# Comparison between Preferred Gain and Nal-NL1 Prescribed Gain Formulae in Naive Adult Hearing Aid Users

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## Abstract

*The aim of the present study was to find the deviation in gain parameters, at three different input levels (soft, moderate and loud level) between preferred and prescribed (NAL NL-1) fitting strategy in naive hearing aid users. The study included 33 participants in the age range of 30 to 80yrs, with mild to severe cochlear hearing loss and using digital BTE hearing aid. The results of the present study revealed, the gain preferences relative to NAL-NL1 is different for different degree of hearing loss. Individuals with mild to moderate hearing loss preferred 3-4 dB lower whereas individuals with moderately severe and severe hearing loss preferred 4-8 dB higher gain than that prescribed by NAL-NL1. The preferred gain differences relative to NAL-NL1 across frequencies revealed greater deviations in mid frequencies than in low and high frequencies and increased with increase in degree of hearing loss.To conclude, Indian population requires higher gain at mid frequencies compared to western population for individuals with moderately severe and severe hearing loss.*

***Keywords:*** *Preferred gain, prescribed gain, NAL-NL1 formula.*

## Introduction

Cochlear hearing loss can vary in terms of degree and configuration. This necessitates tailor made fitting of the hearing aid for every client. Widely practiced approach in the clinics is to use a prescriptive procedure, to provide approximate target amplification. The prescriptive approach for hearing aid fitting is, one in which the amplification characteristics are calculated from some of the hearing characteristics of the individual. This is based on the assumption that certain amplification characteristics suit certain type, degree and configuration of hearing loss. The prescriptive methods were changed over the years due to advancement in technology, better understanding of hearing characteristics and other factors affecting hearing aid performance.

The prescriptive formulae, threshold based or supra threshold based, give the first approximation of gain required. Clinical experiences with prescriptive methods show that the methods cannot eliminate the need for individual adjustments i.e., fine tuning of hearing aid (Dillon, 2001). However, one should bear that fine tuning of gain settings in the hearing aids is performed on prescribed gain. The prescribed gain should be a good approximation to preferred gain, which reduces the trial and error done by the clinician and also saves time (Dillon, 2001).

The gain preferred by naive hearing aid users is lesser than that preferred by experienced users (Humes, Wilson, Barlow & Garner, 2002;Smeds, 2004). The new hearing aid users require lesser gain than that prescribed by NAL-RP (Byrne & Cotton, 1988; Cox & Alexander, 1992; Horwitz& Turner, 1997; Humes, Wilson, Barlow, Garner, 2002, Smeds, 2004). Many investigators from western countries (using English speaking individuals) compared NAL-NL1 formula in naive and experienced hearing aid users (Keidser et al, 2001; Keidser et al., 2006, Keidser et al., 2008; Humes et al., 2002). They observed that NAL-NL1 provides 3 to 6 dB higher gain than that preferred by cochlear hearing loss individuals.

Most of the above studies comparing preferred and prescribed gain were performed on western population. On contrary, Indian population, Mathur and Manjula (2008) showed opposite results, that is Indian populations prefer higher gain than that prescribed by NAL-NL1. However, the studies done by Mathur and Manjula (2008) considered overall gain from hearing aid software program. The difference that is noted between NAL-NL1 and preferred gain mayn't be appropriate because the target formula selected as NAL-NL1 in programming software gives a lesser gain of 10dB than the target gain noted from REIG values. So, further studies are needed to confirm the results of the previous study. There are only limited studies available on comparing preferred gain and prescriptive gain settings in naive hearing aid users in Indian context. Further, general opinion among the clinicians in India is that, majority of the clients prefer different gain settings than that prescribed by NAL-NL1. Hence, it becomes all the more important to compare the prescribed and preferred gain settings in new hearing aid listeners. These deviations can be studied using REIG and speech perception measures.

It is important to use REIG measurements because it provides the true gain in the ear canal. Aazh and Moore (2007) have demonstrated that, the currently available programming software provides an inappropriate gain in the ear canal than that prescribed by the prescriptive procedures. Hence, measuring REIG is an essential tool while fitting the hearing aid.

Many researchers have used speech perception mea-

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sures to check for the acceptance of hearing aid gain characteristics. Some have used continuous discourse with noise (Keidser et al., 2005) and a few others have used speech recognition threshold (Moore, Alcantara & Marriage, 2001). The mentioned studies demonstrate that scores were different between preferred and prescribed condition. Prescriptive formula provides maximum emphasis to speech; it thus becomes an important tool to study the difference in speech perception using preferred and prescribed condition.

The aim of the present study is to find the deviation in gain parameters, at three different input levels (soft, moderate and loud level) between preferred and prescribed (NAL NL-1) fitting strategy in naive hearing aid users.

## Method

### Participants

Thirty three participants (n=33 ears), in the age range of 30 to 80yrs (mean age of 59.2yrs.), with mild to severe cochlear hearing loss and using digital BTE hearing aid were participated in the present study. The participants were native speakers of Kannada (A Dravidian language spoken in a southern state of India), having post-lingual onset of hearing loss and were naive hearing aid users (with duration of Hearing aid use not more than 3 months). The Pure-Tone Average (PTA) ranged from 36.6 dB to 85 dB. The participants were divided into 3 groups namely, Group I, Group II and Group III based on the degree of hearing loss. Group I included 13, Group II and Group III included 10 participants with Mild to Moderate, Moderately severe and severe hearing loss respectively. It was ascertained from a structured interview that none of these participants had any history of neurologic disorders. The mean and standard deviation of pure-tone thresholds at octave frequencies for all the 3 individual groups is plotted in Figure 1.

The experiments were conducted in two phases. In the phase 1 hearing aid was programmed to NAL-NL1 settings, which was followed by measurements of speech Identification Scores. In phase 2, hearing aid was programmed to the participant's preferred setting, which was followed by measurements of speech Identification Scores.

#### *Phase 1*

Initially the hearing aid was programmed accordingto the gain parameters prescribed by NAL-NL1 fitting formula as given by hearing aid fitting software. 'First fit' settings were obtained by using the participant's hearing thresholds and selecting NAL-NL1 prescriptive formula. It has been noted by number of researchers that the hearing aid programming software provides an inappropriate gain than that prescribed by the NAL-

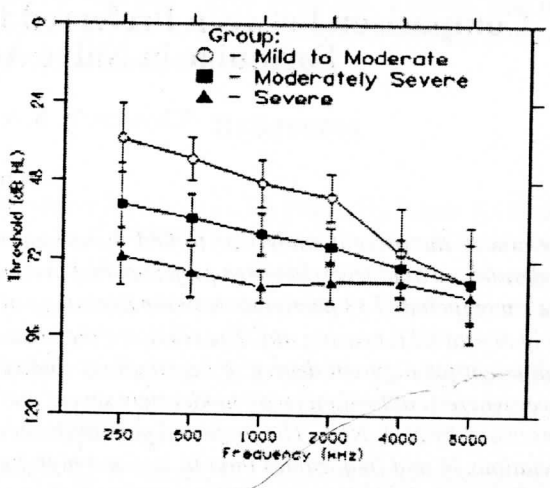


*Figure 1: Mean and standard deviation of pure-tone thresholds for 3 individual **group**.*

NL1 prescriptive procedure (Aazh & Moore,2007). So, REIG was performed to attain appropriate gain parameters of NAL-NL1 by matching REIG value to gain curve generated by FONIX 7000 hearing aid analyzer for NAL-NL1 target. However, it was not possible to achieve the perfect match to the target in all the participants. The relationship between the achieved and NAL-NL1 prescribed 4 frequency averages (4FA) i.e. 500, 1000, 2000 and 4000 Hz for all the participants is given in Figure 2. From the figure it can be inferred that there wasn't much difference between achieved and target REIG values. The mean difference between the achieved and target REIG values for 4FA is 3 dB. The average fit was closer to target at mid frequencies than in low and high frequencies. After approximating the REIG values to FONIX target curve, these values were considered as the NAL-NL1 gain prescribed. Following this Speech Identification Score (%) was measured.

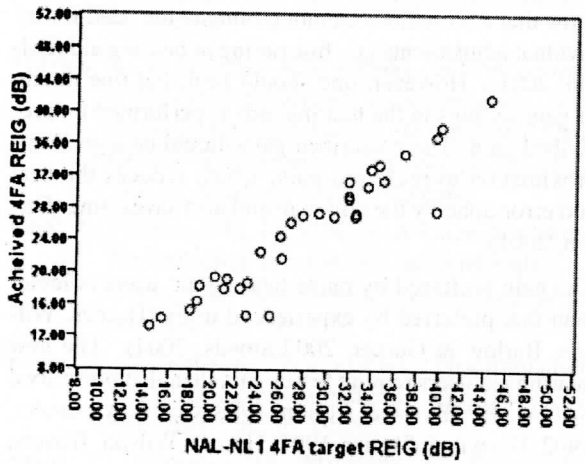


*Figure 2: The relationship between the achieved and NAL-NL1 prescribed 4 frequency averages (4FA) for all the participants.*

***Phase 2***

The hearing aid was programmed as per the preference of the clients. Initially, the automatic fine tuning of the hearing aid was carried out using 'feature activation' or 'Fitting Assistant' designed specifically for hearing aid fitment. Later, 'manual fine tuning' was done by narrating a passage in Kannada at moderate and loud intensity levels. With this, all or few of the hearing aid parameters (listed below) were manipulated as preferred by the participants. The parameters that varied were Overall gain, Gain at individual Frequency Bands, Enhanced Bass Boost and global Compression. The adjustment of overall gain and individual frequency bands gain was performed at 65 dB input level only. It was noted that the gain of 50 dB and 80 dB were also varied while fine tuning the gain for 65 dB input level. Thus, the gain at 50 dB and 80 dB was not changed individually. After, fine tuning of the hearing aid for preferred hearing aid settings, REIG and speech identification scores (%) are measured again.

*Speech Identification Scores:* The open set Speech Identification Scores in quiet were obtained through monitored live voice presentation. Word lists for adults developed by Yathiraj and Vijayalakshmi (2005) was used to obtain the speech identification scores. This test material consisted of 4 phonemically balanced word lists with 25 words each.

The participants were seated comfortably in a double-walled, acoustically treated room. The speech stimuli were presented through the loudspeaker (C 115 Martin Audio) of the audiometer kept at a distance of one meter at 0Â° azimuth. Speech stimuli were presented at 40 dBHL. None of the lists was repeated for any of the listeners, as there were four lists. The order of presentation of conditions was randomized across the listeners. Listeners were instructed to repeat the speech token heard. The speech recognition scores were calculated by counting the number of words correctly repeated.

*Real Ear Insertion Gain (REIG) :* REIG, as defined by ANSI (1997), is the difference in decibels as a function of frequency between the real ear aided gain (REAG) and real ear unaided gain (REUG), obtained with the at same measurement point and similar sound field conditions. Before the REUG is measured, levelling of the probe system of the hearing aid analyser instrument was done using the reference microphone placed above the ear to ensure the smooth frequency output from the hearing aid analyser.

*Measurement of REIG:* The participants were seated at 1 foot distance and at 45 degree azimuth from the loudspeaker of real ear analyser. Real Ear Unaided Gain (REUG) was measured for the subjects without wearing the hearing aid by using Digispeech as the stimuli at 65dBSPL as the input. To ensure proper insertion depth of the probe tube, the probe tube was placed in the ear canal, so that the tube will rest along the bottom of the canal part of the ear mould, with the tube extending at least 5 mm past the ear mould. The stimulus was presented and the output was represented in the form of graph on screen and once the graph on screen is stabilized for more than 10 seconds, the input was stopped. For measuring REAG, the hearing aid was placed into the participant's ear while holding the probe tube so that its position in the ear canal is not disturbed. Then, hearing aid is turned on for measuring REAG. The probe tube microphone measures the dB SPL in the ear canal as delivered by the hearing aid. The REAG was displayed as a curve with frequency (Hz) versus Intensity (dB).The real ear analyser automatically displayed the REIG across frequencies. This was done by the instrument by subtracting REUG from REAG. The values of REIG were noted across 250 Hz, 500 Hz, 700 Hz, 1k Hz,1.5k Hz,2k Hz,3k Hz, 4k Hz, and 6k Hz for each participant. The REIG was also calculated at 3 different input levels i.e., 50, 65 and 80 dB SPL.

## Results

The present study was carried to find the difference in gain between preferred and prescribed (NAL NL-1) strategies in naive hearing aid users at three different input levels (50, 65 & 80dB). The REIG data at three input levels (50, 65 and 80 dB levels) were collected, tabulated and subjected to data analysis. Statistical analyses were carried out using SPSS Statistics Package (version 17).

### Comparison of preferred and prescribed Real Ear Insertion Gain (REIG) values

Majority of previous studies have compared results for overall gain (4FA), LFA (250, 500 and 1000 Hz) and HFA (2000, 3000 and 4000 Hz) at 65 dB input level for different degree of hearing loss. Hence for ease of comparison only 65 dB input level is considered for the analysis of overall gain (4FA), LFA & HFA.

*Relationship between preferred 4FA gain relative to NAL-NL1 and the pure tone average (PTA):* Figure 3 gives the relationship between the preferred 4FA gain relative to NAL-NL1 and the pure tone average (PTA) for all the participants. It can be inferred from the Figure 3 that with increase in hearing loss, there was increment in gain deviation i.e. the gain deviation was higher for greater degree of hearing loss.

From the REIG measurements, gain deviation of preferred from the NAL-NL1 for a 65 dBSPL input was calculated in terms of overall gain (4FA), LFA and HFA for individual groups. The mean and standard deviation of this for three individual groups is given in Figure 4. It can be noted from the figure that the average gain preferred is around 2 dB lower for group 1, whereas group

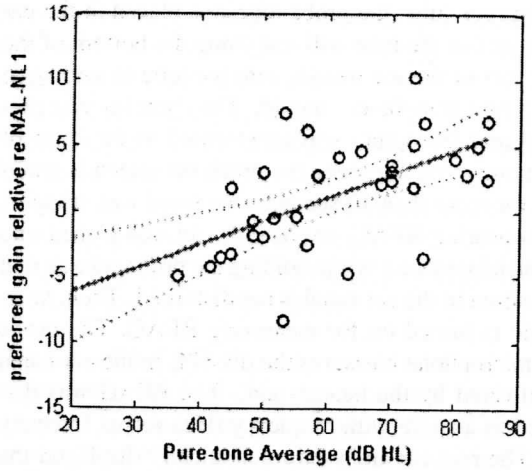


*Figure 3: Shows the relationship between the preferred 4FA gain relative to NAL-NL1 and the pure tone average (PTA). The dotted lines show the regression line and 95% confidence bands.*

2 and group 3 preferred is 2 to 4 dB higher gain than that prescribed by NAL-NL1. Mixed ANOVA was performed to compare the conditions (LFA, HFA & Overall (4FA) across the three groups. Analysis showed no significant main effect of conditions, indicating that mean difference did not reach significance between conditions [$F_{(2,30)}$ =0.7, P= 0.40]. But there was significant main effect of groups [$F_{(2,30)}$ =5.09, P<0.05]. Bonferonni's Post hoc analysis revealed group 1 is significantly different from group 2 and group 3 (p <0.05). But mean difference between group 2 and group 3 did not reach significance.

*Difference in preferred gain and prescribed gain across frequencies:* Further to know the difference in REIG between preferred and that prescribed by NAL-NL1 at each frequency across three groups for different input levels a separate analysis was done.

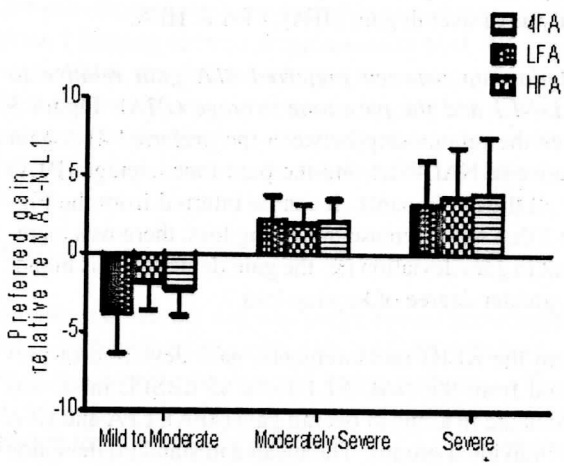


*Figure 4: The comparisons of REIG values at 3 input levels for group 1.*

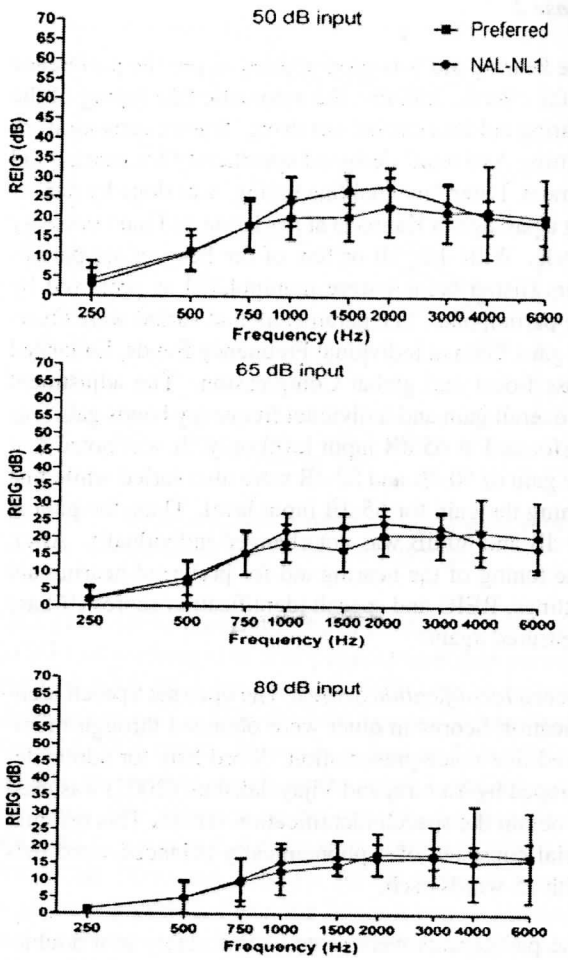


*Figure 5: comparisons of REIG values at 3 input levels for group 2.*

**Group 1-Mild to Moderate HL**

Figure 5 shows the preferred and prescribed REIG data across frequencies for group 1. It can be noted from the figure that for 50 dB and 65dB input levels, individuals with Mild to Moderate hearing loss preferred a gain 5 to 8 dB lower than that prescribed by NAL-NL1 at mid frequencies. However, at 80 dB input level, preferred and prescribed gains were almost similar. Further, it was also noted that there was no difference in mean REIG values at low and high frequencies for all 3 input levels.

Repeated measure ANOVA was performed to compare the gain between conditions (preferred and NAL-NL1) at three input levels (50, 65 & 80dB) across the frequencies. Analysis showed significant main effect frequency [F (2.9, 106.7) =133.5, p<0.01] and level [F (2, 36,) =7.5, p<0.01] but no significant main effect of condition [F (1, 36) =3.59, p=0.06]. Interaction analysis-revealed significant interaction between frequency and condition [F (3.2, 36) =8.01, p<0.01], but other two way and three way interactions were not significant. Following this a Paired sample't' test was performed to assess at which frequencies, difference between condi-

tions reaches significance for three different input levels separately. The results of 't' test, degrees of freedom and level of significance are depicted in Table 1. It can be noted from the Table 1 that for 50 and 65dB input level there was significant difference between preferred and prescribed conditions at 1, 1.5 and 2 kHz only. But, there was no significant difference across frequencies for 80dB input.

*Table 1: Shows the 't' values and level of significance for three input level across frequencies for group 1*

| | Input Level | | |
|---|---|---|---|
| | 50dB | 65dB | 80dB |
| Frequency(Hz) | t value | t value | t value |
| 250 | 1.08 | -0.65 | -0.06 |
| 500 | 0.44 | -1.51 | -0.08 |
| 750 | 0.0 | -0.24 | -0.54 |
| 1000 | -2.97* | -3.3* | -1.78 |
| 1500 | -4.3* | -4.7* | -1.83 |
| 2000 | -3.2* | -2.4* | 1.19 |
| 3000 | -1.18 | -1.42 | 0.44 |
| 4000 | 0.42 | 1.28 | 1.23 |
| 6000 | 0.62 | 1.46 | 0.45 |

**p<0.05, Note: df was 12 for all't' values*

**Group 2- Moderately Severe Hearing loss**

Figure 6 gives the preferred and prescribed REIG data across frequencies for group 2. It can be noted from the figure that for the input level of 50 dB, 2-3 dB higher gain is preferred at low and mid frequencies than that prescribed by NAL-NL1. Whereas for input levels of 65dB and 80 dB, gain preferred is 5-6 dB higher than NAL-NL1 at mid frequencies.

*Table 2: 't' values and level of significance for three input level across frequencies for group 2*

| | Input Level | | |
|---|---|---|---|
| | 50dB | 65dB | 80dB |
| Frequency(Hz) | t value | t value | t value |
| 250 | 1.66 | 1.74 | 2.92* |
| 500 | 0.90 | 1.41 | 2.08 |
| 750 | 2.38* | 2.68* | 3.27* |
| 1000 | 1.23 | 2.38* | 2.73* |
| 1500 | 1.62 | 2.32* | 2.51* |
| 2000 | 1.09 | 2.95* | 2.40* |
| 3000 | 0.13 | 0.75 | 1.60 |
| 4000 | 0.14 | 1.45 | 1.08 |
| 6000 | -0.08 | 3.20* | 0.53 |

**p<0.05, Note: df was 12 for all't' values*

Repeated Measure ANOVA was performed to compare the gain between conditions (preferred and NAL-NL1)

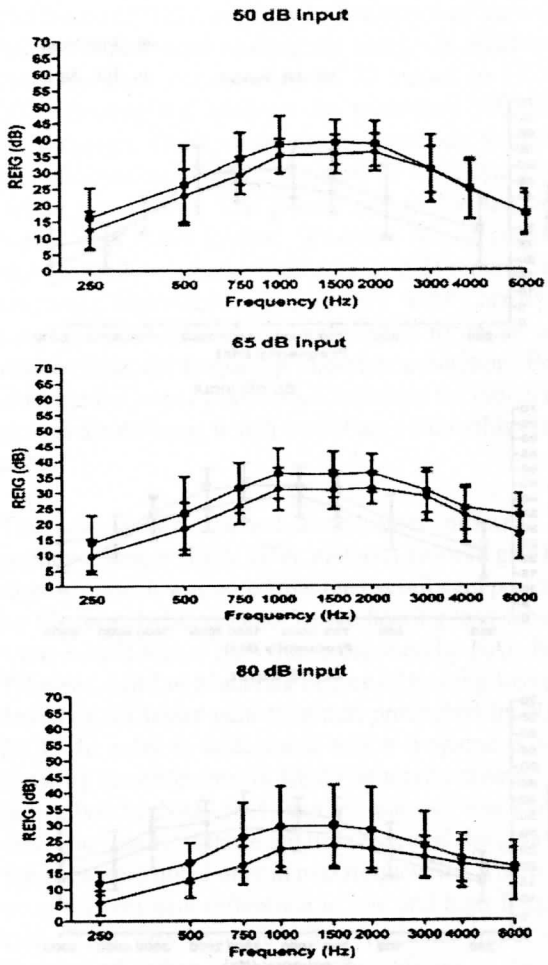


*Figure 6: comparisons of REIG values at 3 input levels for group 2.*

at three input levels (50, 65 & 80dB) across the frequencies. Analysis showed significant main effect of frequency [F (8, 20) =202.6, $p<0.01$], condition [F (1, 27) =13.15, $p<0.01$] and level [F (2, 27,) =6.4, $p<0.05$].Interaction analysis revealed significant interaction between frequency and condition [F (3.04, 82.2) =3.05, $p<0.05$[, but other two way and three way interactions were not significant. Following this a Paired sample't' test was performed to assess at which frequencies difference between conditions reached significance for three different input levels. The results of 't' test, degrees of freedom and level of significance are depicted in table 2. It can be noted from the Table 2 that there was significant difference across 0.75, 1, 1.5, 2, and 6 kHz for 65dB input level and 0.25, 0.75, 1, 1.5, and 2 kHz for 80dB input level between preferred and prescribed conditions. However, for 50 input levels there was significant difference at 0.75 kHz only.

**Group 3-Severe Hearing Loss**

Figure 7 gives the preferred and prescribed REIG data across frequencies for group 3. It can be noted from the figure that the preferred gain was higher than that pre-

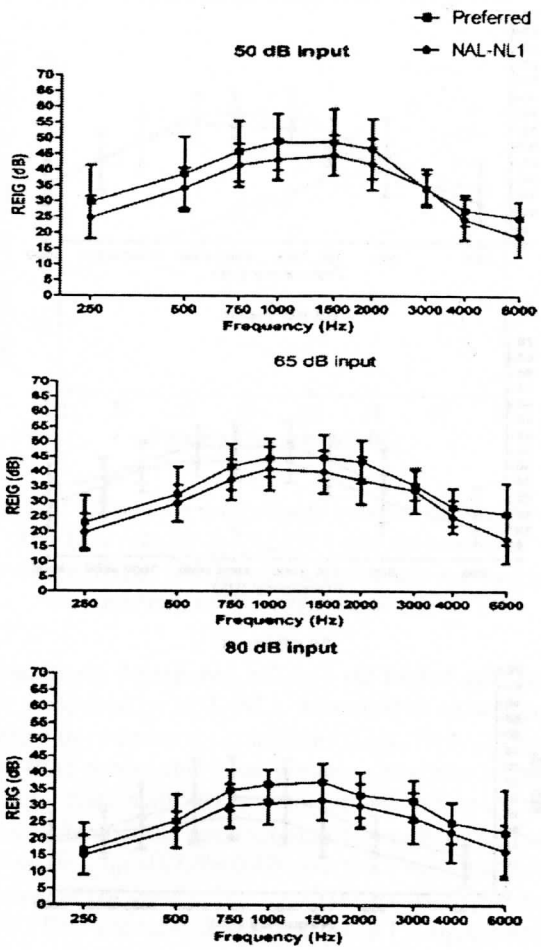


*Figure 7: The comparisons of REIG values at 3 input levels for group 1.*

scribed by NAL-NL1 for all the 3 different inputs. For 50dB and 65dB input, 5-6 dB higher gain is preferred at mid frequencies but, for 80dB input the gain of 7-8 dB higher is preferred at mid frequencies. Repeated Measure ANOVA was performed to compare the gain between conditions (preferred and NAL-NL1) at three input levels (50, 65 &80dB) across the frequencies. Analysis showed significant main effect frequency [F (1.6, 45.08) =72.3, $p<0.01$], level [F (2,27) =10.4, $p<0.01$] and condition [F (1, 27) =42.56, $p<0.01$]. Interaction analysis revealed no significant interaction between any conditions. Following this a Paired sample't' test was performed to assess at which frequencies difference between conditions reaches significance for three different input levels.

The results of 't' test ,degrees of freedom and level of significance are depicted in table 3.It can be noted from the table 3 that for 50 input levels there was significant difference between preferred and prescribed conditions at 750, 1000, 2000 & 6000Hz. However, there was significant difference across 750, 1500, 2000, 4000, 6000 Hz for 65dB input and 750, 1000, 1500, 3000Hz for

*Table 3: 't' values and level of significance for three input level across frequencies for group 3*

| | Input Level | | |
|---|---|---|---|
| | 50dB | 65dB | 80dB |
| Frequency(Hz) | t value | t value | t value |
| 250 | 1.74 | 1.47 | 0.58 |
| 500 | 1.58 | 1.30 | 1.22 |
| 750 | 2.28* | 4.36* | 4.76* |
| 1000 | 3.09* | 2.01 | 4.33* |
| 1500 | 2.15 | 2.72* | 4.31* |
| 2000 | 2.34* | 3.96* | 1.40 |
| 3000 | -0.14 | 0.91 | 2.35* |
| 4000 | 1.69 | 2.37* | 1.31 |
| 6000 | 3.81* | 3.9* | 1.80 |

**p<0.05, Note: df was 12 for all't' values*

80dB input.

***Comparisons of Aided Speech Identification Scores (%) between preferred and prescribed conditions***

Figure 8 shows the comparison of Aided Speech Identification Scores (%) between prescribed and preferred settings across three groups. It can be noted from the figure that there is 5% increase in SIS in preferred gain than in NAL-NL1 settings in Moderately Severe and Severe Hearing Loss individuals. But,there was no difference noted in the mean of Mild to Moderate Hearing Loss group.

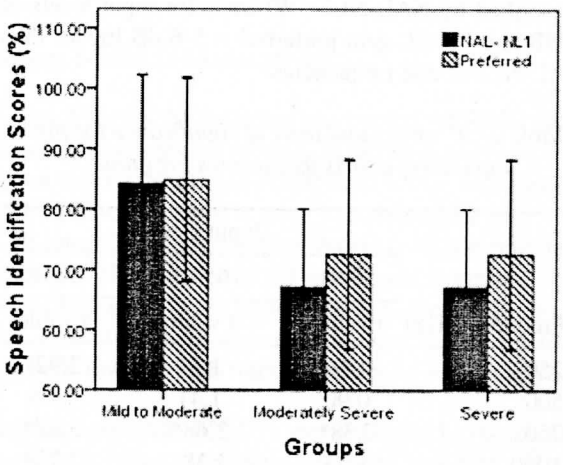


*Figure 8: comparison of Aided Speech Identification Scores (%) between prescribed and preferred settings across three groups.*

Repeated Measure ANOVA was performed to compare the Aided Speech Identification Scores (%) between conditions (preferred and NAL-NL1) across three groups. Analysis showed no significant main effect between conditions ($F_{(1.30,1)}$ =3.1, p=0.27) and

groups ($F_{(2,40.2)}$ =0.75, p=0.4). Bonferonni's Post hoc analysis revealed there is no significant difference between groups.

## Discussion

The aim of the present study was to find the deviation in gain parameters, at three different input levels (soft, moderate and loud levels) between preferred and prescribed (NAL NL-1) gain in naive hearing aid users. This was investigated by comparing REIG values and Speech Identification Scores (%) between preferred and NAL-NL1 settings.

### Comparison of Preferred and Prescribed Gain

The present study compared REIG values between preferred and NAL-NL1 for different degrees of hearing loss. The results of overall gain showed individuals with Mild to Moderate hearing loss preferred 3 to 4 dB lower but Moderately Severe to Severe hearing loss preferred 4-8 dB higher gain than that prescribed by NAL-NL1. Mathur and Manjula (2008) compared the preferred and prescribed gain in naive hearing aid users. They reported individuals with Moderate and Moderately Severe hearing loss prefer 2 to 5 dB lower but severe hearing loss preferred 4 to 7 dB higher gain than that prescribed by NAL-NL1.

The results of the present study are in accordance with those reported by Mathur and Manjula(2008). However, they demonstrated individuals with Moderately Severe hearing loss preferred lower gain of 2 to 5 dB but in the present study higher gain of 3 to 6 dB was preferred. The precise reason for the difference is not known. Difference between studies may be due to methodological differences. One potential methodological reason could be in the present study REIG was matched to FONIX 7000 hearing aid analyzer target for NAL-NL1 but this was not done in Mathur and Manjula (2008).

In the contrary to the present study, Keidser et al., (2001; 2004; 2005;2008) reported that naive hearing aid users requires 2 to 6 dB lesser gain with reference to gain provided by NAL-NL1. The difference in gain preferred with reference to NAL-NL1 among these studies may be due to the subject population. Keidser et al. (2001), Keidser et al. (2004) Keidser et al. (2008) investigated on western population and showed that preferred gain is lower than that prescribed by NAL-NL1. In contrary, studies conducted in Indian population showed that gain preferred is higher than NAL-NL1 (Mathur & Manjula, 2008; Achaiah & Narne, 2011).

Achaiah and Narne (2011) reported on an average 10 dB higher gain is preferred compared to NAL-NL1 fitting formula in experienced hearing aid users. Higher difference noted between present study and Achaiah and Narne (2011) study may be because they have considered experienced hearing aid users. In addition to that they have not matched REIG values to FONIX 7000 Hearing Aid analyzer for prescribed NAL-NL1 gain settings. These results are in agreement with clinical observation made by majority of the clinicians in Indian population. The precise reason for needing a higher gain is not known. Probable reason could be that, as Studebaker and Sherbecoe (1993) reported that frequency importance functions vary widely across the languages and hearing aid prescriptive formulae were derived from the frequency importance function. Probably, the frequency importance functions for Indian languages are different which would have led to this difference.

The analysis was carried across three different frequency averages (LFA, HFA, and 4FA (overall gain) for three groups. It was noted that the overall gain preferred by Moderately Severe and Severe hearing loss subjects were 3-4 dB higher than that prescribed by NAL-NL1. Whereas, Mild to Moderate degree of hearing loss preferred -4 dB lesser gain than that prescribed by NAL-NL1. In order to understand which frequencies were showing the difference in REIG between preferred and prescribed by NAL-NL1, further analysis was carried out. The results of these analysis revealed the gain differences were noted only in mid frequencies. There was no consistent gain difference in low and high frequencies. These may be attributed to frequency importance function of Indian languages. In addition to the gain differences noted at 65 dB input level, the gain differences were also observed in 50 dB & 80 dB input levels. To our knowledge there were no studies that have compared the gain differences at 50 dB & 80 dB input level. One logical reason for gain difference noted was because gains at other input levels were also modulated by varying the gain at 65dB input level in the hearing aid programming software, which would have led to these differences.

Present study also analyzed the relationship between the pure tone average and preferred gain relative to NAL-NL1. It was noted that with the increase in degree of hearing loss, the preferred gain relative to NAL-NL1 increased. This finding are contrary to the findings of Keidser et al. (2008), who reported gain preferred relative to NAL-NL1 was lower with increase in hearing loss. These difference in findings noted in Keidser et al. (2008) study may be because majority of subjects considered were individuals with Mild to Moderate hearing loss but in the present study, the subjects were evenly distributed between different degree of hearing loss.

### Speech Identification Scores

The Aided Speech Identification Scores (%) between prescribed and preferred settings across three groups

were subjected to analysis. It is observed that there is only a 5% mean difference among the group in SIS (%) scores in group 2 and group 3. However, there is no significant differences observed between these groups, this could be attributed to less number of subjects and greater variability (as indicated by large standard deviation). Though there was no significant difference in preferred and NAL-NL1 gain condition on SIS (%), yet the individuals preferred different gain settings over that prescribed by NAL-NL1, for the overall enhancement in speech quality.

## Conclusion

The major findings of the study indicated that the preferred gain differences relative to NAL-NL1 across frequencies was greater at mid frequencies than at low and high frequencies. The differences increased with increase in degree of hearing loss. This study also reflects on the importance of fine-tuning of hearing aids based on participant's preference and to develop a new prescriptive formula specifically for Indian population.

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