Effect of Hearing Aid Acclimatization on Auditory and Working Memory Skills in Individuals with Hearing Impairment

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Abstract

Improvement in hearing and related domains following hearing aid use is termed as hearing aid acclimatization. Hearing aid acclimatization is observed in auditory and speech perception skills. However, it is not known if there is a transfer of acclimatization affects to other domains such as working memory skills. This study aimed to investigate the effect of hearing aid acclimatization on some auditory and working memory skills in individuals with mild to moderate cochlear hearing loss. For this purpose, working memory and auditory assessments were carried out on 10 individuals with cochlear hearing loss, immediately after the fitment of hearing aid and after one month of hearing aid use. Working memory assessment included reading span, auditory digit span and auditory sequencing and auditory assessment included gap detection thresholds, temporal modulation transfer function, pitch discrimination thresholds, duration pattern thresholds, concurrent vowel identification and speech perception in noise. Results revealed that hearing aid use for one month did not bring significant acclimatization effect on working memory skills and most of the auditory skills. However, speech perception in noise showed significant improvement following one month of hearing aid use.

Key words: *Hearing aid acclimatization, working memory capacity*

Introduction

Hearing aids amplifies the sound in order to compensate for the hearing loss that a hearing impaired individual experience. The amplification will increase the audibility and hence enhance the speech cues that were inaudible previously. On using the hearing aid the hearing aid user might experience an immediate improvement in understanding speech. This improvement might increase over time as the hearing aid user gets accustomed to the hearing aid. This improvement can be an effect of practice or a form of perceptual learning. This affect is known as "auditory acclimatization" (Arlinger et al., 1996). The acclimatization effect seems to be greatest in difficult listening situations (nonsense syllable recognition in noise) (Ellis & Munro, 2015). The perceptual consequences of hearing aid fitting in sensorineural hearing loss listeners also support auditory acclimatization effect (Philibert, Collet, Vesson, & Veuillet, 2005).

Hearing aid acclimatization results in improvements in hearing and other related areas. Previous research has indicated improvement in the speech discrimination over time (Bentler, Niebuhr, Getta, & Anderson, 1993; Gatehouse, 1992). Once the hearing aid user gets adapted to the amplification the benefits are seen in multiple facets. The benefits are not restricted only to the speech recognition abilities but also involves other aspects of communication and his/her satisfaction as a hearing aid user (Humes, Wilson, Barlow, Garner, & Amos, 2002). Hearing aid acclimatization also results in increased subjective benefit and sound quality (Bentler et al., 1993; Ovegård et al., 1997), loudness perception and intensity discrimination (Philibert, Collet, Vesson, & Veuillet, 2002), temporal spatial aspects (Dawes, Munro, Kalluri, & Edwards, 2013) and cognitive aspects (Choi et al., 2011; Pichora-Fuller & Singh, 2006; Pinheiro, Iório, Miranda, Dias, & Pereira, 2012). The above studies mostly reported a small but a significant effect of acclimatization while there are few studies reporting of no significant difference between the experienced and the new hearing aid users (Smeds et al., 2006a, 2006b).

The benefit of hearing aid is seen in different areas including social, emotional, cognition and communication, though the changes in cognition are reported to be minimal (Mulrow, Tuley, & Aguilar, 1992). Working memory is a system for the temporary storage, management and manipulation of information required for carrying out complex cognitive tasks such as language comprehension" (Daneman & Carpenter, 1980). As age advances, the auditory performance declines significantly over a period of time. The decline usually is manifested in pure tone thresholds as well as in all speech understanding measures suggesting that nature of speech perception changes in accordance with age. Auditory thresholds measures the speech perception by the peripheral auditory system while the effect of age depicts the degradation of central structures which are accountable for low rate temporal processing (Divenyi, Stark, & Haupt, 2005). The age related decline seen in physiological integrity of neural subsystems is common for sensory as well as cognitive processing and hence it is found that both sensory and cognitive aging would occur concurrently (Lindenberger & Baltes, 1994). Sensory deprivation due to hearing loss contributes to decline in cognitive function (Uhlmann, Larson, Rees, Koepsell, & Duckert, 1989). Peelle, Troiani, Grossman and Wingfield, (2011) supported this with an fMRI study which unveiled the relationship

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between speech abilities and the cortical structures.

Hearing aids now have more complex operations and hence emulate different aspects like higher- level auditory function and cognitive processing which involves attention, memory and language (Pichora-Fuller & Singh, 2006). Choi et al., (2011) reported of improved speech related cognitive function of hearing impaired individuals post hearing aid use indicating hearing aid induce acclimatization of central auditory system. Hearing aids if worn at the early stages of hearing loss it improves the individuals performance on auditory working memory tests (Doherty & Desjardins, 2015).

Need for the study

From the literature mentioned above, it is clear that there is deterioration in the hearing, auditory processing, speech processing and working memory capacity due to aging. It is been observed that auditory and speech perception skills improve with the fitment of the hearing aid over time. This improvement is termed as hearing aid acclimatization. However, it is unclear whether there general transfer of acclimatization affects to other domains such as working memory skills. Given a strong relationship between auditory, speech perception and working memory skills, we hypothesize that hearing fitment may improve persons WMC over time and may result in cognitive acclimatization.

Aim of the study

The present study aims to investigate the effect of hearing aid acclimatization on auditory and working memory skills in individuals with hearing impairment.

Objectives of the study

- To measure and compare gap detection thresholds, temporal modulation transfer function, pitch discrimination thresholds, duration pattern thresholds, concurrent vowel identification and speech perception in noise on first fit and after one month of hearing aid use.
- To measure compare reading span, auditory digit span and auditory sequencing on first fit and after one month of hearing aid use.

METHOD

Participants

Fourteen adults in the age range of 50 to 65 years participated in the study. All participants had bilateral mild to moderate acquired cochlear hearing loss. All the participants were native speakers of Kannada and were able to read and write Kannada. None of the participants showed any evidence of middle ear pathology on immittance evaluation. All participants were naive users of hearing aids. A structured interview was carried out to rule out any gross neurological, cognitive or otological problems. Of the 14 participants only 10 completed the study and hence data from only 10 participants was analyzed. Written informed consent was obtained from all participants prior to their participation.

Hearing aid fitment

All participants were naive hearing aid users. Bilateral digital hearing aid was fitted to all participants using the clinical protocol followed at Department of Audiology, All India Institute of Speech and Hearing. In brief, this involved hearing aid programming and fine tuning using speech identification measures. Paired comparisons between the hearing aids were used for selecting the desired hearing aid.

Test environment

All audiological assessments were carried out in a sound treated room with ambient noise levels within the permissible limits as per ANSI (ANSI S3.1- 1999). Other auditory and cognitive tests were carried out in a quiet room with minimal visual distractions

Procedure

After routine audiological evaluation and hearing aid fitment, participants underwent detailed working memory and auditory assessment. Working memory and auditory assessments were done twice - immediately after the fitment of hearing aid and after one month of hearing aid usage. All audiological evaluations and structured interview was repeated before the second assessment also.

Working memory assessment

The cognitive assessment included primarily assessment of working memory - reading span task, auditory digit span and auditory sequencing.

Reading span task

In reading span task, participants' ability to remember the target stimuli which interleaves with a secondary processing task was evaluated. The secondary processing task was verifying semantic/pragmatic correctness of a sentence. Stimulus for the reading span task had been developed following the guidelines of Kane et al. (Kane et al., 2004). The test was administered using paradigm player. It consisted of a sentence and a syllable to be remembered (e.g. "Ramu is going to school. /ka/").Each element was defined as a combination of one sentence and a syllable to be remembered. Half of the sentences were logical (e.g. Apples are falling from an Apple tree) and other half of the sentences did not follow logic (e.g. People are falling sick because of increasing flowers). The syllables to be remembered were in CV structure with combination of different consonants and vowels. Combinations of a number of elements were defined as a trial. Each trial consisted of two to five elements (sentence-syllable combinations). Three trials of each length were presented for a total of 12 trials (4 lengths   3 trials).

During testing, an element that is a sentence was displayed on the computer screen followed by a syllable to be remembered. The participant's task was to read the sentence aloud and indicate whether it made sense and then read the syllable. Soon after, next sentence-syllable combination was presented. After all the elements in a trial were presented, the participant had to recall each syllable from the preceding set of sentences, in the order they appeared. The number of elements in each trial was varied randomly so that the difficulty level would not be predicted at the beginning of the trial. The accuracy of judging the sentence and also recalling the syllables in the same order was noted.

Scoring was done according to the guidelines provided by Kane et al. (Kane et al., 2004) and Conway et al. (Conway et al., 2005). One point was provided for each element recalled in the correct serial order irrespective of the error made in verifying the processing component of the task (judging whether the sentence made sense). However, it was ascertained that the accuracy on the processing component of the task was not less than 80%. Further, proportion correct score for each trial was calculated and averaged across all the 12 trials to obtain the final score which was the reading span of the participant.

Auditory sequencing

Auditory number sequencing included ascending and descending span. In auditory number sequencing a cluster of numbers were presented increasing in length. The participants' task was to arrange the number in lowest to highest order in ascending span and vice versa in descending span. Total score was calculated based on the digits the participant can successfully recall.

Auditory digit span

Auditory digit span was divided into forward and backward phase. Cluster of digits were presented in random order. The participant's task was to reproduce them in the same order in forward phase and backward order in backward phase. Total score was calculated based on the digits the participant could successfully recall.

Temporal and speech perception assessment

All temporal processing tests except for the duration pattern test were carried out using 'mlp' procedure (Green, 1990) implemented in MATLAB. Details of the stimuli and procedure can be found in Grassi and Soranzo (2008).

Temporal processing

The temporal processing tests included Gap Detection Test (GDT), Duration Pattern Test (DPT), Temporal Modulation Temporal Function (TMTF) and Pitch Discrimination Test (PDT). Stimuli were played at 44,100 Hz sampling rate. Two interval alternate forced choice method was used to estimate the threshold. Stimuli were presented binaurally at an intensity of 80 dB SPL through EAR-3A earphones via laptop.

Gap detection test (GDT): The participant's task was to detect a temporal gap in the centre of a 750 ms broadband noise. The standard stimulus was 750 ms broadband noise with no gap whereas the variable stimuli contained a gap.

Duration pattern test (DPT): The participant's task was to sequence 1000 Hz pure tone of two different durations. The duration of the short stimuli was 250ms and long stimuli was 500 ms with an inter stimulus interval of 250 msec. Six different patterns were generated using the two stimulus. Participants were asked to repeat the sequence verbally.

Pitch discrimination test (PDT): Pitch discrimination threshold was found for a 250 ms complex tone. The tone had four harmonics. The subject had to detect the highest pitch tone. Onset and offset of tones were gated on and off with two 10 - ms raised cosine ramps.

Temporal Modulation Temporal Function (TMTF): Temporal modulation refers to a reoccurring change in a signal over time. A 500msec sinusoidal amplitude modulated noise at modulation frequencies of 2 Hz, 4 Hz, 8 Hz, 16 Hz, 32 Hz, 64 Hz, 128 Hz, 256 Hz were included. The participant's task was to detect the modulation and determine which interval had modulated noise. Depth of the modulated signal was varied based on the participant's response.

Concurrent vowel identification (CCV)

Stimuli used for concurrent vowel identification was same as that reported in (Kumar, & Nambi, 2015). Briefly, five vowels /a/, /e/, /i/, /o/, /u/ was synthesized at the sampling rate of 20 kHz with 270 ms duration using Klatt synthesizer. All the vowels were scaled to have same amplitude. The vowels were synthesized with two fundamental frequencies - 120 Hz and 220 Hz. Later the vowels were resynthesized with 1, 2 and 4 semitones increase from base fundamental frequency resulting in 20 vowels for each base f0 condition. For the purpose of concurrent vowel identification, the vowels were paired with each other. Same vowels were not paired even though they had different F0. Vowel /a/ was kept constant and other vowels were variable. The task of the participant was to identify the vowel ignoring the competent vowel while presented simultaneously to one ear at a time. All 5 vowels were appearing on the screen and the participant had to click on the respective vowel button. Feedback was given for every correct answer.

Speech perception in noise measurement

Speech perception in noise was assessed using Quick speech in noise developed by (Methi, Avinash & Kumar 2009). The test included presentation of sentences without hearing aids with different SNR levels. The presentation was through headphones at comfortable level.

RESULTS AND DISCUSSION

The aim of the present study was to check for the hearing aid acclimatization on some auditory and cognitive measures following one month of hearing aid use. For this purpose reading span task, auditory digit span, auditory sequencing and gap detection thresholds, temporal modulation transfer function, pitch discrimination scores, duration pattern scores, concurrent vowel identification, were presented simultaneously to one speech perception in noise was assessed at a time. The initial fit of hearing aid and after 1 month of hearing aid use. Initially 15 individuals were recruited for the study. However, only 10 participants came back for the second evaluation. Therefore, results of only 10 participants are reported. The analysis was done using IBM SPSS 20.0 software package. Normality of the data was tested using Shapiro-Wilk normality test. Since, most of the data was non-normally distributed non-parametric tests were used for analysis.

Working memory assessment

Reading span

Table 1 shows median, mean, range and one standard deviation of reading span scores between two evaluations. Table 1 reveals that reading span scores did not change much following one month hearing aid use. Maximum change in the reading span score was 2.2 in participant 10. Wilcoxon sign-rank test revealed no significant difference between the reading span scores measured across two evaluations ($|z|=1.581$, $p>0.05$).

backward digit score was 1 in participant 1 and 2.

	Mean	Median	Range	Std. Deviation
Reading span score evaluation 1	3.00	2.95	1.35-5.55	1.20
Reading span score evaluation 2	3.01	2.95	1.60-4.70	1.09

Auditory sequencing

This section of testing involved ascending span and descending span. Table 2 and Table 3 shows median, mean, range and one standard deviation of ascending span scores and descending span scores respectively between two evaluations. Table 2 reveals that ascending span scores did not change much following one month hearing aid use. Maximum change in the ascending span score was 1 in participant 3, 6 and 9. Wilcoxon sign-rank test revealed no significant difference between the ascending span scores measured across two evaluations ($|z|=1.732$, $p>0.05$). Similar findings were found for descending span also. Maximum change in the descending span score was 1 in participant 3, 6 and 9. Wilcoxon sign-rank test revealed no significant difference between the descending span scores measured across two evaluations ($|z|=1.000$, $p>0.05$).

Table 2 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for ascending span

	Mean	Median	Range	Std. Deviation
Ascending span evaluation 1	4.40	4.50	2.00-7.00	1.50
Ascending span evaluation 2	4.10	4.00	2.00-6.00	1.19

Table 3 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for descending span

	Mean	Median	Range	Std. Deviation
Descending span evaluation 1	3.90	4.00	2.00-6.00	1.44
Descending span evaluation 2	4.00	4.00	2.00-6.00	1.33

Auditory digit span

Auditory digit span was divided into forward and backward phase. Table 4 and Table 5 shows median, mean, range and one standard deviation for forward and backward digit span scores between two evaluations. Table 4 reveals that forward digit scores did not change much following the one month hearing aid use. Maximum change in the forward digit score was 1 in participant 2 and 6. Wilcoxon sign-rank test revealed no significant difference between the forward digit scores measured across two evaluations ($|z|=0.000$, $p>0.05$). Similar findings were found for backward digit span ($|z|=1.414$, $p>0.05$). Maximum change in the

Table 4 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for forward digit

	Mean	Median	Range	Std. Deviation
Forward digit evaluation 1	4.50	4.00	2.00-7.00	1.17
Forward digit evaluation 2	4.50	4.00	3.00-6.00	0.97

Table 5 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for backward digit

	Mean	Median	Range	Std. Deviation
Backward digit evaluation 1	3.60	3.00	2.00-6.00	1.31
Backward digit evaluation 2	3.80	3.50	2.00-6.00	1.31

Temporal and speech perception assessment

Temporal processing

This included gap detection test (GDT), duration pattern test (DPT), pitch discrimination test (PDT) and temporal modulation transfer function (TMTF).

GDT, DPT and PDT

Table 6, Table 7 and Table 8 shows median, mean, range and one standard deviation of GDT, DPT and PDT scores respectively between two evaluations. Table 6 reveals that GDT scores did not change much following the one month hearing aid use. Maximum change in the GDT score was 3.7 ms in participant 10. In 5 participants improvement was less than 1ms. Wilcoxon sign-rank test revealed no significant difference between the GDT scores measured across two evaluations ($|z| = 1.785$, $p>0.05$). Similar findings were found for DPT ($|z| =0.141$, $p>0.05$) and PDT ($|z|=0.255$, $p>0.05$).

Table 6 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for GDT in ms

	Mean	Median	Range	Std. Deviation
GDT evaluation 1	7.88	8.16	5.00-11.50	1.92
GDT evaluation 2	6.71	6.25	3.67-10.33	2.22

Table 7 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for DPT

	Mean	Median	Range	Std. Deviation
DPT evaluation 1	24.10	24.00	18.00-29.00	3.78
DPT evaluation 2	23.80	24.00	18.00-28.00	4.18

Table 8 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for PDT in Hz

	Mean	Median	Range	Std. Deviation
PDT pre	19.44	17.31	6.50-50.00	12.45
PDT post	20.28	16.41	5.33-64.83	17.87

Temporal modulation transfer function

Modulation detection thresholds were measured at different modulation frequencies. The modulation frequencies included were 2Hz, 4Hz, 8Hz, 16Hz, 32Hz, 64Hz, 128Hz and 256Hz. Table 9 shows median, mean, range and one standard deviation of modulation delectation thresholds for different modulation frequency between two evaluations. Table 10 gives z values and significance levels between two evaluations across different modulation frequencies. From the table it can be seen that modulation detection thresholds increased significantly following one month of hearing aid use only for 32 Hz modulation frequency.

Table 9 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for TMTF at different modulation frequency in dB

		Mean	Median	Range	Std. Deviation
TMTF 2 Hz	Evaluation 1	-16.69	-19.41	(-21.67) - (-4.33)	5.41
	Evaluation 2	-17.96	-18.50	(-23.00) -(13.00)	3.60
TMTF 4 Hz	Evaluation 1	-22.93	-24.16	(-26.17)- (-12.00)	4.94
	Evaluation 2	-23.26	-24.08	(-29.17)- (-12.00)	4.97
TMTF 8 Hz	Evaluation 1	-21.86	-23.33	(-24.50)- (-18.00)	2.58
	Evaluation 2	-23.05	-24.08	(-25.00)- (-18.17)	2.24
TMTF 16 Hz	Evaluation 1	-19.70	-19.16	(-26.00)- (-17.00)	2.57
	Evaluation 2	-20.51	-20.41	(-22.00)- (-18.50)	1.37
TMTF 32 Hz	Evaluation 1	-17.33	-17.00	(-21.50)- (-14.00)	2.70
	Evaluation 2	-19.04	-18.50	(-23.33)- (-15.00)	2.93
TMTF 64 Hz	Evaluation 1	-14.96	-14.33	(-20.67)- (-11.50)	2.72
	Evaluation 2	-15.53	-14.83	(-23.33)- (-9.61)	3.76
TMTF 126 Hz	Evaluation 1	-13.76	-13.24	(-15.83)- (-11.00)	2.11
	Evaluation 2	-14.13	-13.08	(-18.50)- (-11.67)	2.25
TMTF 256 Hz	Evaluation 1	-9.87	-9.00	(-14.16)- (-6.83)	2.70
	Evaluation 2	-8.62	-8.69	(-13.00)- (-8.00)	2.16

Table 10 : The z values and significance levels assessed between two evaluations across different modulation frequencies

Modulation Frequencies	z value	p value
TMTF 2Hz evaluation 2 - TMTF 2Hz evaluation 1	1.543	0.123
TMTF 4 Hz evaluation 2 - TMTF 4 Hz evaluation 1	0.491	0.624
TMTF 8 Hz evaluation 2 - TMTF 8 Hz evaluation 1	1.785	0.074
TMTF 16 Hz evaluation 2 - TMTF 16 Hz evaluation 1	1.605	0.108
TMTF 32 Hz evaluation 2 - TMTF 32 Hz evaluation 1	2.670	0.008
TMTF 64 Hz evaluation 2 - TMTF 64 Hz evaluation 1	0.980	0.327
TMTF 126Hz evaluation 2 - TMTF 126Hz evaluation 1	0.561	0.575
TMTF 256Hz evaluation 2 - TMTF 256Hz evaluation 1	0.593	0.553

Concurrent vowel identification (CCV)

Table 11 shows median, mean, range and one standard deviation of CCV identification scores between two evaluations. Table 11 reveals that CCV identification did not change much following the one month hearing aid use. Maximum change in the CCV identification was 6 in participant 1. Wilcoxon sign-rank test revealed no significant difference between the CCV identification scores measured across two evaluations ($|z| = 0.783$, $p>0.05$).

Table 11 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for CCV

	Mean	Median	Range	Std. Deviation
CCV evaluation 1	8.00	8.50	4.00-10.00	2.00
CCV evaluation 2	8.50	9.00	5.00-10.00	1.77

Speech perception in noise measurements

Table 12 shows median, mean, range and one standard deviation of QuickSin scores (number of words identified) between two evaluations. Table 12 reveals that QuickSin scores improved following the one month hearing aid use. Wilcoxon sign-rank test revealed significant difference between the QuickSin scores measured across two evaluations ($|z|=2.419$, $p<0.05$).

Table 12 : Mean, standard deviation, median and range values of evaluation 1 and evaluation 2 for QuickSin

	Mean	Median	Range	Std. Deviation
QuickSin evaluation 1	9.20	11.00	0.00-20.00	7.43
QuickSin evaluation 2	11.40	13.00	2.00-20.00	6.71

In summary, one month use of hearing aid did not bring much change in all the working memory skills assessed. There was also no significant change in the majority of non-speech auditory tests. However, significant change was observed in speech perception in noise.

Main aim of the current study was to investigate the effect of hearing aid acclimatization on working memory and cognitive measures. Results showed that one month use of the hearing aids did not bring significant changes in any of the working memory skills assessed. Similar results are reported by other investigators too. Hooren et al., (2005) evaluated the effect of 12 months hearing aid use on cognitive functions in 56 older adults. They were compared with the age matched control group who were not fitted with hearing aids. Cognitive testing was assessed using stroop color word task, concept shifting task, letter digit substitution, visual verbal learning test and verbal fluency test. All the tests were administered on initial hearing aid fit and after 12 months. They found no significant improvement in cognitive test following 12 months of hearing aid use. They concluded that hearing aid use may alleviate the age related difficulties in hearing but has no significant effect on cognitive mechanisms mediated by central nervous system. Similar results were also reported by Tesch-Romer, (1997). He assessed hearing aid acclimatization following 6 months use of hearing aids. He examined the performance of hearing aid users on areas of communication problems, social activities, satisfaction, wellbeing and cognitive functioning. Results showed that hearing aid use had significant positive effect on self-perceived hearing handicap but did not change other domains including cognitive functioning. However, Choi et al.,(2011) reported positive effect of hearing aid use on cognitive functions. They assessed the visual verbal learning test on 18 hearing aid users following 6 months of hearing aid use and compared with control group who did not use hearing aids. Results showed visual verbal learning scores improved significantly following hearing aid use. This change was not observed in control group. They concluded that hearing aid use improves cognitive function. Differences observed among studied may be due to various methodological issues such as number of participants, acclimatization time period, type of cognitive tests used etc.

In the current investigation, we also did not observe the acclimatization effect majority of the auditory skills assessed except for speech perception in noise. Our results are contradicts some of the previous research on hearing aid acclimatization (Cox & Alexander, 1992; Gatehouse, 1992, 1993; Munro & Lutman, 2005) . In the present study we compared the unaided auditory performance measured on initial fit to that after one month. This may be one of the reasons why we may have failed to observe the acclimatization effects. It may be that acclimatization effects are specific to those frequency and intensities altered by hearing aid amplification (Cox & Alexander, 1992). However, in the current study, majority of the auditory measures assessed in unaided condition. Therefore, the stimulus presented did not have typical characteristics of amplified signal that the hearing aid user was exposed. Hence, it is possible that acclimatization effects were not seen. Our results are consistent with Humes & Wilson, (2003). Humes & Wilson, (2003) examined changes in hearing aid performances and benefit in 9 participants over three years period. They measured number of auditory and non-auditory performance following three years of hearing aid use. Auditory measures included, nonsense syllables perception in quiet and in noise, connected speech test in noise and quite. They also evaluated benefit derived from hearing aid through self-reported measures of hearing aid benefit. Performance and benefit was measured at multiple sessions for three years. They failed to evidence any systematic improvement in hearing aid benefit over a period of time. Consistent with these studies, current investigation also failed to observe any hearing aid benefit following one month of hearing aid use.

CONCLUSIONS

The results revealed that there was no significant change in all the working memory skills assessed before and after hearing aid use. Except speech perception in noise none of the auditory skills assessed also demonstrated significant change. Speech perception in noise significantly improved following one month of hearing aid use. These results suggest that short-term use of hearing aids have positive benefit only on speech perception in noise and it does not generalize to other domains.

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