HEARING AID HANDLING SKILLS: COMPARISION ACROSS THE DURATION OF HEARING AID USE

Ishu Mittal

14AUD005

This Dissertation is submitted as part fullfillment for the Degree of Master of Science in Audiology University of Mysore, Mysore

May, 2016

CERTIFICATE

This is to certify that the dissertation entitled "**Hearing aid handling skills: comparison across the duration of hearing aid use**" is the bona fide work submitted in part fulfillment for the degree of Master of Science (Audiology) of the student (Registration No. 14AUD005). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru,

May, 2016.

Dr. S. R. Savithri

Director

All India Institute of Speech and Hearing,
Manasagangothri, Mysuru-570006

CERTIFICATE

This is to certify that the dissertation entitled "**Hearing aid handling skills: comparison across the duration of hearing aid use**" has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

Mysuru

May, 2016

Dr. Rajalakshmi K.

Professor

Department of Audiology

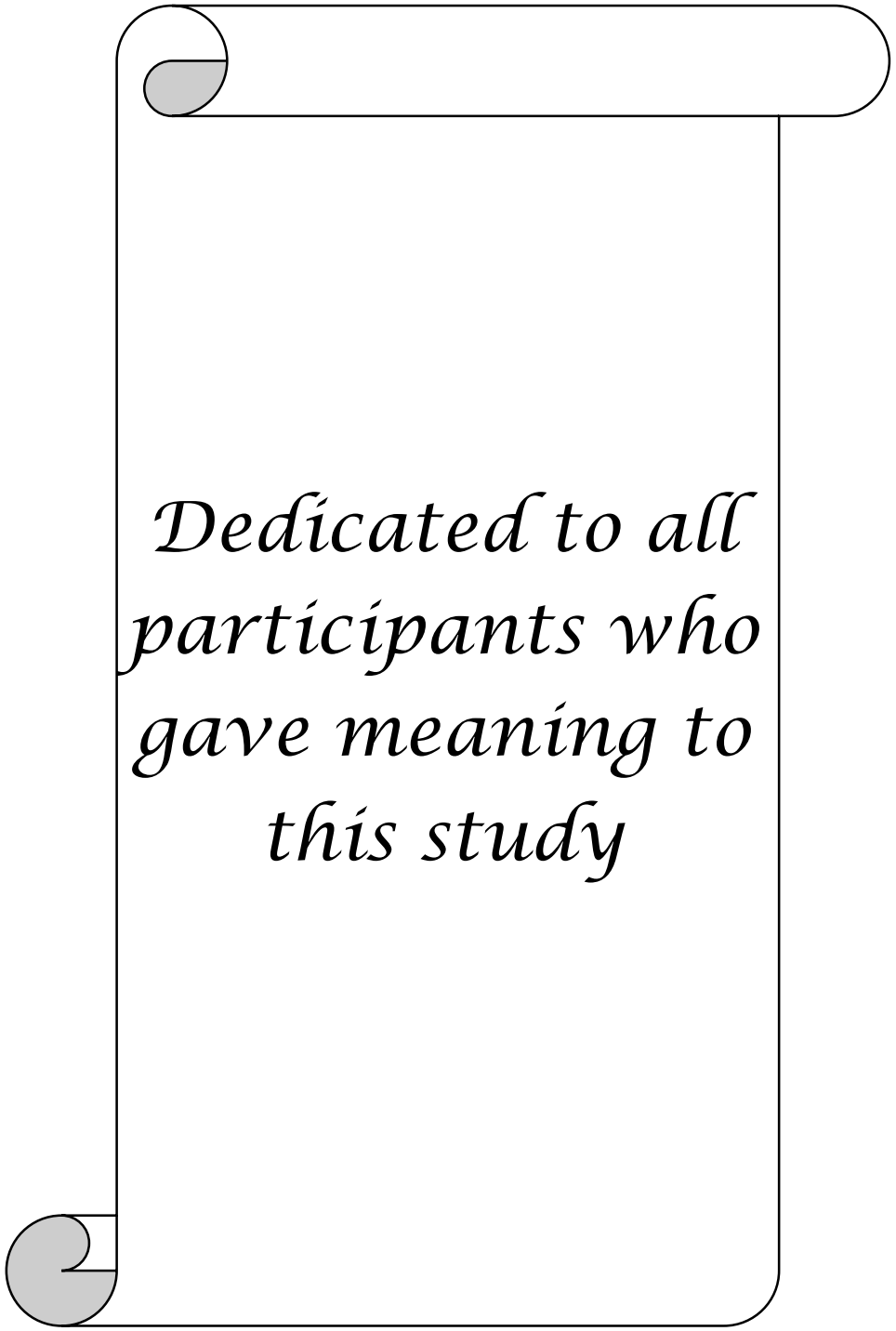
All India Institute of Speech and Hearing,
Manasagangothri, Mysuru.

DECLARATION

This is to certify that this dissertation entitled "**Hearing aid handling skills: comparison across the duration of hearing aid use**" is the result of my own study under the guidance of Prof. Rajalakshmi K, Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not submitted earlier in any other University for the award of any Diploma or Degree.

Mysuru **Register No: 14AUD005**

May, 2016


Dedicated to all participants who gave meaning to this study

ACKNOWLEDGEMENTS

मन्नाथः श्रीजगन्नाथः मद्गुरुः श्रीजगद्गुरुः ।
मदात्मा सर्वभूतात्मा तस्मै श्रीगुरवे नमः ॥

mannaathaH shriijagannaathaH madguruH shriijagadguruH
madaatmaa sarvabhuutaatmaa tasmai shriigurave namaH

Salutation to the noble Guru, who is my Lord and the Lord of the Universe, my Teacher and the Teacher of the Universe, who is the Self in me and the Self in all beings.

Rajalakshmi ma'am. I'm awed by how amazing a teacher you are! Your experience and knowledge speak for themselves. You have guided me not only through this dissertation but have also taught us the a b c's of various aspects of research and at the same time, made the whole problems fun. I'm lucky to have been your student and I fall short of words to thank you for all the encouragement, love, support, guidance and **FOOD** you have provided all through years I have spent here. Being with you always made me feel that I am not far from my family. Thank you for everything ma'am….

I thank the superpower that always looked upon our shoulders giving me strength to morainic obstacles and blessing us with all the good times.

I extend my profound gratitude to my parents and family who gave me the freedom to pursue my interests and always supported me in all my endeavors. Bhai…. (Dr. Rashu mittal) you have inspired me in various ways over time and you are the reason for any bit of success I have achieved till date. Bhabi…. (Dr. Payal Mittal) when you came in family, it's like a got a new friend with whom I can share anything at any time… thanks a lot to both of you for always supporting me. Nishant Mittal bhai sahab (Dholiya) you are a powerhouse who

channelize all your energy towards me, I don't know how many times you have been to bank to transfer money for me. Whenever, whatever I demanded I always got a positive answer. I had never imagined that the brother on whom I used to fight all the days, would be the same brother I would feel blessed to have had. Thanks for always there for me.

My brother from another mother Rahul. I don't know how many times you have been with me for any work, any time in my life. There are no enough words to say thanks to you…. You will always be close to my heart. thanks a lot for being a great person always.

Mahima didi… I was really blessed having a sister in college who really taught me everything from speak to eating professionally. Your timely advises and love had a big role what I am here in AIISH. Thank you …!! For being with me when I was truly needed someone when I came out first time from my comfortable environment.

Extend my gratitude to our director. Prof S. R. Savithri for giving me opportunities for doing this research.

A special thanks to Animesh sir… It was a great time learning under your guidance, you have given us all basic concept of audiology right from our 1st Bsc. and it was a great fun and learning environment when you were HOD of department of audiology. Thank you for everything sir!

Ajith sir previous HOD and Sandeep sir present HOD of department of audiology for making our department so friendly. We always got a smiling face and helping hands any time we

approached both of you, despite of your busy schedules. Thank you for always helping all of us to inspire and being a role models.

I express my endless gratitude to Sujeet sir. Sir, I have immense respect for your knowledge, the dedication and passion you show towards Audiology and yet be the humble person you are. Never did we hear 'come back later when we approached you for help, even if it meant staying back after 5 30. You are the person who lighted the fire of research in me. Thank you ….!!!!!!!!

I shall fail in my duty if I do not thank every single staff here who have taught me and imparted knowledge in me about everything related to speech and hearing. All of you have inspired me in your own ways, for the dynamic personalities you possess! I specially thank my professors, readers and lecturers in Audiology for being the awesome people they are and strengthening my interest in the field. Sharath sir. Antony sir. Vikas sir. Rama ma'am. Megha ma'am and Baba sir. thank you for making us better clinicians and teaching us how to apply our knowledge clinically. I extend my gratitude to Spoorthi akka, Nisha akka, Nike sir, Srikar sir, for your valuable inputs.

Bhuvana Akka, I don't know what made you to care and love me so much, thanks a lot for not just being my senior/notes provider but giving me a family in Mysore. Thanks for giving a wonderful last but best touch.

Sushma akka… I know I gave a lot of trouble to you while writing this dissertation. It was morning 7.00 or night 1.00 you were always there and that always gave me confidence to write without second thought because I knew somebody is there to correct it. Thanks a lot for everything.

Jeevan and maithri so glad to has you my co-pros! Thank you for making this otherwise serious process, a lot fun! Being good classmates to Rajalakshmi mam's kids, the journey was full of smiles (laughter) with you both… Thank you!

Special thanks to Swati bhai…. You were always there to listen me in any condition I was there it was happiness, frustrations, tantrums, sorrows… thanks always giving me best advice and showing right path… thank you this Junglee/Santra will always going to miss you…

Thanks a lot to my seniors Madhu sir, Akshay sir, Mukesh sir, Prabhash sir, Sheela ma'am, Ranjini di, Sweta di, Harshita di, Suman sir, Uday sir, Himanshu sir it was a great time here in hostel with you all.

My sweet juniors Amoolya, Chaithra. Shiva, Keshav, Appas, Vibhu, Mangal, Anup, Anuj, Rahul, Ankita, Kanhiya and Vishali for a great and fun time.

Archana Rao, thanks for throwing me out from this place with all happiness. It was a great farewell.

My class mates Amigozzzz and Masterminds…. You people were awesome… people say I am far from my family. They didn't know how much big family I had in mysore…. I am really going to miss you all forever and keep in touch…!!!!!!!

Abstract

Hearing aid orientation is a very important part of the rehabilitation process for a person with hearing impairment, who use hearing aids. Negative impact of poor handling skills can lead to dissatisfaction, poor outcome related to hearing aid use and rejection of hearing aid. Only few objective tests have been reported in literature which quantify the performance of hearing aid users. The present study focused on development, validation and finding out differences in performance related to hearing aid handling skills among new and experienced hearing aid users. An objective test namely hearing aid handling skill test (HAHST) was developed and administered on 200 participants. Participants were divided into four groups with each group comprising of 50 participants with no experience, 3 months' experience, 6 months' experience and >1 year experience respectively. The results of HAHST revealed that hearing aid users with experience of more than 1 year performed significantly better than those with new and less experienced hearing aid users. Overall performance remained low in all groups of participants as compared with the results of previous studies. This can be attributed to more number of tasks included in this study and some tasks which contains memory related information, which new hearing aid users tend to forget with time. Other findings reveal that participants performed excellently for basic tasks like switch on/off hearing aid, changing old battery and inserting new battery. The performance was poor for those tasks which required more practice to perform and on certain tasks like cleaning different parts of hearing aid and changing different programs of hearing aid the performance was poor as these tasks were infrequently used by them. Results also reveals that there is a requirement to give more importance on some tasks which require more practice and have information related to memory. New hearing aid users require more sessions of hearing aid orientation and counselling. This test will help in finding

out the efficacy of hearing aid orientation programme and the ability of the participant to perform specific tasks related to their hearing aid use and will be able to help the clinician to quantify the scores with respect to satisfaction, acceptation and outcome of their hearing aid.

Table of Contents

List of Tables

List of Figures

Chapter 1

INTRODUCTION

Hearing forms an integral part of effective communication. The physical process of hearing is ability of auditory system to detect/perceive a sound by sensing the vibrations in environment. Interference in this process due to any abnormalities along the auditory pathway leads to loss of audibility and perception of sound and commonly referred as hearing loss. It is a significant contributor to the global burden of disease in individuals, families, communities and countries.

The World Health Organization (2005) estimates indicated that 278 million people are affected by disabling hearing loss, two-thirds of whom live in developing countries. The prevalence of hearing loss in Southeast Asia ranges from 4.6% to 8.8%. In India, 63 million people (6.3%) suffer from significant hearing loss. Hearing loss can occur at any age due to various causes such as middle ear pathology, medicines, genetic etc. The extent of auditory disability totally depends upon the degree (mild, moderate, moderately severe, severe and profound) and type of loss like conductive, mixed or sensorineural hearing loss.

There are different types of management based on degree and types of hearing loss. This includes mostly medical management like medication and surgery and amplification devices. However, hearing aids are most common intervention for people diagnosed with hearing loss specially in case of sensorineural hearing loss which is most common type of hearing loss in adults (Gatehouse, 2002). Hearing aid prescriptive recommendations for hearing losses having a conductive component have received less clinical and research interest than for losses of a sensorineural nature; as a result, much variation remains among current prescriptive methods in their recommendations for conductive and mixed hearing losses (Johnson & Dillon, 2011).

According to the recommendations, policies and ethical criteria of different countries and institutes, usually it is recommended to give a trail period of 30 to 45 days to new hearing aid users. During this period the new hearing aid users usually are counselled over a number of sessions on hearing aid use, maintenance and ways of how to use hearing aid to make communication effective. According to results from the MarkeTrak VII survey, audiologists spent on average a total of 45 minutes during the hearing aid trial period instructing individuals on how to use and care for their hearing aids (Kochkin, 2005). Thus, a new hearing aid user is likely to understand a reasonable amount of new information about their hearing aid in a relatively very less time.

While this may be a difficult task for a new hearing aid user, it could be especially problematic for elderly hearing aid users who may have age-related deficiencies in working memory. elderly hearing aid users may be unable to process and store all of the new hearing aid information, or they may forget critical hearing aid information (Salthouse, 1990). In either case, these individuals could become dissatisfied with their hearing aids.

Inadequate management or rehabilitation can add on to the underlying pathology and would increase frustration because of missed communication. As a result of which person with hearing impairment tries to avoid social activities, spend less time with family and significant others, have personal and social problems, and feel isolated and depressed. Owing to these issues, a proper management of the disorder becomes a crucial part to improve the overall quality of living. In addition to hearing aid prescription, counselling plays an important role in aural rehabilitation. Audiologists need to provide services more than the basics, including the type and degree of hearing loss, understanding the limitations of amplification, and determining what they can do better

to make living with hearing loss easier. Orientation about the use and care leads to increase in acceptance of their amplification device (Stephens, 1977).

Verification of hearing aid orientation is recommended as part of the best practice for fitting hearing aids (Valente, Abrams, Benson, Chisolm, Citron, Hampton, & Sweetow, 2006). Hearing aid orientation refers to effectively instructing and orienting clients about the use and care of their hearing aids.

Individuals with greater difficulties managing and manipulating their hearing aids were not as satisfied, perceived less benefit, and reported lower use of their hearing aids compared with individuals who had less difficulty manipulating their hearing aids (Humes, Ahlstrom, Bratt, and Peek, 2009).

Any difficulty in manipulation of hearing aids by the users would make it unlikely to use it. Various authors quoted that six months after the adaptation to a hearing aid device, about 40% of the individuals did not use it regularly, 30% could not insert it in the ear, and 80% could not handle it for telephone usage (Vuorialho, Karinen & Sorri, 2006). Another study showed that among 96% of experienced hearing aid users who reported the proper use of the devices, only 48% performed such tasks adequately (Desjardins JL & Doherty KA., 2009).

Need for the study

The main goals of audiological counselling in general involve giving the individuals information about their hearing loss, developing skills needed to operate and care their new hearing aids and changing patients' belief and behaviour relating to communication (Boothroyd, 2007; Dillon, 2001). So, appropriate knowledge about handling of a hearing aid device is important to ensure the good adaptation and functioning of device, therefore avoiding the need of repairs and replacements, and especially making sure that the hearing aid users get best benefits from their amplification device.

These requirements bring to the need of a tool, which has the potential to be used clinically as an objective measure to assess the individual's ability to use and care for his or her hearing aids, which should be fast and easy to administer and yield consistent results across different health care providers.

Aim of the study

The purpose of the present study was to compare whether naive hearing aid users know how to correctly use their hearing aids as against the experienced hearing aid users.

Chapter 2

Literature Review

Management of hearing aids, training and education in handling skills are essential part of any audiological rehabilitative program, although there are very few literature which describe about it (Meister, Lausberg, Kiessling, Von Wedel & Walger, 2002; Solheim, Kvaerner, Sandvik & Falkenberg, 2012). Many researchers in the past showed that cause of low hearing aid use is poor hearing aid handling skills (Mulrow, Tuley & Aguilar, 1992; Popelka, Cruickshanks, Wiley, Tweed, Klein & Klein, 1998; Kumar, Hickey & Shaw, 2000) and this can lead to reduced satisfaction (Kumar et al, 2000; Baumfield & Dillon, 2001). Despite this, audiologists (Health care professionals) as a part of audiological rehabilitation program provide training on hearing aid handling and maintenance commonly known as hearing aid post fit orientation and counselling (American Speech-Language Hearing Association, 1998; Audiology Australia, 2013). Clinical studies revealed that level of handling skills remain low in hearing aid users (Upfold, May & Battaglia, 1990; Pothier & Bredenkamp, 2006; Bertoli, Staehelin, Zemp, Schindler, Bodmer, & Probst, 2009).

Brooks (1985) tried to find out under use and dis-satisfaction of post-aural hearing in 731 participants at Withington Hospital. A questionnaire was prepared which included mainly 4 subsets namely, a) frequency of use in a day, b) causes of dis-satisfaction, c) experiences of using hearing aids in different situation and d) the belief. For 128 patients the questionnaire was administered directly by an audiologist and rest of 731 sent it through post. Results indicated that the major reasons of under use and dis-satisfaction are inability of inserting ear mould in ear canal and difficulty in coping in noisy environment which can be attributed to inability to use different programmes in the hearing aids. Other significant factors which leads to under use of hearing aids are

advancing age and medical problems and lack of recognition of the hearing impairment. They concluded that the percentage under use was significantly reduced by hearing aid orientation and counselling.

Margolis (2004) recently pointed out that new hearing aid users might have difficulty remembering all the novel information disseminated at the hearing aid orientation. Different researchers have tried to find out the efficacy of hearing aid orientation programme based on different tasks which usually assess their memory to remember the skills taught by the audiologist or other medical professionals. The results of the studies inspecting patients' ability to recall and remember health-related information in other medical and allied health fields suggest that audiologists may expect new hearing aid users to have difficulty recalling a portion of the hearing aid use and care information presented during the hearing aid orientation. This difficulty may be all the time more present in elderly patients whose memory for episodic information, such as recalling novel facts about hearing aid use, is subject to age-related decline (Kessels & de Haan, 2003).

Uriarte, Denzin, Dunstan, Sellars, & Hickson (2005) investigated hearing aid satisfaction for a group of 1284 elderly adults using programmable digital hearing aids in Australia. All the participants had undergone two questionnaire survey i.e. satisfaction with amplification in daily life (SADL) and Client Satisfaction Survey (CSS). 1014 participants replied for the survey and they found a significant satisfaction with their hearing aids but they found that 90% participants sometime and 4% participants most of the time faced problem in question number 4 in CSS which included questions about hearing aid handling skills like positioning the hearing aid or removing the hearing aid from ear canal, discomfort with ear mould and adjusting control on ear mould etc.

resulting in negative correlation with SADL which indicated that poor handling skills lead to a poor satisfaction of hearing aids.

Cienkowski, Mchugh, Cox, & Baird (2006) developed a new clinical assessment tool named as the Dynamic Assessment of Hearing Aids (DAHA) which includes four domains: communication, physical features, sound quality, and personal reactions. They administered this tool on 171 participants through an intuitive graphical computer interface to record visual analogue ratings of satisfaction with various features of their hearing aids (e.g. clarity, cost, appearance & manipulation). The concurrent validity was determined by comparing DAHA results to those obtained with the Satisfaction with Amplification in Daily Life (SADL). They found a good correlation between these two assessment tools, which indicated that a good handling and care of hearing aids leads to better acceptance and satisfaction of the hearing aids. The DAHA total score was found to have good test/retest and high internal consistency. Concurrent validity was supported by a strong correlation between total scores on the DAHA and the SADL. Results suggest the DAHA may be an effective tool for clinical use.

Pothier & Bredenkamp (2006) study compared patients ability to insert their hearing aids with their ability after an observation from the audiologist. 85 participants provided a rating on the level of their confidence to insert the devices using a visual analogue score (VAS) and that was compared with VAS of their observed level of ability assessed by an audiologist. They found a weak to moderate correlation between the visual analogue scores, so they suggested to consider patient's perceived level of ability for acceptance of hearing aids.

Reese and Smith (2006) in a pilot study in 28 elderly adults tried to find out that how much elderly adults can recall hearing aid knowledge using a self-developed questionnaire Hearing Aid Probed Recall Inventory (HAPRI) which contained 25 items. They assessed the skills in new hearing aid users just after counselling and after four weeks. They found no significant change in the performance but overall execution declined from 80% to 77% which indicate some amount of information were forgotten by some participants. They recommend that there is necessity for more emphasis on certain important skills and care information during hearing aid orientation.

Reese and Smith (2006) examined how well hearing aid users used their hearing aids based on hearing aid orientation. They assessed skills of 100 elderly adults who underwent an intense training session based on (a) landmarks on hearing aid; (b) repair procedures, proper cleaning and storage; (c) battery use; (d) general use; and (e) expectations and limitations of hearing aid use. A multiple-choice test of hearing aid knowledge immediately after the hearing aid orientation and 1 month later was carried out and they found out that participants recognized 74% of the information immediately following hearing aid orientation (HAO) and 78% at 1 month which suggest that hearing aid manipulation skills improve with experience based on the efficacy of the hearing aid orientation programme.

West and Smith (2007) investigated the factor which leads to low hearing aid self-efficacy i.e. low confidence in one's ability to be a successful hearing-aid user. They developed a self-efficacy questionnaire i.e. Measure of Audiological Rehabilitation Self-Efficacy for Hearing Aids (MARS-HA) and assessed on 83 new hearing aid users and 128 experienced hearing aid users once just after hearing aid orientation, two weeks after that to find out test-retest reliability and after one month to find out the effect of experience. They found a good internal consistency and test-retest reliability in both

groups in basic and advanced handling skills, adjustment of hearing aids and listening skills. After one month when two assessments were compared the total mean score improved from 65.1 ±16.5 to 91.8 ± 6.4 which is a dramatic improvement in self-efficacy.

Cox, Alexander, & Xu (2009) developed a device-oriented questionnaire to measure hearing aid outcomes. This questionnaire which contained 40 questionnaire items was administered on 306 hearing aid users. The items of the Devise Oriented Subjective Outcome (DOSO) were made in such a way that they point towards the hearing aid rather than towards the users with the purpose of minimizing the participation of personality in item responses. They found DOSO as more valid and robust self-report.

Desjardins and Doherty (2009) assessed hearing aid handling skills in 50 experienced hearing aid users with a tool developed by them known as Practical Hearing Aid Skills Test (PHAST) to objectively test a hearing aid user's ability to manipulate their hearing aids. They included 8 tasks which was taught to new hearing aid users during orientation session during their first visit after hearing aid fitting. Following that, they administered Satisfaction with Amplification in Daily Life (Cox & Alexander, 1999) and Abbreviated Profile of Hearing Aid Benefit questionnaire (Cox & Alexander, 1995) to find about satisfaction and benefit respectively. Results of the study showed that experienced hearing aid users have range of responses from poor to excellent which highly correlated with their satisfaction and benefit, which in turn show the impact of handling skills on hearing aid outcomes.

Doherty and Desjardins (2012) revised Practical Hearing Aid Skills test (PHAST) by Desjardins & Doherty, 2009 from 5 to 3-point rating scale and included 2 more tasks i.e. cleaning of battery and hearing aid and they re-analysed the data of original

PHAST with PHAST-Revised and they found no significant difference in experienced and non- experienced hearing aid users.

Kemker, Goshorn, & Kaplan (2012) investigated relationship between self-report rating of hearing instrument use or satisfaction with time based measures of hearing instrument operation in 20 male new hearing aid users with no previous experience of hearing aid use. The hearing instrument operation checklist (HIOC; Kemker1999) was administered, which includes tasks like, take out battery from hearing aid and replace it with new batteries, remove hearing aid from ears, turn on and off the instruments and manipulation of the volume. These tasks were administered at initial fitting and 1-year post fitting and it was correlated with hours of use and user satisfaction at 6-weeks and 1-year post fitting using a satisfaction survey. The results suggest that the users were capable of operating their devices if they used it regularly and manipulate it efficiently.

Campos, Bozza, & Ferrari (2014) tried to evaluate hearing aid handling skills in 37 non- experienced and 37 experienced hearing aid users with an age of 18 years and above and they measured how these skills impact wearer's satisfaction and benefit. All the participants completed the tasks of "Practical Hearing Aid Skills Test" (PHAST), which were recorded on a five-point rating scale in which higher scores show better hearing aid handling skills. Experienced users responded to the International Outcome Inventory for Hearing Aids (IOI-HA) and the hearing aid benefit for handicap reduction was considered by the hearing handicap inventory (HHIA/HHIE). They found no significant difference for PHAST in between groups and lower score for tasks of volume control manipulation and telephone usage. They found a moderate correlation between IOI-HA benefit and quality of life items and the PHAST scores. They concluded that hearing aid handling skills affect satisfaction and benefit of the hearing aids.

Table:2.1 ***Descriptive overview of instruments evaluating hearing aid handling skills***

Survey (instrument abbreviation)	Studies	Statement of purpose as defined by original authors	No of items. (Pertaining to hearing aid handling)	Administrator	Response categories	Item examples
Under use and dis-satisfaction	Brooks, 1985	To find factors important in inhibiting effective use of hearing aids.	4 sets (1 subset)	Self-report	Open responses	Have you had any functional problem with your hearing aids.
Patients recall and limits of the memory	Margolis, 2004	Audiologists may expect new hearing aid users to have difficulty recalling a portion of the hearing aid use and care information presented during the hearing aid orientation	Not applicable as survey item can change depends on the health issues	Self-report	Open responses	Recalling of new features of your hearing aid.
Satisfaction with amplification in daily life (SADL)	Uriarte et al, 2005	Self- report inventory to quantify satisfaction with hearing aids	15(1)	Self-report	Likert scale: 7 points	Bothered about getting enough loudness without feedback
Dynamic assessment of hearing aids (DAHA)	Cienkowski et al, 2006	Hearing aids dissatisfaction with various features of record visual analogue ratings of satisfaction and uses an intuitive graphic computer interface to	17(2)	Self-report	Likert scale: 7 points	Satisfaction or dis-satisfaction with hearing aids, physical comfort

Survey (instrument abbreviation)	Studies	Statement of purpose as defined by original authors	No of items. (Pertaining to hearing aid handling)	Administrator	Response categories	Item examples
Insert and removal	Pothier & Bredenkamp, 2006	A rating of their level of confidence in fitting them hearing aid	1 (1)	Self-report	Likert scale: 100 point	Insert hearing aid into ear
Hearing aid probed recall inventory (HAPRI)	Reese & Smith, 2006	recall hearing aid knowledge	25 (23)	Self- report	Likert scale: 35 point	Microphone position and cleaning, changing the batteries
Measure of audiologic rehabilitation self-efficacy for hearing aids (MARS-HA)	West & Smith, 2007	Assesses hearing aid self-efficacy confidence in one's ability to be a successful hearing aid user	24 (12)	Self- report	Likert scale: 10 point	Remove battery from a hearing aid with ease
Device oriented subjective outcome (DOSO)	Cox et al, 2009	A device oriented questionnaire measuring self-reported hearing aid outcomes; relatively independent of personality	40 (4)	Self- report	Likert scale: 7 point	Making easy to change batteries
Practical hearing aid skill test (PHAST) & Revised Practical hearing aid skill test (PHAST-R)	Desjardins & Doherty, 2009; Doherty & Desjardins, 2012	Objectively tests a hearing aid user's ability to manipulate his or her hearing aids	8 (8)	Precision	Like rate: 5 point and 3 point in original and revised respectively	Remove your hearing aids

Survey (instrument abbreviation)	**Studies**	**Statement of purpose as defined by original authors**	**No of items. (Pertaining to hearing aid handling)**	**Administrator**	**Response categories**	**Item examples**
Hearing instrument operation checklist (HIOC)	Kemker et al, 2012	A timed test of six basic but essential manoeuvres with a hearing instrument	6 (6)	Clinical administration	Time recorded: unlimited	Remove your instrument from your ears.
Relationship between handling skill, satisfaction and benefits	Campos et al, 2014	Better handling leads to greater satisfaction and benefits	PHAST- 8 (8) IOI-HA- 8	Precision and self-report	Like rate: 5 points	Remove your hearing aid, Coping in noisy situation

Table 2.2 ***Aspect of hearing aid handling skills evaluated by instruments***

	HIOC	SADL	DAHA	Insertion question	HAPRI	MARS-HA	DOSO	PHAST
On	✓	-	-	-	-	-	✓	-
Off		-	-	-	-	-	✓	-
Insert	✓	-	-	✓	✓	✓	-	✓
Identify left from right	-	-	-	-	-	✓	-	-
Manage discomfort	-	-	✓	-	✓	-	-	-
Manage feedback	-	✓	-	-	✓	✓	✓	-
Remove	✓	-	-	✓	-	✓	-	✓
Frequency of battery change	-	-	-	-	-	-	✓	-
Change battery	✓	-	-	-	✓	✓	✓	✓
Identify components	-	-	-	-	✓	✓	-	-
Clean	-	-	-	-	✓	✓	-	✓
Change programme	-	-	-	-	✓	✓	-	✓
Change volume	✓	-	-	-	-	✓	-	✓
Use tele-coil	-	-	-	-	-	-	-	✓
General management	-	-	✓	-	✓	-	-	-

DAHA: Dynamic assessment of hearing aids; DOSO: Device oriented subjective outcome; HAPRI: Hearing aid probed recall inventory; HIOC: Hearing instrument operation checklist; MARS-HA: Measure of audiologic rehabilitation self-efficacy for hearing aids; PHAST: Practical hearing aid skill test; SADL: Satisfaction with amplification in daily life;

Most of the surveys and questionnaire included in this review were not designed exactly for evaluating hearing aid handling; rather, they contained within an aspect of handling in assessing a hearing aid outcome, such as global benefit or satisfaction (Uriarte, Denzin, Dunstan, Sellars, & Hickson, 2005; Yueh, McDowell, Collins, Souza, Loovis & Deyo, 2005; Cienkowski, McHugh, McHugo, Musiek, Cox & Baird, 2006). The aspects of handling selected for including in these surveys were diverse and, in most cases, no justification for inclusions was reported. For example, ability to clean the hearing aid was only included in three of the surveys, despite the negative effect that debris and cerumen build up can have influence on hearing aid performance (Reese & Smith, 2006; Desjardins & Doherty, 2009; West & Smith, 2007). Variations might be expected because very little is known about which features of handling mostly influence the outcome and benefit and there is only one instrument which is used for clinical administration (Kemker et al, 2012).

The unit of measurement taken to assess handling varied throughout surveys; some measured precision, while some measured speed, self-efficacy, problems experienced, or satisfaction. Thus, in most cases, scores are not similar and comparable across surveys. It cannot be presumed that a client who scores greatly on precision and speed will essentially score highly on satisfaction. Audiologist should be aware of such differences when selecting a survey, so that they can be assured of the satisfaction and benefit of the hearing aid user. This should be done based on the need and environment of the hearing aid users.

At present, not a single survey is available that estimates all characteristics of hearing aid handling skills as known by the works done by other researchers. There is a need for the development of a tool that assesses all features/aspects/skills of hearing aid handling that would allow clinicians to rapidly and efficiently assess whether clients have understood all skills essential for successful hearing aid use, satisfaction and care.

Chapter 3

METHOD

The present study attempted to investigate the hearing aid handling skills/abilities of persons with hearing impairment. The main objectives were:

1. To check how efficiently hearing aid users are using their hearing aids.
2. Investigate the efficacy of the counseling just after the post fitting hearing aid orientation.
3. To find out which hearing aid manipulation or task is more problematic as faced by hearing aid users.

   These were assessed across different duration of experience of hearing aid usage.

3.1 Participants:

3.1.1 Inclusion criteria:

- 200 participants divided in equal numbers in 4 groups in the age range of 18 to 70 years (mean age of 57.67 years) diagnosed as having acquired hearing loss at the Department of Audiology, All India Institute of Speech and Hearing, Mysore were taken in the study.
- The pure-tone unaided thresholds ranged from mild to profound hearing loss.
- All types of hearing loss i.e. conductive, mixed and sensorineural hearing loss participants were included in the study.
- The aided pure-tone threshold was within the speech spectrum (in frequencies between 500 Hz to 4000 Hz).
- The speech identification scores were in proportion to pure-tone hearing thresholds. However, the aided speech identification scores were more than 60%.

- Participants were using digital behind the ear hearing aids who were further classified into four groups based on their experience of hearing aid use.

  Group1: New hearing aid users

  Group 2: Those with an experience of 3 months

  Group 3: Those with an experience of 6 months

  Group 4: Those with an experience of ≥1 year

  Groups 1, 2, 3, and 4 will be further represented as G1, G2, G3 and G4 respectively

- All the participants in the study had undergone a post fitting hearing aid orientation program for minimum of 20 minutes.
- Some participants were counselled again about the hearing aid use during their follow up visit after 6 months of hearing aid fitting.
- None of the participants were trained by the investigator of this study about using their hearing aids.
- Auditory brainstem response patterns were expected as with the severity of hearing loss.
- All participants had oto-acoustic emission in correlation with the degree and configuration of hearing loss indicating the OHC functioning.

3.1.2 Exclusion criteria:

- Participants whose caregivers were taking care of their hearing aid manipulations
- Participants with history or presence of any neurological or Psychological problems.
- History or presence of any other associated problems like tremors and restricted limbs movements.

3.2 Procedure:

Procedure was divided into four phases:

1.Developing hearing aid handling skill test

2.Validation

3.Administration

4.Scoring

Phase I: <u>Developing hearing aid handling skill test</u>

The test was developed in English language with 14 tasks with respect to 4 parameters which were:

1. Recognizing different parts of hearing aid(s)
2. Handling regular operation
3. Trouble shooting of hearing aid(s)
4. Others

These were representative of most basic skills an individual with hearing loss need to know to use his or her hearing aids correctly mentioned in different tests like (Practical Hearing Aid Skills Test, Doherty & Desjardins, 2009), hearing aid instruction manuals of several hearing aid manufactures (GN Resound, 2005; Oticon, 2003; Siemens, 2005) and the input from the practicing audiologists were used. These are typically taught to a new hearing aid user after the hearing aid fitting. Task covers the following skills: (1) hearing aid removal, (2) opening the battery door, (3) changing the hearing aid battery, (4) cleaning the aid, (5) hearing aid insertion, (6) manipulating the volume control, (7) telephone use, and (8) use of different programs (9) handling ear mould (10) Switch off/ Switch on (11) Knowledge about battery (12) Simple

troubleshooting (13) When will you not use your hearing aids (14) Knowledge about serial number.

1. **Remove your hearing aid:** This skill consists of two tasks i.e. a) Grasping aid/dexterity and b) removal of hearing aid from ear(s).
2. **Open the battery door:** This skill consists of two tasks which includes locating and opening of battery door/compartment.
3. **Changing your hearing aid battery:** Under this skill there were two tasks which include removal of old battery and insertion of new battery.
4. **Show me how you clean your hearing aid/Parts of hearing aid:** This skill includes three tasks which includes cleaning sound bore of ear mould, microphone and acoustical vent (This explains better maintained, better speech quality and comfort).
5. **Put your hearing aid(s) back into the ear(s):** This skill includes two basic tasks which were grasping skills and placement of hearing aid back into the ear.
6. **Manipulation of volume control:** This skill consists of two tasks i.e. turn up and turn down the volume.
7. **Show me how you use the telephone with your hearing aid(s):** This includes two tasks which includes correct use of t-coil switch or program and placement of phone in relation to hearing aid.
8. **Show me how to use different programs:** This skill includes using of program switch properly and information regarding when to change programs.
9. **Handling the ear mould/ ear tip:** This skill is also subdivided into 2 tasks which were connecting the mould to ear hook of hearing aid and identifying right/left ear mould.
10. **Switch off/ Switch on the hearing aid:** This skill includes tasks of switch on or off the hearing aid.

11. **Knowledge about the hearing aid battery:** This is a knowledge or memory based skill which included four tasks like information about life of battery, size of battery, battery cover removal for insertion into battery compartment and voltage of battery.
12. **Simple troubleshooting:** This skill includes 3 tasks, the client was given blocked ear mould, old batteries and non-functional hearing aid and hearing aid users were asked to identify and troubleshoot the problems.
13. **When will you not use your hearing aid:** It included question based tasks wherein the hearing aid user had to point out the situation where they were not supposed to use their hearing aids like while bathing, sleeping, during active discharge and also as advised by an Audiologist.
14. **Knowledge about serial number:** This skill includes 3 tasks which includes knowledge about presence of serial number, if yes identify and tell the significance of it on hearing aids.

Phase II: <u>Validation of developed test</u>

For development of the test, feedback from 5 audiologists with more than 10 years of experience, who were effectively working in audiological set-up (regarding the appropriateness of the skills) were taken. The consideration for including items was based on 4-point rating scale which was as follows,

3= Most appropriate

2= Appropriate

1= Less appropriate

0= Not appropriate

Additionally, an option for suggestion was given which was considered for the final construction of the test. Most appropriate and appropriate skills marked only by at least 3 audiologists were included in the test. The final test after including the suggestion and feedback is given in Appendix 1.

Phase III: <u>Administration of the test on hearing aid users</u>

This test was administered just after the counselling for new hearing aid users and for experienced users it was administered in one of the return appointments to the Audiology Clinic. Participants were asked to conduct each task and the level of skills was scored according to five-point rating scale starting from 4 to 0. The criteria of scoring were as follows:

Table 3.1 ***Five-point rating scale***

Scores	Remarks	Explanation
4	Excellent	The participant concludes the task without any mistakes
3	More than satisfactory	The participant makes one mistake, however, still completes the task successfully
2	Satisfactory	The participant makes more than one mistake, but concludes the task successfully
1	Less than satisfactory	The participant tries to conduct the task, but cannot conclude it successfully, or requires other means to conclude it
0	Not satisfactory	The participant cannot execute the task

Phase VI: <u>Scoring</u>

The total score obtained for each task was noted and this score was used toc compare the overall performance of the four groups.

The data obtained was subjected to different statistical procedures.

- Descriptive statistics was carried out on the various tasks of hearing aid handling skills test (HAHST) to obtain the Median.
- The groups would be subjected to check if there is a significant difference or not.
- If significant difference across groups would be obtain than pairwise comparison for those pairs would be done.

The results discussed in the following chapter.

Chapter 4

RESULTS AND DISCUSSION

The present study aimed to investigate the hearing aid handling skills of new hearing aid users, by comparing them with a matched group of experienced hearing aid users and also to check for overall variations in the hearing aid handling abilities according to the tasks. A total of 200 participants were included in the four groups. The participants were divided into four groups based on their experience of hearing aid use. The adapted and standardized version of hearing aid handling skills was administered on all four groups. The responses were scored as per the scoring instructions provided in the method section. The scores for each task in hearing aid handling skills test (HAHST), totalled and tabulated for each group were tabulated and the data obtained from all the groups was analysed using the SPSS software version 21. The following statistical procedures were used:

- Descriptive statistics was carried out for the various tasks included under hearing aid handling skills test (HAHST) to obtain the mean, median and standard deviation.
- Non-parametric tests- Kruskal Wallis test was employed to find the difference, if any, between the groups for overall performance as well as for the performance for each task.
- Mann Whitney U test was employed to find the difference, if any, across the different pairs of groups only for those tasks which had overall difference in Kruskal Wallis test.

The results obtained for each group for each task has been presented and discussed in this chapter under different sections:

1. Comparison of all four groups i.e.
    - G1- New hearing aid users (NHAU),
    - G2- 3 months experienced users (3MEU),
    - G3- 6 months experienced users (6MEU) and
    - G4- >1 year experienced users (>1YEU), as a whole included under HAHST.
2. Comparison of all four groups on various tasks i.e. from T1 to T33 under HAHST.

4.1 Comparison of all four groups as a whole included under hearing aid handling skills test (HAHST).

The performance of all the groups as a whole on all the 33 tasks of hearing aid handling skills were analysed. The data was subjected to descriptive statistical methods to obtain Median. Table 4.1 depicts overall median values of raw scores of different groups included into HAHST.

Table 4.1 ***Performance of the four groups across the overall score included under hearing aid handling skills test(HAHST)***

	Groups	**N**	**Median**	χ^2
Total scores	New hearing aid users	50	65.5000	.000*
	3months of experience	50	63.5000	
	6months of experience	50	65.0000	
	>1 year of experience	50	72.0000	

p ≤ 0.05

On comparison of the overall median values on HAHST it was seen that the median value of total score of the new hearing aid users (G1) M= 65.50, 3 months experienced users (G2) M= 63.50, 6 months experienced users(G3) M= 65.00 and >1 year experienced users was M=72, which was significantly different compared to other three groups. This indicates better performance of individuals of G4 (users with an experience of more than 1 year) in comparison to the individuals in other three groups.

To check if this difference was statistically significant, non-Parametric Kruskal-Wallis test was administered. The results of Kruskal Wallis test revealed a statistically significant difference of χ^2 (3) = 47.138, p= 0.000 between the overall values of the four groups. Comparison of the performance of the four groups are graphically represented in figure 4.1.

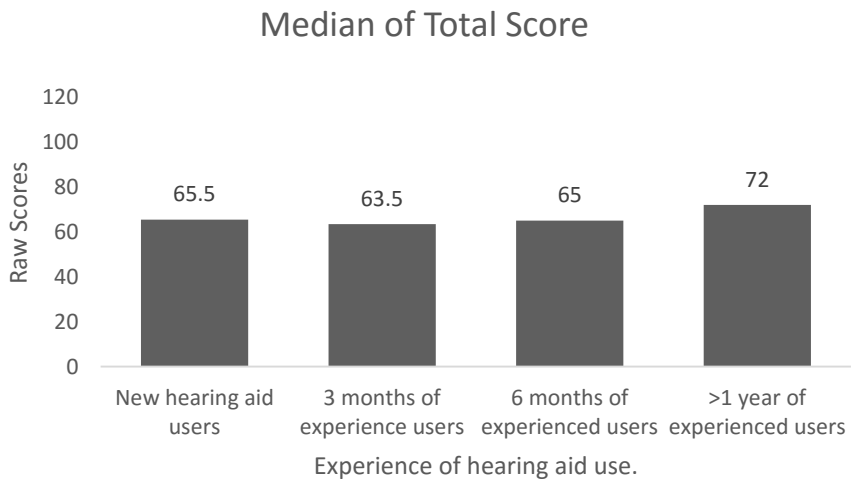


Figure 4.1: Overall Performance of the four groups.

4.2 Pairwise comparison of groups for overall performance

After observing significant difference in Kruskal-Wallis test, pairwise comparison was done using Mann Whitney U test which is depicted in table 4.2. This shows significant

difference in G1 and G4 (/z /= 5.286, p=0.000); G2 and G4 (/z /= 6.139, p=0.000); G3 and G4 (/z/ = 5.122, p =0.000) with respect to their overall performance.

No statistically significant difference was found when other pairs such as G1-G2, G1-G3, G2-G3 were compared. From the table 4.2 it is evident that G4 i.e. hearing aid users with experience of >1 year is significantly different from G1, G2 and G3 and these results are comparable with the median which showed a better performance of G4 when compared with other groups i.e. new hearing aid users, 3 months and 6 months experienced users performed similarly.

Table 4.2 ***Pair wise comparison of groups using Mann Whitney U test***

Pairs	**/Z/**	***p* value**
G1-G2	1.08	0.278
G1-G3	0.10	0.91
G1-G4	5.28	0.00*
G2-G3	0.91	0.36
G2-G4	6.13	0.00*
G3-G4	5.12	0.00*

**p ≤ 0.05 G1-new hearing aid users, G2- 3 months experienced users, G3- 6 months experienced users and G4-> 1 year experienced users*

This improvement in the experienced hearing aid users mainly in G4 can be attributed to the progress in the competency level of the complex task which were difficult for new hearing aid users to perform like cleaning the mould, grasping the hearing aid mould/tip while inserting it into ear canal and turn up and down the volume etc. This can be attributed to practice and more duration of hearing aid use. The finding of this study are in agreement with previous study (Desjardins & Doherty, 2009) who found considerable improvement in the scores of the participants who had at least 1year experience in comparison with new hearing aid users. Similar findings which shows

better performance of experienced users had been found by several authors (Doherty & Desjardins, 2012; Campos, Bozza, and Ferrari, 2014).

The lower scores of handling skills can be because of less duration of hearing aid use compared to participants of group 4 on other side even when the hearing aid users were provided training about hearing aid use, still the skills demonstrated my hearing aid users remained low (Bertoli, Staehelin, Zemp, Schindler, Bodmer & Probst 2009; Desjardins & Doherty, 2009; Doherty & Desjardins, 2012). Desjardins & Doherty, (2009) reported that more than 90% of the new hearing aid users face at least one difficulty in handling skills. The new hearing aid users perform basic tasks like opening the battery compartment or placing or removing the hearing aid from the ear properly but they tend to fail in demonstration of complex tasks (Desjardins & Doherty, 2009).

In this study the poor scores in new and less experienced hearing aid users (up to 6 months) can be attributed to the number of the tasks included into the study which not only targets the handling skills but some information related to their memory like size of battery and life of battery, which is important for a hearing aid user but some time difficult for them to remember.

Among G1, G2 and G3 i.e. new hearing aid users 1 month and 3 month of experienced users there is a slight decrement in the overall score but it is not significant. This shows that new hearing aid users tend to retain the most of the skills which they developed during hearing aid orientation. But it is possible that some amount of participants had forgotten some important information which can lead to small amount of decrement in the scores. Similar findings which shows maintenance of information until the follow up visit has been found previously (Reese & Smith, 2006).

3.3 Comparison of groups under HAHST based on different tasks.

The performance of all the groups as a whole on all the 33 tasks of hearing aid handling skills was analysed. The tasks included T1-Grasping aid/dexterity while removing hearing aid , T2-Removal of aid from ear, T3-Locate the door, T4-Open the door, T5-Remove old battery, T6-Insert new battery, T7-Sound bore of ear mould, T8-Microphone, T9-Vent, T10-Grasping aid/dexterity while inserting the hearing aid, T11-Placement in ear, T12-Turn up volume, T13-Turn down volume, T14-Correct use of T-program/Switch, T15-Placement of phone in relation to hearing aid, T16-How to use different programs T17-Insertion to the ear hook, T18-identify right/left ear mould, T19-Switch on/off the hearing aid, T20-Life of battery, T21-Size of battery, T22-Battery cover removal for insertion of new battery,T23-Voltage of battery, T24-Detecting blocked ear mould, T25- Detecting old battery, T26-detecting hearing aid is not working, T27- Don't use while bathing, T28-While sleeping, T29-During active discharge, T30-As advised by Audiologists, T31-Do they know there is serial no. on hearing aids, T32-Where serial no. is located on their hearing aids, T33-Do they know significance of the serial no. on hearing aids. The data was subjected to descriptive statistical methods to obtain Median. Table 4.3 depicts median values of different tasks of HAHST.

Table 4.3 ***Performance of groups based on different tasks of HAHST***

Tasks#	Group	N	Median	χ^2
T1	NHAU	50	4.00	.839
	3MEU	50	4.00	
	6MEU	50	4.00	
	>1YEU	50	4.00	
T2	NHAU	50	3.00	.160
	3MEU	50	3.00	
	6MEU	50	3.00	
	>1YEU	50	3.00	
T3	NHAU	50	4.00	.742
	3MEU	50	4.00	
	6MEU	50	4.00	
	>1YEU	50	4.00	
T4	NHAU	50	4.00	.859
	3MEU	50	4.00	
	6MEU	50	4.00	
	>1YEU	50	4.00	
T5	NHAU	50	3.00	.809
	3MEU	50	3.00	
	6MEU	50	3.00	
	>1YEU	50	3.00	
T6	NHAU	50	4.00	1.000
	3MEU	50	4.00	
	6MEU	50	4.00	
	>1YEU	50	4.00	

T1-Grasping aid/dexterity while removing hearing aid , T2-Removal of aid from ear, T3-Locate the door, T4-Open the door, T5-Remove old battery, T6-Insert new battery

Tasks#	Group	N	Median	χ^2
	NHAU	50	1.00	.037*
T7	3MEU	50	1.00	
	6MEU	50	1.00	
	>1YEU	50	2.00	
	NHAU	50	0.00	.072
T8	3MEU	50	0.00	
	6MEU	50	0.00	
	>1YEU	50	0.00	
	NHAU	50		
T9	3MEU	50		
	6MEU	50		
	>1YEU	50		
	NHAU	50	2.00	0.00*
T10	3MEU	50	2.00	
	6MEU	50	2.00	
	>1YEU	50	2.00	
	NHAU	50	2.00	0.00*
T11	3MEU	50	2.00	
	6MEU	50	2.00	
	>1YEU	50	2.00	
	NHAU	50	3.00	.001*
T12	3MEU	50	3.00	
	6MEU	50	3.00	
	>1YEU	50	3.00	
	NHAU	50	3.00	.039*
T13	3MEU	50	3.00	
	6MEU	50	3.00	
	>1YEU	50	3.00	
	NHAU	50	1.00	.598
T14	3MEU	50	1.00	
	6MEU	50	1.00	
	>1YEU	50	1.00	
	NHAU	50	.0000	.182
T15	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	

 # T7-Sound bore of ear mould, T8-Microphone, T9-Vent, T10-Grasping aid/dexterity while inserting the hearing aid, T11-Placement in ear, T12-Turn up volume, T13-Turn down volume, T14-Correct use of T-program/Switch, T15-Placement of phone in relation to hearing aid

**$p \leq 0.05$*

Tasks#	Group	N	Median	χ^2
T16	NHAU	50	3.0000	.572
	3MEU	50	3.0000	
	6MEU	50	3.0000	
	>1YEU	50	3.0000	
T17	NHAU	50	2.0000	.006
	3MEU	50	2.0000	
	6MEU	50	2.0000	
	>1YEU	50	2.0000	
T18	NHAU	50	.0000	.030*
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	1.0000	
T19	NHAU	50	4.0000	.620
	3MEU	50	4.0000	
	6MEU	50	4.0000	
	>1YEU	50	4.0000	
T20	NHAU	50	1.0000	.917
	3MEU	50	.5000	
	6MEU	50	.5000	
	>1YEU	50	1.0000	
T21	NHAU	50	1.0000	.670
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	
T22	NHAU	50	3.5000	.997
	3MEU	50	3.0000	
	6MEU	50	3.0000	
	>1YEU	50	3.0000	
T23	NHAU	50	.0000	.015*
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	
T24	NHAU	50	2.0000	.017*
	3MEU	50	2.0000	
	6MEU	50	2.0000	
	>1YEU	50	2.0000	

*# T16-How to use different programs T17-Insertion to the ear hook, T18-identify right/left ear mould, T19-Switch on and off the hearing aid, T20-Life of battery, T21-Size of battery, T22-Battery cover removal for insertion of new battery, T23-Voltage of battery, T24- Detecting blocked ear mould. *p ≤ 0.05*

Tasks#	Group	N	Median	χ^2
T25	NHAU	50	3.0000	.015
	3MEU	50	3.0000	
	6MEU	50	3.0000	
	>1YEU	50	3.0000	
T26	NHAU	50	2.0000	.017
	3MEU	50	2.0000	
	6MEU	50	2.0000	
	>1YEU	50	2.0000	
T27	NHAU	50	4.0000	.169
	3MEU	50	4.0000	
	6MEU	50	4.0000	
	>1YEU	50	4.0000	
T28	NHAU	50	3.5000	.102
	3MEU	50	4.0000	
	6MEU	50	4.0000	
	>1YEU	50	4.0000	
T29	NHAU	50	.0000	.918
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	
T30	NHAU	50	.0000	.999
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	
T31	NHAU	50	.0000	.995
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	
T32	NHAU	50	.0000	.948
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	
T33	NHAU	50	.0000	.963
	3MEU	50	.0000	
	6MEU	50	.0000	
	>1YEU	50	.0000	

 # T25- Detecting old battery, T26-detecting hearing aid is not working, T27- Don't use while bathing, T28-While sleeping, T29-During active discharge, T30-As advised by Audiologists, T31-Do they know there is serial no. on hearing aids, T32-Where serial no. is located on their hearing aids, T33-Do they know significance of serial no. on hearing aids

On comparison of the median values of different tasks of HAHST as mentioned in table 4.3, it was found that for tasks T1, T3, T4, T6, T19, T27 and T28 the median value is higher (M= 4) as compared to other tasks i.e. T2, T5, T12, T13, T16, T22 and T25 (M= 3), T7, T10, T11, T17, T24 and T26 (M=2), T14 and T20 (M=1) and T8, T15, T21, T23, T29, T30, T31. T32 and T33 (M=0). This indicated a difference of the performance in T1, T3, T4, T6, T19, T22, T27 and T28 task in comparison to the other tasks whereas task T9 was not carried out by any group of participants because no acoustical modification (Vent) has been provided to them.

Table 4.4: ***Task wise performance of the hearing aid users of all the groups***

Tasks	**Performance**
T1, T3, T4, T6, T19, T27,T28	Excellent
T2, T5, T12, T13, T16, T22, T25	More than satisfactory
T7, T10, T11, T17, T24, T26	Satisfactory
T14, T20	Less than satisfactory
T8, T15, T21, T23, T29, T30, T31. T32,T33	Poor

T1-Grasping aid/dexterity while removing hearing aid , T2-Removal of aid from ear, T3-Locate the door, T4-Open the door, T5-Remove old battery, T6-Insert new battery, T7-Sound bore of ear mould, T8-Microphone, T9-Vent, T10-Grasping aid/dexterity while inserting the hearing aid, T11-Placement in ear, T12-Turn up volume, T13-Turn down volume, T14-Correct use of T-program/Switch, T15-Placement of phone in relation to hearing aid, T16-How to use different programs T17-Insertion to the ear hook, T18-identify right/left ear mould, T19-Switch on/off the hearing aid, T20-Life of battery, T21-Size of battery, T22-Battery cover removal for insertion of new battery,T23-Voltage of battery, T24- Detecting blocked ear mould, T25- Detecting old battery, T26-detecting hearing aid is not working, T27- Don't use while bathing, T28-While sleeping, T29-During active discharge, T30-As advised by Audiologists, T31-Do they know there is serial no. on hearing aids, T32-Where serial no. is located on their hearing aids, T33-Do they know significance of the serial no. on hearing aids

From the table 4.4 it is attributed that participants in all the groups have performed excellent and above satisfaction for most of the basic tasks like locating and opening battery door, switch on/off the hearing aid, inserting/removing a new battery, turn up and down the volume, change the program of the hearing aid and some information about care of hearing aid like not to use hearing aid while sleeping and bathing. All above mentioned tasks are very important for a hearing aid user to perform independently in daily life situations. The finding of the present study is in agreement with other authors who shows excellent performance in removal/insertion of hearing aid, battery door opening, insertion of a new battery and manipulation of volume switch tasks (Desjardins & Doherty, 2009; Doherty & Desjardins, 2012; Campos, Bozza, and Ferrari, 2014).

All the participants performed less than satisfactory and poor performance of some tasks like using the t-coil switch/programme, placing of telephone with respect to hearing aid, cleaning the part of mould and hearing aid, size of battery and connecting the mould to the hearing aid. These all finding are in agreement of previous studies, which says that the hearing aid users tends to fail to perform all these tasks and forgets the maintenance related information (Desjardins & Doherty, 2009; Campos, Bozza, and Ferrari, 2014) The reasons behind these findings can be less frequency of manipulation of these tasks regularly.

This study found very poor scores for information related to care and maintenance like cleaning of microphone, serial number related information, voltage of battery and other advises by audiologist like not to use hearing aid during active discharge. The reason behind poor performance can be because most of these tasks are memory related and hearing aid users are tending to forget with span of use or they were not oriented for some tasks or information.

To check which all tasks are statistically significant among four groups of participants, a non-Parametric Kruskal-Wallis test was administered and the results are depicted in table 4.3. The results of Kruskal Wallis test revealed a statistically significant difference in task T7 of χ^2 (3) = 8.50, p= 0.037; T10 of χ^2 (3) = 29.676, p= 0.000; T11 of χ^2 (3) = 28.69, p= 0.000; T12 of χ^2 (3) = 15.46, p= 0.001; T13 of χ^2 (3) = 8.36, p= 0.039; T17 of χ^2 (3) = 12.43, p= 0.006; T18 of χ^2 (3) = 8.91, p= 0.030; T23 of χ^2 (3) = 10.48, p= 0.015 and T24 of χ^2 (3) = 10.24, p= 0.017 between the four groups.

4.4 Pairwise comparison of groups across tasks.

After observing significant difference in Kruskal-Wallis test, pairwise comparison was done using Mann Whitney U test only for those tasks which were significant. Results are depicted in Appendix 2.

The results showed that there was a significant difference between the participants of G1and G2 for the task T10 (/z /= -4.011, p=0.000) and task T11 (/z/= -2.065, p=0.039). When participants of G1and G3 were compared there was no significant difference on any of the tasks.

However, when G1and G4 were compared, there was significant difference between the participants for task T7 (/z /= -2.447, p=0.014); T11 (/z /= -2.527, p=0.012); T12 (/z /= -3.163, p=0.002); T13 (/z /= -2.359, p=0.018); T17 (/z /= -2.694, p=0.007); T23 (/z /= -1.986, p=0.047) and T24 (/z /= -2.574, p=0.010). When G2 and G3 were compared there was a significant difference in task T10 (/z/ = -2.432, p = 0.015) and T11 (/z/ = -2.031, p = 0.042).

When G2 and G4 were compared, there was significant difference between the participants with respect to significant tasks T7 (/z /= -2.447, p=0.014); T10 (/z /= -

5.271, p=0.000); T11 (/z /= -4.944, p=0.000); T12 (/z /= -3.163, p=0.002); T13 (/z /= -2.359, p=0.018); T17 (/z /= -2.826, p=0.005); T18 (/z /= -2.659, p=0.008); T23 (/z /= -2.553, p=0.011) and T24 (/z /= -2.719, p=0.007).

When G3 and group G4 were compared there was a significant difference between the participants with respect to only those tasks which were significant T7 (/z /= -2.096, p=0.036); T10 (/z /= -3.082, p=0.002); T11 (/z /= -3.693, p=0.000); T12 (/z /= -3.163, p=0.002); T13 (/z /= -2.359, p=0.018); T17 (/z /= -2.826, p=0.005); T18 (/z /= -2.346, p=0.019); T23 (/z /= -2.553, p=0.011) and T24 (/z /= -2.251, p=0.024).

Thus, we can conclude that the overall performance of G4 was significantly better with respect to group G1, G2 and G3 but there was no significant difference in overall performance between G1, G2 and G3 groups. But when the median of these significant tasks across the groups, it was found to have no comparable differences across the groups, so the mean rank was considered to compare all the groups as depicted in Appendix 3.

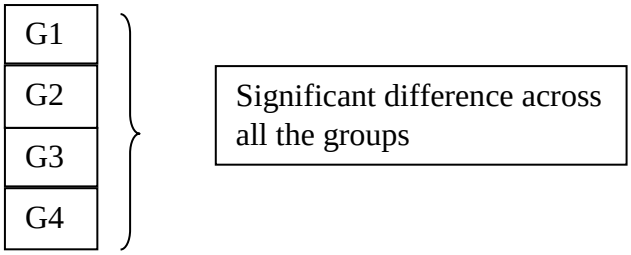
From the above results it is found that there was significant difference in the tasks like Sound bore cleaning, grasping skills while inserting the hearing aid, volume control manipulation, connecting tip/mould to the ear hook, identify left/right ear mould, voltage of matter and troubleshooting the hearing aid like detecting blocked ear mould. But if we observe appendix 2 there is significant difference for all above tasks only with respect to G4(>1 year experienced users) with respect to all 3 groups except T10 and T11 which shows an improvement in the performance of 3 months and 6 months of hearing aid users with respect to New hearing aid user.

As already mentioned initially this improvement in the experienced hearing aid users mainly in group 4 can be attributed to the progress in the competency level of the task which were difficult for new hearing aid users to perform like cleaning the mould,

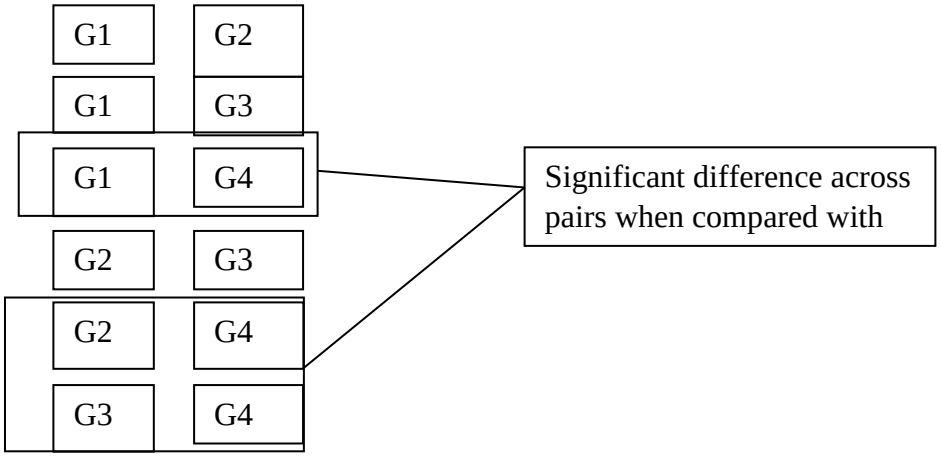
grasping the hearing aid mould/tip while inserting it into ear canal and turn up and down the volume etc. This can be attributed to practice and more duration of hearing aid use. The finding of this study are in agreement with Desjardins and Doherty (2009) who found considerable improvement in the scores of the participants who had at least 1year experience in comparison with new hearing aid users. For task T10 and T11 i.e. grasping/dexterity of mould/tip while insertion and proper placement of hearing aid, it was found to be a continuous improvement in the performance which can be attributed to the practice and duration of the use of the hearing aid.

Summary of results obtained across the groups

Comparison of groups:



Pair wise comparison:



Chapter 5

SUMMARY and CONCLUSION

The World Health Organization (2005) estimates indicated that 278 million people are affected by disabling hearing loss, two-thirds of whom live in developing countries. The prevalence of hearing loss in Southeast Asia ranges from 4.6% to 8.8%. In India, 63 million people (6.3%) suffer from significant hearing loss. Hearing loss can occur at any age due to various causes such as middle ear pathology, medicines, genetic etc.

There are different types of management based on degree and types of hearing loss. This includes mostly medical management like medication and surgery and amplification devices. However, hearing aids are most common intervention for people diagnosed with hearing loss specially in case of sensorineural hearing loss which is most common type of hearing loss in adults (Gatehouse, 2002).

A new hearing aid user is likely to understand a reasonable amount of new information about their hearing aid in a relatively very less time. While this may be a difficult task for a new hearing aid user, it could be especially problematic for elderly hearing aid users who may have age-related deficiencies in working memory. Elderly hearing aid users may be unable to process and store all of the new hearing aid information, or they may forget critical hearing aid information (Salthouse, 1990). In either case, these individuals could become dissatisfied with their hearing aids. Verification of hearing aid orientation is recommended as part of the best practice for fitting hearing aids (Valente, Abrams, Benson, Chisolm, Citron, Hampton, &

Sweetow, 2006). Hearing aid orientation refers to effectively instructing and orienting clients about the use and care of their hearing aids.

Individuals with greater difficulties managing and manipulating their hearing aids were not as satisfied, perceived less benefit, and reported lower use of their hearing aids compared with individuals who had less difficulty manipulating their hearing aids (Humes, Ahlstrom, Bratt, and Peek, 2009).

The present study aimed to investigate the efficacy of hearing aid use in experienced hearing aid users as compared with new hearing aid users. 200 participants with behind the ear hearing aid were divided into four groups based on their experience of hearing aid use. Each group included 50 participants having no experience, 3 months, 6 months and > 1 year of experience respectively. A new hearing aid handling skill test (HAHST) was developed, validated and administered on all the participants to find out their proficiency to carry out 33 tasks included under HAHST.

Descriptive statistics was carried out on the various tasks of hearing aid handling skills test (HAHST) to obtain the mean and standard deviation. Kruskal Wallis test was employed to find out the significant difference between the groups. Mann Whitney U test was employed to find out the significant difference across the different groups (pairwise) only in those tasks which had over all significant difference.

The results of present study revealed that:

Overall performance of the participants having experience of more than one year was significantly better than other three groups i.e. new hearing aid users, 3 month experienced users and 6 months experienced users. This improvement in the experienced hearing aid users mainly in group 4 can be attributed to the progress in the competency level of the complex task which were difficult for new hearing aid users.

This can be attributed to practice and more duration of hearing aid use. The finding of this study are in agreement with previous study (Desjardins and Doherty, 2009).

The lower scores of handling skills in new and less experienced hearing aid users (up to 6 months) can be because of less duration of hearing aid use compared to participants of group 4 on other hand even when the hearing aid users were provided training about hearing aid use, still the skills demonstrated by hearing aid users remained low (Bertoli et al, 2009; Desjardins & Doherty, 2009; Doherty & Desjardins, 2012).

Participants in all the groups have performed excellent and above satisfaction for most of the basic tasks like locating and opening battery door, switch on/off the hearing aid, inserting/removing a new battery, turn up and down the volume, change the program of the hearing aid and some information about care of hearing aid like not to use hearing aid while sleeping and bathing. All above mentioned tasks are very important for a hearing aid user to perform independently in daily life situations. The finding of the present study is in agreement with other authors who show excellent performance in removal/insertion of hearing aid, battery door opening and insertion of a new battery and manipulation of volume switch tasks (Desjardins & Doherty, 2009; Doherty & Desjardins, 2012; Campos, Bozza, and Ferrari, 2014).

Other finding of this study reveals that all the participants performed less than satisfactory and poor performance of some tasks like using the t-coil switch/programme, placing of telephone with respect to hearing aid, cleaning the part of mould and hearing aid, size of battery and connecting the mould to the hearing aid. All these findings are in agreement with the previous studies, which says that the hearing aid users fail to perform all these tasks and forget the maintenance related

information (Desjardins & Doherty, 2009; Campos, Bozza, and Ferrari, 2014). The possible reason for this poor performance could be related to less frequent manipulation of these tasks by many hearing aid users on a regular basis.

From the results of the present study, it can be inferred that,

- The ability to handle the hearing aid improves with the duration of hearing aid use but overall performance remains low.
- There is a need to give extra concentration on those tasks which requires more personal practice and skill to achieve efficiency like inserting mould/tip into ear canal themselves.
- Information taught to clients initially remains same for a period of time and there is a tendency that hearing aid users forget some important information.
- Hearing aid users requires a longer periods of time and practice to understand the use of their hearing aid so that they learn to manipulate their hearing aids adequately and frequent follow up sessions should be provided to new hearing aid users.

Implication:

- Hearing aid skill test would give us an insight into the efficacy of counseling provided in the audiology clinic.
- It will also give us an idea about the skills, those must be considered important during counseling.
- This study will help us to find out the skills which are difficult to perform and to tackle those difficult tasks while handling the device.
- The study will help us in designing a standard counseling format.
- The study will help us to come up with a video on counseling.

References

American Speech-Language-Hearing Association. 1998. Guidelines for hearing aid fitting for adults

Audiology Australia. 2013. Audiology Australia Professional Practice Standards - Part B Clinical Standards, p. clinical guidelines

Baumfield, A., & Dillon, H. (2001). Factors affecting the use and perceived benefit of ITE and BTE hearing aids. *British journal of audiology*, *35*(4), 247.

Bennett, R. J., Taljaard, D. S., Brennan-Jones, C. G., Tegg-Quinn, S., & Eikelboom, R. H. (2015). Evaluating hearing aid handling skills: A systematic and descriptive review. *International journal of audiology*, (ahead-of-print), 1-12.

Bertoli, S., Staehelin, K., Zemp, E., Schindler, C., Bodmer, D., & Probst, R. (2009). Survey on hearing aid use and satisfaction in Switzerland and their determinants. *International journal of audiology*, *48*(4), 183-195.

Boothroyd, A. (2007). Adult aural rehabilitation: What is it and does it work? Trends in Amplification, 11(2), 63-71.

Brooks, D. N. (1979). Counselling and its effect on hearing aid use. *Scandinavian audiology*, 8(2), 101-107.

Brooks, D. N. (1985). Factors relating to the under-use of postaural hearing aids. *British Journal of Audiology*, *19*(March), 211–217.

Campos, P. D., Bozza, A., & Ferrari, D. V. (2014, February). Hearing aid handling skills: relationship with satisfaction and benefit. In *CoDAS* (Vol. 26, No. 1, pp. 10-16). Sociedade Brasileira de Fonoaudiologia.

Cienkowski, K. M., McHugh, M. S., McHugo, G. J., Musiek, F. E., Cox, R. M., & Baird, J. C. (2006). A computer method for assessing satisfaction with hearing aids: Un método computacional para evaluar la satisfacción en el uso de auxiliares auditivos. *International journal of audiology*, *45*(7), 393-399.

Cox, R. M., Alexander, G. C., & Xu, J. (2009). Development of the Device-Oriented Subjective Outcome (DOSO) Scale. *Journal of the American Academy of Audiology*, *25*(8), 727.

Desjardins, J. L., & Doherty, K. A. (2009). Do experienced hearing aid users know how to use their hearing aids correctly? *American journal of audiology*, 18(1), 69-76.

Dillon, H., Ching, T., Katsch, R., & Keidser, G. (2001). NAL-NL1 procedure for fitting nonlinear hearing aids: Characteristics and comparisons with other procedures. *American academy of audiology*, 12(1), 37-51.

Doherty, K. A., & Desjardins, J. L. (2012). The Practical Hearing Aids Skills Test—Revised. *American journal of audiology*, 21(1), 100-105.

Gatehouse, S. (2002). Electronic aids to hearing. British medical bulletin, 63(1), 147-156.

GN ReSound. (2005). User guide: ReSound Metrix mini BTE. Bloomington, MN: Author

Johnson, E. E. (2013). Prescriptive Amplification Recommendations for Hearing Losses with a Conductive Component and Their Impact on the Required Maximum Power Output: An Update with Accompanying Clinical Explanation. *Journal of the American Academy of Audiology*, 24(6), 452-460.

Johnson, E. E., & Dillon, H. (2011). A comparison of gain for adults from generic hearing aid prescriptive methods: Impacts on predicted loudness, frequency bandwidth, and speech intelligibility. *Journal of the American Academy of Audiology*, 22(7), 441-459.

Humes, L. E., Kinney, D. L., Thompson, E., & Hickson, L. (2009). Comparison of benefits provided by various hearing aid technologies in older adults. Hearing care for adults 2009: *The challenge of aging*, 131-138.

Humes, L. E., Wilson, D. L., Barlow, N. N., & Garner, C. (2002). Changes in hearing-aid benefit following 1 or 2 years of hearing-aid use by older adults. *Journal of Speech, Language, and Hearing Research*, 45(4), 772-782.

Kemker, B. E., Goshorn, E. L., & Kaplan, H. (2012). Analysis of hearing instrument use, satisfaction, and operation in independent elderly male veterans. *Asia Pacific Journal of Speech, Language and Hearing*, *15*(1), 19-28.

Kessels, R. P., & Haan, E. H. (2003). Implicit learning in memory rehabilitation: A meta-analysis on errorless learning and vanishing cues methods. *Journal of clinical and experimental neuropsychology*, 25(6), 805-814.

Kochkin, S. (2000). MarkeTrak V : " Why my hearing aids are in the drawer ": The consumers ' perspective. *The Hearing Journal*, *53*(2), 34–41.

Kumar, M., Hickey, S., & Shaw, S. (2000). Manual dexterity and successful hearing aid use. *Journal of laryngology and otology*, *114*(8), 593-597.

Lutman, M. E. (Ed.). (2014). Hearing science and hearing disorders. Academic Press.

Margolis, R. H. (2004). Boosting Memory With Informational CounselingHelping Patients Understand the Nature of Disorders and How to Manage Them. *The ASHA Leader*, *9*(14), 10–28.

Meister, H., Lausberg, I., Kiessling, J., von Wedel, H., & Walger, M. (2002). Identifying the needs of elderly, hearing-impaired persons: the importance and utility of hearing aid attributes. *European archives of oto-rhino-laryngology*, 259(10), 531-534.

Mulrow, C. D., Tuley, M. R., & Aguilar, C. (1992). Correlates of successful hearing aid use in older adults. *Ear and Hearing*, 13(2), 108-113.

Öberg, M. (2008). Approaches to audiological rehabilitation with hearing aids: Studies on pre-fitting strategies and assessment of outcomes.

Oticon. (2003). User instructional brochure: Gaia. Copenhagen,Denmark: Author

Popelka, M. M., Cruickshanks, K. J., Wiley, T. L., Tweed, T. S., Klein, B. E., & Klein, R. (1998). Low prevalence of hearing aid use among older adults with hearing loss: the Epidemiology of Hearing Loss Study. *Journal of the American Geriatrics Society*, *46*(9), 1075-1078.

Pothier, D. D., & Bredenkamp, C. (2006). Hearing aid insertion: correlation between patients' confidence and ability. *The Journal of Laryngology & Otology*, *120*(05), 378-380.

Salthouse, T. A. (1990). Working memory as a processing resource in cognitive aging. *Developmental review*, *10*(1), 101-124.

Saunders, G. H., Lewis, M. S., & Forsline, A. (2009). Expectations, prefitting counseling, and hearing aid outcome. *Journal of the American Academy of Audiology*, 20(5), 320-334.

Reese, J. L., & Smith, S. L. (2006). Recall of hearing aid orientation content by first-time hearing aid users. *Seminars in Hearing*, *27*(4), 337–344.

Siemens. (2005). General hearing instrument information.Piscataway, NJ: Author.

Solheim, J., Kværner, K. J., Sandvik, L., & Falkenberg, E. S. (2012). Factors affecting older adults' hearing-aid use. *Scandinavian Journal of Disability Research*, *14*(4), 300-312.

Stephens, S. D. G. (1977). Hearing aid use by adults: a survey of surveys. *Clinical Otolaryngology & Allied Sciences*, 2(4), 385-402.

Upfold, L. J., May, A. E., & Battaglia, J. A. (1990). Hearing aid manipulation skills in an elderly population: a comparison of ITE, BTE, and ITC aids. *British journal of audiology*, *24*(5), 311-318.

Uriarte, M., Denzin, L., Dunstan, A., Sellars, J., & Hickson, L. (2005). Measuring Hearing Aid Outcomes Using the Satisfaction with Amplification in Daily

Life (SADL) Questionnaire: Australian Data. *Journal of American Academy of Audiology*, *16*, 383–402.

Valente, M. (Ed.). (2002). Strategies for selecting and verifying hearing aid fittings. Thieme.

Valente, M., Abrams, H., Benson, D., Chisolm, T., Citron, D., Hampton, D., & Sweetow, R. (2006). Guidelines for the audiologic management of adult hearing impairment. Audiology Today, 18(5), 32-37.

Vuorialho, A., Karinen, P., & Sorri, M. (2006). Counselling of hearing aid users is highly cost-effective. *European Archives of Oto-Rhino-Laryngology and Head & Neck*, 263(11), 988-995.

West, R. L., & Smith, S. L. (2007). Development of a hearing aid self-efficacy questionnaire. *International journal of audiology*, 46(12), 759-771.

World Health Organization. (2013). Deafness and hearing loss. World Health Organization

Yueh, B., McDowell, J. A., Collins, M., Souza, P. E., Loovis, C. F., & Deyo, R. A. (2005). Development and validation of the effectiveness of auditory rehabilitation scale. *Archives of Otolaryngology–Head & Neck Surgery*,*131*(10), 851-856.

Appendix 1

HEARING AID HANDLING SKILLS TEST (HAHST)

S.No.	Skills	Tasks	Excellent(4)	More than Satisfactory (3)	Satisfactory (2)	More than Satisfactory (1)	Not Satisfactory (0)	Remarks
1.	Remove your hearing aid	a) Grasping aid/dexterity						
		b) Removal of aid from ear						
2.	Open the battery door.	a) Locate the door						
		b) Open the door						
3.	Change your hearing aid battery	a) Remove old battery						
		b) Insert new battery						
4.	Show me how you clean your hearing aid/ Parts of hearing aid.	a) Sound bore of ear mould						
		b) Microphone						
		c) Vent						

S.No.	Skills	Tasks	Excellent(4)	More than Satisfactory (3)	Satisfactory (2)	More than Satisfactory (1)	Not satisfactory (0)	Remarks
5.	Put your hearing aid(s) back in your ear(s).	a) Grasping aid/dexterity						
		b) Placement in ear						
6.	Manipulation of volume control	Turn up volume						
		a) Turn down volume						
7.	Show me how you use the telephone with your hearing aid(s)	a) Correct use of program/ t-coil switch						
		b) Placement of phone in relation to hearing aid						

S.No.	Skills	Tasks	Excellent (4)	More than Satisfactory (3)	Satisfactory (2)	More than Satisfactory (1)	Not Satisfactory (0)	Remarks
8.	Show me how to use different programs							
9.	Handling the ear mould/ Ear tip	a) Connecting to the ear hook						
		b) Identifying right/left ear mould						
10.	Switch off/ Switch on the hearing aid							
11.	Knowledge about hearing aid battery	a) Life of battery						
		b) Size of battery						
		c) Battery cover removal for insertion into battery compartment						
		d) Voltage of battery						

S.No.	Skills	Tasks	Excellent (4)	More than Satisfactory (3)	Satisfactory (2)	More than Satisfactory (1)	Not Satisfactory (0)	Remarks
12.	Simple trouble shooting	a) Detecting Blocked ear mould						
		b) Detecting Old battery						
		c) Detecting Hearing aid is not working						
13.	When will you not use your hearing aid?	a) While bathing						
		b) While sleeping						
		c) During active discharge						
		d) As advised by Audiologists						

S.No.	Skills	Tasks	Excellent(4)	More than Satisfactory (3)	Satisfactory (2)	More than Satisfactory (1)	Not Satisfactory (0)	Remarks
14.	Knowledge about serial no.	a) Do you know that, there is serial no. on hearing aids						
		b) Identify serial no. where it is located on your hearing aids?						
		c) Do you know the significance of serial no. on hearing aids						

Appendix:2 Pair wise comparison of groups using Mann Whitney U test

Pair	Task	/Z/	p value
G1-G2	T7	.000	1.00
	T10	4.011	.00*
	T11	2.065	.03*
	T12	.000	1.00
	T13	.000	1.00
	T17	.151	.88
	T18	.793	.42
	T23	.584	.55
	T24	.153	.87
G1-G3	T7	.407	.68
	T10	1.554	.12
	T11	.833	.40
	T12	.000	1.00
	T13	.000	1.00
	T17	.151	.88
	T18	.505	.61
	T23	.584	.55
	T24	.350	.72
G1-G4	T7	2.447	.01*
	T10	1.670	.09
	T11	2.527	.01*
	T12	3.163	.00*
	T13	2.359	.01*
	T17	2.694	.00*
	T18	1.777	.07*
	T23	1.986	.04*
	T24	2.574	.01*

*$p \leq 0.05$

Appendix2: Pair wise comparison of groups using Mann Whitney U test

Pair	Task	/Z/	p value
G2-G3	T7	.407	.68
	T10	2.432	.01*
	T11	2.031	.04*
	T12	.000	1.00
	T13	.000	1.00
	T17	.000	1.00
	T18	.276	.78
	T23	.000	1.00
	T24	.505	.61
G2-G4	T7	2.447	.01*
	T10	5.271	.00*
	T11	4.944	.00*
	T12	3.163	.00*
	T13	2.359	.01*
	T17	2.826	.00*
	T18	2.659	.00*
	T23	2.553	.01*
	T24	2.719	.00*
G3-G4	T7	2.096	.03*
	T10	3.082	.00*
	T11	3.693	.00*
	T12	3.163	.00*
	T13	2.359	.01*
	T17	2.826	.00*
	T18	2.346	.01*
	T23	2.553	.01*
	T24	2.251	.02*

*$p \leq 0.05$

Appendix 3. Mean rank scores of hearing aid users across the different tasks

Tasks	Groups#	N	Mean Rank
T1	NHAU	50	97.96
	3MEU	50	97.96
	6MEU	50	100.58
	>1YEU	50	105.50
T2	3MEU	50	93.90
	6MEU	50	93.90
	>1YEU	50	113.49
	NHAU	50	100.71
T3	NHAU	50	97.40
	3MEU	50	97.40
	6MEU	50	103.22
	>1YEU	50	103.98
T4	3MEU	50	98.06
	6MEU	50	98.06
	>1YEU	50	105.38
	NHAU	50	100.50
T5	NHAU	50	97.56
	3MEU	50	99.20
	6MEU	50	106.04
	>1YEU	50	99.20
T6	3MEU	50	100.50
	6MEU	50	100.50
	>1YEU	50	100.50
	NHAU	50	100.50
T7	NHAU	50	92.62
	3MEU	50	92.62
	6MEU	50	96.91
	>1YEU	50	119.85
T8	NHAU	50	93.56
	3MEU	50	102.04
	6MEU	50	92.81
	>1YEU	50	113.59

#NHAU- New hearing aid users, 3MEU- 3months experienced hearing aid users, 6MEU- 6months experienced hearing aid users, >1YEU- >1 YEAR experienced hearing aid users

Tasks	Groups	N	Mean Rank
T10	NHAU	50	106.74
	3MEU	50	79.00
	6MEU	50	93.48
	>1YEU	50	122.78
T11	3MEU	50	99.48
	6MEU	50	85.00
	>1YEU	50	92.92
	NHAU	50	124.60
T12	NHAU	50	92.14
	3MEU	50	92.14
	6MEU	50	92.14
	>1YEU	50	125.58
T13	3MEU	50	94.56
	6MEU	50	94.56
	>1YEU	50	94.56
	NHAU	50	118.32
T14	NHAU	50	103.73
	3MEU	50	95.32
	6MEU	50	95.32
	>1YEU	50	107.63
T15	3MEU	50	96.36
	6MEU	50	96.36
	>1YEU	50	96.36
	NHAU	50	112.92
T16	NHAU	34	71.88
	3MEU	42	82.11
	6MEU	44	80.50
	>1YEU	38	82.28
T17	3MEU	50	94.14
	6MEU	50	92.72
	>1YEU	50	92.72
	NHAU	50	122.42

#NHAU- New hearing aid users, 3MEU- 3months experienced hearing aid users, 6MEU- 6months experienced hearing aid users, >1YEU- >1 YEAR experienced hearing aid users

Tasks	Groups	N	Mean Rank
T18	NHAU	50	98.96
	3MEU	50	91.18
	6MEU	50	93.89
	>1YEU	50	117.97
T19	3MEU	50	96.61
	6MEU	50	98.52
	>1YEU	50	98.52
	NHAU	50	108.35
T20	NHAU	50	104.88
	3MEU	50	98.21
	6MEU	50	98.21
	>1YEU	50	100.70
T21	3MEU	50	107.06
	6MEU	50	96.18
	>1YEU	50	96.18
	NHAU	50	102.58
T22	NHAU	50	101.90
	3MEU	50	99.77
	6MEU	50	100.56
	>1YEU	50	99.77
T23	3MEU	50	98.19
	6MEU	50	94.05
	>1YEU	50	94.05
	NHAU	50	115.71
T24	NHAU	50	93.20
	3MEU	50	91.71
	6MEU	50	96.69
	>1YEU	50	120.40
T25	NHAU	50	96.55
	3MEU	50	96.55
	6MEU	50	95.00
	>1YEU	50	113.90

#NHAU- New hearing aid users, 3MEU- 3months experienced hearing aid users, 6MEU- 6months experienced hearing aid users, >1YEU- >1 YEAR experienced hearing aid users

Tasks	Groups	N	Mean Rank
T26	NHAU	50	94.80
	3MEU	50	92.92
	6MEU	50	99.22
	>1YEU	50	115.06
T27	NHAU	50	97.18
	3MEU	50	102.61
	6MEU	50	98.99
	>1YEU	50	103.22
T28	NHAU	50	100.53
	3MEU	50	100.04
	6MEU	50	100.04
	>1YEU	50	101.39
T29	3MEU	50	99.94
	6MEU	50	99.94
	>1YEU	50	99.94
	NHAU	50	102.18
T30	6MEU	50	99.24
	>1YEU	50	99.24
	NHAU	50	99.24
	3MEU	50	104.28
T31	NHAU	50	103.05
	3MEU	50	98.97
	6MEU	50	98.97
	>1YEU	50	101.01
T32	NHAU	50	97.94
	3MEU	50	95.62
	6MEU	50	99.38
	>1YEU	50	109.06
T33	NHAU	50	101.35
	3MEU	50	92.84
	6MEU	50	99.80
	>1YEU	50	108.01

#NHAU- New hearing aid users, 3MEU- 3months experienced hearing aid users, 6MEU- 6months experienced hearing aid users, >1YEU- >1 YEAR experienced hearing aid users