Comparison Of Hearing Aid Acclimatization In Individuals Using Receiver In The Canal (RIC) And Behind The Ear (BTE) Hearing Aids

Sahana V.[1] & Jijo P.M.[2]

Abstract

It was hypothesized that magnitude of acclimatization while using Receiver in the canal (RIC) hearing aids could be higher than that of Behind the ear (BTE) instruments. This could be due to increased bandwidth in the high frequency region and better access to high frequency information in RIC hearing aids. Additionally, the acclimatization effect should be observed in both quiet and noise. The present study assessed hearing aid acclimatization in quiet and noise in individuals with sloping sensorineural hearing loss who were naive users of RIC and BTE hearing aids. There were 10 participants in the age range of 47 to 82 years, who had mild to moderately-severe sloping sensorineural hearing loss involved in the study. Five of the participants were naive users of RIC hearing aids and the remaining five were naive users of BTE hearing aids. Perception of high frequency words, sentence identification in the presence of noise were evaluated at two different time intervals. Initial testing was carried out at the time of hearing aid fitting and a follow up evaluation was carried out after 1 month of uninterrupted hearing aid usage. Additionally, hearing aid benefit questionnaires was also administered. It was found that both RIC and BTE hearing aid users showed significant aided benefit in both high frequency word test and sentence identification in noise. However, no significant difference in test results was found between RIC and BTE hearing aid users. Similarly, bjective questionnaire rating showed no significant difference between RIC and BTE hearing aids. In individuals with sloping sensorineural hearing loss the acclimatization effect was seen in both quiet and noise. Further, the amount of acclimatization was similar for both RIC and BTE hearing aid users.

Key words: *Reliability, contralateral inhibition, otoacoustic emissions*

Introduction

One of the important aspects in rehabilitation of individuals with hearing impairment is providing amplification through hearing aids. With the provision of amplification, the rehabilitation program should also involve procedures that help the individuals to get accustomed to the amplification over a period of time (Gatehouse, 1992). Bentler, Holte, and Turner, (1999) defined acclimatization as the improvement in speech recognition abilities over a course of time, probably due to the amplification and the learned use of newly available speech cues. This acclimatization can be measured objectively using speech recognition tests as well as subjectively using self-reported questionnaires (Cox & Alexander, 1992). The underlying physiology behind acclimatization is the plasticity (Robinson & Gatehouse, 1995) where in anatomical and physiological changes will be seen in the auditory cortex over a period of time with altered input to the auditory system.

Though many studies have demonstrated an acclimatization effect (Gatehouse, 1992; Surr, Cord, & Walden, 1998; Yund, Roup, Simon, & Bowman, 2006), a few have failed to show considerable amount of hearing aid acclimatization (Bentler, Bender, Niebuhr, & Anderson, 1993; Gabrielle & Kathleen, 1997). The difference in the results obtained in these studies could be because of the limitations in their methodology. Gabrielle and Kathleen, (1997) found no evidence of acclimatization over the first 3 months of hearing aid use evaluated using CID W- 1 spondee word list and Hearing in Noise Test. They acknowledged that the test materials used were not high frequency weighted and thus were less sensitive to measure changes in high frequency region. Similar results were found by Neuman et al.(1997). Hence, it was suggested by Bentler et al.(1999) that to expect acclimatization, the subjects must be selected with enough high frequency hearing loss, must have audibility returned to them and tested using high frequency stimulus.

Deterioration in unaided scores over a period of time might have resulted in aided improvement that cannot be attributed to acclimatization. A study conducted by Cox , Alexander, Taylor, and Gray (1996) evaluated the benefit of behind the ear (BTE) hearing aids in 22 older individuals in the age range of 60-82 years. Speech intelligibility testing was carried out over 12 weeks after fitting the hearing aid. Though there was an improvement seen for the group as a whole at the beginning of 6 weeks, only 3 subjects showed marked improvement, while the magnitude of improvement was small in others. However, long term follow up showed increasing benefits in some individuals but it was clearly accredited to the decline in the unaided performance.

In recent times, open-fit receiver in the canal (RIC) hearing instruments are favoured by audiologists and patients alike, because of their small size, discreet appearance and their ability to minimize occlusion. RIC instruments are also capable of a broader bandwidth than receiver in the aid instruments (Kuk & Baekgaard, 2008) and may present lowered feedback risk because of the distance between the microphone and receiver,

1. sahana.vasudevamurthy@gmail.com
2. jijoaudio@gmail.com

and increased maximum gain before feedback (Hoen & Fabry, 2007; Hallenbeck & Groth, 2008). Increased bandwidth in the high frequency region may provide better access to high frequency information and lead to faster/higher acclimatization to amplification.

Recently, Mondelli, Garcia, Hashimoto and Rocha (2015) compared the performance on speech perception in 20 individuals using receiver in the aid (RITA) and receiver in the ear hearing aids (RITE). Their participants were above 18 years of age having mild to moderate sloping sensorineural hearing loss. Speech perception was assessed using Hearing in noise test (HINT) and also using a questionnaire (satisfaction with amplification in daily life). The authors could not find any significant improvement in scores post 6 months hearing aid fitting when compared to the results obtained at the time of fitting. The results obtained could be due to the use of stimuli that were not high frequency concentrated. The authors also found no significant difference in speech perception between the two types of hearing aids. It was inferred that similar speech perception in these two hearing aids could be because of the similar output characteristics in RITA and RITE hearing aids as revealed by the probe microphone measurements in the study.

Hearing aid acclimatization has not been systematically studied with respect to RIC instruments. Although Mondelli et al.(2015) compared BTE and RIC hearing aids there was no acclimatization effect found in these two types of hearing aids. Aided speech perception in individuals using RITA and RITE hearing aids evaluated using Hearing in noise test (HINT) and also using a questionnaire (satisfaction with amplification in daily life). HINT sentences were also presented in quiet situation. It was found in quiet environment that there was a significant improvement in the aided performance over the unaided condition in both the types of hearing aids. However, the performance between 2 aided conditions i.e., at the time of fitting and 6 months post fitting, did not show any significant difference. Similar results were obtained in the presence of noise. The results obtained could be due to the low frequency dominance in Hearing in noise test (HINT). These stimuli were not sensitive enough to demonstrate the learnt use of new acoustic information available to the listeners in the high frequency region. Further, identical results found between two hearing aid types. This could be because of the similar gain provided by both the hearing aid types as depicted by probe microphone measurements wherein the gain from the hearing aid in all the participants matched to the target according to NAL-NL1. In addition, the participants included were limited to moderate degree of hearing loss.

Similarly, earlier studies on hearing aid acclimatization have used test materials that assess mainly the low frequency information (Gabrielle & Kathleen, 1997). Further, Bentler et al.(1999) suggested that acclimatization could be evident among individuals having high frequency hearing loss and have audibility returned in those frequencies. Thus, there is a need to investigate hearing aid acclimatization in individuals having high frequency sloping loss using a high frequency test material. Therefore, the present study aimed to compare hearing aid acclimatization in individuals using BTE and RIC hearing aids.

Methods

The present study aimed to compare the hearing aid acclimatization in individuals with sloping sensorineural hearing loss using Behind the Ear (BTE) and Receiver in the Canal (RIC) hearing aids. Aided perception of high frequency words and sentence identification in presence of noise was assessed in both unaided and aided conditions. In order to estimate the acclimatization effect a follow up testing was carried out for all the participants after 1 month of hearing aid use.

Participants

Ten participants with sloping sensorineural hearing loss (SNHL) between the age range of 47 to 82 years (Mean age: 67.5 years, SD= 12) participated in the study.

Among them, five individuals were naïve RIC hearing aid users and the remaining five subjects were naïve BTE users. Participants fitted with monaural or binaural hearing aids were selected. All the participants were native speakers of Kannada. The demographic and audiologic details of the participants can be seen in Table 1.

Procedure for the selection of participants

A structured interview was carried out to choose the participants who met the following criteria:

1. No history of external or middle ear infection,
2. No history of any speech and language problem,
3. No gross neurological or cognitive dysfunction(Evaluated using Standardised Mini Mental Status Examination).

Table 1: Demographic and audiologic details of the participants

Sl.No	Age/ Gender	PTA (dBHL)		SIS(%)		Tympanogram (bilateral)	Acoustic Reflex (bilateral)	Hearing aid
		Right	Left	Right	Left			
1	47 Y/F	50	55	100	92	A	Present	RIC
2	66 Y/M	45	45	96	96	A	Present	RIC
3	82 Y/M	62.5	58.75	92	92	A	Absent	RIC
4	76 Y/F	32.5	36.5	92	96	A	Present	RIC
5	75 Y/M	50	50	88	88	A	Present	RIC
6	66 Y/M	60	65	92	92	A	Absent	BTE
7	76 Y/M	54	55	100	100	A	Present	BTE
8	74 Y/M	60	65	88	92	A	Absent	BTE
9	54 Y/M	45	50	100	92	A	Present	BTE
10	59 Y/M	60	58.75	92	92	A	Absent	BTE

PTA=Pure-tone average, SIS=Speech identification score

In addition to the above criteria, only participants who manifested the following findings were included in the study:

1. Pure-tone hearing threshold in the range of mild to moderately severe sloping sensorineural hearing loss with 5-12 dB increase in threshold per octave (Silman & Silverman, 1991).
2. Symmetrical hearing loss, where the difference in threshold between the two ears should not exceed 10 dB HL at any frequency (Figure 1).
3. 'A' type tympanogram.

Prior to collection of data, detailed audiological evaluation was carried out for all the participants. Pure-tone thresholds were obtained via the modified Hughson and Westlake procedure (Carhart & Jerger, 1959), using a calibrated diagnostic audiometer. Calibrated immittance instrument was used to obtain tympanograms and acoustic reflex thresholds. Speech identification scores were obtained using a phonemically balanced word test in Kannada, developed by Yathiraj and Vijayalakshmi (2005).

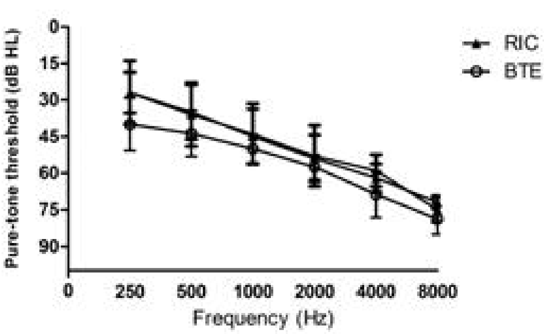

Figure 1. The mean and ±1SD of pure tone air conduction thresholds across frequencies in RIC and BTE hearing aid users.

Test stimulus

The stimuli used for the study include high frequency word list in Kannada (Kavitha & Yathiraj, 2002) and a sentence test in Kannada (Geetha, Kumar, Manjula & Pavan, 2014). The former stimuli were used to evaluate the ability of the participants to use the high frequency information and the latter was used to evaluate the speech perception performance in adverse listening conditions. Both word and sentence test were performed in the unaided as well as aided conditions. The high frequency word list in Kannada had three lists in it, each having 25 words. The recorded version of any of the three word list was presented at 40 dBHL and the percentage of correctly identified words was calculated.

Four lists of sentences were taken from the recorded sentence test in Kannada. Each list contained ten sentences and each sentence had five key words. All the sentence lists were phonemically balanced. The ten sentences in each list were mixed with speech shaped noise at different signal to noise ratios (SNR) ranging from 12 dB to -6 dB SNR in 2dB step-sizes. The speech shaped noise was generated by randomizing the phase of the Fourier spectrum of concatenated sentences of original signals using MATLAB software. The noise was added to the sentence based on root mean square (RMS) level. The stimuli were RMS normalized to maintain equal loudness. The SNR at which 50% of the sentences were perceived will be calculated using the Spearman-Kärber equation (Finney, 1952), which is as follows:

$$50\% \text{ point } = I+(0.5\times d)-d\ (\#\ correct)/w$$

where, I is initial presentation level (dB SNR), d is the decrement step size (attenuation), and w is the number of words per decrement.SNR 50 was obtained from each participant in the unaided and aided conditions.

To assess the performance in real life situation Hearing Aid Benefit questionnaire for adults (Kanwer & Devi, 2011) was used. The check-list was administered to assess communication abilities of participants in the unaided and aided conditions. First two divisions of the questionnaire that assess the performance of participants in favourable (quiet) and unfavourable (noise) situations were utilized.

Test environment

The study will be carried out in an acoustically treated air-conditioned room with permissible noise level as per ANSI S3.1, (1999).

Hearing aid programming

A wide dynamic range compression BTE and RIC hearing aids with similar number of channels (4-6) as well as gain and compression characteristics was utilized for the study. BTE hearing aids were fitted using custom made soft ear moulds and the RIC hearing aids were fitted using domes of appropriate size. The hearing aids were programmed using a personal computer loaded with a NOAH software (version-4) and hearing aid specific software. Programming was done separately for each participant to provide appropriate output characteristics at first fit.

Real ear insertion gain measurement

All the participants were tested for their real ear insertion gain characteristics. Prior to the testing, otoscopic examination of the ear canal was performed. A loudspeaker was placed at a distance of 12 inches and 00 azimuth from the participants. A calibrated probe tube was placed within approximately 5 mm of the ear drum of the participants. Real ear insertion gain curves were obtained for each of the participants by subtracting the real ear aided and unaided gain curves. The procedure was same for both BTE and RIC except that the reference microphone was switched off in order to avoid artifacts caused by the feedback suppression technology in the RIC hearing aids. It was ensured through real ear measurements that appropriate gain was provided using both RIC and BTE hearing aids.

Test Procedure

Each participant was evaluated to assess both unaided and aided speech perception abilities. Speech perception abilities of each participant were assessed at two different time intervals. First evaluation was performed soon after fitting hearing aids. Another evaluation was performed 4-5 weeks after uninterrupted use of the hearing aid. Each participant was tested in their aided ear while blocking the unaided ear using ear mould impression material. The recorded versions of the word test as well as sentence test were utilized to evaluate their performance. The stimuli were played using a computer. The output of the computer was routed through a calibrated audiometer and heard by the participants through a loud speaker kept at a distance of 1 meter at 00azimuth. The stimuli were presented at 40 dB HL. No participant heard the same list more than once to avoid any familiarity effect. The participants were instructed to repeat the stimuli and the responses were noted by the experimenter. The SNR was adjusted depending on the participant's response to obtain 50% response. Similarly, the word identification scores was calculated by counting the number of words identified correctly.

Analyses

The data obtained from 10 ears of 5 individuals using binaural RIC hearing aids and 8 ears (3 binaural and 2 monoaural hearing aid users) of BTE users were analysed using SPSS (version 20). Descriptive statistics, Wilcoxon Signed Rank test, Mann-Whitney U test were performed to analyse the data.

Results

The present study compared the hearing aid acclimatization in individuals with sloping sensorineural hearing loss using RIC and BTE hearing aids. In order to quantify the acclimatization effect, speech perception abilities of the participants were evaluated in quiet and noise. Perception of high frequency words and sentence identification in noise (SNR-50) were carried out to evaluate the performance in quiet and noise respectively. Both the testings were carried out at the time of hearing aid fitting (trial 1) as well as after 1 month of hearing aid use (trial 2). Additionally, the participants were asked to fill a questionnaire on hearing aid benefit at the end of 1 month of hearing use.

Perception of high frequency words

In order to obtain the aided benefit using high frequency word list, the difference between aided and unaided scores was determined. This was carried out separately for trial 1 and trial 2. The mean and SD of unaided and aided scores for RIC and BTE hearing aids can be seen in table 2. Participants showed similar unaided scores in both the trials whereas the aided scores improved in trial 2.

Table 2: The mean and standard deviation for the unaided and aided scores using RIC and BTE hearing aids for trial 1 and trial 2

Hearing aid type	Unaided scores		Aided scores	
	Mean (Standard deviation)		Mean (Standard deviation)	
	Trail 1	Trail 2	Trail 1	Trail 2
RIC	3.70 (2.16)	3.70 (2.16)	14.10 (2.42)	19.30 (1.25)
BTE	1.75 (2.19)	1.75 (2.19)	13.75 (1.90)	17.75 (1.98)

The difference in the aided benefit between the two trials yielded the acclimatization effect. Table 3 shows the mean, median and standard deviation of aided benefit in both RIC and BTE hearing aid users. It is clearly seen that aided benefit obtained after 1 month of hearing aid usage was higher than that obtained at the time of hearing aid fitting. Wilcoxon Signed Rank test was carried out in both RIC and BTE hearing aid users to determine the significance of improvement in speech identification scores. The results showed a significant improvement in speech identification for both RIC ($|z| = 2.82$, $p< 0.05$) and BTE ($|z| = 2.53$, $p< 0.05$) hearing aid users at the end of 1 month of hearing aid use. The difference in speech identification scores between two trials in RIC and BTE hearing aid users can also be found in Figure 2.

In order to determine the acclimatization effect, aided benefit obtained on trial 1 was subtracted from trial 2. This was carried out separately for RIC and BTE hearing aid users. The mean, median and standard deviation of acclimatization effect in both RIC and BTE hearing aid users can be seen in table 4. It is noted that the acclimatization effect obtained in the RIC users was slightly better than that of the BTE users.

Further, Mann-Whitney U test was administered to check the significance of difference in the amount of acclimatization between RIC and BTE users. The results revealed no significant difference in the amount of acclimatization between the two types of hearing aids ($U= 25.00$, $p>0.05$).

Table 3: The mean, median and standard deviation for the aided benefit using RIC and BTE hearing aids for trial 1 and trial 2

Hearing aid type	Aided benefit					
	Trial 1			Trial 2		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation
RIC	10.00	11.00	3.34	15.60	15.00	2.28
BTE	12.00	11.50	3.46	16.00	16.00	2.67

Table 4: The mean, median and standard deviation of acclimatization effect for high frequency words in RIC and BTE hearing aid

Hearing aid type	Acclimatization effect		
	Mean	Median	Standard eviation
RIC	5.20	5.00	1.87
BTE	4.00	3.50	2.20

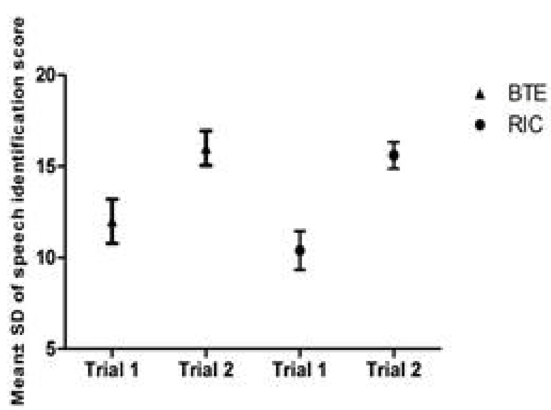

Figure 2: Speech identification score (mean and ±1SD) obtained using high frequency wordlist across two trails in BTE and RIC hearing aid users.

Sentence identification in noise

Sentence perception in noise was evaluated using aided SNR-50 in both trial 1 and trial 2. The mean, median and standard deviation for the aided SNR-50 in both the trials is depicted in table 5. It is evident in both BTE and RIC hearing aid users that SNR-50 obtained on trial 1 was poor compared to that of trial 2. Wilcoxon Signed Rank test was performed to assess the significance of difference in SNR-50 between the two trials. This was done separately for RIC and BTE hearing aid users. The results revealed that both RIC ($|z| = 2.80$, $p< 0.05$) and BTE ($|z| = 2.53$, $p <0.05$) hearing aid users showed significant difference in SNR-50 between the two trials. The difference in SNR-50 between two trials in RIC and BTE hearing aid users can also be found in Figure 3.

Acclimatization effect was determined by taking the difference in SNR-50 between the two trials. Table 6 shows the mean, median and the standard deviation for the acclimatization effect for SNR-50 in both the groups. Mann-Whitney U test was done to see the significance of difference in amount of acclimatization between the two types of hearing aid. As shown by the results, the amount of acclimation was not significantly different between BTE and RIC hearing aid users ($U= 23.00$, $p > 0.05$).

Table 5: The mean, median and standard deviation for the SNR-50 in RIC and BTE hearing aids for trial 1 and trial 2

	SNR-50					
Hearing aid type	Trial 1			Trial 2		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation
RIC	+8.60	+8.75	1.05	+3.35	+3.75	1.70
BTE	+8.44	+8.00	1.68	+4.44	+4.25	2.11

Table 6: The mean, median and standard deviation of acclimatization effect for SNR-50 in RIC and BTE hearing aid

Hearing aid type	Acclimatization for SNR-50		
	Mean	Median	Standard deviation
RIC	5.25	5.05	1.84
BTE	4.00	4.25	1.60

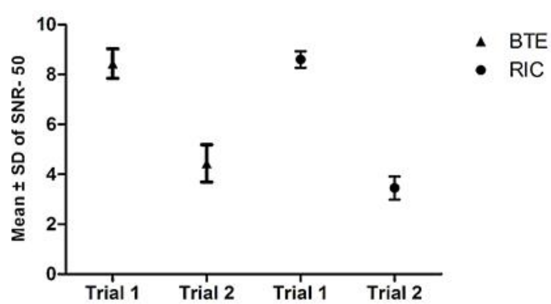

Figure 3: SNR-50 (mean and ±1SD) obtained across two trails in BTE and RIC hearing aid users.

Hearing aid benefit questionnaire

In order to assess the performance in real life situation Hearing Aid Benefit questionnaire for adults (Kanwer & Devi, 2011) was administered after 1 month of hearing aid use. Each question was answered with respect to unaided and aided condition in both quiet and noise. The mean and standard deviation of the same can be seen in table 7.

The differences between the aided and unaided scores were calculated. Table 8 shows the mean, median and standard deviation of aided benefit on both the subscales. It is clear that both RIC and BTE hearing aid users showed aided benefit on both the subscales.

Table 7: The mean and standard deviation for the unaided and aided scores using RIC and BTE hearing aids in both quiet and noise

Hearing aid type	Quiet		Noise	
	Mean (Standard deviation)		Mean (Standard deviation)	
	Unaided	Aided	Unaided	Aided
RIC	16.56 (12.68)	68.13 (12.43)	7.20 (6.20)	57.22 (12.20)
BTE	6.25 (1.28)	64.47 (2.35)	2.77 (2.27)	47.57 (1.30)

Table 8: The mean, median and standard deviation of aided benefit in BTE and RIC hearing aid users in quiet and noise subscales

Hearing aid type	Aided benefit Quiet			Aided benefit Noise		
	Mean	Median	Standard deviation	Mean	Median	Standard deviation
RIC	51.56	46.88	11.10	50.01	51.40	9.41
BTE	58.22	58.59	1.51	44.79	45.14	8.52

Mann-Whitney U test was administered to see if there was significant difference in the aided benefit between RIC and BTE hearing aids. On both the subscales i.e., quiet ($U= 8.00$, $p > 0.05$) and noise ($U= 8.50$, $p > 0.05$), there was no significant difference in aided benefit in both RIC and BTE hearing aid users.

Discussion

The present study compared the acclimatization in individuals with sloping sensorineural hearing loss using RIC or BTE hearing aids. The results of the study showed significant acclimatization effect in both RIC and BTE hearing aid users. However, there was no significant difference in acclimatization between the two types of hearing aids. This was evident through both speech perception tests as well as subjective measures.

Perception of high frequency words

The results of the high frequency word test revealed that the perception of high frequency words improved significantly at the end of 1 month of hearing aid usage in both RIC and BTE hearing aid users. Perceptual improvement in high frequency word scores accounts for the acclimatization effect in quiet. Due to high frequency sloping hearing loss, the study participants were unable to access the high frequency information in the unaided condition. After fitting hearing aid that provided sufficient gain in the high frequency region, the participants were able to make use of the high frequency information that helped them to perceive high frequency cues better. Moreover, we used the test stimuli that tap the perception of high frequency information. Similarly, previous work on hearing aid benefits by Gatehouse (1992; 1993) and Yund et al.(2006) have also showed significant acclimatization effect. In these studies they used test materials such as four alternative auditory feature (FAAF) and nonsense syllable test (NST), which tap more of high frequency content. In contrast, Gabrielle and Kathleen (1997) did not show significant acclimatization effect. The reason they attributed for lack of acclimatization was the test material that did not tap the high frequency perception. Thus, they suggested the use of stimuli that taps the high frequency perception while assessing the acclimatization in individuals with sloping sensorineural hearing loss. Thus, significant acclimatization in the current study participants who had sloping sensorineural hearing loss could be attributed to access to newly available high frequency cues that were evaluated using appropriate test stimuli.

The study also indicated that there was no significant difference in the amount of acclimatization between RIC and BTE hearing aids. This could be because both RIC and BTE hearing aids were efficient in providing adequate high frequency gain. This was confirmed using real ear measurements. Similar results were found by Mondelli et.al. (2015) where in the authors reported no significant difference in acclimatization between RIC and BTE hearing aid users.

Sentence identification in noise

Perception of sentences in noise represents the aided performance in the presence of noise. It can be seen that the SNR-50 improved significantly at the end of 1 month post acclimatization in both RIC and BTE hearing aid users. However, the amount of improvement was not significantly different between the two types of hearing aids.

It could be expected that with acclimatization, individuals learn to use newly available speech cues in the high frequency region and this might have resulted in the improved performance in the presence of noise. Similar results on speech perception in noise were obtained by Prates and Iório, (2006). However other studies by Gabrielle and Kathleen, (1997) and Mondelli et al. (2015) reported that no significant acclimatization effect on speech perception in noise while using SPIN and HINT stimuli respectively.

In many aspects the present study is comparable to the one conducted by Mondelli et al.(2015). Both the studies had individuals with sloping sensorineural hearing loss, they used similar types of hearing aids (RIC and BTE) and similar tasks i.e., perception of sentences in noise. In spite of these similarities, study by Mondelli et al.(2015) failed to show significant acclimatization effect even after 6 weeks post hearing aid fitting. However, the present study showed significant acclimatization effect in both the types of hearing aids. The possible reason for the difference in the findings could be because of the frequency content of the stimuli as revealed by the long term average speech spectrum (LTASS). Earlier study used HINT sentences which were concentrated majorly on low frequencies with the roll off starting at 1000 Hz (Nilsson, Soli & Sullivan, 1994). In contrast, the present study used sentences which had more high frequency concentration compared to HINT. Even though, major concentration of the stimuli was in the low frequencies, the roll off started at a much higher frequency at about 10000 Hz (Geetha, Kumar, Manjula & Pavan, 2014). Thus, in the present study, significant acclimatization was seen since the stimuli tapped high frequency information.

The present study also revealed that there was no significant difference in the amount of improvement in the SNR-50 between the two types of hearing aids. The results are in accordance with the study conducted by Mondelli et.al. (2015), which is the only study that compared acclimatization in BTE and RIC hearing aids. The authors reasoned that both the types of hearing aids provide adequate high frequency gain and thus the results did not show any significant difference in terms of acclimatization.

Hearing aid benefit questionnaire

The intention of administering the subjective questionnaire was to see whether the participant's subjective rating was more in favour of one of the hearing aid types. The above results of the objective evaluation are in accordance with the subjective measures as revealed by the hearing aid benefit questionnaire. The first subscale i.e., aided benefit in quiet revealed that there was an improvement in the aided condition when compared to unaided condition in both RIC and BTE hearing aid users. However, there was no significant difference in the amount of improvement between the two types of hearing aids.

Similarly, the subscale representing the aided benefit in the presence of noise, showed benefit in aided condition over unaided condition. However, no significant difference in the amount of benefit was obtained with both the types of hearing aids. Since both the types of hearing aids provided similar gain, the subjective rating might not have revealed any significant changes between RIC and BTE hearing aids. However, the questionnaire was administered only once after the acclimatization period and hence we are unable to get information regarding the effect of acclimatization on parameters in the questionnaire.

Overall results of the present study showed that both RIC and BTE hearing aids provide significant benefit for speech perception both in quiet and noise. The improvement with the hearing aids was evident on both the speech perception tests as well subjective questionnaire. However, none of the two types of hearing aids proved to be significantly better over other type of hearing aid. This may be due to the similar gain provided by both the types of hearing aids. Thus, in individuals with sloping sensorineural hearing loss both RIC and BTE hearing aids showed similar amount of acclimatization probably due to their identical gain characteristis.

Conclusions

The present study compared the acclimatisation to RIC and BTE hearing aids in individuals with mild to moderately severe sloping sensorineural hearing loss. It was found that both RIC and BTE hearing aids resulted in significant improvement in speech perception abilities in individuals with sloping sensorineural hearing loss. The amount of acclimatization was similar for both RIC and BTE hearing aid users.

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