each group.

**Participants Selection Criteria**

The following criteria will be considered for selecting the participants in the present study.

**Inclusion criteria for Group I (Children with RCLP)**

* The children with RCLP/ repaired cleft palate/ repaired soft palate.
* Children in the age range of five to twelve years.
* Children with Kannada as their native language.
* Children with normal cognitive and mental abilities will be considered based on reports by psychologist.
* Children will be screened for hearing abilities and children with less than 20 dB hearing thresholds in the poorer ear will be included for the study.

**Inclusion Criteria for Group II (TDC)**

* Children who passed informal screening for speech and hearing disorders by a qualified SLP.
* Children with hearing sensitivity in normal limits with no middle earpathologies.
* Children in the age range of five to twelve years
* Children with Kannada as their native language
* Children exhibiting normal oromotor structure and functions.
* Children ruled out for different types of disability by administering World Health Organization (WHO) checklist (Singhi, Kumar, Malhi, & Kumar, 2007).

**Exclusion Criteria for Group I (children with RCLP).**

* Children with any associated syndromes, congenital heart defects ordisorders based on the reports of the pediatrician or physician.
* Children with unrepaired cleft lip and palate/ cleft palate, submucous palate, facial clefts.
* Children with secondary pharyngeal surgeries.
* Children with history of frequent ear discharge, upper respiratory tract infection, disorders related to ear, throat and nose pathologies based on the reports of otorhinolaryngologist.
* Children associated with neuromotor dysfunction such as dysarthria and apraxia were not considered.
* Children attained puberty were not considered (based on appearance of secondary sexual characteristics and voice characteristics among males).

**Exclusion criteria for group II**

* Children with cold/ cough/ upper respiratory tract infection,
* Children with deviated nasal septum/ enlarged tonsils
* Children with frequent history of otitis media/ adenoidectomy were not considered

**Subjective Evaluation**

**Classification of Participants with RCLP Based on Perceptual Analysis**

The purpose of perceptual evaluation is to classify the children with RCLP into different groups based on severity of nasality. The details of the procedure are as follows.

***Stimuli***

The stimuli for perceptual evaluation task will be spontaneous speech sample (on self-introduction, school, leisure activities and picture description) for duration of five to ten minutes and repetition of five oronasal and five oral sentences in Kannada language (Jayakumar & Pushpavathi, 2005). The speech samples of all the participants will be video recorded. A minimum of 50 to 60 words will be elicited for the analysis from the spontaneous speech sample. If spontaneous speech could not be elicited from participants then picture description task will be used to elicit speech. The picture description task consists of eliciting words with pressure consonants (ex: playground concept - the pictures containing children playing cricket, girls playing skipping). The oronasal sentences will be balanced with oral and nasal consonants whereas oral sentences dominantly consist of oral consonants. The oral and oronasal sentences will be modelled by the investigator, who could enunciate the Kannada sentences fluently.

***Recording***

The participants will be seated comfortably in an upright position on a chair in a quiet room condition. The speech samples will be recorded by using *Sony handy cam(Model no: DCR-SR88).* The recording will be performed by placing the handy cam at a distance of 2 feet from the participant. The stimulus will consist of spontaneous speech, oral and oronasal sentences. During the recording, the participants will be instructed to speak at comfortable loudness and pitch levels. The recording of the stimuli will be carried out with an inter stimulus interval of approximately 5 seconds. After completion of the entire recording, the investigator recheck the recorded samples and save them in the hard disk of a HP computer with Windows 7 operating system before the participant leaves the recording room premises.

***Material***

The video recorded speech samples (spontaneous speech, oral sentences and oronasal sentences) elicited from participants will be subjected to perceptual evaluation. The standardized perceptual rating scale developed by Henningsson, Kuehn, Sell, Sweeney, Trost- Cardamone, and Whitehill (2007) will be used to rate the samples by three experienced SLP’s. The perceptual rating classifies the data onto a 4-point rating scale that reflects increasing severity of hypernasality from 0 through 3, where 0 = within normal limits (WNL), 1 = mild, 2 = moderate, 3 = severe. The description is provided in table 1 which will be provided to speech language pathologists (SLP’s) who will be selected as judges.

**Table 1**

*Severity ratings and corresponding descriptors for hypernasality*

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| Severity Rating | Descriptors |
| 0=WNL | * Nasality does not exceed nasality heard in regional speech and there is no perceptual evidence of cleft type speech |
| 1=Mild | * Nasality exceeds regional speech nasality * There is increased nasality heard on high vowels primarily * There is inconsistent or intermittent increased nasality across vocalic segments * Nasality is perceived as socially acceptable in most circles * Patient or parent are satisfied with individual’s speech resonance * Speech specialist probably would not recommend physical management after instrumental assessment |
| 2=Moderate | * Hypernasality is perceived as pervasive and draws attention to itself and away from the message. * There is increased nasality heard on high and low vowels * Most vowels retain their identity * Speech is socially unacceptable * The speech specialist probably would recommend physical management after instrumental assessment |
| 3=Severe | * Hypernasality is perceived and interferes with speech understandability. * There is increased nasality heard on vowels and some voiced consonants * Some vowels may lose their identity * Nasality is socially very unacceptable * The speech specialist definitely would recommend physical management after instrumental assessment |

***Selection of speech samples for familiarization task to Judges***

Fifteen speech samples of children with RCLP will be randomly selected and presented to three experienced SLP’s. The speech samples will include spontaneous speech, oral and oronasal sentences. The judges will be instructed to rate the samples using standardized four point rating scale (0=normal, 1=mild, 2=moderate, 3=severe) proposed by Henningsson et al. (2007).Out of these samples two samples in each severity category accounting for a totalnumber of 8 samples, which will be best agreed by the judges will be finalized for familiarization task. Out of these, two normal, two mild, two moderate and two severe degree of nasality will be selected for familiarization task. These reference samples will not be included in the final perceptual task.

***Familiarization to judges***

The study will include three SLP’s for performing the perceptual evaluation of nasality across different stimuli. These three judges should bepost graduate qualified SLP’s and fluent Kannada speakers. To familiarize the judges, prior to the actual perceptual task they will be provided with eight reference speech samples depicting the severity of nasality. These samples will be randomized and presented to the judges. The detail description of rating scale ranging from 0 to 3 given by Henningsson, et al., (2007) will be given to the judges. The judges will be requested to rate the speech sample for perceived nasality. The perceptual score by the judges for each speech sample will be compared with the predetermined ratings given to the speech samples by the expert judges. The feedback will be given to the judges to correct their errors. Once they get familiarized to perceive the severity of hypernasality indicated in these samples, then the actual samples will be played for perceptual analysis.

***Procedure***

The obtained audio-visual speech samples will be subjected to perceptual analysis. In order to acquire valid perceptual rating, the samples will be rated by three experienced judges for perceived severity of nasality. The perceptual analysis will be done separately by three judges. The three judges will be seated before a multimedia computer consisting of Intex headphones to perform the perceptual rating task after getting familiarized with the samples. The description of rating scale ranging from 0 to 3 will be given to the judges and explained before performing the actual perceptual rating task. The judges will be requested to listen, analyse and finally rate the samples based on severity of the nasality perceived. The speech samples will be presented at comfortable listening level. The audio-visual speech samples will be played thrice. The participants will be grouped based on consensus in the rating obtained from any two judges for perceived nasality. The speech samples of participants rated by the judges as mild will be considered as Group Ia. The speech samples of participants rated as moderate and severe are together considered as Group Ib.

***Reliability Measures***

Inter and intra judge reliability measures were obtained. The inter judge reliability was obtained based on the perceptual ratings obtained by three judges. The intra judge reliability ratings will be obtained by performing the perceptual rating task twice by the same judge for the same speech sample with a time interval of one week.

**Instrumental Evaluation**

**Nasalance measures for vowel /a/, /i/, oral, nasal and oronasal sentences**

Nasalance is the objective measure of nasality derived from the ratio of nasal to nasal-plus-oral acoustic energy during speech using Nasometer. This measure is derived by calculating the proportion of the nasal energy in speech from separate measurements of nasal and oral sound pressure level from Nasometer (Fletcher, 1970, 1976). Nasometer II 6400 will be used for obtaining mean nasalance values of speech stimuli. The Nasometer II will be calibratedeach day by the investigator prior to the data collection according to the instructionsprovided by the manufacturer.

***Material***

The vowel (/a/ & /i/) and sentences (five oral, five nasal& five oronasal) will be considered for obtaining nasalance values. The standardized Kannada oral and nasal sentences (Jayakumar & Pushpavathi, 2005) will be used. These sentences are of six to ten syllables in length. The oral sentences are loaded with only oral consonants along with the vowels. The nasal sentences are loaded dominantly with nasal consonants and oronasal sentences are balanced approximately with the same percentage of oral and nasal consonants.

***Instructions***

The participant will be seated comfortably in an upright position. Nasometer headgear will be placed on the participant and further adjusted to avoid discomfort. The phonation of vowel (/a/ & /i/) and production of sentences will be demonstrated prior to the recording session by the investigator. All the participants will be instructed to phonate the vowels thrice at their comfortable vocal pitch and loudness level. The vowels will be repeated thrice with an inter stimulus duration of three seconds to obtain valid nasalance measures.

The sentences will be repeated in the similar manner. The sentences will be recorded only once, as the variability in the nasality measures was reported to be less if the length of the stimulus is around six syllables (Watterson, Lewis, & Foley-Homan,1999). These samples will be audio recorded in the computer using Nasometer software and saved separately for further analysis. The investigator will listen to the sample before allowing the participant to leave the recording room.

***Analysis***

The speech stimulus will be recorded on system for analysis of nasalance. The Nasogram of the speech stimuli appears on the Nasometer screen. The part of thestimulus required for analysis will be selected using cursors on the screen from onset tothe offset of the stimulus. The vowels will be produced thrice and the average of the nasalance measures of three productions will be calculated for vowel. The mean nasalance values of each sentence will be measured and documented. Twenty five percent of the participants will be randomly selected for measuring test retest reliability. The measures will be repeated again after a gap of 5 minutes in the same session on the same day without replacing the headgear and the stimuli will be analyzed to obtain mean nasalance values.

***Measuring the nasalance distance and nasalance ratio***

Another acoustic parameter considered for analysis is nasalance distance and nasalance ratio. These are derived post hoc measures from the mean values for bothsets of sentences. The nasalance distance and nasalance ratio will be derived from the following formulas proposed by Bressmann et al. (2000). Nasalance distance will becalculated as difference between maximum nasalance and minimum nasalance.Nasalance ratio will be estimated as ratio of minimum nasalance to maximum nasalance.

***Procedure***

The nasalance values will be derived from Nasometer for oral sentences and nasal sentences as mentioned above. The mean of the nasalance values of both oral and nasal sentences will be considered to obtain derived nasalance measures. The mean of nasalance values of five oral sentences and five nasal sentences will be calculated to measure nasalance distance and nasalance ratio. Nasalance distance for sentences is the difference between mean nasalance values of nasal sentences to mean nasalance value of oral sentences. Nasalance ratio for sentences is derived by taking the ratio of mean nasalance values of oral sentences to mean nasalance value of nasal sentences.

**One-Third Octave Spectra Analysis**

One third octave spectra analysis includes analyzing the spectral band energy at an interval of one third’s of an octave from 100 Hz to 16000 Hz (Kataoka, Michi, Okabe, Miura, & Yoshida, 1996).

**Instrumentation**

A desktop computer will be used which had windows 7 operating system. The *Praat* software will be used to record and edit the data required for one third octave spectra analysis. *MATLAB* software will be used to obtain one third octave spectra analysis.

**Material**

The speech sample used for evaluation of one-third octave spectral analysis is the phonation of /a/ and /i/ and /i/ in the non nasalized CVC contexts (/pit/ & /tip/). To analyze the one third octave spectral amplitudes of vowel /a/ and /i/ will be used widely in the context of CVC syllables (/pit/ & /tip/). The production of /i/ in /pit/ & /tip/ will be considered to evaluate the effect of nasality on /i/ in the context of CVC.

**Instructions:** The participants will be seated in front of a microphone in a quiet room. The investigator provided the model of stimulus production and ensured the correct production of stimulus from participants by multiple repetitions before recording. The participants will be instructed to phonate steady state vowels (/a/ & /i/), and /i/ in a non nasalized CVC contexts (/pit/ & /tip/) thrice at a comfortable pitch and loudness with an inter stimulus duration of 10-15seconds.

**Procedure:** Each stimulus will be recorded separately using *Praat software* and the steady state portion of middle 500 millisecond section for vowel (/i/) and 50 milliseconds of vowel /i/ in CVC syllables /pit/ and /tip/ will be selected for one third octave spectra analysis. The edited stimuli will be subjected to detailed analysis by using the *MATLAB 7.0 version software*, and the amplitude at one third octave spectral intervals will be obtained. Overall, amplitudes at 23 one third octave bands (over a frequency range of 100–16,000 Hz) will be obtained. Each average long-term RMS value of one-third octave band pass are obtained by summation and averaging components over one-third octave intervals with center frequencies ranging from 100 Hz to 16,000Hz. One third octave spectra amplitude will be calculated for frequency bands between 100–16,000 Hz on all samples (/i:/, /pIt/, /tIp/). However, based on previous studies statistical analysis was performed only on those frequency bands (between 396 Hz and 4000 Hz) that had demonstrated sensitivity to hypernasality (Kataoka, Warren, Zajac, Mayo, & Lutz, 2001; Lee, Yang, & Kuo, 2003). The frequency bands considered for analysis were 396Hz, 500Hz, 630Hz, 793Hz, 1000Hz, 1259Hz, 1587Hz, 2000Hz, 2519Hz, 3174Hz, and 4000Hz. To measure the reliability of acoustic measurements twenty five percent of the original data recorded was reanalyzed by the same investigator and compared that results with the remaining complete data used in the study. To measure the reliability of acoustic measurements twenty five percent of the original data recorded was reanalyzed by the same investigator and compared that results with the remaining complete data used in the study.

**Statistical Analysis**

The data obtained by all these measures will be subjected to appropriate statistical analysis using Statistical Package for Social Science (SPSS), Version 21. The normality of the data within each group will be analyzed using Shapiro - Wilk test. The participants, indicated as outliers frequently across all the variables will not be considered for further analysis. The Kappa measures will be used to perform inter and intra rater reliability measures. Then Spearman’s rank order correlation will be used to analyze the correlation between estimated NSI values with the perceptual ratings.

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| **4.2** | **Time schedule of activities giving milestones** | |
|  | Review of literature: | 1 Month |
|  | Recording and analyses of data: | 8 Months |
|  | Data interpretation and report writing: | 3 Months |
| **5.0 Budget summary** | |  |
| **Item** | | **Expenditure (Rupees)** |
| **Salaries**  Designation(No. of persons)\* Monthly Emoluments \* No. of months | | 1\*39,000\*24 months = 4, 68,000/- |
| **Consumables** | | 10, 000/- |
| **Travel** | | 40, 000/- |
| **Other costs** (specify) | | 5, 000/- |
| **Total** | | 5, 23, 000/- |

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| **6.0** | **Implications of the results of the study** (Illustrative) | | | |
|  |  | 1. Presentation of scientific papers in professional seminars / publication of articles: | The findings would be disseminated in suitable forums. | |
|  |  | 1. Discussion with professionals: | The study would be extremely helpful in enhancing the services rendered to children with RCLP. Thus, the information would be placed for discussion among SLPs. | |
|  |  | 1. To utilize the results in the development of remediation: | The findings may aid in deciding line of intervention, monitoring the progress of therapy etc. on the basis of index values. | |
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| **7.0** | **Utilization of results of the study** | | The findings of the study may pave way for using spectral measures to evaluate nasality and also the nasality severity index will ease the communication among the multidisciplinary professionals regarding the severity of perceived nasality and planning the line of intervention. | |
| **Part –B** | | | | |
| **Personal profile of Principal Investigators and Principal Co-Investigators**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Part -B** | | | | | | **Personal profile of Principal Investigators** | | | | |  | | : |  | | **1.1.1.** | Name | : | Dr. A. Navya | | **1.1.2.** | Date of birth : 07-06-2016 |  | Age: 30 | | **1.1.3.** | Present Position held | : | Lecturer in Speech Sciences, AIISH. | | **1.1.4.** | Institution | : | All India Institute of Speech and Hearing, Mysore. | | **1.1.5.** | Whether belongs to SC/ST | : | No |   **1.1.6.** Academic & Professional Career  Ph. D (SLP) Awarded in 2016, University of Mysore.  **Title of the Thesis:** “Nasality Severity Index”.  MSC (ASLP). Awarded in 2010, Osmania University.  **Dissertation:** Monotic and Dichotic Measures of Auditory Steady State Responses in normal hearing adults.  BSC (ASLP). Awarded in 2008, Osmania University  **1.1.7.** Projects completed (Principal Investigator) : Nil.  **1.1.8.** Projects completed (Co-investigator): Nil  **1.1.9.** Doctoral theses guided: Nil  **1.1.10.** Doctoral theses under progress:  **1.1.11.** Master’s dissertation guided: Nil  **1.1.12.** Master’s dissertation under progress**: Nil**  **1.1.13.** Publication in journals:  **Journal Publications: 06**  **International Journal Publications: 01**   1. **Navya, A**. & Pushpavathi, M. (2014). Derived nasalance measures of nasality for sentences in children with repaired cleft lip and palate. Online journal*,* [*www.languageinindia.com*](http://www.languageinindia.com)*, 14(8),* 125-138. **(ISSN 1930-2940).**   **National level: 05**   1. **Navya. A. (2014).** The correlation between derived nasalance measures and perceived nasality in children with repaired cleft lip and palate.Otolaryngology Online Journal, 4(2). **(ISSN 2250-0359).** 2. **Navya, A**. & Pushpavathi, M. (2013). One third octave analysis**:** A diagnostic tool to measure nasality in conjunction with nasalance in children with repaired cleft lip and palate. *Journal of All India Institute of Speech and Hearing. (Article in Press)* **(ISSN 0973 - 662X).** 3. **Navya. A**., Gopi Kishore. P., & Pushpavathi. M. (2012). Effect of palatal lift prosthesis on laryngeal Aerodynamics and voice quality in sub-mucous cleft palate. *Journal of All India Institute of Speech and Hearing, 30: 23-32.* **(ISSN 0973 - 662X).** 4. **Navya, A**., Pushpavathi, M., Sreedevi, N., & Dakshaini, M. R. (2011). Effect of palatal prosthesis on few spectral parameters of speech in cleft lip and palate: a case study. *Journal of All India Institute of Speech and Hearing, 30:* 33-41. **(ISSN 0973 - 662X).** 5. **Navya, A**. & Gopi Kishore, P. (2008). Comparison of Monotic & Dichotic multiple techniques in determining ASSR thresholds using Exponential modulation stimuli. *Journal of the Indian Speech and Hearing Association, 22*, 25–31**. (ISSN 0974-2131)**.   **Conference Proceedings: 04**  **International conference proceedings: 01**   1. **Navya, A**. & Pushpavathi, M. (2012). Outcomes of prosthodontic management and speech therapy in person with submucous cleft. *7th Biennial World Cleft Lip and Palate Congress- International Cleft Lip and Palate Conference, Mahe Island, Seychelles,* 7th – 11th May.   **National level conference proceedings: 03**   1. Pushpavathi, M., **Navya, A**., Sreedevi, N., & Dakshaini, M. R. (2013). Client centered rehabilitation for individuals with cleft lip and palate.*6th National Women’s Science Congress held at Raichur, India*, 07th – 09th November. **(ISSN 2250-3978).** 2. Pushpavathi, M., Sowmya, K., & **Navya, A**. (2013). Speech outcome following palatoplasty in telugu speakers with cleft palate. *6th National Women’s Science Congress held at Raichur, India*, from 07th – 09th November 2013. **(ISSN 2250-3978).** 3. **Navya, A**., Pushpavathi, M., Sreedevi, N., & Dakshaini, M. R. (2011). Influence of palatal obturation on acoustic measures of speech: a case study. *4th National Women’s Science Congress held at Bangalore, India*, 07th – 09th November. **(ISSN 2250-3978).**   **1.1.14. Books edited, monographs : Nil**  **1.1.15.** Awards   * Received **Best Paper Presentation Award** for the scientific paper presented titled "Influence of palatal obturation on acoustic measures of speech: A case study" at the 4th National women’s science congress held at Bangalore, India, from 07th – 09th November, 2011. * Awarded **Full** **Foreign Travel Grant** from **Indian Council of Medical Research** (Ref No: 3/2/TG-27/HRD-2012) **and also from Department of Science and Technology**, (Ref No: SR/ITS/0263/2012-2013) Government of India, New Delhi for attending and presenting a research paper at ***International Conference on Cleft Lip and Palate*** – 7th Biennial world cleft lip and palate congress held at Mahe Islands, Seychelles, 7th-11th May 2012. However, I have utilized the grants only from DST for my travel. * Awarded ***Junior Research Fellowship for a period of three years*** from All India Institute of Speech and Hearingfor pursuing Ph.D in Speech Language Pathologyprogram on regular basis from All India Institute of Speech and Hearing, Mysore. (Dec 26th 2011 to Dec 26th 2014).   **1.1.16.** Memberships   * Life member of **Indian Speech and Hearing Association (ISHA)**, Membership No: L14012294. * Member of **Rehabilitation Council of India** (RCI), Membership No: A37518.   **1.1.17.** Others : Nil  **1.1.18.** Other research projects as Co-Investigators (ARF, Extra Mural)  **1.1.19** Principal Investigator address: Lecturer in Speech Sciences, Dept. of ENT, NSCB Medical College, Jabalpur- 482003  Telephone: Mob: 08962700516  E mail: navyaaslp@gmail.com | | | |
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