Investigating problems associated with hearing aid use: The importance of hearing aid management skills

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Ear Sciences Centre, School of Medicine, Faculty of Medicine, Dentistry and Health Sciences, The University of Western Australia

2018
THESIS DECLARATION

I, Rebecca Jane Bennett, certify that:

This thesis has been substantially accomplished during enrolment in the degree.

This thesis does not contain material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution.

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The research involving human data reported in this thesis was assessed and approved by The University of Western Australia Human Research Ethics Committee. Approval numbers: RA/4/1/4653, RA/4/1/7667, RA/4/1/7679, and RA/4/1/8593.

Written participant consent has been received and archived for the research involving patient data reported in this thesis.

The work described in this thesis was funded by an Australian Government Research Training Program (RTP) Scholarship, Unitron Australia and Ear Science Institute Australia.

This thesis contains published work and/or work prepared for publication, some of which has been co-authored.

Signature: [redacted]

Date: 20/09/2018
Abstract

Hearing aids are the primary intervention for hearing impairment. However, up to 25% of people who own a hearing aid report never using it. Reported reasons for hearing aid non-use include beliefs that one’s hearing is not “bad” enough to require hearing aids or fear of stigmatisation associated with hearing aid use. Importantly, the most commonly cited reasons for hearing aid non-use pertain to physical problems experienced with the device, such as discomfort when in use, difficulty adjusting the sound, or breakdowns. These device-related problems are both avoidable and rectifiable through modification to the hearing aid or improving skills relating to use and maintenance of the hearing aid. Therefore, improvements in the way in which clinicians provide hearing aid training during the process of hearing aid acquisition would be likely to reduce the frequency and impact of hearing aid problems and subsequently result in higher rates of hearing aid use and associated benefits.

The objective of this project was to develop a clinical tool to support clinicians and hearing aid owners in addressing and preventing problems associated with hearing aid use. First, hearing aid owners and clinicians were involved in a group concept mapping study to develop a framework for understanding hearing aid problems. This included generating a comprehensive list of hearing aid related problems faced by adult hearing aid owners and identifying those problems that have the greatest impact on successful hearing aid use. The majority of problems having the greatest negative impact on hearing aid success related to hearing aid handling and maintenance.

This led onto the second phase of this project, during which we developed a clinical survey to evaluate the skills and knowledge required for hearing aid handling and maintenance: the Hearing Aid Skills and Knowledge Inventory (HASKI). Both a clinician-administered and self-administered version were developed to allow for use at various stages throughout the aural rehabilitation process. Participatory methods were used, involving both clinicians and hearing aid owners in item development and pilot testing of the surveys. Concept mapping
techniques were used to identify the knowledge, skills and tasks required for hearing aid use and maintenance. This list of 111 items of required knowledge and skill informed item development of the HASKI surveys. Psychometric evaluation of the surveys were performed using clinical cohorts from seven clinics across Australia. This demonstrated that both versions of the HASKI are valid, reliable and clinically feasible measures.

The third phase of this project investigated participant factors that influence hearing aid management skills. It identified older persons and women as being most at risk for lower levels of hearing aid skill. Furthermore, participants with lower levels of hearing aid skill and knowledge were more likely to demonstrate poorer outcomes following rehabilitation, including lower levels of self-reported hearing aid benefit and satisfaction.

Key findings of this thesis include elucidation of the high prevalence of deficiency in hearing aid management skill and knowledge among hearing aid owners (99% of participants), the magnitude of the deficiency (with participants self-reporting incompetence or lack of knowledge in one third of the items assessed), and the impact of poor management skills to hearing aid outcomes. These findings highlight the need for clinicians to designate more time and resources towards ensuring hearing aid owners have the skills and knowledge to adequately use and care for their hearing aids. The HASKI-self and HASKI-clin developed in this thesis are the most extensive clinical surveys currently available evaluating the skills and knowledge required for hearing aid management. The psychometric evaluations presented demonstrate that the HASKI-self and HASKI-clin are valid and reliable tools for hearing aid management evaluation. They are freely available for clinicians to download and use in their clinical practice (www.earscience.org.au/research/clinical-research).
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Statement of candidate contribution

This thesis contains published work that has been co-authored. The bibliographical details of the work, where it appears in the thesis and author contributions are outlined below.

In regard to Regulation 41.2 from the Rules Governing Research Higher Degrees of the Graduate Research School of The University of Western Australia, the candidate was the primary contributor to the design, analysis, interpretation and preparation and revision of manuscripts for each of the studies reported in this thesis.

Chapter 3


The study design was formulated by Rebecca Bennett, Dr Laplante-Lévesque and Prof Eikelboom. Data for this study was collected by Rebecca Bennett and Dr Laplante-Lévesque. Statistical analysis was conducted by Rebecca Bennett. All four authors contributed to analysis and interpretation of the results. Writing of the manuscript was performed by Rebecca Bennett and all co-authors contributed to editing the manuscript.

Chapter 4


The study design was formulated by Rebecca Bennett, Dr Taljaard and Prof Eikelboom. Data for this study was collected by Rebecca Bennett and Dr Brennan-Jones. Analysis was conducted by Rebecca Bennett. Analysis and interpretation of the results was conducted by
all five authors. Writing of the manuscript was performed by Rebecca Bennett and all co-authors contributed to editing the manuscript.

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The study design was formulated by Rebecca Bennett, Dr Meyer and Prof Eikelboom. Data collection and statistical analyses for this study was conducted by Rebecca Bennett. Analysis and interpretation of the results was conducted by all four authors. Writing of the manuscript was performed by Rebecca Bennett and all co-authors contributed to editing the manuscript.

Chapter 8


The study design was formulated by Rebecca Bennett, Dr Meyer and Prof Eikelboom. Data collection and statistical analyses for this study was conducted by Rebecca Bennett. Analysis and interpretation of the results was conducted by all five authors. Writing of the manuscript was performed by Rebecca Bennett and all co-authors contributed to editing the manuscript.

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Professor Marcus D. Atlas (Co-ordinating Supervisor)

On behalf of all other co-authors
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<td>Audiological rehabilitation – clinical global impression</td>
</tr>
<tr>
<td>BTE</td>
<td>Behind-the-ear</td>
</tr>
<tr>
<td>COSIMIN</td>
<td>Consensus-based standards for the selection of health measurement instruments</td>
</tr>
<tr>
<td>DAHA</td>
<td>Dynamic assessment of hearing aids</td>
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<tr>
<td>DOSO</td>
<td>Device oriented subjective outcome</td>
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<td>EAR</td>
<td>Effectiveness of auditory rehabilitation</td>
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<td>ESIA</td>
<td>Ear Science Institute Australia</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioner</td>
</tr>
<tr>
<td>GRRAS</td>
<td>Guidelines for reporting reliability and agreement studies</td>
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<tr>
<td>HA</td>
<td>Hearing aid</td>
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<td>HHS</td>
<td>Hearing aid handling skills</td>
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<td>HASKI</td>
<td>Hearing aid skills and knowledge inventory</td>
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<td>HASKI-self</td>
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<tr>
<td>HASKI-clin</td>
<td>Hearing aid skills and knowledge inventory – clinician-administered</td>
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<tr>
<td>HAUQ</td>
<td>Hearing aid users questionnaire</td>
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<td>HIOC</td>
<td>Hearing instrument operation checklist</td>
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<tr>
<td>IOI-HA</td>
<td>International outcome inventory for hearing aids</td>
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<tr>
<td>ITE</td>
<td>In-the-ear</td>
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<tr>
<td>LHC</td>
<td>Lions Hearing Clinic</td>
</tr>
<tr>
<td>M</td>
<td>Mean</td>
</tr>
<tr>
<td>MARS-HA</td>
<td>Measure of audiologic rehabilitation self-efficacy for hearing aids</td>
</tr>
<tr>
<td>NS</td>
<td>Not significant</td>
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<tr>
<td>OHS</td>
<td>Office of Hearing Services</td>
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<tr>
<td>PHAST</td>
<td>Practical hearing aid skills test</td>
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<tr>
<td>PRISMA</td>
<td>Preferred reporting items for systematic reviews and meta-analyses</td>
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<tr>
<td>SADL</td>
<td>Satisfaction with hearing aid performance</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviations</td>
</tr>
<tr>
<td>SPS</td>
<td>Style preference survey</td>
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<td>SPSS</td>
<td>Statistical package for the social sciences</td>
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<tr>
<td>UWA</td>
<td>University of Western Australia</td>
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<td>WHO</td>
<td>World Health Organization</td>
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CHAPTER ONE

General Introduction

1.1 Personal motivation for this thesis

Working as a clinical audiologist for twelve years I watched hearing aid owners experience a myriad of problems that inhibited their ability to use and gain benefit from their hearing aids. I found it alarming how often patients would report ‘putting up’ with problems rather than asking their clinicians to rectify the problems. Especially as majority of the problems described could quite easily be improved by the clinician through modification to the hearing aid or provision of additional training. It was these experiences that inspired me to embark upon a PhD in this field. At this early stage, I wasn’t sure exactly what my PhD would produce, only that I wanted to develop a clinical tool to identify and address hearing aid problems, and subsequently improve hearing aid use and associated patient outcomes. It was important to me to engage both hearing aid owners and clinicians in this process to increase the appropriateness and acceptability of the tool.

1.2 Purpose of thesis

Up to 25% of hearing aid owners do not use their hearing aids, implying that current methods of hearing aid provision are inadequate. The most commonly reported reasons for hearing aid non-use pertain to problems associated with the physical fit, sound quality, or performance of the device. Although clinicians can rectify majority of the problems...
reported, these problems persist and continue to prevent hearing aid owners from receiving the full benefits of their hearing aids. The purpose of this series of investigations was thus to examine the problems faced by adult hearing aid owners and to develop a clinical tool to assist hearing aid owners and clinicians in addressing these problems to improve hearing aid use and associated outcomes.

1.3 Aims of thesis
The first aim of this research was to identify the full range of problems experienced by hearing aid owners and to identify those problems perceived to have the greatest impact on hearing aid success. The second aim of this thesis was to use a participatory mixed methods approach to develop a clinical survey to assist hearing aid owners and clinicians to comprehensively detect and address problems associated with hearing aid management. This included evaluation of the psychometric properties of the survey in a large and diverse cohort. The third aim of this study was to investigate the impact of hearing aid management skills on hearing aid outcomes.

1.4 Organisation of thesis
This thesis is organised as a series of publications and every attempt to minimise repetition has been made. Chapter Two provides a literature review that introduces the reader to the topics of hearing impairment, treatment with hearing aids and known barriers to hearing aid use. Chapter Three presents a study published in Ear & Hearing and uses group concept mapping to explore problems associated with hearing aid use, from the perspectives of both hearing aid owners and clinicians. Chapter Four presents a study published in the International Journal of Audiology and provides a systematic and descriptive review of the content and quality of available surveys evaluating hearing aid handling and management. Chapter Five presents an explorative pilot study aimed to determine if hearing aid owners are able to accurately identify and self-report handling difficulties when provided with an itemised list of handling tasks. This study was published in the International Journal of Audiology; however, during the peer review process the reviewers requested removal of a section investigating the impact of the number of response items on participant responses.
This section has been included in this thesis as the outcome of the investigation influenced decisions regarding survey development in the study described in Chapter Seven. Chapter Six was published in the American Journal of Audiology and proposes a conceptual framework for understanding hearing aid management skills and how they are acquired; in doing so, identifying the full array of knowledge, skills and tasks required for hearing aid management and the importance of each of these to overall success with hearing aids. Chapters Seven and Eight were written as two parts of one larger study and were accepted for publication to the American Journal of Audiology. Chapter Seven describes the development and validation of the Hearing Aid Skills and Knowledge Inventory (HASKI); evaluating the skills and knowledge required for hearing aid management. Chapter Eight explores the factors associated with hearing aid management skills and the impact that low skills have on clinical outcomes.

1.5 Conference presentations arising from this thesis


Bennett, R. J., Laplante-Lévesque, A., Meyer, C. J. & Eikelboom, R. H. Hearing aid handling & management: Are you getting the full story? Audiology Australia WA Chapter Conference: Shining a Light on Contemporary Care, Perth, Western Australia, November 2017. (invited speaker)


Bennett, R. J., Laplante-Lévesque, A., Meyer, C. J. & Eikelboom, R. H., Hearing aid handling & management: Are you getting the full story? Audiology Australia TAS Chapter Conference:
Challenges and Opportunities for Contemporary Audiology Practice, Hobart, Australia, November 2017. (invited speaker)


**Bennett, R. J.**, Taljaard, D. & Eikelboom, R. H. Self-reported hearing aid handling skills. ESIA ‘A life worth hearing’ Symposium, Perth, 27th June 2014. (oral presentation)

1.6 Awards and recognition during candidature

Much of the work conducted during this thesis has been of national and international interest in its field and has directly informed clinical practice, resulting in translational outcomes for audiology services across Australia. The influence of both empirical findings and translational benefits to the community of this work have been recognised by a number of personal awards and recognition:

- Winner, UWA Convocation Postgraduate Research Travel Award 2016
- Winner, poster award World Congress of Audiology, Vancouver, September 2016
- Invitation to present webinar on PhD findings to Audiology Australia members, October 2016
- Invited keynote speaker at the ACAud National Congress 2017, Adelaide, Australia, August 2017
- Invited keynote speaker at the three series Audiology Australia Chapter Conferences (WA, SA & TAS), Australia, November 2017
1.7 Other publications arising during candidature


### 1.8 Other conference presentations arising during candidature


Bennett, R. J., Jayakody, D. M, Dupuis, K. & Eikelboom, R. H. Why should audiologists care about cognitive function: Clinical applications of the Montreal Cognition Assessment (MoCA). WA Audiology Australia State Conference, Perth, 28th November 2014. (oral presentation)

Bennett, R. J., Taljaard, D. & Eikelboom, R. H. Validation and modification of the PHAST-R. Sensitivity and specificity of self-reported hearing difficulty in adults over 60 years of age. 32nd World Congress of Audiology, Brisbane, 3-7 May 2014. (oral presentation)

Bennett, R. J., Taljaard, D. & Eikelboom, R. H. Development of a self-administered hearing aid management survey: the PHAST-self. 32nd World Congress of Audiology, Brisbane, 3-7 May 2014. (oral presentation)

Bennett, R. J. & Taljaard, D. Counselling for and about hearing loss – Are we becoming counsellors? 32nd World Congress of Audiology, Brisbane, 3-7 May 2014. (Instructional Course)

Bennett, R. J., Taljaard, D. & Eikelboom, R. H. Clients don’t always know what they don’t know. ESIA ‘A life worth hearing’ Symposium, Perth, 27th June 2013. (oral presentation)
CHAPTER TWO

Background & Rationale

2.1 Foreword to Chapter Two
The purpose of this chapter is to review and synthesise literature relevant to the topic of this thesis. This review of the literature identified gaps in the current knowledge which warrant further investigation. This chapter concludes with an overview of the purpose, findings and applications for each of the studies included in this thesis.

2.2 Hearing impairment
Hearing impairment is a global public health concern, affecting many facets of an individual’s life (Ferguson et al., 2017; Chia et al., 2007; Chisolm et al., 2007; Tambs, 2004). The World Health Organization estimates that there are over 1.2 billion people in the world living with hearing impairment, 360 million of which have a disabling degree of impairment (World Health Organization, 2017). In Australia, hearing impairment is estimated to affect one in six, costing Australians $11.75 billion or 1.4% of GDP (Access Economics, 2006). While hearing impairment can affect all ages, it is considered to be one of the most common causes of disability amongst the ageing population, affecting approximately one third of adults over the age of 55 and three in every four people aged over 70 years (Chia et al., 2007; World Health Organization, 2014).
Due to the association between hearing impairment and age, the prevalence of age-related comorbidities increase in those with hearing impairment. At the disease-specific level, epidemiological studies have demonstrated associations between hearing impairment and elevated risk rates for diabetes (Horikawa et al., 2012; Sommer et al., 2017), stroke (Lin et al., 2008) and heart disease (Tan et al., 2017), although the nature of these relationships are still unknown. Additional comorbidities include vision impairment (Crews & Campbell, 2004), reduced dexterity (Chia et al., 2007; Kumar et al., 2000), increased likelihood of falls (Lin & Ferrucci, 2012) and reduced cognitive function and all-incident dementia (Lin et al., 2011a; Lin et al., 2011b; Lin et al., 2011c). These co-morbidities not only compound to affect one’s quality of life, they can also negatively impact the process and outcomes of treatment for hearing impairment (Dupuis et al., 2014; Erber, 2003; Pichora-Fuller et al., 2013).

The consequences of a hearing impairment manifest themselves in a broad spectrum of an individual’s life, including impacts at home, in the workplace and in the community. Hearing impairment can negatively affect interpersonal communication (Hallberg et al., 2008), intimate relationships (Hétu et al., 1993), access to education (Rydberg et al., 2009), employment opportunities (Kramer et al., 2006) and economic independence (Olusanya et al., 2014). Untreated hearing impairment can lead to reduced social activity (Seniors Research Group, 1999; Solheim et al., 2011), social isolation (Weinstein et al., 2016), lower levels of self-esteem (Tambs, 2004), loneliness (Pronk et al., 2011), and reduced quality of life (Ferguson et al., 2017; Chisolm et al., 2007; Dalton et al., 2003). Untreated hearing impairment has also been associated with increased rates of anxiety (Andersson & Green, 1995; Jones & Swain, 1992), depression (Kvam et al., 2007; Tambs, 2004), poor mental health (Tambs, 2004) and lower life expectancy (Appollonio et al., 1996; Karpa et al., 2010). For these reasons hearing impairment is considered the fourth leading cause of years-lived-with-disability and thus researchers and economists have called for more funding and further efforts to promote hearing loss prevention, reduce the costs of treatment, and improve service provision (Wilson et al., 2017).
2.3 Management of a hearing impairment
Treatments for hearing impairment vary, and depend on the severity, cause and impact of the impairment. People experiencing milder forms of hearing impairment often take no action towards treatment. It is estimated that people live with hearing impairment for an average of 7-10 years before seeking help (Davis et al., 2007; Manchaiah et al., 2015; Yueh et al., 2010). This is in part due to the nature of hearing impairment in that in most people it develops slowly over many years. This slow decline results in individuals not realising that their hearing is deteriorating until the impairment reaches a level that is causing noticeable problems. Alternatively, people may be aware of their hearing impairment, yet choose not to address it. It is common for people to normalise their experience of hearing impairment, that is, assume that hearing impairment is a normal part of ageing and thus deem it unnecessary to seek treatment (McMahon et al., 2014).

Often cures or medical treatments are available for hearing impairment caused by disease. In contrast, there is currently no cure for the two main causes of hearing impairment: age-related hearing impairment (presbycusis) or noise induced hearing loss. Management options for these include amplification devices (such as hearing aids, hearing implants, or television headsets) or listening and communication training (such as use of visual cues or paraphrasing to ensure one understands an instruction) (Gatehouse, 1994; Gatehouse & Noble, 2004; Hickson et al., 2007; Kelly et al., 2013; Saunders et al., 2009; Sweetow & Sabes, 2007). By far the most common option for managing mild to severe hearing impairment for children and adults is the hearing aid.

2.3.1 Hearing aids
Typically, hearing aids are offered as part of an aural rehabilitation program comprising four stages or types of appointments, each with a different purpose: 1) the hearing assessment; 2) discussion about rehabilitation options and hearing aid selection (when indicated); 3) the initial fitting of the hearing aid; and 4) follow-up fine tuning appointments (Figure 2.1). During the hearing assessment the clinician evaluates the client’s hearing sensitivity, which is subsequently used to determine the initial acoustic settings of the hearing aid. During this appointment the clinician also has the opportunity to discuss with the client their reasons
for seeking help for the hearing impairment, the impact that the hearing impairment is having on them and the people around them, their goals for the rehabilitation program, as well as establish the client’s motivation and level of engagement with the rehabilitation program. The hearing aid discussion and selection stage requires the clinician to provide information regarding the range of hearing aids available that would be suitable for the client based on their hearing sensitivity and goals for rehabilitation, describing how each hearing aid feature might address the specific hearing and communication difficulties expressed by the client.

**Figure 2.1.** Schematic representation of the four stages required for aural rehabilitation with hearing aids.

The initial fitting appointment consists of ensuring the physical fit of the hearing aid is appropriate and includes the process of programming the acoustic settings of the hearing aid. The hearing aid settings are then reviewed and adjusted over several follow-up appointments to account for the acclimatisation to renewed sound and to fine tune the devices to the specific needs of the hearing aid owner (Völker et al., 2016). The entire process of aural rehabilitation with hearing aids is reported to take two to five and even up to 10 sessions (Kochkin et al., 2010a; Bennett et al., 2016).

Training, counselling and education at all appointments are crucial to the successful use and uptake of a hearing aid. Clinical guidelines recommend that hearing healthcare clinicians provide training and information during the fitting and follow up fine tuning appointments on hearing aid comfort, use, management, repairs and troubleshooting for common problems (American Speech-Language-Hearing Association, 2015; Audiology Australia, 2013). Additionally, since hearing aids do not fully restore normal hearing function, the
clinician is encouraged to provide counselling on the personal and emotional experiences of acquiring hearing aids, including how the hearing aid will address personal communication difficulties, what the hearing aid owner can expect from their hearing aid, the process of acclimatising to the new sounds they will hear, how to manage residual limitations and how personal motivation and involvement will influence the outcomes of the aural rehabilitation program.

Throughout this period, the clinician will use objective measures of hearing aid performance (such as speech perception tests with their hearing aid fitted) and subjective measures of hearing aid owners’ perception of hearing aid performance (such as self-report survey evaluating hearing aid use, benefit or satisfaction) to establish whether the hearing aid rehabilitation program was successful. Once the clinician and hearing aid owner are satisfied with the performance of the hearing aid and the outcomes of the rehabilitation program, and the program is considered completed. Some clinics offer ongoing support, such as in the form of an annual hearing aid review appointment; however, this is not offered by all audiology clinics.

2.3.2 Successful hearing aid use
There is no universally agreed definition or measure of successful hearing aid use. Clinicians and researchers have reported the use of over 246 objective measures (such as improved hearing sensitivity) and subjective measures (such as self-reported hearing aid benefit or satisfaction) to evaluate hearing aid outcomes (Granberg et al, 2014). Kochkin et al. (2010a) investigated the impact of the hearing healthcare clinician on the success of the hearing aid program. They measured hearing aid success using a combination of self-reported hearing aid usage in hours, self-reported satisfaction with the ability of the hearing aid to improve their hearing, perceptions of hearing handicap reduction in pre-defined listening situations, and reports of whether the hearing aid owners would recommend their clinician, their hearing aids or their hearing aid brand to a friend. Similarly, Hickson et al. (2014) examined associations between audiological and non-audiological factors and successful hearing aid use in older adults. They defined participants as being a successful hearing aid user if they
self-reported using their hearing aid for at least one hour per day and self-reported at least moderate benefit from hearing aids in the situation the individual most wanted to hear better (based on items one and two of the International Outcomes Inventory - Hearing Aids: IOI-HA; Cox & Alexander, 2002). Three of the most commonly used measures to report hearing aid success include self-reported 1) hearing aid use, 2) benefit from hearing aids, and 3) satisfaction with hearing aids (Granberg et al., 2014).

2.3.2.1 Hearing aid use

Although it is well established that hearing aids provide benefit to people with hearing impairment (Ferguson et al., 2017; Chisolm et al., 2007), there are varying reported that anywhere between 0% and 24% of hearing aid owners do not use their hearing aids (Heuermann et al., 2005; Hartley et al., 2010). One contributing factor may be the inconsistency by which “non-use” is defined and measured. Perez and Edmonds (2012) systematically reviewed studies reporting hearing aid use and its corelates. They noted that the parameters for classification of non-use appears somewhat arbitrary across some studies, and they urged for future research to report numerical values for hearing aid use to provide clarification and allow for comparison across studies. As for how hearing aid use and non-use is evaluated, 15 different methods were identified. The most commonly reported measure of hearing aid use was the International Outcomes Inventory - Hearing Aids (IOI-HA) (Cox & Alexander, 2002), a seven-item survey developed to assess the effectiveness of hearing aids in improving hearing and general life enjoyment in real-life situations. Item one of the IOI-HA asks participants to indicate “on an average day, how often do you use your hearing aid/s?”, using a five point Likert scale: Never, Less than 1 hour a day, 1 to 4 hours a day, 5 to 8 hours a day, More than 8 hours a day. There is growing support for the use of the IOI-HA both clinically and in research to facilitate cohort comparisons. Thus, the studies contained within this thesis used the IOI-HA to determine hearing aid fitting outcomes, including daily hours of hearing aid use.

2.3.2.2 Hearing aid benefit

Reports of hearing aid benefit are considered high across clinical cohorts of hearing aid owners (Hickson et al., 2010; Bennett et al., 2016; Heuermann et al., 2005). Hearing aid benefit can be evaluated using a single self-report question or a series of questions
investigating a range of possible benefits from hearing aids. An example of a commonly used single global question evaluating hearing aid benefit is item two on the IOI-HA: “Think about the situation where you most wanted to hear better, before you received your current hearing aid(s). Over the past two weeks, how much have the hearing aid(s) helped in that situation?” scored on a scale of “helped not at all”, “helped slightly”, “helped moderately”, “helped quite a lot”, “helped very much” (Cox & Alexander, 2002). Successful hearing aid use has been described as perceiving moderate benefit on the aforementioned question and a minimum of one hour of hearing aid use per day (Hickson et al., 2017). When evaluating hearing aid benefit via a series of questions, studies may use validated surveys evaluating self-reported hearing aid benefit such as the Abbreviated Profile of Hearing Aid Benefit (Cox & Alexander, 1995) and the Hearing Aid Users Questionnaire (Dillon et al., 1999), or generate a list of listening environments and ask hearing aid owners to rate their self-perceived benefit (Hickson et al., 2010).

2.3.2.3 Hearing aid satisfaction

As with self-reported hearing aid benefit, self-reported satisfaction with hearing aids is found to be consistently high, with studies reporting 54-74% of hearing aid owners to be satisfied with their hearing aids (Hickson et al., 2010; Bennett et al. 2016; Kochkin, 2010b). Some suggest that the high rates of satisfaction documented likely reflect the ceiling effects of the tools used to measure satisfaction, subsequently affecting our ability to accurately deduce any meaningful data from measures of hearing aid satisfaction (Hickson et al. 2010; Wong et al, 2003). Self-reported satisfaction with hearing aids is either measured using a single global question requiring reflection of one’s overall satisfaction with their hearing aids (Kochkin, 2010a; Bennett et al., 2016) or by inferring satisfaction based on responses to a range of questions designed to measure aspects contributing to overall satisfaction (Kochkin 2010b, Cox & Alexander, 1998). The multi-question design may be in the form of a validated survey (such as the Satisfaction with Amplification in Daily Life; Cox & Alexander, 1999), or a list of questions defined by the research team (Kochkin 2010b). Aspects of the hearing aid experience evaluated in an attempt to infer overall satisfaction with hearing aids include satisfaction with cost, appearance, acoustic benefit, comfort, and service.
2.3.3 Factors associated with hearing aid success

The hearing aid non-use, insufficient benefit or low satisfaction reported by some hearing aid owners comes at a cost. There is a financial cost to the individual, health insurance companies and/or publicly funded healthcare systems. There may also be reputational costs to the clinical provider because of a dissatisfied client. More importantly though, is the personal cost to the individual in terms of ongoing hearing and communication difficulties (see 2.2). Researchers have investigated factors associated with hearing aid success in order to identify those individuals at greater risk of experiencing low hearing aid success and those clinical processes more likely to contribute to low success.

Client factors that have been found to be associated with successful hearing aid use include degree of hearing impairment (those with more severe hearing impairment report a greater amount of hearing aid use per day) (Bertoli et al., 2009; Brännström & Wennerström, 2010; Cox et al., 2000), perceived hearing difficulty (Bertoli et al., 2009; Helvik et al., 2008), perceived impact of hearing impairment on daily life (Cox et al., 2007), and lifetime hearing aid experience (Hosford-Dunn, 2001; Saunders & Jutai, 2004). For example, Bertoli et al. (2009) surveyed 8707 adult hearing aid owners in Switzerland to determine factors contributing to successful hearing aid use. Of the 1306 (15%) participants that reported low hearing aid use or never using their hearing aid, 39.5% reported the perception that only certain situations were difficult enough to warrant hearing aid use and 23.7% reported no perceived need to use the hearing aid (despite acquiring it). Similarly, Helvik et al. (2008) compared hearing aid candidates who maintained using and who discontinued using hearing aids 1.5 years after issue. They found that clients who felt they had few problems with their hearing or minimised or repressed their shortcomings, were more inclined to discontinue using their hearing aid.

Although early studies suggested that some participant demographics may be associated with hearing aid outcomes (such as age, gender or education), a review of the literature by Knudsen et al. (2010) found that the vast majority of the included studies concurred that there is no influence of age, gender or living arrangement on either hearing aid use or satisfaction. However, the relationship between socioeconomic status and hearing aid use...
or satisfaction were unclear. Furthermore, there were no studies included that investigated the association between educational level and hearing aid use or satisfaction. More recently, Oberg et al. (2012) investigated hearing aid uptake and outcomes in a cohort of older adults (over 85 years of age). They showed that better health was associated with more frequent hearing aid use, greater hearing aid benefit, and better scores for hearing-aid-related quality of life. No significant differences in gender, years of education, mental health status or cognitive skills were found between frequent hearing aid users and non-users. Similarly, Hickson et al. (2014) compared successful and unsuccessful hearing aid users and found no significant differences in gender, socioeconomic status (being on an aged pension versus having no pension), educational status, employment status or living status. In this cohort, age was significantly associated with hearing aid success, with unsuccessful hearing aid owners 4.6 years older than successful hearing aid users.

The relationship between age and hearing aid success is multifaceted. While older people are more likely to adopt hearing aids due to their predisposition to greater hearing impairment (Kochkin, 2009; Popelka et al., 1998), increasing age is negatively associated with ability to handle and use hearing aids (Desjardins & Doherty, 2009), which is likely due to a reduction in dexterity required to handle the device (Singh et al., 2013). Other age-related factors such as low cognitive function, poor haptic touch (finger sensitivity) and visual impairment have also been suggested to negatively influence successful hearing aid use (Erber, 2003; Kumar et al., 2000; Lunner et al., 2009; Singh et al., 2013). To overcome the limitations caused by these co-morbidities hearing aid manufacturers have developed features such as signal processing to overcome the effects of reduced working memory on speech understanding (Lunner et al., 2009), or extended-wear hearing aids that do not require any handling and maintenance (such as insertion, cleaning or battery change) (Branda, 2012; Sim et al., 2014).

Links between specific attitudinal beliefs and successful hearing aid use have been established in the literature. Saunders et al. (2016) investigated hearing beliefs and behaviors of adults seeking hearing help for the first time and found that hearing aid outcomes (reported using the IOI-HA) were associated with participants readiness for change towards helpful hearing health behaviours (reported using the University of Rhode
Island Change Assessment: URICA; McConnaughy et al., 1983) and their hearing beliefs (reported using the Hearing beliefs questionnaire: HBQ; Saunders et al., 2013). Expectations and attitudes towards hearing aids, in particular positive expectations and readiness to improve hearing, have been found to predict positive outcomes for hearing aid satisfaction and benefit (Ferguson et al., 2016; Saunders et al., 2009). As such, research groups have developed counselling programs to alter attitudinal beliefs and demonstrated the benefits, including improved hearing aid outcomes (Montano et al., 2013; Preminger & Yoo, 2010; Saunders & Forsline, 2012).

The pivotal role of significant others in the success of aural rehabilitation is now more clearly understood. Several studies have demonstrated the impact of hearing impairment and hearing aid use on the significant other, and the role of the significant other in improving hearing aid uptake, use and satisfaction with hearing aids (Barker et al., 2017; Vas et al., 2017; Kamil & Lin, 2015; Scarinci et al., 2008; Meyer & Hickson, 2012; Preminger & Meeks, 2010, 2012; Stark & Hickson, 2004; Singh et al., 2015). For example, Hickson et al. (2014) reported positive support from significant others (based on the Attitude to Hearing Aids Questionnaire) to predict successful hearing aid use. Subsequently, tutorials are now available to clinicians describing how to better involve significant others in the development and implementation of rehabilitation programs (Hickson et al., 2016; Singh et al., 2016).

One of the most recent and comprehensive studies exploring factors associated with successful hearing aid use is that by Hickson et al. (2014). They investigated the influence of audiological factors, attitudinal beliefs (as derived from the Health Belief Model), client demographics, psychological factors, and age-related factors on successful hearing aid use in older adults. They found participants who had greater support from significant others, more difficulties with hearing and communication in everyday life before getting hearing aids, more positive attitudes to hearing aids, and perceived to be receiving more benefit from their devices were more likely to be successful hearing aid owners. Although relatively comprehensive compared to other studies, this study did not look at device-related factors that may have influenced success with hearing aids. The importance of device-related factors in determining success with hearing aids use had been alluded to by previous studies.
describing the self-reported reasons for hearing aid non-use (Bertoli et al. 2009; Kockkin, 2000; Oberg et al., 2012). A scoping study investigating why people fitted with hearing aids do not use them identified ten articles reporting reasons for non-use of hearing aids, wherein 38 unique reasons were identified as contributing to hearing aid non-use (McCormack & Fortnum; 2013). Of these, 22 were device specific, including poor sound quality (Bertoli et al. 2009; Kockkin, 2000), discomfort (Bertoli et al. 2009; Kochkin, 2000; Cohen-Mansfield & Taylor, 2004), difficulty handling the device (Tomita et al., 2001; Oberg et al., 2012; Kochkin, 2000), or breakdowns (Kochkin, 2000; Cohen-Mansfield & Taylor, 2004). Although these device-specific problems have been identified by hearing aid owners as reasons for hearing aid non-use, their impact on hearing aid outcomes have not been quantified.

2.4 The need for further research
While studies to date have focused on the audiological and personal factors affecting successful hearing aid use, few studies have investigated the impact of device-related factors. Specifically, there is paucity regarding the full range of hearing aid problems experienced by hearing aid owners, how they impact hearing aid use and what can be done to assist hearing aid owners to overcome these barriers. Accordingly, the purpose of this research project was to examine the problems faced by adult hearing aid owners and to develop a clinical tool to assist hearing aid owners and clinicians in addressing these problems in order to improve hearing aid use and associated outcomes.

Presented in this thesis are a series of studies that explore the range and prevalence of problems associated with hearing aid use and the impact of these problems on the success of an aural rehabilitation program. In order to address some of the issues identified, this project developed, pilot tested and validated a clinical survey designed to assist hearing healthcare clinicians in reducing the frequency and impact of hearing aid associated problems. The background rationale, aim and general findings of each study are presented below.
Participatory research was employed by the studies described in this thesis to ensure that research methodology, knowledge gained and materials developed aligned with the needs of the end users. Participatory research is defined as the “co-construction of research through partnerships between researchers and the people affected by the issues under study” (Jagosh et al., 2012; page 312). These people are described as stakeholders and may include clinicians, patients, policy makers and third party payers (such as government or insurance agencies). Engagement with stakeholders requires a bi-directional relationship that results in informed decision making regarding the research priorities, methodology, as well as dissemination and implementation (Concannon et al., 2014). The benefits of participatory research include: 1) culturally and logistically appropriate research; 2) high quality outputs and outcomes over time; and 3) sustainability of projects beyond the funded time frames (Jagosh et al., 2012). Participatory research was employed in several stages throughout this project. Firstly, group concept mapping studies engaging hearing aid owners and clinicians were used to generate a comprehensive list of problems associated with hearing aid use, and then to identify those hearing aid problems having the greatest negative impact on hearing aid success. Secondly, hearing aid owners and clinicians were involved in group sessions to identify the full range of knowledge and skill required to use a hearing aid. This comprehensive list was subsequently used to inform item development for the survey created within this project. Thirdly, hearing aid owners and clinicians further contributed to survey development by pilot testing early drafts of the survey and making recommendations on how the surveys could be improved.

2.4.1 Exploring hearing aid problems: perspectives of hearing aid owners and clinicians (Chapter Three)

While barriers to hearing aid use have been reported in the literature, knowledge regarding the full spectrum of problems experienced by hearing aid owners and the impact that these problems have on hearing aid outcomes is unknown. The aim of the work described in Chapter Three was thus to generate a conceptual framework for understanding hearing aid related problems; in doing so, it identified key aspects of the hearing aid fitting process that could be improved. To undertake this, group concept mapping techniques were employed to describe the hearing aid related problems that hearing aid owners experience, from the
perspectives of both hearing aid owners and clinicians. These perspectives were then used to generate a conceptual framework to understand the relationship between and importance of the key concepts identified.

Participants included 17 hearing aid owners and 21 hearing healthcare clinicians. Participants attended two group sessions in Perth, Western Australia, wherein they generated statements describing the problems associated with hearing aid use and then grouped and rated the statements. The subsequent analysis identified key themes or concepts. Participants identified 80 individual problems associated with hearing aid use, across four concepts: 1) Hearing Aid Management; 2) Hearing Aid Sound Quality and Performance; 3) Feelings, Thoughts and Behaviours and 4) Information and Training. The magnitude and diversity of hearing aid problems identified in this study highlight the ongoing challenges that hearing aid owners face and suggest that current processes for hearing aid fitting can be improved. Problems relating to hearing aid handling and management were most often deemed to have the greatest impact on hearing aid success and to be the most preventable/solvable; thus are a good starting point when addressing hearing aid related problems.

2.4.2 Evaluating hearing aid handling skills: A systematic and descriptive review (Chapter Four)

Although hearing healthcare clinicians provide training on hearing aid handling and maintenance as part of the rehabilitation program, clinical studies suggest that the level of handling skills demonstrated by hearing aid owners remains low (Campos et al., 2014; Desjardins & Doherty, 2009). Typically, two methods are employed to assess hearing aid handling and management skills. The first is where clinicians ask clients at the end of the rehabilitation program if they are comfortable with how to use their hearing aids (Desjardins & Doherty, 2009). If the client says “yes”, then the clinician assumes no further training is required (Desjardins & Doherty, 2009). Whilst this method is common in clinical practice, studies have suggested that client reports are unreliable (Desjardins & Doherty, 2009; Doherty & Desjardins, 2012; Pothier & Bredenkamp, 2006) and subsequently the need
for further training may be overlooked. The second method, although less utilised, is client survey.

Surveys evaluating hearing aid skills provide: 1) a checklist for clinicians to follow to ensure they have provided sufficient training for the client on the large number of skills required to use and maintain a hearing aid, and 2) a means to evaluate the client’s level of skill to identify whether additional training and support is required.

To date there has been no review of the surveys that are available to assess hearing aid skills. Systematic reviews have become increasingly important in health care as clinicians use them to maintain evidence-based practice, policy developers use them in developing clinical guidelines, and they are often used to inform direction for further research (Mokkink et al., 2009; Moodie et al., 2011; Swingler et al., 2003).

The aim of the work described in Chapter Four was to systematically identify, describe and critically review the content and quality of available surveys evaluating hearing aid management. Twelve surveys were identified as containing at least one item evaluating hearing aid management. Fifteen aspects of hearing aid management were evaluated across the 12 studies although none of the surveys evaluated all aspects of skills identified. Furthermore, not all management skills required for hearing aid use were included in these studies thus identifying the need for further research to identify the full range of hearing aid management skills necessary for successful hearing aid use.

2.4.3 Are hearing aid users able to identify and report handling difficulties? (Chapter Five)

The previous study identified three existing surveys specifically designed to evaluate hearing aid management skills. All three studies were designed to be clinician-administered. The clinical utility of these surveys is limited in that they require face-to-face contact with a clinician. Therefore, they can only be administered as part of the clinical consultation, taking up time when consultation times are often too short to fit in all the required tasks. The development of a self-administered survey evaluating hearing aid handling skills may reduce the clinical load, save consultation time and facilitate more frequent use than face-to-face
consultations allow. For example, completing a self-report survey on hearing aid handling skills in the few months following hearing aid acquisition may identify gaps in skills that were not fully understood. Furthermore, completing a self-report survey on handling skills one or more years after hearing aid acquisition may identify age-related changes in hearing aid handling skills, such as those arising from reduced cognitive function (Pichora-Fuller & Singh, 2006), vision (Erber, 2003), or finger dexterity (Kumar et al., 2000; Singh et al., 2013). Although a self-administered survey for hearing aid handling skills may provide a more efficient medium for ongoing client care, there is currently no evidence to support whether hearing aid owners can accurately self-report handling skills.

To explore this concept, the study described in Chapter Five developed and pilot-tested a self-administered survey evaluating hearing aid handling skills (Hearing aid Handling Skills survey: HHS-self). This explorative pilot study aimed to determine whether hearing aid owners were able to identify accurately and self-report handling difficulties when provided with an itemised list of handling tasks. The self-administered survey demonstrated high sensitivity when compared to clinician evaluation of skills, with 93% of participants accurately self-identifying and reporting whether hearing aid handling skill training was required. The results of this study thus demonstrated that hearing aid owners are able to accurately self-report hearing aid handling difficulties when provided with an itemised list of skills. Such a survey could be used as a screening tool to identify those hearing aid owners who would benefit from additional clinical consultation.

2.4.4 Investigating the knowledge, skills and tasks for hearing aid management (Chapter Six)

Although the results of the previous study (Chapter 5) suggested that hearing aid owners are able to accurately identify and self-report handling difficulties, the survey used to measure hearing aid handling skills only included a portion of the skills needed for hearing aid use. To date, the range of tasks and the detailed level of knowledge and training required for optimal hearing aid management has not been defined. Availability of a complete list of the knowledge, skills and tasks required for hearing aid management would benefit both clinicians and hearing aid owners as it could be used as: 1) a training guide to be followed during initial hearing aid management training sessions; 2) a checklist to review
at the end of the training program to ensure all necessary information and training was provided and 3) an assessment tool to evaluate whether the knowledge and skills were adequately learned and retained.

The purpose of the work described in Chapter Six was to generate a conceptual framework for understanding hearing aid management skills and how they are acquired. In doing so, it identified the full array of knowledge, skills and tasks required for hearing aid management and the importance of each of these to overall success with hearing aids, from the perspectives of both hearing aid owners and clinicians. Concept mapping techniques were used, wherein participants generated, sorted and rated the importance of statements in response to the question “What must hearing aid owners do in order to use, handle, manage, maintain and care for their hearing aids?” Participants identified 111 unique items describing hearing aid management within six concepts: 1) Daily Hearing Aid Use; 2) Hearing Aid Maintenance and Repairs; 3) Learning to Come to Terms with Hearing Aids; 4) Communication Strategies; 5) Working with Your Clinician and 6) Advanced Hearing Aid Knowledge. The results of this study highlighted the magnitude of information and skills required to optimally manage hearing aids.

2.4.5 Evaluating hearing aid management: Development and validation of the Hearing Aid Skills and Knowledge Inventory (HASKI) (Chapter Seven)
Where Chapter 3 identified the need for an increased focus to be placed on hearing aid management skills, Chapter 4 identified a gap in the availability of clinical tools to guide training and evaluation of hearing aid skills; specifically, the lack of a clinical survey evaluating the full array of knowledge, tasks and skills required for hearing aid management. Chapter 5 demonstrated that hearing aid owners are able to self-identify and report hearing aid management skills through the use of self-report survey. Chapter 6 then identified the full array of skills to be included in such a survey. This has all led to the work described in Chapter Seven: to develop and validate a self-administered survey to support clinicians with the identification of hearing aid management difficulties, the Hearing Aid Skills and Knowledge Inventory (HASKI).
The HASKI was developed to evaluate 73 items describing hearing aid skill and knowledge across three domains: 1) Daily hearing aid use, 2) Hearing aid maintenance and repairs and 3) Advanced hearing aid knowledge. Two versions of the HASKI were developed: a self-administered (HASKI-self) and a clinician-administered (HASKI-clin) version. A score of competency could be generated from both versions of the survey. They were validated on 518 adult hearing aid owners (17 to 97 years of age), recruited from seven clinics across Australia. The surveys demonstrate high internal consistency, interdimensional relationships, construct validity, test-retest reliability, inter-observer reliability and criterion validity. This study demonstrated that the HASKIs are valid and reliable measures of hearing aid handling and management skills with good potential for use in clinical settings. The additional finding that 99% of participants in this study reported difficulty with some aspect of hearing aid management skill or knowledge and that, on average, participants reported difficulty with almost one third of items listed, suggests that the informational and training needs of hearing aid owners are not being met by current clinical practices. Clinical use of the HASKIs have the potential to improve hearing aid fitting outcomes, specifically hearing aid use, benefit and satisfaction.

2.4.6 Factors associated with hearing aid skills and knowledge (Chapter Eight)
Chapter Seven describes the development and validation of a self-administered survey for the evaluation of hearing aid management skills (HASKI). Further research investigating the patient and hearing aid factors affecting hearing aid management skills may assist clinicians in identifying those hearing aid owners who are at greatest risk of not developing sufficient skills. Additionally, a better understanding of the impact that hearing aid handling skills have on hearing aid outcomes may motivate both clinicians and hearing aid owners to place greater emphasis on the development of these skills. Chapter Eight describes a study of the prevalence of hearing aid skills across seven Australian hearing clinics and reports factors associated with these skills. The aims of this study were to: 1) investigate the demographic and hearing aid factors that influence hearing aid management skills and knowledge and 2) investigate the impact of hearing aid management skills and knowledge on hearing aid outcomes.
Participant and hearing aid factors found to be associated with hearing aid skills and knowledge included participants’ age, gender, style of hearing aid, age of current hearing aid, and total years of hearing aid ownership. Higher levels of hearing aid handling skills and knowledge were found to be associated with better hearing aid outcomes, specifically higher self-reported satisfaction with hearing aids, perceived benefit from hearing aids, and overall outcome of the hearing aid fitting as evaluated by the International Outcomes Inventory for Hearing Aids survey. Hearing aid management difficulties were greatest for older people and for women, suggesting that clinicians need to be cognisant of the additional needs for these two groups.
2.5 References


CHAPTER THREE

Exploring hearing aid problems: Perspectives of hearing aid owners and clinicians

(Ear and Hearing, 2018, 39(1), 172-187)

3.1 Foreword to Chapter Three

Chapter Two of this thesis provided a review of the literature describing the benefits and barriers to use of hearing aids in the management of hearing impairment. The concept of barriers to hearing aid use requires greater attention for two reasons. First, in exploring hearing health behaviours, Saunders et al. (2013) found that perceived barriers to hearing aid use explained the greatest variance in hearing aid owners’ decisions to use their hearing aids or not. Second, while a number of barriers to hearing aid use have been identified in the literature, there is paucity regarding the full range of barriers experienced by hearing aid owners, how these barriers impact hearing aid use and what can be done to assist hearing aid owners overcome these barriers so that adults with hearing impairment can receive the full benefits of their hearing aids. Accordingly, the aim of this Chapter was to explore perceived barriers to hearing aid use, specifically problems that arise when using the hearing aid. To undertake this, group concept mapping techniques were employed; a participatory mixed methods approach combining qualitative group approaches to data
collection with quantitative analyses to produce visual maps of how people view a particular topic (Burke et al., 2005; Trochim & Kane, 2005; Trochim, 1989). Studies have established the validity of concept mapping techniques to identify multiple stakeholder perspectives and to develop frameworks to inform future directions in healthcare research (Burke et al., 2005; Trochim & Kane 2005). In this instance, the views and beliefs of hearing aid owners and clinicians were explored to inform research addressing problems that arise with hearing aid use.

3.2 Abstract

Objectives: To gather perspectives of hearing aid owners and hearing healthcare clinicians with regard to problems that may arise following hearing aid fitting and use these perspectives to generate a conceptual framework to gain a better understanding of these problems.

Design: Participants included a group of 17 hearing aid owners and a group of 21 hearing healthcare clinicians; data collection occurred separately for each group. Participants each attended two group sessions in Perth, Western Australia, wherein they: 1) generated statements describing the problems associated with hearing aids and 2) grouped the statements to identify key themes and rated the statements to investigate perceived impact of the identified items on overall success with hearing aids. Concept mapping was used to generate a conceptual framework.

Results: Four concepts were generated from participant grouping data regarding hearing aid problems: 1) Hearing Aid Management; 2) Hearing Aid Sound Quality and Performance; 3) Feelings, Thoughts and Behaviours and 4) Information and Training. While hearing aid owners and clinicians generated similar results regarding the concepts derived, the clinicians reported that the problems identified had a greater negative impact on hearing aid success than did hearing aid owners.

Conclusions: The magnitude and diversity of hearing aid problems identified in this study highlight the ongoing challenges that hearing aid owners face and suggest that current processes for hearing aid fitting can be improved. Problems relating to hearing aid management were most often deemed to have the greatest impact on hearing aid success.
and be the most preventable/solvable, and thus are a good starting point when addressing hearing aid related problems.

3.3 Introduction

Hearing loss is a common chronic health problem most often managed with hearing aids (Ferguson et al., 2017; Chisolm et al., 2007). Despite the benefits associated with hearing aid use (Ferguson et al., 2017; Chisolm et al., 2007), only one third of those who could benefit from hearing aids own them (Hartley et al., 2010), and up to one quarter of hearing aid owners do not use their hearing aids regularly (Hartley et al., 2010; Hickson et al., 2010; Kochkin, 2010). Reasons for hearing aid non-use identified in qualitative studies with hearing aid owners include high cost of hearing aids, negative attitude towards hearing aids, perception that hearing aids are not required and the unattractive appearance of hearing aids, with the majority of the reasons for non-use pointing towards hearing aid related problems (McCormack & Fortnum, 2013). Specifically, issues relating to physical fit, hearing aid handling (such as difficulty inserting batteries), performance issues (such as sound quality or inability to reduce background noise) and complaints regarding ongoing maintenance requirements (such as cleaning and basic repairs) have been reported (Goggins & Day, 2009; Kochkin, 2000a; McCormack & Fortnum, 2013).

Although clinicians can rectify the majority of these problems through modifications to the hearing aid, providing additional training or support and through communication training or aural rehabilitation (Goggins & Day, 2009; Meyer, Hickson & Fletcher, 2014), problems persist that prevent many hearing aid owners from receiving the full benefits of amplification. According to best-practice guidelines, aural rehabilitation with hearing aids comprises: 1) hearing aid fitting and programming to enhance auditory function; 2) instruction on device management; 3) communication training and 4) emotion based counselling supporting a problem-solving process aimed at enhancing the activities and participation of an individual with hearing difficulties, improving their quality of life, minimising any effect on significant others, and facilitating their acceptance of any residual problems (American Speech-Language-Hearing Association, 2015; Audiology Australia, 2013; Stephens, 2009; Boothroyd, 2007). However, clinical observations suggest that the duration
of the rehabilitation program, the number of appointments provided and the content of what is actually delivered and provided varies across clinics and clinicians. At the completion of the program, the onus is generally placed on the hearing aid owner to seek help for any problems that may arise. It is possible that hearing aid owners are not seeking help for their problems because they are oblivious to the fact that they are experiencing problems (Desjardins & Doherty, 2009), some may be unaware that the difficulties they are experiencing are rectifiable (Southall et al., 2006), or they may be unaware of what to do when problems arise (Southall et al., 2006).

More studies are needed that describe the array of hearing aid related problems currently being experienced by hearing aid owners, the impact of these problems and the hearing aid owners’ behaviours and beliefs regarding these problems. Knowledge gained may facilitate change in clinical practice that could prevent the problems from occurring or may support patients in solving the problems as they arise. Qualitative research has the ability to generate new information that may otherwise have been overlooked as it focuses on the experiences and perceptions of people, in this case, living with hearing loss (Knudsen et al., 2012). There is a growing body of literature utilising qualitative techniques in audioligic research (Grenness et al., 2014; Laplante-Lévesque et al., 2010a; Laplante-Lévesque et al., 2012; Laplante-Lévesque et al., 2006; Linssen et al., 2013). However, mixed methods approaches to behavioural research in audiology are less common. One such study (Poost-Foroosh et al., 2011) employed a mixed methods approach called concept mapping.

Concept mapping is a participatory mixed methods approach combining qualitative individual or group approaches to data collection with quantitative analyses to produce visual maps of how people view a particular topic (Burke et al., 2005; Trochim & Kane, 2005; Trochim, 1989). Concept mapping engages a group of participants to put forward statements describing their experiences, perceptions, thoughts or ideas about a specific topic, and to then give meaning to these statements through grouping and ranking (Trochim, 1989). In this way, the participants play an active role in not just generating the statements, but also synthesising and interpreting the data (Burke et al., 2005; Trochim, 1989). The concept maps generated represent how the group (or groups) discern the
interrelationships between statements and concepts, thus providing a basis for further discussion, interpretation and action (Rosas & Kane, 2012).

Studies have established the validity of concept mapping techniques to identify multiple stakeholder perspectives and develop frameworks to inform future directions. Concept mapping has been used to better understand the context surrounding health related outcomes (Burke et al., 2005) and is recommended in healthcare research that aims to evaluate services and plan improvements (Trochim & Kane, 2005). The purpose of this study was to generate a conceptual framework for understanding hearing aid problems and how hearing aid owners respond to these problems; in doing so, identifying key aspects of the hearing aid fitting process that could be improved. To undertake this, concept mapping techniques were employed to describe: 1) the hearing aid related problems that hearing aid owner’s experience and 2) how they respond to these problems, from the perspectives of both hearing aid owners and clinicians. These perspectives were then used to generate a conceptual framework to understand the relationship between and importance of the key concepts identified. Knowledge gained will inform best practices to reduce the prevalence and impact of hearing aid related problems, and subsequently reduce hearing aid rejection. For example, the list of problems identified could be used to inform item development for a clinical survey with the purpose of identifying and addressing hearing aid related problems. Similarly, the list of problems could be used to inform development of a self-help tool describing the common problems experienced by hearing aid owners and a detailed explanation of how to prevent and overcome each of the problems, with priority placed on the concepts deemed to be most urgent by the participants. Although participants in this study generated data for the two research questions (identification of the problems associated with hearing aid use, and how hearing aid owners respond to these problems), only the first will be presented here with the latter to be published in a subsequent paper.

3.4 Methods

This study used concept mapping techniques to generate a conceptual framework for understanding hearing aid problems, using the perspectives of hearing aid owners and clinicians.
3.4.1 Participants

Hearing aid owners were recruited through a chain of hearing aid dispensing clinics in Perth, Western Australia. The research group contacted, via email or post, potential participants who owned a hearing aid for up to three years. The decision to cap the number of years since hearing aid fitting was based on the assumption that majority of problems are likely to occur relatively soon after fitting and after a period of three years memories of problems associated with their latest hearing aid are more likely to have been forgotten. Hearing aid owners completed a short demographic questionnaire including participant age, gender, age of current hearing aid, duration of hearing aid use (total number of years of experience), style of hearing aid (behind-the-ear: BTE or in-the-ear: ITE), hearing aid funding source (whether they paid in full for their hearing services: private, or received government subsidies through the Australian Office of Hearing Services: office of hearing service), and satisfaction with hearing aids (with the response options very dissatisfied, dissatisfied, neutral, satisfied, and very satisfied). Participant recruitment continued until a minimum of one participant was recruited that represented each demographic group, i.e. at least one male and one female, and at least one wearing a BTE and one wearing an ITE. Despite being relatively new owners of their current hearing aid, the majority of participants were experienced hearing aid owners in that the current hearing aid was not their first hearing aid. Clinicians with experience dispensing and programming hearing aids were recruited through two of the Australian bodies representing audiologists (university trained with a postgraduate-level qualification) and audiometrists (non-university trained hearing aid technicians). For the ease of participant recruitment, all members of these two bodies were invited to attend a professional development workshop, with the first half of the session delivering a lecture reviewing the literature on audiological patient-centred care, with the second half providing a medium for data collection for this study. By attending the workshop clinicians gave consent to participate in the study; potential attendees were advised of this before registering for the workshop. Including independent participants with diverse perspectives contributes to the validity of the concept maps generated (Rosas & Kane, 2012).
3.4.2 Procedures

The Human Research Ethics Office of The University of Western Australia granted ethical approval for this study (RA/4/1/7667). All participants provided written consent to participate.

Concept mapping was used to generate and analyse the data (Burke et al., 2005; Trochim & Kane, 2005). The four steps of concept mapping are described in detail below, and include: a) brainstorming; b) grouping and rating; c) data analyses and d) interpretation (Burke et al., 2005; Trochim & Kane, 2005). An overview of the procedures can be found in Table 3.1.

Participants were required to attend two data collection sessions; the brainstorming task was conducted in Session One and the grouping and rating tasks were conducted in Session Two. These sessions were not recorded. The research group performed data analysis and interpretation after data collection was completed. Data analysis was conducted using the concept mapping software Concept Systems (Concept Systems Incorporated, 2011); specifically, generating the concept maps and conducting statistical analyses on the concept map generated (described in detail below).
Table 3.1. Overview of procedures.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Description</th>
<th>Hearing aid owners</th>
<th>Clinicians</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstorming</td>
<td>Participants were asked to generate statements that describe “what hearing aid related problems arise following hearing aid fitting”. Brainstorming session were conducted separately for hearing aid owners and clinicians.</td>
<td>n = 17</td>
<td>n = 21</td>
<td>RB and ALL</td>
</tr>
<tr>
<td>Pooling and refining of brainstormed statements</td>
<td>The research team pooled all the statements that both groups generated. The research team reviewed all the statements to eliminate redundant and irrelevant statements, as well as editing the statements to ensure they were clear and understandable.</td>
<td></td>
<td></td>
<td>RB, ALL and RE</td>
</tr>
<tr>
<td>Grouping</td>
<td>Participants grouped the statements to identify common themes. Participants were then asked to provide titles that captured the content of each group.</td>
<td>n = 10</td>
<td>n = 7</td>
<td>RB</td>
</tr>
<tr>
<td>Rating</td>
<td>Participants were given the list of statements and asked to rate them on a 5-point Likert scale as to: 1) how much they believed each problem impacts overall success with hearing aids (1 = minimal impact to 5 = high impact) and 2) whether they believed each problem can be solved or prevented (1 = cannot be solved/prevented at all to 5 = can be completely solved or prevented).</td>
<td>n = 13</td>
<td>n = 9</td>
<td>RB</td>
</tr>
<tr>
<td>Data analysis and interpretation</td>
<td>Multidimensional scaling generated a point map graphically displaying the results of the grouping task. Hierarchical cluster analysis determined the concepts the participants generated and represented them as cluster maps. Stress indexes were used to evaluate the correspondence of the represented model to the original participant structures. Split-half reliability tests were used to determine the consistency of the participant input using the grouping and rating data. Participants’ ratings were used to identify the perceived impact of each concept on overall success with hearing aids as well as participants’ beliefs as to whether problems could be solved/prevented. Reliability estimates of the ratings data were calculated using Cronbach’s alpha to determine internal consistency. Cohort comparisons were made using a pattern matching graph. Welch’s t test was used to compare the mean ratings between clusters.</td>
<td></td>
<td></td>
<td>RB and RE</td>
</tr>
</tbody>
</table>
3.4.2.1 Session One: Brainstorming

There were two separate brainstorming sessions, one for each of the hearing aid owner and clinician groups, both held in Perth, Western Australia. These sessions were split into two parts, with 45 minutes allowed for each part. Firstly, participants were asked to generate statements that describe “what hearing aid related problems arise following hearing aid fitting”. The wording was carefully chosen to focus on problems experienced with emphasis on those occurring following hearing aid fitting as we were interested in the problems that occurred once the hearing aid owners were no longer in frequent contact with the clinic, when the onus was on them to seek help for their problems. Secondly, participants were asked to generate statements that describe “what hearing aid owners do in response to these problems”; however, these data were presented in a subsequent manuscript. These sessions were conducted as face-to-face group sessions, led by the research team, wherein statements the participants put forward were typed into Microsoft Excel and displayed onto a large screen for all to see. During the session, both questions were delivered in a neutral tone and participants were not prompted beyond re-asking the same question, using the same wording, when there was a lull in contributions. The research team accepted all statements during the brainstorming activity, responding with a neutral tone. All members of the group were given equal opportunity to provide input. While some participants were more vocal than others, none seemed to dominate the conversation and all participants put forward at least one statement. The sessions were not recorded and the reflective comments included in this report were based on the memory and experience of the two researchers (RB & ALL) present during data collection.

For the hearing aid owner participant group, this session was used only for data collection.
For the clinician group, the first half of the session was a workshop discussing current research on help-seeking for hearing aid uptake. Clinicians were asked to consider help-seeking for hearing aid problems and whether hearing aid owners’ strategies and likelihood to seek help for problems after the fitting may differ from help-seek prior to the fitting. Following an open discussion on this topic, the researchers explained the purpose of this study, how concept mapping is conducted and then commenced Session One data collection; generation of brainstormed statements. Although, the time allocated to the
brainstorming activity was 45 minutes per question (1.5 hours in total), the full time allocated was not utilised as participants reported having contributed everything within the first 20-30 minutes. Participants were invited to email through any additional thoughts following the event, but none did.

The purpose of the groups for the brainstorming activity was to allow discussion between participants and to promote ideas to flow from each other’s suggestions. We chose to separate hearing aid owners and clinicians so that they would feel comfortable talking about problems that may be associated with the other group. During data collection we found this to be the case. The hearing aid owners choice of words suggested that they believed the problems were due to the clinicians’ actions, that ultimately the clinicians were responsible for problem prevention and resolution. In contrast, the language used by clinicians suggested that they felt it was the responsibility of the hearing aid owners to manage their hearing aids and prevent or solve problems.

Following the brainstorming session, the research team (RB, ALL and RE) pooled all the statements that both groups generated. The research team reviewed all the statements to eliminate redundant and irrelevant statements, as well as editing the statements to ensure they were clear and understandable. Redundant statements included those that were repeated during the brainstorming session, for example “broken aid”, “stops working”, “when my hearing aid dies”, “if the aid goes dead”, or “when it just stops”. Rather than including all of these variations, we reworded the sentiment to include statement 21. The hearing aid stops working. Some statements were omitted as they were not considered problems by the research team; for example, “used to have ears cleaned out every 6 months as I had itchy ears, but I no longer need to since getting hearing aids”. Some statements were reworded to make them more general and thus applicable to a wider range of participants; for example “poor clarity on phone, especially hearing phone numbers being recited by Americans” was reworded to statement 10. The hearing aid owner has difficulty hearing people clearly over the phone. Some statements were combined; for example “missing the beginnings of sentences even with the hearing aids”, “difficulty hearing clearly when children speak and my aids are in”, “I can’t hear all people, especially those that don’t articulate properly” and “I can’t hear the wife well even with the aids in”
were combined to make statement #5 *The hearing aid owner has difficulty hearing certain people clearly when wearing their hearing aids.* All the statements were reworded in a way to ensure they were not in the first person and thus could be used by both hearing aid owners and clinicians for the grouping and rating activities, i.e. “The hearing aid owner…”. The resulting set of statements were used for the grouping and rating tasks (Session Two).

### 3.4.2.2 Session Two: Grouping and rating

During Session Two, participants grouped the statements to identify common themes. Participants were instructed to group the statements in a way that made sense to them, ensuring that (a) each statement was only placed in one group, (b) they were to create at least five groups (although not all did), (c) a statement could be put in its own group if it is unrelated to the other statements or if it stood alone as a unique statement, and (d) they were not to have a “Miscellaneous” or “Other” group. Participants were informed that there was no right or wrong way to group the statements. Participants were then asked to provide titles that captured the content of each group.

For the rating task, participants were given the list of statements and asked to rate them on a 5-point Likert scale as to: 1) how often they personally experienced (or witnessed hearing aid owners experiencing) the problems listed (1 = almost never to 5 = almost always); 2) how much they believed each problem impacts overall success with hearing aids (1 = minimal impact to 5 = high impact) and 3) whether they believed each problem can be solved or prevented (1 = cannot be solved/prevented at all to 5 = can be completely solved or prevented). The results of 2) and 3) are reported here. Although rating data for the frequency of problems was collected, reflection on the wording of the question (specifically the use of the word “personal experience” which would arguably result in different magnitudes of scale for the hearing aid owners versus the clinicians) and the small cohort sizes for the rating tasks led to the decision to omit this data from the study. We plan to investigate the frequency of hearing aid problems identified by this study in a future project using a larger and more diverse sample population.
For the hearing aid owner group, grouping and rating tasks were conducted via face-to-face group sessions. Two hours was allocated for the session, although many finished the task early and were free to leave. One participant required additional time and assistance due to immobility (partial paraplegic) and was assisted by a carer not associated with the study and given as much time as he required to complete the tasks. Statements were printed on individual cards. Participants were asked to sort the cards into groups based on how similar in meaning they were to one another, and to provide a title for each group. For the rating task, hearing aid owners were provided with three printed lists of the statements (pen and paper, survey style), one for each of the rating questions. Although hearing aid owners attended Session Two as a group, participants were instructed to work independently. They were permitted to discuss their thoughts but asked to complete the activities based on their own personal opinions. Most participants completed the tasks alone, a few discussed the task with other participants during the grouping task, but mainly to clarify a statement rather than discuss which group it belonged to.

There was no need for the grouping and rating tasks to be conducted as group sessions, and they were not for the clinician group. The reason we chose to run a group session for the grouping and rating tasks for the hearing aid owners, was so that one of the researchers was present and available for the full two hour session to explain what was required of people and answer any questions as they arose.

For the clinician group, grouping and rating tasks took place via an online portal (Concept Systems Incorporated, 2011), wherein clinicians logged in to complete the tasks at any time and as many times as they wished. Clinicians were asked to complete the tasks within six weeks. For the online grouping task, the software displayed all of the statements on one side of the screen and instructed the clinicians to move the statements across to the other side of the screen into folders, as many folders as required, and then to name the folders accordingly. For the online rating task, the software displayed the statements and the rating scales in the format of an online survey. Clinicians were unable to view each other’s grouping and rating responses.
All participants (17 hearing aid owners and 21 clinicians) attended the brainstorming sessions and contributed to the generation of statements for both research questions 1) hearing aid problems and 2) responses to problems (to be reported separately). Participants were then randomly allocated into two groups using a random number generator in Microsoft Excel. Each group was randomly assigned to one of the two research questions for the Session Two grouping and rating tasks. All participants were invited to complete grouping and rating for both research questions, starting with the question for which they were randomly allocated to. We chose to split the group to reduce participant burden. The grouping and rating exercises can be arduous and time consuming and we did not want to pressure the participants. Thus, once they finished the task for their assigned group, they were given the option of leaving or to stay and complete the grouping and rating tasks for the other research question. If we had insisted that everyone stay for a four hour session to complete all the tasks, it is possible that participants’ data may not have reflected their true thoughts as they may have rushed the exercises or lost attention. Furthermore, extending the session to four hours or requiring participants to return for a third session may have resulted in further dropouts.

Of the 17 hearing aid owners who participated in Session One (brainstorming), 13 attended Session Two (the nine who were allocated to this research question and four who opted to complete the tasks for both research questions); all of the 13 completed the rating activity and ten completed the grouping activity (no drop outs). Of the 21 clinicians who participated in Session One (brainstorming), nine participated in Session Two (eleven were allocated to this research question; however, two did not complete the Session Two grouping and rating activities despite being sent five reminders via email); all of these nine completed the grouping activity and seven completed the rating activity (18% drop out rate).

The literature describing concept mapping processes does not specify a minimum number of participants for the brainstorming activity, although Trochim (1989) indicates a preference for groups of 10 to 20 people to ensure a variety of opinions and still enable group discussion. Participants should be diverse and represent all stakeholders involved in a topic, in this case, both hearing aid owners and clinicians. The minimum number of
participants recommended for the grouping activity is 15, as studies with fewer than 15 participants are more likely to generate less reliable concept maps (indicated by the stress value; described in detail below) (Rosas & Kane, 2012). The number of participants required for the rating activity depends on the purpose for collecting the rating data. Studies with large cohort sizes may be able to discuss similarities between their rating data and the larger population and describe prevalence of their findings. However smaller cohorts, such as used in this study, cannot be described as representative of the wider population and such rating data is instead used to inform areas of future research and investigation. Each of the brainstorming, grouping and rating activities do not necessarily have to be performed by the same participants or the same number of participants (Trochim, 1989).

3.4.2.3 Data analysis and interpretation

Data were entered into the Concept Systems software (Concept Systems Incorporated, 2011), with participants’ grouping and rating data coded as client or clinician. Participant rating data included: 1) impact on success and 2) whether or not problems could be solved/prevented, and were analysed separately. Multidimensional scaling generated a point map graphically displaying the results of the grouping task. A point map displays each statement as one point and visualises the relationship and proximity of statements to one another. The statements that participants frequently grouped together are represented closer together in the two dimensional space than statements that participants infrequently grouped together. The strength of the multidimensional scaling analysis was tested by computing a stress index. The stress index indicates the goodness of fit of the two dimensional configuration to the grouping data and a stress value between 0.205 and 0.365 is considered acceptable (Kane & Trochim, 2007).

Hierarchical cluster analysis determined the concepts the participants generated and represented them as cluster maps. The cluster map graphically depicts clusters of points (statements) based on a consensus of how the participants grouped the individual statements. The breadth or tightness (i.e., shape and size) of a cluster represents whether it is a broader or narrower conceptual area. Two of the researchers (RB & RE) selected the appropriate number of clusters after reviewing the statements within each cluster and
discussing whether the merging or splitting of clusters was appropriate; that is, it made sense given the statements in that particular cluster (Jackson & Trochim, 2002). These decisions were also informed by bridging scores, indicating which statements were anchors in a specific area of the map and which ones were bridging across different areas of the map. The lower the bridging score for a particular cluster, the more often participants grouped these statements together. Conversely, a higher bridging score indicated that participants were less likely to have grouped these statements together and thus the cluster may have benefited from being split into several clusters. There are no minimum bridging scores or threshold values indicated in the literature. To determine the appropriate number of clusters for the data the authors considered each concept’s bridging score and whether splitting the cluster made sense given the reallocation of the statements between the new clusters generated, as well as whether the bridging scores for the new clusters were better or worse than the bridging score for the one combined cluster. It is important to note here that the researchers only decided the number of clusters; the hierarchical cluster tree structure is entirely determined by the grouping data put forward by participants (Jackson & Trochim, 2002). With cluster analysis, the most appropriate number of clusters depends on the level of specificity desired and the context at hand, factors that are best assessed by the researchers (Jackson & Trochim, 2002). In this case, when we selected three clusters, the concepts identified were: 1) hearing aid management; 2) hearing aid sound quality and performance and 3) poor advice from clinicians (these three concept names were based on the grouping names put forward by participants). When we then selected four clusters, the third cluster (bridging score 0.43) was split into two clusters: hearing aid owner reluctance and expectations (bridging score 0.51), and insufficient information and training (bridging score 0.32). Bridging scores improved for one of the clusters, but not the other when compared to the bridging score when the clusters were combined as one cluster. Of importance to note is that the individual statements contained within each of the two new clusters made sense in that they seemed to fit well with each of the two new cluster groups and cluster name.

When we then moved from four clusters to five clusters, the participant data resulted in the splitting of concept Hearing aid Management (bridging score 0.21) into two clusters, describing management difficulties (bridging score 0.15) and physical comfort (bridging
score 0.40). However, the individual statements included within each of these two new clusters were not consistent with the cluster name, that is, many statements from one should have been in the other. For example statement 21. *The hearing aid stops working* and 22. *The hearing aid whistles* were placed in the new cluster “physical comfort” when they don’t really describe aspects of physical comfort. Thus, the research team decided to use the four cluster solution as the best concept map to represent the data. Any disagreements in selecting the number of clusters would have been resolved by voting among the authors; however, there was no disagreement on the editing of statements or the final selection of clusters.

Each cluster, representing a unique concept, was given a name based on the grouping labels the participants designated, as well as a descriptive overview based on the statements it contains and the grouping labels the participants indicated. For example, for the concept Hearing Aid Management, the group labels put forward by participants included Physically wearing the hearing aid; Hearing aid handling and maintenance; Management difficulties; Hearing aid care and cleaning; Hearing aid upkeep, maintenance and repairs; Problems with hearing aid use; Cleaning, maintenance and handling; and Management. This entire process resulted in a concept map. Validity of the concept map generated is achieved through assessment of external representational validity performed by seeking verification that the brainstormed statement set represents the topic under enquiry using multiple data collection and analysis methods (Rosas & Kane, 2012).

A concept map was generated for each cohort (hearing aid owners and clinicians). A split-half reliability measure comparing the two cohorts was conducted using the concept mapping software (Concept Systems Incorporated, 2011) and Spearman-Brown Prophecy Formula correction applied using IBM SPSS Statistics (IBM, 2014), to determine whether the cohort concept maps differed significantly. If the maps did not differ, the hearing aid owners and clinicians’ data would be combined and one concept map would be generated for the data set and further analyses. Correlation above 0.7 was considered high and acceptable to combine the data (Hinkle et al., 2003).
A similar reliability analysis was conducted for the final concept map (clinician and hearing aid owner data combined) using split-half reliability (Trochim, 1989). The participant cohort was randomly split into two sub-cohorts and separate similarity matrices and concept maps were generated for each sub-cohort, based on the number of clusters selected for the final map. Correlation between the two maps was evaluated by applying the Spearman-Brown correction correlation to the split half reliability measure (Trochim, 1989) using IBM SPSS Statistics. The split-half reliability test evaluates the consistency of the participant input, thus indicating the reliability of concept (Rosas & Kane, 2012).

Participants’ ratings were used to identify the impact of each concept on overall success with hearing aids as well as participants’ beliefs as to whether problems could be solved/prevented. Reliability estimates of the ratings data were calculated using Cronbach’s alpha to determine internal consistency (Rosas & Kane, 2012). Cohort comparisons were made using a pattern matching graph; a ladder graph that displays a comparison of average cluster ratings between two variables (in this case cohorts), based on the cluster map selected and the participants rating data. Welch’s t test was used to compare the mean ratings between clusters (Concept Systems Incorporated, 2011). A go zone graph was used to plot the individual statements according to participant rating scores (impact against solvable/preventable). This facilitated identification of the problem statements that were deemed to have the greatest impact and to be the most solvable/preventable.

3.5 Results

The two participant groups were heterogeneous with respect to demographic and hearing aid related factors. Hearing aid owners (n=17) were between 67 and 88 years of age (M = 75.94, SD = 8.46), with 35.29% (n=6) male and 64.71% (n=11) female. Self-reported severity of hearing loss (when not wearing hearing aids) ranged from mild to severe. The majority (70.59%; n=12) of participants had owned hearing aids for less than five years, 23.53% (n=4) reported having five to ten years’ experience, and 5.89% (n=1) reported having more than ten years’ experience. More than half of the participants (n=10) received a government subsidy for their hearing aids and hearing services, the other seven paid in full. Participants wore behind-the-ear and in-the-ear style hearing aids from six different manufacturers. How
much hearing aid owners used their hearing aids and their satisfaction with them varied. Participants indicated how often they used their hearing aids in the past two weeks based on an item from the International Outcome Inventory for Hearing Aids (Cox et al., 2000) with responses ranging from “no use” to “more than 8 hours per day”. Participants indicated their satisfaction with their hearing aids based on a question adopted from the MarkeTrak consumer survey (Kochkin, 2000b), with responses ranging from Dissatisfied to Highly Satisfied.

Clinicians (n=21) were between 23 and 60 years of age (M = 35.14, SD = 10.67), with 19.05% (n=4) male and 80.95% (n=17) female. Employment varied in type, with 11 clinicians working for a not-for-profit organisation, and others working at a university (n=2), hospital (n=1), government funded chain (n=2), independent private clinic (n=2) or private clinic group (n=3). Audiologists (n=20) outnumbered audiometrists (n=1). Almost half (n=10) of the clinicians had less than five years’ experience in dispensing and programming hearing aids; 23.81% (n=5) indicated five to ten years’ experience and 28.57% (n=6) indicated more than ten years’ experience. The 16 clinicians who participated in Session two were between 23 and 60 years of age (M = 34.36, SD = 11.01), with 25.00% (n=4) male and 75.00% (n=12) female.

3.5.1. Brainstorming
Brainstorming sessions yielded a total of 160 statements across both cohorts describing the problems that arise following hearing aid fitting. Reducing and editing the statements resulted in a final list of 80 statements used in the rating and grouping tasks (Table 3.2). The majority of statements (n=50) described device-related issues (physical handling and acoustic performance) and the remaining 30 statements described person related issues (skills, knowledge and emotions). Device-related problems focussed on aspects of hearing aid design (such as poor fit, small controls or complicated systems), as well as aspects relating to performance (associated with sound quality and benefit in desired situations). Person-related problems described feelings, thoughts and behaviours of hearing aid owners in relation to getting used to hearing aids (including expectations, motivation and apprehensions) and problems associated with knowledge and skill acquisition.
3.5.2 Grouping and rating

Although during the grouping activity participants were instructed to create at least five groups, one did not. The number of groups created by participants ranged from four to 18 (M = 8.47, SD = 3.31).

3.5.3 Data analysis and interpretation

The concepts identified through cluster map generation for the hearing aid owner and the clinician groups did not differ significantly (split-half correlation for the grouping task was 0.675 and application of the Spearman-Brown correction resulted in a reliability of 0.806) and therefore a combined cluster map was generated and used for the remainder of the analyses. The final cluster map selected had a stress index of 0.247, suggesting that the concept map appropriately represents the grouping data (Kane & Trochim, 2007). Reliability testing of the grouping task using split-half correlation was 0.798, and application of the Spearman-Brown correction resulted in a reliability estimate of 0.887, suggesting high consistency between how the individuals grouped the data (Trochim, 1989). That is, when hearing aid owner and clinician data were combined and then randomly split into two sub-cohorts, the statements were grouped in similar ways.
Table 3.2. Four concepts describing problems associated with hearing aids.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Concept</th>
<th>Description</th>
<th>Statements</th>
</tr>
</thead>
</table>
| Device          | Hearing Aid      | Problems relating to hearing aid use, handling and ongoing care. | 6. The HA owner finds it hard to change the small components of the hearing aid, like the battery or wax protector  
1. The hearing aid gets blocked with wax  
66. The HA owner finds it hard to change the program (rocker switch)  
62. The HA owner is unsure which is the left and which is the right hearing aid  
64. The HA owner has difficulty inserting the hearing aid  
12. The hearing aid flicks across the room when the HA owner takes their glasses off  
24. The HA owner is unsure which buttons to press and what the buttons do  
55. The hearing aid gets lost regularly  
54. The HA owner finds it a hassle having to clean blockages from the hearing aid every day  
38. The HA owner experiences difficulties using their remote control/ Bluetooth streamer/ TV streamer  
35. The HA owner finds it difficult to insert the batteries  
52. The HA owner can’t tell when the hearing aid battery is going flat  
34. The HA owner is unsure why one ear is easier to insert than the other ear  
13. The hearing aid falls off/out of the HA owner ear  
15. The HA owner is afraid to touch the buttons in fear that they might break the hearing aid  
60. The hearing aid gets wet and the HA owner doesn't know how to fix it  
71. The HA owner finds it an effort putting the hearing aid in and taking it out each day  
73. The HA owner does not use the dry store  
58. The ear moulds work their way out of the HA owner ears when chewing  
80. The HA owner is unsure how to use the hearing aid with the phone; how to use the phone program or where to hold the phone  
21. The hearing aid stops working  
3. The HA owner is not sure how long hearing aid batteries are supposed to last  
77. The hearing aid doesn't sit properly when worn with glasses  
49. The nursing staff lose the hearing aid regularly  
29. The nursing home staff don’t know how to help the HA owner with their hearing aid problems  
22. The hearing aid whistles (feedback)  
18. The hearing aid is uncomfortable |
<p>| Management      |                  |                                                           |  |</p>
<table>
<thead>
<tr>
<th>Device</th>
<th>Hearing Aid</th>
<th>Sound Quality and Performance</th>
<th>Problems relating to hearing aid performance; may be influenced by the clinicians programming of the hearing aid or the hearing aid owners expectation or use of the hearing aid.</th>
</tr>
</thead>
</table>
| Person | Feelings, Thoughts and Behaviours | Problems related to the personal and individual experience of getting used to hearing aids and influenced by the wearers’ expectations, reluctance (internal) | 79. The hearing aid hurts the HA owner's ear  
69. The hearing aids make the HA owners ears itch (not just at first, but all the time)  
19. The hearing aid makes everything sound too loud  
75. The hearing aid picks up people talking at a distance, but does not pick up people close by  
5. The HA owner has difficulty hearing certain people clearly when wearing their hearing aids  
26. The HA owner is frustrated by the difference in clarity between each ear  
36. The hearing aid sounds tinny and sharp  
4. Soft sounds are too loud, like walking or keys jiggling  
2. The HA owner finds loud noises (like the car horn) so loud it makes them jump  
20. The HA owners own voice sounds echoey  
74. Wearing the hearing aid makes it difficult to sing in tune, especially in a choir  
28. The hearing aid picks up sounds that the HA owner does not want to hear  
53. The HA owner finds the loudness of the background noise leaves them with a headache  
11. The HA owner finds listening to music isn't enjoyable as the hearing aid distorts the sound  
37. The HA owner gets frustrated as the hearing aid doesn't work well in noisy environments  
48. Hearing on the phone is still difficult when wearing the hearing aid, especially in a noisy environment  
10. The HA owner has difficulty hearing people clearly over the phone  
76. The hearing aid doesn’t work well in windy environments  
51. The HA owner finds it difficult to hear people speaking from behind them, like in the back seat of the car  
78. The hearing aid cannot pick up people speaking from the next room  
8. The HA owner feels that TV is not as clear through hearing aids as it is through headphones  
33. The HA owner has difficulty adjusting to the sound of the hearing aids  
9. The HA owner still needs to concentrate hard when watching TV  
56. The HA owner feels that they hear just as well without hearing aids  
7. The HA owner has unrealistic expectations of what the hearing aid should be able to do  
63. The HA owner doesn't wear their hearing aid as they live on their own and feel that they therefore don’t need to hear everything  
40. The HA owner feels that they hear well when they wear just one hearing aid, and do not see the benefit in wearing both hearing aids  
50. The HA owner doesn't wear their hearing aids often, finds them a bother and can't get used to them  
16. The HA owner expects more than hearing aids are able to provide |
<table>
<thead>
<tr>
<th>Person and Training</th>
<th>Problems relating to the transfer of information and training from the clinician to the hearing aid owner.</th>
</tr>
</thead>
<tbody>
<tr>
<td>27. The HA owner is not willing to pay for a new set of hearing aids given that the first set was not successful</td>
<td></td>
</tr>
<tr>
<td>61. The HA owner doesn’t wear their hearing aid because they feel they don’t need it</td>
<td></td>
</tr>
<tr>
<td>32. The HA owner feels that the new hearing aids are not as good as the old hearing aids</td>
<td></td>
</tr>
<tr>
<td>23. The hearing aid batteries don’t last long</td>
<td></td>
</tr>
<tr>
<td>46. The hearing aid did not reduce the HA owners tinnitus</td>
<td></td>
</tr>
<tr>
<td>67. The HA owner is disappointed with hearing aids given the cost</td>
<td></td>
</tr>
<tr>
<td>45. The HA owner was told that they needed the more expensive hearing aid, but still can’t hear clearly. The HA owner now feels that hearing aids are not worth the cost</td>
<td></td>
</tr>
<tr>
<td>14. The hearing aid looks clunky</td>
<td></td>
</tr>
<tr>
<td>30. The HA owner is frustrated at the cost of hearing aid batteries</td>
<td></td>
</tr>
<tr>
<td>31. The HA owner is frustrated by the need to buy hearing aid batteries</td>
<td></td>
</tr>
<tr>
<td>47. Since getting hearing aids, the HA owner now needs to have their ears suctioned every 6 months</td>
<td></td>
</tr>
<tr>
<td>70. The hearing aid causes ear infections</td>
<td></td>
</tr>
</tbody>
</table>

Person Information and Training

42. The clinician did not provide information about all of the features and options available with hearing aids

39. The HA owners was not informed that loan aids are available while hearing aids are being repaired

57. The clinician did not demonstrate how to clean the hearing aid

59. The clinician did not explain what all the extra pieces in the hearing aid the box were for

43. The clinician did not provide adequate instructions

17. The HA owner forgets the information/training provided by the clinician

41. The HA owner was overwhelmed with the amount of information provided by the clinician and found it too much to take in

44. The user booklet instructions are too small and hard to understand

68. The clinician pressured the HA owner to choose the more expensive hearing aid

72. The HA owner is unsure whether they can wear the hearing aid with noisy machinery or power tools

25. The HA owner cannot memorise everything - too many instructions, too much information

65. The HA owner was informed by their doctor that they didn’t really need hearing aids

Note: Statements are listed in ascending order of their bridging scores, that is, those statements that participants most often placed in this group appear higher on the list; thus they best represent the core meaning of the concept.
The concept map revealed four concepts, or groupings of hearing aid problems: 1) Hearing Aid Management; 2) Hearing Aid Sound Quality and Performance; 3) Feelings, Thoughts and Behaviours and 4) Information and Training (Figure 3.1). Hearing Aid Management described problems relating to hearing aid use, handling and ongoing care. These statements tended to be device focused, for example, statement 13. *The hearing aid falls off/out of the hearing aid owners ear* and 21. *The hearing aid stops working* (Table 3.2). Hearing Aid Sound Quality and Performance described problems relating to hearing aid performance; this may be influenced by the clinicians’ programming of the hearing aid or the hearing aid owners’ expectation or use of the hearing aid. Similarly, these statements also tended to be device focused, for example, statement 19. *The hearing aid makes everything too loud* and 76. *The hearing aid does not work well in windy environments.* However, some of these statements also described the hearing aid owners’ ongoing difficulty when using the hearing aid, for example, statement 53. *The hearing aid owner finds the loudness of the background noise leaves them with a headache.* Feelings, Thoughts and Behaviours described the personal and individual experience of getting used to hearing aids; this may be influenced by the hearing aid owners’ expectations, reluctance and/or motivation. For example, statement 16. *The hearing aid owner expects more than the hearing aids are able to provide* and 67. *The hearing aid owners is disappointed with the hearing aids given the cost.* Information and Training described problems relating to the transfer of information and training from the clinician to the hearing aid owner. These statements tended to describe the inadequacy or lack of training provided by clinicians on specific topic areas such as statement 42. *The clinician did not provide information about all of the features and options available with hearing aids* and statement 59. *The clinician did not explain what all the extra pieces in the hearing aid box were for.*
Figure 3.1. Concept map of the four concepts describing problems associated with hearing aids.

Note: The smaller numbers refer to the individual statements listed in Table 3.1. The bridging scores for each concept (shown in brackets) indicate how often participants grouped these statements together, with a lower score indicating that participants more often grouped these statements together.

The Concept Map displays the four concepts based on the participants grouping data, depicting the concepts as separate groups, fairly evenly spaced and not overlapping. This suggest that participants tended to agree with each other as to how the statements should be grouped, but also that participants identified the concepts as unique from each other. The literature describing concept mapping does not offer minimum participants numbers for the brainstorming activity, rather Trochim (1989) recommends a diverse sample representing the various stakeholders associated with the research topic. In this study, the stakeholders were hearing aid owners and hearing healthcare clinicians. The participants involved in this study were diverse in age, gender and years of experience with hearing aids. While all of the hearing aid owners were recruited from a single chain of hearing clinics, the
Clinic provided services by 24 clinicians across seven sites and selected hearing aids from four different manufacturers. It is likely that the experiences of each participant would have differed, despite receiving services from the same provider. Although all clinicians participating in this study were from Western Australia, they worked in a variety of settings including hospitals, small private clinics and large chains, and brought a variety of experiences to the brainstorming discussion. The final concept map generated in this study was based on the grouping data of 19 participants (ten hearing aid owners and nine clinicians, combined); this is above the minimum of 15 participants recommended by Rosas and Kane (2012). Furthermore, the high stress index achieved by the resultant map denotes the high reliability of the concept map as compared to the grouping data generated by the individual participants. Rating data were generated by 13 hearing aid owners and seven clinicians. This sample size does not allow us to infer whether these findings are representative of the beliefs of the wider population; however, they offer future directions for further research.

Reliability estimates of the rating data demonstrated high internal consistency for all four concepts across both rating scales; impact on overall success (Hearing Aid Management \( \alpha = 0.982 \), Hearing Aid Sound Quality and Performance \( \alpha = 0.960 \), Feelings, Thoughts and Behaviours \( \alpha = 0.961 \), and Information and Training \( \alpha = 0.935 \)) and whether the problems can be solved/prevented (Hearing Aid Management \( \alpha = 0.950 \), Hearing Aid Sound Quality and Performance \( \alpha = 0.909 \), Feelings, Thoughts and Behaviours \( \alpha = 0.935 \), and Information and Training \( \alpha = 0.928 \)).

The first pattern matching graph depicts the impact of each concept on overall success with hearing aids, as indicated by participant rating scores (Figure 3.2). Although visual inspection of the graph may suggest that the clinician group identified Hearing Aid Management as having a greater impact on hearing aid success than Information and Training, there was no statistically significant difference between concept means for the clinician group. In contrast, hearing aid owners indicated that problems associated with Hearing Aid Sound Quality and Performance had a significantly greater impact on overall success with hearing aids than the other three concepts \( t(48) = -3.031, p<0.01 \). There was a significant difference between cohorts for the mean impact ratings for all four concepts, with clinicians indicating
a greater impact on hearing aid success than hearing aid owners for all four concepts: Hearing Aid Management \[t(56)= -14.149, p<0.001\], Hearing Aid Sound Quality and Performance \[t(40)= -6.038, p<0.001\], Feelings, Thoughts and Behaviours \[t(34)= -11.591, p<0.001\], and Information and Training \[t(22)= -9.528, p<0.001\].

**Figure 3.2.** Pattern matching graph comparing hearing aid owners’ and clinicians’ rating of the impact of the concepts of hearing aid related problems (1 = minimal impact to 5 = high impact). The mean cohort rating for each concept is indicated in brackets.

The second pattern matching graph depicts participants’ opinions as to whether the problems identified can be solved/prevented (Figure 3.3). Although visual inspection of the graph may suggest that the hearing aid owner group regarded the statements contained within the Information and Training concept as more solvable/preventable than the statements within the concept Feelings, Thoughts and Behaviours, there was no statistically significant difference between participant groups for concept means. In contrast, clinicians
indicated that problems associated with Information and Training \( t(31)=4.327, p<0.001 \) and Hearing Aid Management \( t(45)=5.240, p<0.001 \) were significantly more solvable/preventable than the other two concepts. There was a significant difference between cohorts for the mean solved/prevented ratings for two concepts, with clinicians indicating that Hearing Aid Management \( t(56)=-3.629, p<0.001 \) and Information and Training \( t(22)=-2.5173, p<0.05 \) were more solvable/preventable than the hearing aid owners regarded. There was no significant difference between cohort means for Hearing Aid Sound Quality and Performance \( t(40)=-0.978, p>0.05 \) and Feelings, Thoughts and Behaviours \( t(34)=1.180, p>0.05 \).

**Figure 3.3.** Pattern matching graph comparing hearing aid owners and clinicians rating of the extent to which the concepts of hearing aid related problems can be solved or prevented (1 = cannot be solved/prevented at all to 5 = can be completely solved or prevented). The mean cohort rating for each concept is indicated in brackets.
The go zone graph provides a visual representation of the problems according to their impact on overall success with hearing aids and whether they are considered solvable/preventable (Figure 3.4). Here, rating data for each cohort are combined. More statements (26/80) fell within the top left quadrant than the other quadrants, deemed to be the most solvable/preventable but have low impact. These statements largely came from the concepts Hearing Aid Management (14/26) and Information and Training (10/26). Twenty statements (20/80) fell into the bottom left quadrant, deemed to be the least solvable/preventable and low impact. Half of these were from the concept Feelings, Thoughts and Behaviours and the other half from the other three concepts. Nineteen statements (19/80) fell into the bottom right quadrant, deemed to have high impact but less solvable/preventable. Majority (14/19) of these were from the concept Hearing Aid Sound Quality and Performance. Fifteen statements (15/80) fell within the top right quadrant, deemed to have the greatest impact on hearing aid success and be the most solvable/preventable. The majority of these statements were from the concept Hearing Aid Management (8/15). Four of these statements were from the concept Hearing Aid Sound Quality and Performance: statement 19. *The hearing aid makes everything sound too loud,* 20. *The hearing aid owners own voice sounds echoey,* 51. *The HA owner finds it difficult to hear people speaking from behind them, like in the back seat of the car;* 75. *The hearing aid picks up people talking at a distance, but does not pick up people close by.* Two of the statements were from the concept Feelings, Thoughts and Behaviors: statement 7. *The hearing aid owner has unrealistic expectations of what the hearing aid should be able to do* and 16. *The hearing aid owner expects more than hearing aids are able to provide.* One of the statements was from the concept Information and Training: statement 44. *The user booklet instructions are too small and hard to understand.*
3.6 Discussion

Two overarching themes of hearing aid related problems that arise following hearing aid fitting were identified by the researchers: 1) problems relating specifically to the hearing aid (Concepts: Hearing Aid Management; Hearing Aid Sound Quality and Performance) and 2) problems relating to the experience of the hearing aid owner, mainly relating to their interaction with the clinic and the clinician (Concepts: Feelings, Thoughts and Behaviours; Information and training). The majority of the problems identified were grouped into the two concepts associated with the hearing aid device. It is likely that these findings were influenced by the device-centric wording of the research question and the brainstorming statement, asking participants to reflect on, “what hearing aid related problems arise following hearing aid fitting?” It is also possible that the results emulate the nature of clinical practice that focuses on the device rather than the person and interaction between the person and the clinician (Erdman et al., 1994; Ekberg et al., 2014).
The observation that hearing aid owners chose words indicating that clinicians had responsibility for problems, prevention and solutions is similar to how participants in the study by Poost-Foroosh et al. (2011) worded their statements. It is possible that the unidirectionality of the statements put forward by hearing aid owners indicates a need for greater client empowerment throughout the hearing aid fitting process. Empowerment describes the process of helping clients discover personal strengths and capacities to take control of their lives, and can be facilitated by adopting a client-centred approach to care (Aujoulat et al., 2007). Empowerment can be facilitated by the clinician, through conveying sufficient information in an easy to understand manner, involving the client in decision making and supporting the client’s choices (Poost-Foroosh et al., 2011). Hearing aid owners’ views that problem prevention and resolution remain the responsibility of the clinician possibly highlight the historical dominance of the biomedical model in audiology, presenting the clinician as the expert and the hearing aid owner as the passive recipient of care. In contrast, the clinicians’ views that problem prevention and resolution should be the responsibility of the hearing aid owner suggest a willingness to work towards client empowerment.

3.6.1 Theme One: Problems related specifically to the hearing aid

3.6.1.1 Hearing aid management

The difficulties that hearing aid owners experience with regard to hearing aid management are well documented (Desjardins & Doherty, 2009; Ferrari et al., 2015; McCormack & Fortnum, 2013), thus, it is not surprising that participants in this study described 29 different problems relating to hearing aid use, handling and ongoing care. More statements were generated for this concept than for any of the other three concepts. Also, the majority of the problems that fell within the top right quadrant of the go zone graph, and thus deemed to have the greatest impact on hearing aid success and be the most solvable/preventable, were from the concept Hearing Aid Management. Improving hearing aid management is a good starting point for improving hearing aid related problems. There are a range of tools available to identify problems associated with hearing aid management, such as the clinical surveys reviewed by Bennett et al. (2015), including the MARS-HA (West...
& Smith, 2007); however, it appears that uptake of clinical surveys in audiology practice remains limited (Humes, 2012; Kochkin et al., 2010; Lindley, 2006).

Participants in this study described how insufficient, or inexistent, information and training affected their ability to acquire appropriate skills for hearing aid use. In this way, the concepts Hearing Aid Management and Information and Training are interrelated. The process of information exchange during clinical appointments facilitates development of the client-clinician relationship, as well as the opportunity for the client to evaluate the clinician’s individual working style and to determine the extent to which the clinician’s attitudes and behaviours match the client’s own preferences and expectations (Poost-Foroosh et al., 2015). Studies interviewing hearing aid owners reveal that they report receiving insufficient practical training and support on hearing aid use (Kelly et al., 2013), and consequently report low levels of confidence in their ability to manage their hearing aids (West & Smith, 2007). This has led research groups to investigate novel ways to provide hearing aid management training, such as group training (Abrahamson, 2000; Krics, 2000), use of recorded electronic materials (Ferguson et al., 2015; Kramer et al., 2005), and internet based training programs (Laplante-Lévesque et al., 2006; Thorén et al., 2014). The problems relating to Hearing Aid Management identified in this study could become a checklist for the development of such materials to ensure they encapsulate the problematic aspects of hearing aid management as described by hearing aid owners and dispensing clinicians.

### 3.6.1.2 Hearing aid sound quality and performance

The problems relating to Hearing Aid Sound Quality and Performance identified in this study reflect the multi-faceted nature of hearing aid use. For example, statement 28. *The hearing aid picks up sounds that the HA owner does not want to hear* may reflect: 1) the limitations of current hearing aid technology; 2) the hearing aid owners’ lack of understanding (or unrealistic expectations) as to what the hearing aid classifies as noise (for example, speech may be the preferred signal in some environments and deemed noise in others); 3) the inappropriate programming of the hearing aid by the clinician or 4) the inappropriate use of the hearing aid by the owner (such as using the wrong program for a particular environment). Irrespective of the root cause of the problem, participants worded their
statements in a way that suggests the hearing aid is at fault. Similar findings were reported by Laplante-Lévesque et al. (2013) where participants emphasised the hearing aid, rather than the audiological services as the main determining influence towards attaining optimal hearing aid use. This is not surprising given the emphasis on the hearing aid device in current clinical practice.

While clinicians program the hearing aid based on research driven prescriptive formulas, patient preferences can often result in modifications to the hearing aid settings (Dillon et al., 2006). However, there are no real evidence-based guidelines for patient guided modifications or limits as to how the clinician might adjust the hearing aid. Whilst the clinician adjusts the hearing aid at the patients’ request, it is questionable whether these minor changes would have any significant positive impact on hearing aid performance (Cunningham et al., 2001). Clinical decision making in this situation is difficult as the clinician must determine the nature of the client’s complaint, infer the acoustics associated with the problematic situation, and deduce which parameter of the hearing aid to adjust. Furthermore the clinician must determine the appropriate direction and extent of the adjustment to be made based upon a clients’ subjective experience (Dillon et al., 2006). This is a complex process and some clients may persist with underperforming or inappropriate hearing aid settings. Furthermore, these adjustments may need to be repeated several times before the client is happy with the settings or in some cases this may not eventuate and the patient may persist with an underperforming hearing aid or cease wearing the hearing aid entirely. Through this process, clinicians generally address one problem at a time. That is, when a patient reports a problem, the clinician adjusts the hearing aid to address that problem, potentially causing or exacerbating other problems relating to sound quality and performance. For example, reducing high frequency amplification may overcome reports of disliking the harsh or sharp sound of their surroundings, but may simultaneously reduce audibility for female voices or impair functionality of directional microphones. Clinicians could use the list of hearing aid related problems identified in this study to identify the full array of problems being experienced by an individual hearing aid owner, informing how to adjust the hearing aid in response to client preferences without compromising well performing aspects of hearing aid function.
3.6.2 Theme Two: Problems related to the hearing aid owner

3.6.2.1 Feelings, thoughts and behaviours

The psychosocial implications of adjusting to hearing loss and hearing aids are widely recognised in both research and clinical practice. Participants in this study described feelings of disappointment and frustration when discussing their experiences involving hearing aid problems. It is possible that in the clinical setting, older adults’ psychosocial concerns regarding hearing aid problems may remain unaddressed within audiology appointments. A recent study by Ekberg et al. (2014), which analysed the discourse between audiologists and patients, revealed that when patients expressed concerns regarding psychosocial aspects of obtaining hearing aids, clinicians often ignored their concerns or provided hearing aid specific information and rarely provided empathic responses, despite patients persistently re-raising their concerns (Ekberg et al., 2014). It appears that clinicians may require further training in identifying patient needs and providing emotion-based counselling regarding the psychosocial aspects of hearing aid use (Carson 2005; Ekberg et al., 2014).

The thoughts and behaviours described by participants in this study indicated the impact of preconceived expectations and motivation on ongoing use of hearing aids. Several studies have demonstrated the positive relationship between high (yet realistic) expectations and successful hearing aid fitting (Gatehouse, 1994; Jerram & Purdy, 2001; Saunders et al., 2009). Furthermore, studies have demonstrated the positive effects of emotion-based counselling on hearing aid owners’ expectations and subsequent improvements in hearing aid use and benefit (Brooks, 1989; Jerram & Purdy, 2001; Saunders et al., 2009). The clinician faces the challenge of ensuring realistic expectations for hearing aid benefit (Solheim, 2011) and an understanding of the client involvement required for successful hearing aid use and maintenance (Knudsen et al., 2013), while at the same time promoting the personal benefits of amplification. The findings of this study may assist clinicians when managing expectations of new hearing aid owners during the early months following hearing aid acquisition, particularly the diverse range of problems that may arise. Providing hearing aid owners with information regarding problems associated with hearing aid use and the means to prevent or overcome these problems may empower hearing aid owners to better manage the aspects of hearing aid ownership that require personal care and attention, such as daily cleaning techniques or at home repairs.
3.6.2.2 Information and training

Two types of counselling occur in the audiology setting: 1) informational and 2) emotion based counselling (Erdman, 2000). Participants identified both of these as concepts in this study. Problems associated with emotion based counselling were captured by the Feelings, Thoughts and Behaviours concept and problems associated with informational counselling were highlighted in the Information and Training concept. The statements within the latter described the role of the clinician as providing information, demonstration and training on physical tasks, as well as providing ongoing support. Problems associated with clinicians’ current methods included the provision of insufficient, excessive or overly complex information. There were no reports of participants receiving information that was too simplistic in nature: effective health communication is both clear and simple. Poost-Foorosh et al. (2011) reported similar findings, with the concept “Conveying device information by clinician” identified as a key factor in client-clinician interactions that influence hearing aid adoption. This concept was one that was rated as being more important by clients than by clinicians and highlighted the perceived need for the clinician to provide comprehensive information to the client during the hearing aid adoption process.

Information transfer in the audiology setting has been described as ‘information dumping’ (English, 2008), with hearing aid owners unable to recall between 25-65% of information provided during the consultation four weeks later (El-Molla et al., 2012; Reese & Hnath-Chisolm, 2005). This is likely compounded by the hearing loss itself impacting on the hearing aid owners’ ability to hear within the clinical setting, and exacerbated by the mode of information delivery, being most commonly verbal. Furthermore, the high level of health literacy required to understand the content of spoken and written information provided in clinical consultations often results in hearing aid owners mishearing or misinterpreting the information provided (Nair & Cienkowski, 2010). This ineffective exchange of information is suggested to have a negative impact on the client’s process of decision-making and problem-solving abilities (Laplante-Lévesque et al., 2010a; Laplante-Lévesque, Hickson & Worrall, 2010b). Improving the way clinicians provide information and deliver training may not only improve hearing aid owners’ level of skill, but also their ability to problem solve new issues as they arise.
Arguably, sufficient information and training delivered by the clinician is required for a hearing aid owner to develop optimal hearing aid management skills, to receive hearing aid sound quality and performance, and to understand and work through their thoughts, feelings and behaviours pertaining to hearing aid use. In this way, the concept Information and Training is interconnected with the other three concepts.

3.6.3 Rating hearing aid related problems: Impact, prevention and solutions

Clinicians indicated that the identified problems have a significantly greater impact on overall hearing aid success than what hearing aid owners indicated. These results suggest that either: 1) hearing aid problems do not impact hearing aid owners as much as clinicians believe they do or 2) hearing aid owners may be unaware of the full consequences of some hearing aid related problems. If the first is correct and hearing aid problems have less of an impact on hearing aid success than clinicians believe, it may be that hearing aid owners are resourceful in devising ways to work around the problem (such as sticky taping the hearing aid to their glasses to prevent it from falling off the ear, or removing the hearing aid when in a noisy environment so as to avoid the extra amplification of these uncomfortable sounds) or simply persevere with ongoing problems. Alternatively, clinicians may be intentionally withholding information (such as not discussing hearing aid use relating to travel if the hearing aid owner has not mentioned traveling, or omitting complex cleaning tasks from the training based on an assumption that a client will not be able to complete them) or unintentionally withholding information (such as running out of time or forgetting to cover certain items). Subsequently, hearing aid owners may not be fully aware of the consequences of the problems they are experiencing. For example, not changing microphone covers can lead to a build-up of dirt on the microphone port, which may result in dulling or distortion of sound entering the hearing aid and thus compromise the hearing aid performance. While clinicians are aware of this chain of effects, hearing aid owners may be unaware of the reasons behind clinical recommendations or the consequences of deviating from recommended practices. This is concerning as current clinical practice leaves the onus on the hearing aid owner to: 1) recognise that they have a problem and 2) seek help for the problem.
Hearing aid owners and clinicians generally agreed on whether problems could be solved or prevented, agreeing that problems associated with Information and Training were the most likely to be solvable/preventable and that hearing aid owners’ Feelings, Thoughts and Behaviours would be the least solvable/preventable. It is interesting to note that hearing aid owners indicated that they did believe that problems relating to hearing aid owners’ Feelings, Thoughts and Behaviours are solvable/preventable. Similarly, clinicians indicated that the problems associated with the provision of information and training are highly solvable/preventable. Both hearing aid owners and clinicians recognised their shortcomings and identified room for improvement with regard to overcoming or preventing hearing aid related problems.

The majority of the statements in the top right quadrant of the go zone graph (the greatest impact and the most solvable/preventable) were from the concept Hearing Aid Management, suggesting that improving the delivery of hearing aid management training may be a good starting point for reducing hearing aid related problems. The other individual statements in this quadrant also require attention, describing aspects of Information and Training. Interestingly, much research is already occurring in these fields, specifically studies investigating the quality and readability of hearing aid user manuals (Caposecco et al., 2014), investigations into the impact of hearing aid owners’ expectations (Jerram & Purdy, 2001; Saunders et al., 2009), and ongoing research and development into improving hearing aid sound quality and performance.

Also of interest are the statements in the other three quadrants. Half of the statements placed in the quadrant deemed to be the least solvable/preventable and having the least impact on hearing aid success were from the concept Thoughts, Feelings and Behaviours. It should be noted that participants did not indicate that these problems were having no impact, only that the impact was less than the other problems listed. More research is needed into the psychosocial impacts of hearing aid problems and the strategies that could be implemented by clinicians to relieve these impacts. This may include training for clinicians to be more client-centred in their approach to the hearing aid prescription and fitting process.
This study increases our understanding of the problems hearing aid owners face and of their impact on overall success with hearing aids. One of the strengths of this study is that it includes the perspectives of both hearing aid owners and clinicians who were diverse in age, gender and experiences with hearing loss and hearing aids. Furthermore, given the nature of concept mapping, in that participants contribute to data collection as well as analysis and interpretation of the data, the results of this study are face valid and highly relevant to clinical practice. The list of hearing aid related problems generated in this study could be used to: 1) inform item development for clinical surveys to identify and address hearing aid related problems; 2) assist development of a clinical training tool to provide new hearing aid owners with an overview of the common problems experienced by hearing aid owners and how to prevent or overcome them and 3) a checklist for developers of training materials to ensure they encapsulate the problematic aspects of hearing aid management as described by hearing aid owners and dispensing clinicians. Additionally, this study informs areas that future clinical research should target to improve hearing aid related problems.

3.6.4 Limitations and future research

Although participating clinicians were recruited from a range of clinics and working environments across Western Australia, participating hearing aid owners were recruited from a single chain of clinics, which makes generalising the findings to other settings difficult. However, while these hearing aid owners were likely to have had similar experiences due to the clinical procedures instigated at the clinic (such as trial periods, costs of devices, length of appointments and number of appointments during the trial period), there would have been variation in their experiences based on the differing devices owned by individuals (acoustic or manual features), and the personal attributes of individuals (for example, level of hearing loss, motivation). As clients of this clinic were serviced by 24 different clinicians at the time of data collection, a variety of personal approaches to client care may also have had an impact.

Participants self-selected to volunteer for the study and although the sample sizes were sufficient for concept mapping procedures (Trochim, 1993; Rosas & Kane, 2012), data from
only 38 participants (17 hearing aid owners and 21 hearing healthcare clinicians) may have biased the content of the statements captured and the ratings.

Wording of the questions used to prompt statement generation during brainstorming sessions are likely to influence the statements put forward. Concept mapping techniques should be aware of this and perhaps pilot test the wording of the question on a range of stakeholders to ensure the types of responses elicited are within the scope of what was expected. Nonetheless, the findings are informative and provide a framework for improving the hearing aid experience through comprehensive training, education and support, aimed at both the hearing aid owners and the clinicians. The detailed list of problems generated in the study can inform in development of materials and tools aimed at addressing hearing aid problems. In this way, clinicians and researchers can ensure that common hearing aid problems are adequately addressed.

### 3.7 Conclusion

Clinicians face the balancing act of managing the technical side of hearing aid programming, the educational role of providing information and training, and the affective role of counselling and supporting hearing aid owners through the process of aural rehabilitation with hearing aids. The magnitude and diversity of hearing aid problems identified in this study indicate a gap in current clinical practices, specifically, a gap in training for hearing aid owners and clinicians. The finding that more problems were identified relating to hearing aid management than any of the other three concepts, and that these problems were described as having a greater impact on overall hearing aid success, suggests that hearing aid management should receive greater emphasis during clinical consultations in order to improve hearing aid problems. When addressing individual hearing aid problems during clinical consultations, clinicians should first identify the full range of problems an individual is experiencing, as well as how adjustments to the hearing aid to address one problem may affect other problems or cause additional problems. Furthermore, providing hearing aid owners with information regarding problems associated with hearing aid use and the means to prevent or overcome these problems during the initial appointment of hearing aid adoption may empower hearing aid owners to better manage the aspects of hearing aid
ownership that require personal care and attention, such as daily cleaning techniques or at home repairs. Additionally, improving the way clinicians provide information and deliver training may not only improve hearing aid owners’ level of skill, but also their ability to problem solve new issues as they arise.
3.8 References


CHAPTER FOUR

Evaluating hearing aid handling skills: A systematic and descriptive review

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4.1 Foreword to Chapter Four

The magnitude and diversity of hearing aid problems identified in Chapter Three highlight the ongoing challenges that hearing aid owners face and suggest a gap in current clinical processes. Problems relating to hearing aid handling and management were most often deemed to have the greatest impact on hearing aid success and be the most preventable/solvable. Thus results from Chapter Three support the rationale for improving hearing aid handling and management skills as a starting point for reducing problems associated with hearing aid use.

Currently, two clinical methods are employed to evaluate hearing aid handling and management skills. The first is where the clinician asks the client if they are comfortable with how to use their hearing aids at the end of the rehabilitation program (Desjardins & Doherty, 2009). If the client says “yes”, then the clinician assumes no further training is required (Desjardins & Doherty, 2009). Whilst this method is common in clinical practice, studies have suggested that client report in this manner is unreliable (Desjardins & Doherty, 2009; Pothier & Bredenkamp, 2006) and subsequently the need for further training may be overlooked. The second method, although less utilised, is client survey (Humes, 2012;
Reported barriers to survey use include uncertainty regarding what outcome measure should be used (Taylor, 2007), lack of awareness, motivation, or willingness to change habits (Moodie et al., 2011), the perception of insufficient time during appointments to incorporate additional protocols (Grol & Grimshaw, 2003), and undervaluing of the benefits of employing evidence-based practices such as client survey (Moodie et al., 2011; Squires et al., 2011). Thus systematic reviews can provide clinicians and researchers with up to date information on survey development and their psychometric properties (Swingler et al., 2003; Moodie et al., 2011). The purpose of Chapter Four was thus to systematically identify, describe and critically review the content and quality of available surveys evaluating hearing aid management.

4.2 Abstract

Objective: To review and appraise the content and quality of surveys that evaluate hearing aid handling.

Design: A systematic and descriptive review of twelve surveys containing at least one item evaluating hearing aid handling.

Results: Fifteen aspects of hearing aid handling were evaluated. None of the surveys evaluated all aspects of handling skills identified. While the majority of studies reported some psychometric evaluation during survey development, the quality of the methodology used and extent of psychometric evaluation reported varied considerably.

Conclusions: There is currently no single survey that evaluates handling skills comprehensively. In the absence of an ideal survey, the Practical Hearing Aid Skills Test appears to be the most inclusive clinician-administered survey and the Hearing Aid User’s Questionnaire appears to be the most inclusive self-report survey evaluating hearing aid handling precision; however, there are limitations in the analysis of their psychometric properties. Nonetheless, use of these surveys in clinical practice could identify areas of handling that warrant additional training in order to improve hearing aid success. Research identifying the full range of hearing aid handling skills necessary for successful hearing aid use will further contribute knowledge to the complex construct of successful hearing aid use.
4.3 Introduction

Education and training in the handling and management of hearing aids is an essential component of any rehabilitation program, despite being underrepresented in the literature (Meister et al., 2002; Solheim et al., 2012). Low hearing aid handling skills are associated with low hearing aid use (Mulrow et al., 1992; Popelka et al., 1998; Kumar et al., 2000) and reduced satisfaction (Kumar et al., 2000; Baumfield & Dillon, 2001). Although hearing healthcare professionals provide training on hearing aid handling and maintenance as part of the rehabilitation program (American Speech-Language-Hearing Association, 1998; Audiology Australia, 2013), clinical studies suggest that the level of handling skills demonstrated by hearing aid owners remains low (Upfold et al., 1990; Pothier & Bredenkamp, 2006; Bertoli et al., 2009; Desjardins & Doherty, 2009; Doherty & Desjardins, 2012). For example, Desjardins & Doherty (2009) assessed the ability of 50 hearing aid owners to use their hearing aids appropriately. Although all participants were experienced hearing aid owners (obtained their hearing aids more than 12 months prior to assessment) and reported using their hearing aids daily, more than 90% demonstrated difficulty on at least one handling task (Desjardins & Doherty, 2009). Majority of participants were competent with basic tasks such as hearing aid insertion and removal, where competency levels decreased for complex tasks such as cleaning or use of a noise program.

The mechanism by which handling skills affect hearing aid success is multifaceted. Kochkin (2000) describes the top ten reasons for hearing aid non-use given by hearing aid owners in the USA. While handling skills was not given a category of its own, it could be argued that poor handling skills may have contributed to six of the top ten reasons listed: poor fit and comfort may be caused by incorrect insertion (Pothier & Bredenkamp, 2006); poor sound quality and thus poor benefit may be caused by debris or cerumen in the microphone and soundbore, preventable with appropriate cleaning and maintenance (Block, 2001); insufficient cleaning and maintenance can also lead to breakages (Block, 2001); ongoing repair costs may have contributed to dissatisfaction with price and cost (Kochkin, 2000); and volume control issues may be due to poor handling skills (Upfold et al., 1990). Generally, older participants demonstrate lower handling skills (Desjardins & Doherty, 2009), possibly
due to lower manual dexterity and haptic (touch) sensitivity (Kumar et al., 2000; Singh et al., 2013).

Clinically, two methods are employed to assess handling skills. The first is where clinicians ask clients if they are comfortable with how to use their hearing aids at the end of the rehabilitation program (Desjardins & Doherty, 2009). If the client says “yes”, then the clinician assumes no further training is required (Desjardins & Doherty, 2009). Whilst this method is common in clinical practice, studies have suggested that client report is unreliable (Pothier & Bredenkamp, 2006; Desjardins & Doherty, 2009; Doherty & Desjardins, 2012) and subsequently the need for further training may be overlooked. The second method, although less utilised, is client survey.

Surveys evaluating hearing aid handling skills provide a checklist for clinicians to follow to ensure they have provided sufficient training on the large number of skills required to use and maintain a hearing aid, provide a means to evaluate the client’s level of skill and identify whether additional training and support is required, as well as to determine if training improved survey scores and thus used as an outcome measure. Currently, clinical uptake of surveys remains limited (Saunders et al., 2005; Lindley, 2006; Squires et al., 2011; Humes, 2012; Kochkin et al., 2012). Reported barriers to survey use include uncertainty regarding what outcome measure should be used (Taylor, 2007), lack of awareness, motivation, or willingness to change habits (Moodie et al., 2011), the perception of insufficient time during appointments to incorporate additional protocols (Grol & Grimshaw, 2003), and undervaluing of the benefits of employing evidence-based practices such as client survey (Moodie et al., 2011; Squires et al., 2011).

One way in which survey developers demonstrate the clinical usefulness of a survey is through psychometric evaluation, specifically whether the survey actually measures what it purports to measure (validity) and whether the different scores represent differences between (or changes within) participants (reliability). Use of surveys that have not been validated can result in data that misrepresents the reality (Scott, 1997; Fitzpatrick et al., 1998; Juniper, 2009). Survey responses can be affected by participant factors such as not reading the questions carefully or selecting any response in order to finish the survey.
quickly (Mueller & Picou, 2010). Furthermore, participants may offer socially desirable responses to questions describing issues with well-known or socially acceptable beliefs in the community (Scott, 1997; Mueller & Picou, 2010). For example, participants are likely to overestimate daily hours of hearing aid use on self-report survey when compared to objective measures of hours of use (data logging) (Humes et al., 1996).

Given the rapid development of hearing aid technology and the consequential expansion of hearing aid candidacy and types of hearing aid users, the process of survey validation is ongoing (Bentler & Kramer, 2000) and ensures that survey data provides useful and trustworthy information (Scott, 1997; Juniper, 2009). In order to keep up to date with survey development and psychometric evaluation clinicians and researchers often rely on systematic reviews (Swingler et al., 2003; Moodie, Kothari et al., 2011). A systematic review is a structured literature review identifying, appraising, selecting and synthesising all research relevant to a pre-defined research question. Systematic reviews have become increasingly important in health care as clinicians use them to maintain evidence-based practice; policy developers use them in developing clinical guidelines; and they are often used to inform direction for further research (Swingler et al., 2003; Moher et al., 2009; Mokkink et al., 2009; Moodie et al., 2011).

The purpose of this review was to systematically identify, describe and critically review the available surveys evaluating hearing aid handling. Subsequently, clinicians will more easily be able to make informed decisions as to which survey to incorporate into clinical practice, thus addressing the potential deficit in hearing aid handling skills for their patients. Although handling skills are not an outcome of hearing aid fitting in their own right, they are a vital component of aural rehabilitation contributing to success with hearing aids and thus warrant research and clinical attention.

4.4 Methods
This study used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) to ensure the literature search was extensive and inclusive and that the methodology was transparent and repeatable. The PRISMA guidelines
are an evidence-based minimum set of items for conducting and reporting systematic reviews and meta-analyses.

In the absence of universal criteria to grade the quality of survey-based outcome measures in audiology, this study used the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) checklist to evaluate the quality of the surveys included in this review. The COSMIN was developed by a multidisciplinary, international team of 43 experts in health status measurement and provides a guide to systematically review outcome measures through critical appraisal and comparison of the content and measurement properties of all instruments evaluating a certain topic (Mokkink et al., 2006; Mokkink et al., 2010). The criteria by which each measure is evaluated against are general and numerical cut-offs may vary depending on the field. As such, we incorporated recommendations from the literature (specific to audiological research where available) when defining the cut-offs for the criteria used in this review, which are described in more detail in Table 4.1 (Guyatt et al., 1992; Bentler & Kramer, 2000; Hyde, 2000; Terwee et al., 2007; Revicki et al., 2008; Kottner et al., 2011; Barten et al., 2012; Perez & Edmonds, 2012).

4.4.1 Search strategy

An electronic search strategy was conducted in the following five databases: PubMed, Scopus, EMBASE, MEDLINE and CINAHL, as they are the most likely to index reports of studies in rehabilitative audiology (Cox, 2003; Cox, 2005; Hickson et al., 2013). The search strategy used the following search terms: (hearing aid OR hearing device OR hearing instrument) AND (manage OR management OR handle OR handling OR use) AND (outcome OR survey OR questionnaire OR tool) NOT (child OR infant OR adolescent OR paediatric OR implant OR BAHA OR tinnitus). Only articles published in English between January 2000 and May 2014 were included. Studies published prior to January 2000 were excluded as this review aimed to focus on outcome measures that are currently used in clinical research; however, the outcome measures identified from these studies were reviewed irrespective of the year that the survey was first published.
4.4.2 Selection criteria

The selection procedure occurred in two phases: 1) identification of measures used to evaluate hearing aid fittings by reviewing the abstracts retrieved from the database search and 2) identification of measures evaluating at least one aspect of hearing aid handling by reviewing the full version of all measures identified in Phase One.

In Phase One the abstracts of all articles retrieved were reviewed to generate a list of measures used to assess hearing aid fitting in adult populations. Therefore, measures were not included if the abstract revealed that the study involved only a paediatric population (<18 years old), devices other than hearing aids (cochlear implants, bone anchored hearing aids, assistive listening devices, tinnitus maskers, noise protectors), surgical intervention or only pre-fitting factors (such as expectations), or if the measure was not identified by name in the study title or abstract. Additionally, review papers identified by the database search were obtained, the full text was reviewed and any additional measures meeting the criteria were added to the list.

For Phase Two full versions of identified measures were sourced by searching electronic databases, the internet and by contacting the authors. Measures were included if they contained at least one item evaluating hearing aid handling. Measures that only included items related to handling but not specifically evaluating hearing aid handling were excluded, for example, measures were excluded if they focused on seeing or using small objects other than hearing aids, or satisfaction with hearing aid reliability. Measures were excluded for being unavailable in publications or reports, through internet searches or following extensive attempts to contact the authors.

The decision to include a survey in the present review was conducted by the first author and cross-checked by the third author. Disagreement for inclusion was resolved by discussion, leading to a consensus agreement. Five of the measures were flagged for discussion to determine whether they should be included in the study. Four were excluded following these discussions as they did not specifically measure hearing aid handling skills: Expected Consequences of Hearing aid Ownership (ECHO) (Cox & Alexander, 2000); Attitudes towards Loss of Hearing Questionnaire (ALHQ) (Saunders & Cienkowski, 1996; Saunders et al., 2013);
Hearing Beliefs Questionnaire (HBQ); and Hearing Aid Status Questionnaire (HASQ) (Takahashi et al., 2007). The ‘Insertion/Removal Question’ (Pothier & Bredenkamp, 2006), a single question rather than a multi-question survey, was included as it does assess one aspect of hearing aid handling.

Articles reporting the development, modification, or validation of each measure were sourced from PubMed and grey literature (www.OpenGrey.eu and trove.nla.gov.au) by searching the name (full name and acronym) of the measure and from Google Scholar by searching articles that had cited the study reporting development of the measure. Only peer-reviewed articles published in English were used for extraction of data for further analysis. Some measures were validated across multiple studies, thus the number of studies included in this review was greater than the number of measures (Figure 4.1).

Figure 4.1. PRISMA flow chart of the search and retrieval process for studies included in the systematic review.

Some measures were reported under different names due to minor modifications including language translations, shortened or updated versions, electronic versions, versions adapted
for different populations, or parts of existing measures being renamed. For analysis, such variations were grouped under the most commonly used name.

4.4.3 Data extraction

All measures that met the inclusion criteria were survey-based measures. Data extraction was performed independently by three blinded authors (RJB, CGBJ and STQ) for the final list of twelve surveys that met the selection criteria, with disagreement resolved by discussion leading to a consensus agreement.

4.4.3.1 Descriptive information

Descriptive information was collated, including intended purpose for the survey as defined by original authors, administration (self-report or clinician-administered), mode of delivery, measurement unit used to evaluate hearing aid handling (precision, speed, self-efficacy, satisfaction, problems experienced), the type and number of response categories, and an example of an item evaluating hearing aid handling skills.

Aspects of hearing aid handling evaluated by each outcome measure were compiled to develop a list of handling skills currently assessed by available surveys. The surveys were then cross-referenced with this list to establish which aspects of hearing aid handling skills were most often included.

4.4.3.2 Psychometric properties

Each survey was subjected to an assessment against 12 pre-specified criteria (Table 4.1), apprising the quality of the methodology used and the outcomes achieved in reporting of psychometric evaluation, adapted from published survey evaluation reviews and recommended guidelines (Guyatt et al., 1992; Bentler & Kramer, 2000; Hyde, 2000; Terwee et al., 2007; Revicki et al., 2008; Mokkink et al., 2010; Kottner et al., 2011; Barten et al., 2012).
Table 4.1. Criteria description and requirements for point allocation.

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<th>Criteria</th>
<th>Description</th>
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<td>1. Content validity</td>
<td>Examines the extent to which the concepts of interest are represented by the items on the survey (Nunnally, Bernstein et al., 1967; Guyatt et al., 1993), and is often achieved through expert opinion, opinion of the intended population or reviewing the literature and existing surveys.</td>
<td>One point if expert or subject opinion was sought, or literature reviews or existing surveys were used to inform item development.</td>
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<td>2. Face validity</td>
<td>Examines whether a survey appears to measure what it intends to measure (Guyatt, Feeny et al., 1993). Where some authors suggest face validity can be evaluated by experts in the field (Hyde, 2000; Streiner &amp; Norman, 2008), others recommend face validity is best achieved through interviews or pilot studies with the intended population (Nevo, 1985; Jenkinson, Peto et al., 1996; Higginson, 2007).</td>
<td>One point if hearing aid users were involved in the item development and inclusion process through interviews or a pilot study.</td>
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<td>3. Construct validity</td>
<td>Measures the extent to which scores on a survey relate to characteristics of participants and subgroups of participants, in a way that is consistent with theoretically derived hypotheses (Guyatt, Feeny et al., 1993; Barten, Pisters et al., 2012).</td>
<td>One point if hypotheses were predefined, evaluated with a sample size of at least 50 participants and reported to support relationships between items and subgroup characteristics in 75% of cases (Hyde, 2000; Terwee, Bot et al., 2007; Barten, Pisters et al., 2012).</td>
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<td>4. Criterion validity</td>
<td>Refers to the extent to which scores on a survey relate to a gold standard (Hyde, 2000; Terwee, Bot et al., 2007).</td>
<td>One point if the gold standard selected was a validated measure evaluating the same concepts, if convincing arguments were made for the selection of the gold standard, and if the correlation with the gold standard</td>
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5. **Test-retest reliability**
Examines the degree to which repeated measurement in stable populations produces similar results (Terwee, Bot et al., 2007).

- One point if: 1) intraclass correlation or Cohen’s kappa scores were greater than 0.70; 2) included a sample size of greater than 50 or justification for smaller sample size; and 3) the time between test and retest was less than four weeks (Fitzpatrick, Davey et al., 1998; Juniper, 2009; Kottner, Audige et al., 2011; Barten, Pisters et al., 2012; Paiva et al., 2014).

6. **Internal consistency**
Describes the relationship between survey items and examines the extent to which items are correlated and thus measure the same concept (Terwee, 2007). Internal consistency is important for surveys intending to measure a range of related aspects of a single underlying concept, such as satisfaction, but less appropriate for surveys evaluating independent aspects of a collective concept, such as handling skills.

- One point where a Cronbach’s alpha score of at least 0.70 was achieved (Terwee, Bot et al., 2007; Barten, Pisters et al., 2012).

7. **Inter-observer reliability**
The degree of similarity between survey scores obtained by two or more administrators (Kottner, Audige et al., 2011).

- One point where studies: 1) provided clear descriptions of the methodology and statistical analysis used in measuring inter-observer reliability; (2) report the sample size for raters (n ≥ 2) and participants (n ≥ 50 or justification for a smaller sample size) and (3) considered to be in ‘perfect agreement’ where intraclass correlation or Cohen’s kappa of 0.81 or higher was achieved (Landis & Koch, 1977), in line with guidelines proposed by Kottner et al. (2011).
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<td>8. Responsiveness</td>
<td>Refers to a survey’s ability to detect clinically important changes over time (Guyatt, Kirshner et al., 1992).</td>
<td>One point where the survey was shown to detect a statistically significant change in participant scores when administered to the same cohort either under different conditions or as part of a longitudinal study, such as pre and post intervention or to detect organic changes in scores over time (Revicki, Hays et al., 2008).</td>
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<td>9. Cohort descriptions</td>
<td>Inform for whom the survey is validated and aid clinical interpretation of survey scores.</td>
<td>One point if age, gender, hearing loss, and experience with hearing aids were reported in all studies reporting survey development and validation (Chisolm et al., 2007).</td>
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<td>10. Survey scores</td>
<td>May differ significantly across various populations, such as cohorts with mild as opposed to severe hearing loss (Cox &amp; Alexander, 2002), and thus such information can be clinically informative.</td>
<td>One point if mean scores and standard deviations were reported for the overall cohort and at least two subgroups, such as age groups or device differences (Barten, Pisters et al., 2012).</td>
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<td>11. Feasibility</td>
<td>Describes the degree of burden associated with the survey on the administrator and participant.</td>
<td>One point where feasibility of the survey was reported, including: 1) length of time to complete the survey or number of items; 2) mode of administration and 3) instructions for scoring (Fitzpatrick, Davey et al., 1998).</td>
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<td>12. Interpretability</td>
<td>Describes the degree to which qualitative meaning can be given to quantitative scores.</td>
<td>One point where clinical significance of survey scores were reported (Terwee, Bot et al., 2007).</td>
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</tbody>
</table>
A ‘not applicable’ (NA) option was selected where the criteria described in Table 4.1 was not appropriate for the design or intended purpose of the survey. Each survey was given an overall grading based on whether the psychometric properties and methods of evaluation reported met the criteria set for this review. The overall score was calculated by summing the number of psychometric tests reported that met the criteria for this review and dividing by the total number of psychometric tests appropriate to the survey, presented as a percentage. Reviewing surveys in this manner facilitates ranking of their development, validation and clinical utility (Perez & Edmonds, 2012).

4.5 Results

The database search yielded 597 abstracts, which generated a list of 79 measures published between 1979 and 2014, used to evaluate hearing aid fitting in general (Figure 4.1). Twelve measures met the selection criteria, evaluating hearing aid handling, all of which were survey-based measures, published between 1990 and 2013. Sixty-five measures were excluded as they did not include at least one question specifically evaluating hearing aid handling and two measures were excluded as full versions could not be obtained.

4.5.1 Descriptive information

Three surveys were identified that assess only hearing aid handling skills, all of which were designed for clinician administration. The nine other surveys assessed hearing aid handling among other items associated with hearing aid outcomes. The unit of measurement used to evaluate hearing aid handling varied between precision, speed, self-efficacy, satisfaction, and problems experienced (Table 4.2). The number and type of response options varied from a two point (yes/no) scale to a 100-point Likert scale, with one survey including open response questions and another recording time taken to complete tasks (Table 4.2).

Fifteen aspects of hearing aid handling were identified from the included surveys, with the most commonly included items being managing feedback and changing the battery (Table 4.3).
4.5.2 Psychometric properties

Not all validity and reliability assessments are appropriate for all types of surveys. Most notably, the Marke Trak was not intended for clinical purpose and thus many of the validation and reliability assessments included in the review criteria were not applicable. One of the surveys, the Satisfaction with Amplification in Daily Life (SADL) (Cox & Alexander, 1999), met all applicable criteria for quality psychometric evaluation set in this review (Table 4.4).
Table 4.2. Descriptive overview of instruments evaluating hearing aid handling skills.

<table>
<thead>
<tr>
<th>Survey (Instrument abbreviation)</th>
<th>Studies</th>
<th>Statement of purpose as defined by original authors</th>
<th>Number of items (pertaining to hearing aid handling)</th>
<th>Administr</th>
<th>Mode of delivery</th>
<th>Units of measure used to evaluate handling</th>
<th>Response categories (type and number)</th>
<th>Item example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marke Trak</td>
<td>(Kochkin, 1990; Humes et al., 2001; Humes et al., 2002; Humes et al., 2002; Kochkin, 2002; Kochkin, 2009; Kochkin, 2010)</td>
<td>&quot;the goal of Marke Trak is to report relevant trends and report on new topics that contribute to the knowledge of the hearing aid owner population&quot;</td>
<td>Not applicable as the survey items change each time it is administered</td>
<td>self-report</td>
<td>paper</td>
<td>satisfaction</td>
<td>Likert scale: 5 point</td>
<td>Show how satisfied you are with... Overall fit/comfort</td>
</tr>
<tr>
<td>Hearing Aid Users Questionnaire (HAUQ)</td>
<td>(Dillon et al., 1997; Dillon et al., 1999; Dillon &amp; So, 2000; Uriarte et al., 2005)</td>
<td>&quot;designed to assess hearing aid use, benefit, problems and overall satisfaction&quot;</td>
<td>24 (4)</td>
<td>self-report</td>
<td>paper</td>
<td>problems experienced</td>
<td>yes/no: 2 options</td>
<td>Do you have difficulty positioning the hearing aid or removing it?</td>
</tr>
<tr>
<td>Hearing Instrument Operation Checklist (HIOC)</td>
<td>(Kemker, 1999; Kemker et al., 2012)</td>
<td>&quot;a timed test of six basic but essential manoeuvres with a hearing instrument&quot;</td>
<td>6 (6)</td>
<td>clinician-administered</td>
<td>paper</td>
<td>speed and precision</td>
<td>time recorded: unlimited</td>
<td>Remove hearing instrument from ear</td>
</tr>
<tr>
<td>Satisfaction with Amplification in Daily Life (SADL)</td>
<td>(Cox &amp; Alexander, 1999; Cox &amp; Alexander, 2001; McLeod et al., 2001; Uriarte et al., 2005)</td>
<td>&quot;self-report inventory to quantify satisfaction with hearing aids&quot;</td>
<td>15 (1)</td>
<td>self-report</td>
<td>paper</td>
<td>problems experienced</td>
<td>Likert scale: 7 point</td>
<td>Are you bothered by an inability to get enough loudness from your hearing aid without feedback (whistling)?</td>
</tr>
<tr>
<td>Effectiveness of Auditory Rehabilitation (EAR)</td>
<td>(Yue et al., 2005; Collins et al., 2009; Collins et al., 2013)</td>
<td>&quot;evaluates the effectiveness of treatment for sensorineural hearing loss&quot;</td>
<td>28 (3)</td>
<td>self-report</td>
<td>paper</td>
<td>satisfaction</td>
<td>Likert scale: 100 point</td>
<td>How would you rate the following...Having to change its batteries</td>
</tr>
<tr>
<td>Test Name</td>
<td>Authors</td>
<td>Description</td>
<td>Participants</td>
<td>Administered</td>
<td>Scoring</td>
<td>Result Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>--------------</td>
<td>--------------</td>
<td>---------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic Assessment of Hearing Aids (DAHA)</td>
<td>(Cienkowski et al., 2006)</td>
<td>&quot;uses an intuitive graphic computer interface to record visual analogue ratings of satisfaction and dissatisfaction with various features of hearing aids&quot; &quot;a rating of their level of confidence in fitting their hearing aid”</td>
<td>17 (2)</td>
<td>self-report</td>
<td>electronic satisfaction Likert scale: 100 point</td>
<td>Satisfaction or dissatisfaction with hearing aids... Physical comfort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion/Removal Question</td>
<td>(Pothier &amp; Bredenkamp, 2006)</td>
<td>&quot;assesses hearing aid self-efficacy... confidence in one's ability to be a successful hearing-aid user”</td>
<td>1 (1)</td>
<td>clinician-administered</td>
<td>paper precision Likert scale: 100 point</td>
<td>Insert hearing aid into ear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure of Audiologic Rehabilitation Self Efficacy for Hearing Aids (MARS-HA)</td>
<td>(West &amp; Smith, 2007; Meyer et al., 2014)</td>
<td>&quot;interview instructions for assessing outcome following hearing aid fitting based on clinical global impressions&quot;</td>
<td>24 (12)</td>
<td>self-report</td>
<td>paper self-efficacy Likert scale: 10 point</td>
<td>I can remove a battery from a hearing aid with ease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audiological Rehabilitation – Clinical Global Impression (AR-CGI)</td>
<td>(Oberg et al., 2009)</td>
<td>&quot;device oriented questionnaire measuring self-report hearing aid outcomes; relatively independent of personality&quot; &quot;objectively tests a hearing aid users ability to manipulate his or her hearing aids&quot;</td>
<td>16 (2)</td>
<td>clinician-administered*</td>
<td>phone problems experienced open response (telephone interview)</td>
<td>Have you had any functional (practical) problems with your hearing aid...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device Oriented Subjective Outcome (DOSO)</td>
<td>(Cox et al., 2009)</td>
<td>&quot;measures outcomes associated with hearing aid style differences&quot;</td>
<td>40 (4)</td>
<td>self-report</td>
<td>paper problems experienced Likert scale: 7 point</td>
<td>How good are the hearing aids at... Making the batteries easy to change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practical Hearing Aid Skills Test (PHAST)</td>
<td>(Desjardins &amp; Doherty, 2009; Doherty &amp; Desjardins, 2012)</td>
<td>&quot;objectively tests a hearing aid users ability to manipulate his or her hearing aids&quot;</td>
<td>8 (8)</td>
<td>clinician-administered</td>
<td>paper &amp; electronic^ precision Likert scale: 3 point</td>
<td>Remove your hearing aids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style Preference Survey (SPS)</td>
<td>(Smith et al., 2013)</td>
<td>&quot;measures outcomes associated with hearing aid style differences&quot;</td>
<td>35 (14)</td>
<td>self-report</td>
<td>paper problems experienced Likert scale: 10 point</td>
<td>I notice my hearing aids when they are in my ears because they are uncomfortable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Although the AR-CGI is clinician-administered it is not an objective measure as the administrator relies on client self-report in order to evaluate and score the client.

^ = The PHAST is designed to be administered in paper format, however software is available to assist with the scoring.
Table 4.3. Aspects of hearing aid handling skills evaluated by instruments.

<table>
<thead>
<tr>
<th>Instrument(s)</th>
<th>On</th>
<th>Off</th>
<th>Insert</th>
<th>Identify left from right</th>
<th>Manage discomfort</th>
<th>Manage feedback</th>
<th>Remove</th>
<th>Frequency of battery change</th>
<th>Change battery</th>
<th>Identify components</th>
<th>Clean</th>
<th>Change programs</th>
<th>Change volume</th>
<th>Use telecoil</th>
<th>General management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V</td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HAUQ</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>V*</td>
<td>V*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HIOC</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V*</td>
<td>V*</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SADL</td>
<td></td>
<td></td>
<td>-</td>
<td></td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>EAR</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DAHA</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V*</td>
<td>V*</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Insertion question</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V*</td>
<td>V*</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>MARS-HA</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V*</td>
<td>V*</td>
<td>V*</td>
<td>V*</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>AR-CGI</td>
<td></td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>DOSO</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>PHAST</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td></td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>SPS</td>
<td>V</td>
<td>-</td>
<td>V</td>
<td></td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>-</td>
<td>V*</td>
<td>V*</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

V* = question did not specify program or volume changes, but evaluated management of hearing aid controls.

Table 4.4. Appraisal of psychometric properties and methodology reported for surveys evaluating hearing aid handling skills.

<table>
<thead>
<tr>
<th>Survey</th>
<th>Content validity</th>
<th>Face validity</th>
<th>Construct validity</th>
<th>Criterion validity</th>
<th>Test-retest reliability</th>
<th>Internal consistency</th>
<th>Inter-observer reliability</th>
<th>Responsiveness</th>
<th>Participant cohort</th>
<th>Subgroup scores</th>
<th>Feasibility</th>
<th>Interpretability</th>
<th>Overall grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marke Trak</td>
<td>1</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>67%</td>
</tr>
<tr>
<td>HAUQ</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>55%</td>
</tr>
<tr>
<td>HIOC</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>30%</td>
</tr>
<tr>
<td>SADL</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>EAR</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>82%</td>
</tr>
<tr>
<td>DAHA</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>82%</td>
</tr>
<tr>
<td>Insertion/Removal Question</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>0</td>
<td>NA</td>
<td>0*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>30%</td>
</tr>
<tr>
<td>MARS-HA</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>NA*</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>90%</td>
</tr>
<tr>
<td>AR-CGI</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0*</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>DOSO</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>NA</td>
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<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>55%</td>
</tr>
<tr>
<td>PHAST</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>NA*</td>
<td>0*</td>
<td>NA*</td>
<td>0*</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>40%</td>
</tr>
<tr>
<td>SPS</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>0*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>90%</td>
</tr>
</tbody>
</table>

* = indicates where studies have reported performing psychometric evaluation, but the methodology used or the results achieved did not meet the criteria outlined in this review.

4.6 Discussion

Surveys provide clinicians and researchers with a means of measuring client and/or population characteristics, in this case self-reported and observed behaviour with respect to hearing aid handling. The challenge for survey developers is to ensure that the survey actually measures what it claims to measure, that it can discriminate between clients with various levels of skill, that it is sensitive to change in the clients’ status over time, and, where intended for clinical use, it is clinically meaningful (Juniper, 2009). This study provides a critical review of surveys evaluating hearing aid handling that is intended to assist clinicians and researchers in selecting the appropriate survey for evaluating these skills.

The majority of the surveys evaluated in this review were not designed specifically for assessing hearing aid handling; rather, they included an aspect of handling in evaluating a hearing aid outcome, such as overall benefit or satisfaction (Kochkin, 1990; Cox & Alexander, 1999; Dillon et al., 1999; Yueh et al., 2005; Cienkowski et al., 2006). The aspects of handling selected for inclusion in these surveys varied and, in most cases, no rationale for inclusions was reported. For example, ability to clean the hearing aid was only included in two of the surveys, despite the negative impact that debris and cerumen build up can have on hearing aid performance (Block, 2001; Desjardins & Doherty, 2009). This variability might be expected because little is known regarding which aspects of handling are most likely to influence outcomes. Further research identifying the aspects of hearing aid handling that are most influential on hearing aid outcomes will inform survey development and clinical practice.

The unit of measurement chosen to evaluate handling varied across surveys; some measured precision, while others measured speed, self-efficacy, problems experienced, or satisfaction. Thus, in most cases, scores are not comparable across surveys. It cannot be assumed that a client who scores highly on precision and speed will necessarily score highly on satisfaction. As such, clinicians and researchers should be cognisant of such variations when selecting a survey, so as to ensure that response categories of the survey align with what they are intending to measure.
Currently, there is no single survey available that evaluates all aspects of hearing aid handling skills as identified by the literature. Furthermore, there may be additional skills not included in this list, such as frequency of cleaning, ability to use rechargeable devices, ability to use dehumidifying units, telephone use (other than telecoil), use of accessories such as remote controls, or general maintenance such as changing microphone covers and tubes/domes. Qualitative interviews with hearing aid users and clinicians, such as the methods used in the development of the SADL (Cox et al., 1999), may elucidate additional items necessary for clinicians to investigate when assessing hearing aid handling skills (Knudsen et al., 2012; Laplante-Lévesque et al., 2012). Development of a survey that evaluates all aspects of hearing aid handling would enable clinicians to quickly and effectively assess whether clients have learned the skills necessary for successful hearing aid use and care.

Given that administrative burden is one of the main barriers to the clinical uptake of outcome measures (Grol & Grimshaw, 2003), and that recent studies have demonstrated that 54-81% of older adults regularly use personal computers (Hunter & Bridger, 2008; Henshaw et al., 2012; Thorén et al., 2013), it is surprising that only one of the surveys in this review was developed for electronic administration (Cienkowski et al., 2006). Although this survey, the Dynamic Assessment of Hearing Aids (DAHA) (Cienkowski et al., 2006), was developed with an electronic interface it was not validated to be self-administered, but to be completed with the clinician in the clinic, thus failing to reduce the administrative burden. Although electronic administration may not be suitable for all clients, it may be more appealing to clinicians given the reduced burden of administration and scoring. Modification of surveys for online administration may thus improve uptake of outcome measures into clinical practice (Hyde, 2000; Thorén et al., 2012).

4.6.1. Psychometric properties
Validity and reliability are not fixed properties, rather they result from interaction between the survey, the administrators and the respondents (Bentler & Kramer, 2000; Hyde, 2000; Kottner et al., 2011). As such study results are only interpretable when the methodology is clearly and explicitly defined. There was a wide variation in the reporting of survey development and psychometric evaluation, regarding the number and mix of psychometric
measures used. Content validity and internal consistency were the most widely reported psychometric properties. This is possibly because they are the easiest to calculate in that they require a single point of measurement (as opposed to test-retest and responsiveness) and can be conducted by a single author (as opposed to face validity and inter-observer reliability). However, the lack of psychometric data for audiological surveys may contribute to the low uptake and inappropriate use of existing surveys (Bentler & Kramer, 2000; Hyde, 2000; de Vet et al., 2003).

Many definitions for content and face validity exist in the literature and the distinction between the two is not always clear. Nunnally and Bernstein (1994) define content validity as the extent to which items represent a proper sample of the theoretical construct. This was reported in the development of all 12 surveys through expert or subject opinion, or reviews of the literature or existing surveys. In most cases content validity was determined by the authors as “experts” in the field. Only the SADL, Device Oriented Subjective Outcome (DOSO) (Cox et al., 2009) and Style Preference Survey (SPS) (Smith et al., 2013) piloted an earlier version to evaluate whether the survey items measured what they intended to measure. However, the quality of the process undertaken to assess content validity was not evaluated in this study. That is, whether the item development was systematic and formalised (Hyde, 2000), whether the survey is written at an 8th grade comprehension level, i.e. the items are short and simple and there are no double-barrel questions (Terwee, Bot et al., 2007), and inclusion of a clear description of the conceptual framework explaining how all items together comprehensively reflect the construct to be measured (Hyde, 2000; Mokkink et al., 2010).

Face validity is defined as the extent to which the items actually measure what they intend to measure (Nunnally et al., 1967). Nevo (1985) differentiates types of validity, describing face validity as being informed by participants, content validity as being informed by “experts” and the term hypothesised validity as describing the case where “experts” judge the face validity on behalf of participants. Face validity was reported by six of the 12 included surveys (Table 4.4). In development of the DAHA survey Cienkowski et al. (2006) used hypothesised validity by asking the research team to speculate what client needs were rather than involving clients. However, the research team based their speculations on previous studies in which patients’ opinions were obtained, thus evaluating face validity. The importance of involving
participants when determining face validity was demonstrated by Jenkinson et al. (1996) in evaluating the short form 36 (SF 36) health survey questionnaire (Ware Jr & Sherbourne, 1992). A subsample of 50 from the 438 participants completed semi-structured interviews about the issues raised by the SF 36 and their experience in completing the SF 36. During the interviews participants reported difficulty with some of the terminology and phrases used in the questionnaire revealing that they had provided incorrect responses to some survey items. The consequences of omitting face validity assessment may include response bias such as social desirability bias (faking good) (Mueller & Picou, 2010), refusal to respond to items (Hyde, 2000), or reduced motivation to perform well, which in turn leads to lower test performance (Chan et al., 1997).

For a clinician-administered survey to be an effective clinical tool it must yield consistent results irrespective of the administering clinician; that is, it must have high inter-observer reliability. Inter-observer reliability was reported by three of the four clinician-administered surveys, however, the quality of the methodology (Pothier & Bredenkamp, 2006; Desjardins & Doherty, 2009) or the agreement achieved (Oberg et al., 2009) was below the standards set for this review. Incomplete and inadequate reporting of inter-observer reliability is not unique to audiological research (Kottner et al., 2011) and the authors recommend future studies use the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) to improve the quality of reporting in future studies (Kottner et al., 2011).

Responsiveness describes a surveys ability to detect clinically important changes over time (Guyatt et al., 1992) and is an important clinimetric parameter for outcome measures evaluating treatment effectiveness (de Vet et al., 2003). Overall reporting of responsiveness was low, with only the SADL, Measure of Audiologic Rehabilitation Self Efficacy for Hearing Aids (MARS-HA) (West & Smith, 2007) and Effectiveness of Auditory Rehabilitation (EAR) (Yueh et al., 2005) effectively reporting survey responsiveness. Although Smith et al. (2013) report on the responsiveness of the SPS (Smith et al., 2013), the methods used did not meet the criteria in this review. Smith et al. (2013) compared SPS results between groups (traditional custom-fitted hearing aids and open-fit hearing aid users) rather than comparing SPS scores for one group under both conditions, as recommended by Revicki et al. (2008). In general, surveys will be of greater value to clinicians if they are sensitive to clinically important
changes and thus provide useful information for clinical decision making. Results from this study highlight the need for further research into the responsiveness of available surveys in line with available guidelines (Guyatt et al., 1992; Terwee et al., 2007; Revicki et al., 2008).

Surveys can perform very differently when administered to different populations and, as such, study cohorts should be described in detail to facilitate appropriate clinical use (Hyde, 2000). For example, the SPS survey (Smith et al., 2013) evaluates client outcomes associated with hearing aid style across the following five subscales: (1) feedback; (2) occlusion/own voice effects; (3) localization; (4) fit, comfort and cosmetics and (5) ease of use. During development of the survey the authors identified that traditional custom-fitted hearing aid users had significantly poorer outcomes than open-fit hearing aid users on four of the five subscales. As such, normative data were provided for the overall cohort as well as for the two groups (hearing aid styles) to assist clinicians with clinical interpretation of SPS scores and inform clinical decision making. While cohorts were generally well described, only five studies reported sub-group mean scores and standard deviations. The other seven reported mean scores and standard deviations only for the entire cohort. Cohort descriptions and sub group means are not only important when determining how well the sample drawn for survey development is representative of the population of interest, they inform for whom the survey is validated and how to interpret the scores.

While this review has highlighted some gaps in the psychometric reports for surveys evaluating hearing aid handling, this does not necessarily mean that the surveys are not valid, nor that they have not been validated, only that their psychometric properties are not readily available. This is problematic as researchers and clinicians rely on psychometric properties when selecting surveys for research and clinical use (Bentler & Kramer, 2000; Hyde, 2000; de Vet et al., 2003). Assessment of validity, reliability and responsiveness are not only important steps in survey development, they are also vital in establishing clinical utility, informing clinicians how, when and for whom to administer the survey, as well as how to interpret survey results.
4.6.2 Clinical implications

This systematic review provides clinicians with an overview of current surveys that evaluate hearing aid handling skills. Of the clinician-administered surveys the Practical Hearing Aid Skills Test (PHAST) (Desjardins & Doherty, 2009) covers the most aspects of handling skills, and received the highest quality rating for reporting of psychometric properties; however, some aspects of validity, responsiveness and reliability, specifically inter-observer reliability, warrant further evaluation. Nonetheless, in its current form the PHAST offers clinicians a standardised list of basic handling skills that hearing aid owners should be able to complete in order to use and maintain their hearing aids appropriately.

Of the self-report surveys the SADL met the most criteria demonstrating robust psychometric properties in a range of populations; however, the SADL was developed to evaluate satisfaction with hearing aids, not handling skills, and thus includes only one aspect of hearing aid handling. Of the self-report surveys the MARS-HA included the most aspects of handling skills. It should be noted that the MARS-HA was designed to evaluate self-efficacy (perceived capability for performing a specific task) rather than actual ability. For clinicians searching for a self-report survey evaluating precision of hearing aid handling skills the Hearing Aid Users Questionnaire (HAUQ) (Dillon et al., 1997) appears to be the best option as it evaluates self-perceived ability; for example, “Do you have difficulty positioning the hearing aid or removing it?”; however, the HAUQ was designed to assess hearing aid benefit and thus includes only six of the 15 skills identified in this review. There does not appear to be a self-report survey specifically evaluating precision of hearing aid handling skills. While a clinician-administered survey will yield the required information, a self-administered survey may be suitable so as to lower administrative and clinical load and to evaluate handling skills from the client’s perspective. Irrespective of actual level of skill, if a client believes they are not managing their hearing aid well, then clinician input is required. However, no conclusions can be drawn from this study as to whether clinician-administered or self-report surveys are more appropriate for evaluating handling skills in the clinical setting, or in fact whether hearing aid users are capable of accurately reporting hearing aid handling precision.

Although this study has identified some gaps in the literature regarding the reporting of psychometric properties during survey development, our intent is not to discourage their use.
On the contrary, we aim to highlight the importance of hearing aid handling skills and promote the use of surveys to evaluate handling skills in clinical practice. In doing so, hearing aid handling will receive the attention it requires and researchers will improve surveys currently available or generate new ones. The benefits of evaluating handling skills as part of clinical practice include: 1) providing clinicians with a checklist of all important aspects of hearing aid handling; 2) a means to establish whether clients have learned all hearing aid handling skills taught during the rehabilitation program; 3) fewer breakdowns and repairs as a result of improved handling skills (Block, 2001) and 4) improved outcomes as better hearing aid handling skills are associated with higher hearing aid use (Popelka et al., 1998; Kumar et al., 2000) and greater satisfaction with hearing aids (Kumar et al., 2000; Baumfield & Dillon, 2001).

4.6.3 Limitations and future research
The authors attempted to include all hearing aid outcome measures that evaluate at least one aspect of hearing aid handling skills; however, we acknowledge that it is possible that surveys may have been overlooked in the selection process. This review restricted analysis to those in the English language; those surveys in language other than English may warrant a separate review. The initial search excluded studies published prior to January 2000, but did not place date restrictions on when the outcome measure was first published. Although this process identified outcome measures published between 1979 and 2014, it is possible that additional measures may have been identified had the date range of the initial search been extended; however, this review aimed to focus on outcome measures currently used in clinical research. Furthermore, there were two surveys identified by the literature search that may have met the selection criteria for this study; however, they were not included in this review as full versions of the surveys could not be obtained through literature search or contacting the authors (Garstecki & Erler, 1998; Cohen-Mansfield & Taylor, 2004). This may also be the case for psychometric properties, in that psychometric evaluation may have been performed but was not readily available through peer-reviewed journal publications.
4.7 Conclusion

The inclusion of items evaluating hearing aid handling in outcome measures suggests that there is currently an awareness of the importance of handling skills for hearing aid success. This review reveals no single survey that evaluates handling skills comprehensively. In the absence of an ideal survey, the PHAST appears to be the most inclusive clinician-administered survey, although there are limitations in the analysis of its reliability. The HAUQ appears to be the most inclusive self-report survey evaluating precision of hearing aid handling; however, it was designed to evaluate hearing aid benefit and thus includes a limited number of items evaluating handling skills and there are limitations in the analysis of its validity and reliability. No conclusions can be drawn as to whether clinician-administered or self-report surveys are more appropriate for evaluating handling skills in the clinical setting, or, in fact, whether hearing aid users are capable of accurately reporting hearing aid handling precision. Research identifying the full range of hearing aid handling skills necessary for successful hearing aid use will further contribute knowledge to the complex relationship between hearing aid use and satisfactory outcomes.
4.8 References


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CHAPTER FIVE

Are hearing aid users able to identify and report handling difficulties?

(International Journal of Audiology, 2015; 56(11), 887-893)

5.1 Foreword to Chapter Five

A key finding of the previous chapter was that there was no existing self-report survey available specifically evaluating precision of hearing aid handling skills. While a clinician-administered survey will yield the required information, a self-administered survey may be suitable so as to lower administrative and clinical load and to evaluate handling skills from the client’s perspective. Irrespective of actual level of skill, if a client believes they are not managing their hearing aid well, then clinician input is required. However, it is unknown whether hearing aid users are capable of accurately reporting hearing aid handling precision. Desjardins and Doherty (2009) compared 50 hearing aid owners’ perceptions of their ability to manage their hearing aid (using the single question “do you know how to use your current hearing aids well?”) to their actual ability to manage their hearing aids (based on a clinician-administered skills assessment survey). Although 96% of participants self-reported competency in hearing aid management (single question), only 5% were able to demonstrate full competency (clinician evaluated), suggesting that hearing aid owners are unaware of their handling difficulties. However, the self-report measure used by Desjardins and Doherty (2009) was a single global question on overall management skills. There was no evidence to support whether hearing aid owners could accurately self-report handling
skills if provided with a self-report survey itemising the individual aspects of hearing aid handling required for effective hearing aid management. To explore this concept, the purpose of this Chapter was to develop and pilot-test a self-administered survey evaluating hearing aid handling skills (Hearing aid Handling Skills survey: HHS-self). In order to compare self-report skills with clinician-assessed skills, this study also developed an alternate clinician-administered version of the survey (clinician-administered Hearing aid Handling Skills survey: HHS-clin). This explorative pilot study aimed to determine whether hearing aid owners were able to accurately identify and self-report handling difficulties when provided with an itemised list of handling tasks.

5.2 Abstract

Objective: Although clinician administered surveys evaluating hearing aid handling skills exist, the development of a self-administered version may reduce clinical load, save consultation time, and facilitate more frequent use than face-to-face consultations allow. However, there is currently no evidence to support whether hearing aid owners can accurately self-report hearing aid handling skills via self-report survey that systematically evaluates the ability to accurately perform the individual aspects of hearing aid handling required for effective hearing aid management.

Design: An explorative pilot study using a prospective research design. The study sample included nineteen adult hearing aid owners, aged between 65 and 93 years.

Results: The self-administered survey demonstrated high sensitivity when compared with clinician evaluation of skills, with 93% of participants accurately self-identifying and reporting whether hearing aid handling skill training was required.

Conclusions: Hearing aid owners are able to accurately self-report hearing aid handling difficulties when provided with an itemised list of skills.

5.3 Introduction

Education and training in the handling and management of hearing aids is essential for successful hearing aid use (Meister et al., 2002; Solheim et al., 2012). Inability to competently handle and manage one’s own hearing aid can have negative implications for hearing aid use (Kumar, et al., 2000; Mulrow et al., 1992; Popelka et al., 1998), benefit (Campos et al., 2014) and satisfaction (Baumfield & Dillon, 2001; Kumar et al., 2000). It is therefore a concern that between 60-90% of hearing aid owners experience difficulty with basic handling tasks required for everyday hearing
aid use (e.g., cleaning, making volume adjustments and telephone use) (Desjardins & Doherty, 2009). It has been suggested that current clinical methods used to evaluate hearing aid handling skills are inadequate and that handling difficulties are not being identified (Desjardins & Doherty, 2009; Ferrari et al., 2015; Pothier & Bredenkamp, 2006).

At the end of the rehabilitation program clinicians typically ask clients if they are comfortable with how to use their hearing aids. If the client says “yes”, then the clinician generally assumes that no further training is required (Desjardins & Doherty, 2009). Studies have suggested that this practice is unreliable (Desjardins & Doherty, 2009; Pothier & Bredenkamp, 2006). Desjardins and Doherty (2009) evaluated 50 experienced hearing aid owners’ perspectives on their ability to manage their hearing aid with the single global statement “I feel I know how to use my current hearing aids well”. Participants’ self-reported ability was compared to performance on a clinician-administered survey, the Practical Hearing Aid Skills Test, that evaluated eight basic skills required for hearing aid handling. Although 96% of participants reported that they were able to manage their hearing aids on the single global statement, only approximately 10% were able to demonstrate full competence on handling tasks in the clinician-administered survey (Desjardins & Doherty, 2009). Desjardins and Doherty (2009) concluded that hearing aid owners are unable to self-report overall handling skills and recommended the use of a clinician-administered survey to evaluate hearing aid handling skills.

Although three clinician-administered surveys specifically designed to evaluate aspects of hearing aid handling skills are readily available (Doherty & Desjardins, 2012; Kemker, 1999; Pothier & Bredenkamp, 2006), their clinical utility is limited in that they require face-to-face contact and thus can only be administered as part of the clinical consultation. The development of a self-administered survey evaluating hearing aid handling skills may reduce the clinical load, save consultation time, and facilitate more frequent use than face-to-face consultations allow. For example, completing a self-report survey on hearing aid handling skills in the few months following hearing aid acquisition may identify gaps in skills that were not previously recognised. Although a self-administered survey for hearing aid handling skills may provide a more efficient medium for ongoing patient care, there is currently no evidence to support whether hearing aid owners can accurately self-report handling skills via self-report survey that systematically evaluates the ability to accurately perform the individual aspects of hearing aid handling required for effective hearing aid management.
Currently, no self-report survey exists that systematically evaluates the ability to accurately perform the individual aspects of hearing aid handling required for effective hearing aid management (Bennett et al., 2015). To explore this concept, we developed and pilot-tested the self-administered Hearing aid Handling Skills survey (HHS-self). In order to compare self-report skills with clinician-assessed skills, this study used an alternate clinician-administered version of the survey, the clinician-administered Hearing aid Handling Skills survey (HHS-clin). The primary aim of this pilot study was to determine if hearing aid owners were able to accurately identify and self-report handling difficulties when provided with an itemised list of handling tasks. If so, such a survey could be used as a screening tool to identify those hearing aid owners who would benefit from additional clinical consultation. A secondary aim was to explore whether self-reported hearing aid handling skills were associated with participant demographic or device-related factors. Such information would provide insight as to factors that might predict greater hearing aid handling difficulty and whether handling skills affect overall hearing aid use or satisfaction.

5.4 Methods

5.4.1 Materials

Participants completed a clinical history form, the HHS-self and the HHS-clin. A clinical history form was used to collect participant demographic and device data, including: age, gender, hearing aid style (i.e., behind-the-ear or in-the-ear), previous experience with hearing aids. An item from the International Outcome Inventory for Hearing Aids (Cox & Alexander, 2002) survey evaluating hearing aid use in the past two weeks on a five point Likert scale (where 1 indicated no use and 5 indicated more than 8 hours per day) and a question adopted from the MarkeTrak consumer survey (Kochkin, 2000) evaluating overall satisfaction with hearing aid/s on a five-point Likert scale (where 1 indicated Very Satisfied and 5 indicated Very Dissatisfied) were also included.

5.4.1.1 Development of the HHS-self and HHS-clin

A review of existing audiology outcome surveys (Bennett et al., 2015) identified a series of hearing aid handling skills frequently asked. These were used to create the nine-item surveys: the HHS-self (Appendix A) and the HHS-clin. One item identified in the review was not considered a necessary skill for hearing aid handling, i.e. evaluating the ability to identify components of the hearing aid,
and was not included. The authors concluded that being able to name the components was not necessary as long as the hearing aid owner was able to use and care for the components accurately, as evaluated by the other survey items.

Published recommendations for survey development were considered in the development of the HHS surveys. In particular, we ensured they were brief, clear, unambiguous and free of jargon, written at a Reading Grade Level between 3rd and 6th grade, and avoided the word “not” and double barrel questions (Caposecco et al., 2011; Drost, 2011; Fitzpatrick et al., 1998; Hyde, 2000; Terwee et al., 2007).

**HHS-self.** The HHS-self was originally designed with a 3-point Likert scale. However, when evaluated with a group of ten hearing aid owners, participants requested inclusion of an additional response option “Most of the time”. Subsequently, the HHS-self was amended to utilise a four-point Likert scale. The four points were labelled as Never/Unsure, Sometimes, Most of the time, and Always. A Not Applicable option was also available. More complex tasks were split into two parts. For example, for item seven, participants were first asked to rate their physical ability to switch between hearing aid programs, and then asked to rate their ability to recognise which program to use in different situations.

Scoring of the HHS-self can be performed in one of two ways. Firstly, the clinician or hearing aid owner can peruse the responses to determine an overall pass/fail; that is, whether any individual items were identified to be problematic. Secondly, an overall score can be calculated by adding the points for each task (as indicated on the survey sheet) and converting it to a percentage of competency (by subtracting from 48 and dividing by 0.48). A higher score indicates greater competency (i.e., a score of 100% represents full competency).

The overall pass/fail can be used to indicate whether a hearing aid owner has a problem with at least one task and thus would benefit from additional training. The clinician can then peruse each item on the survey to ascertain specifically which item(s) require additional skills training, in essence, using the survey as a training guide. The survey score can be used to compare the extent of handling difficulties for a single hearing aid owner before and after additional skills training, or between hearing aid owners or group of owners (such as used for research purposes).
In this study a participant was considered to have failed a question on the HHS-self if they indicated they could manage a skill Most of the time, Some of the time or Never able to manage. “Most of the time” could have been categorised either way, but the authors agreed that participants who selected “Most of the time” may benefit from training and thus were classified as failing the item. This impact of this was investigated and is discussed below.

**HHS-clin.** The HHS-clin was developed based on the HHS-self, with minor variations to the language and scoring. Whilst the subject and order of all the survey items remained the same, where the wording of each question in the self-administered version commenced with “Can you...”, the clinician-administered version used “Please show me how you...”. Furthermore, where the HHS-self was modified to use a four-point Likert scale, the HHS-clin remained a three-point Likert scale graded as Performs inaccurately or unable to perform, Would benefit from some additional training, or Performs task accurately and with no difficulty; there was also a Not Applicable option. Initially, the authors hypothesised that there may be some clinical benefit in delineating those clients who demonstrated some difficulty and thus required some additional training from those clients who were completely unable to perform the task. However, during this pilot study the administering clinicians suggested that in a clinical setting only a pass/fail indication would be required, as a client who does not demonstrate full competence requires additional support, irrespective of whether they show partial difficulty or complete incompetence. However, allowing for comparisons between individuals’ self-reported handling skills and clinician evaluation of their handling skills in this study, HHS-clin scores were generated in the same way as the HHS-self, resulting in an overall pass/fail and an overall score. A participant was considered to have failed a task on the HHS-clin if the administrator selected either of the response items “Performs inaccurately or unable to perform” or “Would benefit from some additional training”.

### 5.4.2 Participants

Hearing aid owners were recruited from an audiology clinic in Western Australia. All clients aged 18 years or older who had been provided with hearing aids between 12 and 36 months prior to the date of data collection were contacted via mail and invited to participate in the study. A total of 19 hearing aid owners (19.7% response rate) participated. Where the list of potential participants generated by the clinic (n=374) ranged in age from 22 to 98 years (M = 69.92, SD =
those who volunteered and participated in study ranged in age from 65 to 93 (M = 78.00, SD = 7.12). Participants’ demographic and audiological details can be found in Table 5.1.

<table>
<thead>
<tr>
<th>Table 5.1. Cohort description (n = 19)</th>
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<tbody>
<tr>
<td>Age (range, mean ± SD) (years)</td>
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<tr>
<td>Gender</td>
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<tr>
<td>Male: n (%)</td>
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<tr>
<td>Female: n (%)</td>
</tr>
<tr>
<td>Amplification</td>
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<tr>
<td>Binaural: n (%)</td>
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<tr>
<td>Monaural: n (%)</td>
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<tr>
<td>Hearing aid style</td>
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<td>BTE: n (%)</td>
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<tr>
<td>ITE: n (%)</td>
</tr>
<tr>
<td>Years of experience with current hearing aid(s) (range, mean ± SD)</td>
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<tr>
<td>Is this your first hearing aid</td>
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<tr>
<td>Yes: n (%)</td>
</tr>
<tr>
<td>No: n (%)</td>
</tr>
<tr>
<td>Hearing aid use (IOI-HA item 1)</td>
</tr>
<tr>
<td>Never: n (%)</td>
</tr>
<tr>
<td>Less than 1 hours per day: n (%)</td>
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<tr>
<td>1-4 hours per day: n (%)</td>
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<tr>
<td>4-8 hours per day: n (%)</td>
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<td>More than 8 hours per day: n (%)</td>
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<tr>
<td>Satisfaction with hearing aid</td>
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<tr>
<td>Very Dissatisfied: n (%)</td>
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<td>Dissatisfied: n (%)</td>
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<tr>
<td>Neutral: n (%)</td>
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<tr>
<td>Satisfied: n (%)</td>
</tr>
<tr>
<td>Very Satisfied: n (%)</td>
</tr>
</tbody>
</table>

Notes: IOI-HA: International Outcomes Inventory for Hearing Aids.
Three clinicians who each held postgraduate qualifications in audiology participated as administrators of the survey in this study. The clinicians were female and varied in terms of age (28, 30 and 47 years) and years of clinical experience (3, 8 and 14 years). Only one of the clinicians was involved in the development of the survey, the other two were trained in the use of the survey by the research team. While all three clinicians worked for the same organisation, they did not work in the same centre and thus were not familiar with each other’s methods of hearing aid skills training or evaluation.

5.4.3 Procedure
Ethical approval for this study was granted by the Human Research Ethics Office of The University of Western Australia and the Behavioural and Social Sciences Ethical Review Committee of the University of Queensland. All participants provided written consent to participate and for additional information to be collected from their patient files.

Participants attended one 30-minute data collection session wherein they first completed a short clinical history form and the HHS-self in the waiting room, without clinician involvement. Participants were then taken into a private consultation room and administered the HHS-clin, with the clinicians blinded to the HHS-self scores. To evaluate reliability of HHS-clin scores, three clinicians evaluated each participant simultaneously: one clinician read the exact wording of each question, and all three clinicians scored independently of each other. The clinicians were instructed not to discuss their answers with each other for the duration of the study.

5.4.4 Data analysis
All data were analysed using IBM SPSS Statistics (v21, 2014). Data were inspected for outliers (i.e., visual inspection of boxplots and |z| score calculations using a cut-off point of 2.58) and tests of normality and skewness (i.e., Shapiro-Wilk test of normality and Q-Q plots) were conducted. Skewed data were transformed using logarithmic and square root transformations; however, transformation did not result in normally distributed data and as such nonparametric tests were used for all analyses.
Given that the HHS-clin (clinician evaluation of handling skills) is to be used as the benchmark when evaluating whether hearing aid owners are able to identify and self-report handling skills using the HHS-self, the first step was to establish validity and reliability for the HHS-clin. Content validity (whether concepts of interest are represented by the items on the survey) was informed by including all items included in existing surveys evaluating hearing aid handling (with exception of one as described above), and through expert opinion wherein five clinical audiologists reviewed and tested earlier versions of the survey (Guyatt et al., 1993). Face validity (whether a survey measures what it purports to measure) was informed by the five clinical audiologists who tested an earlier version of the survey and the ten hearing aid owners on whom the audiologists evaluated the survey on (Guyatt et al., 1993). Construct validity (the extent to which scores on a survey relate to characteristics of participants and subgroups of participants, in a way that is consistent with theoretically derived hypotheses) was assessed using Spearman’s correlations for the following three hypotheses (Guyatt et al., 1993): 1. HHS-clin scores will be positively correlated with overall satisfaction with the hearing aid (Campos et al., 2014); 2. HHS-clin scores will be negatively correlated with age (Desjardins & Doherty, 2009); 3. HHS-clin scores will not be associated with overall hearing aid use (Desjardins & Doherty, 2009).

Inter-observer reliability of the HHS-clin was evaluated using intraclass correlations of raw scores to determine how often clinicians similarly distinguished participants with good handling skills from those with poor handling skills. Inter-observer agreement for pass/fail rates were evaluated using Krippendorf’s alpha to determine whether the three clinicians agreed on which participants required additional training. Interpretation of the results was in line with the recommendations of Landis and Koch (1977): less than 0 indicating ‘no concordance (agreement/reliability)’, 0 to 0.20 ‘slight concordance’, 0.21 to 0.40 ‘fair concordance’, 0.41 to 0.60 ‘moderate concordance’, 0.61 to 0.80 ‘substantial concordance’, and 0.81 to 1.0 ‘almost perfect concordance’.

5.4.4.1 Self-report of hearing aid handling difficulties

The primary purpose of this study was to determine whether a self-report survey could be used to identify those participants who were experiencing hearing aid handling difficulties. Thus, participants self-reported difficulties as indicated by the HHS-self were examined in line with their actual difficulties as indicated by the HHS-clin. This was investigated by comparing overall scores and pass/fail rates between the HHS-clin and HHS-self. Given the difference in response categories
between the two surveys, overall scores were transformed into z-scores. Using z-scores a
Wilcoxon signed rank test was used to determine whether there were significant differences
between individuals’ HHS-self scores and HHS-clin scores. To investigate rank order similarity
between clinician rating and participants’ self-rating of handling skills, inter-observer reliability
was evaluated using intraclass correlations of HHS-clin and HHS-self z-score transformations. In
this case, the inter-observer reliability measure lists the participants in order of their overall scores
and evaluates how similar the ordering is for when they are ranked by HHS-self scores versus HHS-
clin scores.

The relationship between HHS-self and HHS-clin pass/fail rates were examined using inter-
observer agreement analysis using Cohen’s kappa as well as sensitivity and specificity analyses.
There was concern that classification of the HHS-self response option “Most of the time” as a fail
may have affected the analyses; therefore, the aforementioned statistical analyses were
conducted with the response category “Most of the time” considered separately as a pass and also
as a fail.

**5.4.4.2 Factors associated with self-reported handling skills**

Investigation of associations between participants’ self-reported handling skills (HHS-self scores)
and participant factors (age, gender, hearing aid style, experience with hearing aids, hearing aid
use, and overall satisfaction with hearing aids) was performed using Spearman’s rank-order
correlations and Mann-Whitney U test.

**5.5 Results**

Overall, hearing aid handling skills were high; the mean HHS-clin score was 91.15% (SD = 9.36,
range = 66% to 100%), with 31% of participants demonstrating full competency in every task on
the HHS-clin; that is, 69% of the participants demonstrated a need for retraining by failing at least
one hearing aid handling task. Two of the three hypotheses for criterion validity were met: HHS-
clin scores were positively correlated with overall satisfaction with the hearing aid \([r_s (19) = 0.525,
p = 0.021]\) and HHS-clin scores were not associated with overall hearing aid use \([r_s (19) = 0.179, p =
0.463]\). One of the hypotheses was not met; HHS-clin scores were not correlated with age \([r_s (19) =
0.030, p = 0.903]\). The HHS-clin demonstrated “almost perfect” inter-observer reliability
(ICC=0.951, \( p<0.001 \), 95%CI: 0.894 to 0.979) and “moderate” inter-observer agreement (\( k=0.409, p<0.01 \), 95%CI: 0.266 to 0.551), and therefore the means of the three HHS-clin scores for an individual generated by the three clinicians were used in this study against which to compare the participants’ HHS-self scores.

Self-reported hearing aid handling skills were also high; the mean HHS-self score was 79.74% (SD = 15.78, range = 45 to 100%), lower than the mean HHS-clin scores (91.15% ± 9.36) indicating that participants reported more difficulty than was observed by the clinicians. However, a Wilcoxon signed rank test revealed that the difference was not significant (\( z = -0.04, p = 0.968 \)). Upon visual inspection of the data, there was high congruency between self-reported and clinician-rated competency for tasks such as hearing aid removal, battery changing, and cleaning; and low congruency for hearing aid insertion, telephone use, accessory use, and making changes to volume and program settings (Figure 5.1). Inter-observer reliability between the HHS-clin and HHS-self scores was “moderate” (ICC=0.536 \( p<0.056 \), 95%CI: 0.205 to 0.821).

Pass/fail rates for the HHS-self were investigated in two ways: 1) with the response category “Most of the time” classified as a pass and 2) with the response category “Most of the time” classified as a fail. When “Most of the time” was classified as a pass, 63.16% (n=12) of participants identified difficulty with at least one item (failed the HHS-self). When “Most of the time” was classified as a fail, 84.21% (n=16) of participants identified difficulty with at least one item (failed the HHS-self). Of the four participants whose classification of passing or failing the survey overall pivoted on the classification of the “Most of the time” response category, three failed the HHS-clin and one passed the HHS-clin.

The majority of participants demonstrated an ability to identify and self-report the need for further skills training based on HHS-self pass/fail rates as indicated by the inter-observer agreement and the sensitivity and specificity calculations (Table 5.2). Inter-observer agreement and sensitivity was higher when selection of the response category “Most of the time” was classified as failing the item. Specificity of the HHS-self was higher when selection of the response category “Most of the time” was classified as passing the item.
Figure 5.1. Percentage of participants that indicated or demonstrated difficulty or inability to perform tasks (“Most of the time” classified as a fail).

Table 5.2. The effect of response category classification on the sensitivity of the HHS-self to the HHS-clin.

<table>
<thead>
<tr>
<th>HHS-self</th>
<th>Inter-observer agreement between HHS-self and HHS-clin</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>k</td>
<td>p</td>
<td>95% CI</td>
</tr>
<tr>
<td>With the response category “Most of the time” classified as a pass</td>
<td>0.278</td>
<td>0.211</td>
<td>0.052 to 0.504</td>
</tr>
<tr>
<td>With the response category “Most of the time” classified as a fail</td>
<td>0.377</td>
<td>0.084</td>
<td>0.132 to 0.622</td>
</tr>
</tbody>
</table>

No significant association was found between self-reported handling skills (HHS-self scores) and participant factors, with the exception of overall satisfaction with hearing aids (Table 5.3). Participants with low handling skills were more likely to self-report low satisfaction with their hearing aids.
Table 5.3. Associations between self-reported handling skills (HHS-self scores) and participant factors.

<table>
<thead>
<tr>
<th>Participant factors</th>
<th>Spearman’s correlations</th>
<th>Mann-Whitney U</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>rs</td>
</tr>
<tr>
<td>Age</td>
<td>17</td>
<td>-0.011</td>
</tr>
<tr>
<td>Gender</td>
<td>25.000</td>
<td>0.115</td>
</tr>
<tr>
<td>Style of hearing aid (behind-the-ear or in-the-ear)</td>
<td>11.000</td>
<td>0.057</td>
</tr>
<tr>
<td>Previous experience with hearing aids</td>
<td>38.000</td>
<td>0.734</td>
</tr>
<tr>
<td>Hearing aid use</td>
<td>17</td>
<td>0.259</td>
</tr>
<tr>
<td>Hearing aid satisfaction</td>
<td>17</td>
<td>0.590**</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level

5.6 Discussion

Surveys provide clinicians and researchers with a means of measuring client and/or population characteristics. The challenge for survey developers is to ensure that the survey actually measures what it claims to measure and that it is sensitive enough to detect a range of impairment or, in this case, skill (Bennett et al., 2015). This pilot study explored the concept of self-identification and reporting of hearing aid handling skills through self-report survey. It is important to note that the participants of this study were older in age (M = 78 years) and had more than 12 months experience owning hearing aids. As such, the generalizability of these results pertains only to this sub-population of hearing aid users. None the less, majority of hearing aid owners are older (by nature of the deterioration of hearing over time) and in the same way, most hearing aid owners are experienced as due to the lack of a cure for hearing loss, hearing aid use continues for the remainder of life. Despite their experience with hearing aids, participants in this study demonstrated difficulty with a range of hearing aid handling skills as found by similar studies (Desjardins & Doherty, 2009; Doherty & Desjardins, 2012; Ferrari et al., 2015).

The findings suggest that hearing aid owners are able to accurately identify and self-report handling skills when provided with an itemised list describing tasks relating to hearing aid handling. However, many participants scored lower on the HHS-self than the HHS-clin, indicating
that these participants reported more difficulty than was observed by the three clinicians. It is possible that participants’ tendency to understate their handling skills on the HHS-self may be influenced by self-efficacy (peoples’ judgement of their capabilities to perform tasks), as competent functioning requires both possession of skills and self-efficacy (Bandura, 1986b; Meyer, Hickson & Fletcher, 2014; Pajares, 1997; West & Smith, 2007). Generally, participants demonstrated fewer difficulties and high congruency for basic and frequently performed tasks (hearing aid removal, on/off, battery, cleaning, insertion). In contrast, participants tended to understate their ability for complex and infrequently performed tasks (use of volume control, programs, use of telephone and accessories). This is consistent with research from psychology studies, whereby self-efficacy is influenced by the complexity of the task, the amount of effort required to complete the task and the amount of external support received during completion of the task (Bandura, 1986a). People are typically more confident at basic tasks and less confident at complex tasks (Bandura, 1986a; Bell & Kozlowski, 2002; Gist & Mitchell, 1992; Stajkovic & Luthans, 1998). Thus the role of the clinician should not be to simply provide instructions for hearing aid handling, but to establish whether hearing aid owners have learned the skills necessary and developed sufficient self-efficacy for hearing aid success, with special attention paid to more complex hearing aid handling tasks. Smith and West (2014) offer self-efficacy enhancing techniques for doing so in the clinical setting.

An aspect of survey development investigated in this pilot study was the classification of response items, specifically, whether those participants who selected the response option “Most of the time” should be classified as passing or failing the item. In this pilot study, classification of the response item “Most of the time” affected the overall passing or failing of the survey for four (21.05%) participants, three of which demonstrated difficulty (failed the HHS-clin) and one of which demonstrated full competence (passed the HHS-clin). Thus, if the response category “Most of the time” was classified as a pass, three participants (15.79%) who demonstrated difficulty and would have benefitted from additional training would not have been detected by the self-administered survey. Alternatively, by classifying “Most of the time” as a fail, in a clinical setting, these three participants would be identified as having difficulty and treated as requiring additional support. In doing so, the one participant (5.26%) who selected “Most of the time” yet did not display any difficulties when evaluated by a clinician, would have been prompted to return to the clinic for additional consultation despite not needing it. Given that the HHS-self is designed to be used as a screening tool in clinical practice, it is more important that it has higher sensitivity than...
specificity. While the low specificity could result in an increase of seemingly unnecessary appointments in clinical practice, it could be argued that a client who self-reports difficulty (despite demonstrating full competency) may still benefit from consultation if it helps to improve their confidence in hearing aid handling (Meyer et al., 2014). Thus, we recommend the HHS-self classify “Most of the time” as a fail to increase sensitivity and ensure that all clients experiencing difficulty get the help they need.

Where studies have demonstrated a clear positive association between hearing aid handling skills and self-reported satisfaction with hearing devices (Bennett et al., 2015; Campos et al., 2014; Kumar et al., 2000), results from this pilot study suggest the same may be the case for self-reported handling skills. While the sample size of this pilot study restricts assumptions regarding the greater population, these findings elude to a relationship between hearing aid satisfaction and self-reported handling skills and suggest the need for further investigation into the potential benefits of self-report survey. Cognitive ability of participants was not evaluated in this pilot study; however, future studies investigating handling skills should account for cognitive function to investigate not only whether handling skills are associated with cognitive impairment, but whether ability to complete self-report survey is affected by cognitive function. Although studies have demonstrated an association between hearing aid handling skills and age (Desjardins & Doherty, 2009), no such association was measured for self-reported handling skills (HHS-self scores) or clinician evaluated handling skills (HHS-clin scores) in this study. This was possibly due to the small sample and narrow range of age of participants in this study. The relationship between age and self-report of hearing aid handling skill requires further investigation.

The primary purpose of this study was to determine whether a self-report survey could be used to identify those participants experiencing hearing aid handling difficulties. The findings suggest that a self-report survey is a viable method for identifying hearing aid handling difficulties, such as for the purpose of a screening tool. The development of a self-administered survey evaluating hearing aid handling skills may reduce the clinical load, save consultation time, and facilitate more frequent use than face-to-face consultations allow. For example, completing a self-report survey on hearing aid handling skills in the few months following hearing aid acquisition may identify gaps in skills that were not previously recognised. Furthermore, completing a self-report survey on handling skills at intervals over an extended period of time following hearing aid acquisition may identify age-related changes in hearing aid handling skills, such as those arising from reduced
cognitive function (Pichora-Fuller & Singh, 2006), vision (Erber, 2003), or finger dexterity (Kumar et al., 2000; Singh et al., 2013).

5.6.1 Limitations and future directions
This pilot study explored whether self-report is a reliable method for the evaluation of hearing aid handling skill. While the results are promising, the sample size used in this pilot study was insufficient to validate the survey for clinical use. The sample included only experienced hearing aid owners and so the findings cannot be generalised to new hearing aid owners. Furthermore, the surveys developed did not cover all aspects of hearing aid use (such as use of a dehumidifier and replacing domes, tubes or microphone covers) and thus the authors caution that the HHS is not a comprehensive measure in its current form. Future studies should first identify the full breadth of what skills are required for hearing aid use and ensure survey validation is conducted on a larger, multi-centre clinical cohort to inform psychometric properties and clinical applications. Such studies may also consider factors that might account for hearing aid handling beyond age and experience, such as hearing aid model, features or settings, or the hearing aid owners’ cognitive ability, dexterity, visual acuity, ability to learn new tasks, or motivation to learn hearing aid handling tasks.

5.7 Conclusion
This explorative pilot study has demonstrated that a comprehensive self-report survey that evaluates specific tasks required for hearing aid handling can be used to identify participants who required additional training. The use of a self-report survey evaluating hearing aid handling skills would allow clinicians to evaluate and re-evaluate client’s skills at regular intervals and with reduced burden on clinical time than currently available clinician-administered measures.
5.8 References


CHAPTER SIX

Investigating the knowledge skills and tasks for hearing aid management

(American Journal of Audiology, 2018; 27, 67-84)

6.1 Foreword to Chapter Six

Results of the previous study suggested that hearing aid owners were able to accurately identify and self-report handling difficulties when provided with an itemised list of handling tasks required for daily hearing aid use; by comparing hearing aid owners’ perceptions of their own ability to handle and manage their hearing aids with their actual ability as evaluated by a clinician. However, the survey used to measure hearing aid handling skills only included a portion of the skills needed for hearing aid use. To date, the range of tasks and the detailed level of knowledge and training required for optimal hearing aid management has not been defined. Availability of a complete list of the knowledge, skills and tasks required for hearing aid management would benefit both clinicians and hearing aid owners as it could be used as: 1) a training guide to be followed during initial hearing aid management training sessions; 2) a checklist to review at the end of the training program to ensure all necessary information and training was provided and 3) an assessment tool to evaluate whether the knowledge and skills were adequately learned and retained.

Concept mapping provides a systematic mechanism for generating and identifying the conceptual framework of a phenomenon of interest and thus is an ideal platform for scale development.
(Rosas & Camphausen, 2007). Concept mapping integrates qualitative and quantitative approaches in a multistep process that elicits the perspectives of key stakeholders (in this case hearing aid owners and clinicians) on a desired topic, and performs multivariate statistical analyses (multidimensional scaling and hierarchical cluster analysis), and group interpretation of the data informing construct validity of the subsequent scale (Trochim, 1989). Additionally, through involvement of key stakeholders, concept mapping identifies the scale items pertinent to the population for which the scale will be used, thus addressing face and content validity of the subsequent scale (Rosas & Camphausen, 2007). Accordingly, the purpose of Chapter Six was to generate a conceptual framework for understanding hearing aid management skills; in doing so, identifying the full array of knowledge, skills and tasks required for hearing aid management to inform survey development.

6.2 Abstract

Objective: To identify hearing aid owners’ and clinicians’ opinions of the knowledge, skills and tasks required for hearing aid management and the importance of each of these to overall success with hearing aids.

Design: Concept mapping techniques were used to identify key themes, wherein participants generated, sorted and rated the importance of statements in response to the question “what must hearing aid owners do in order to use, handle, manage, maintain and care for their hearing aids?” Twenty-four hearing aid owners (56 to 91 years of age; 54.2% male) and 22 clinicians (32 to 69 years of age; 9.1% male) participated.

Result: Participants identified 111 unique items describing hearing aid management within six concepts: 1) Daily Hearing Aid Use; 2) Hearing Aid Maintenance and Repairs; 3) Learning to Come to Terms with Hearing Aids; 4) Communication Strategies; 5) Working with Your Clinician and 6) Advanced Hearing Aid Knowledge. Clinicians’ opinions of the importance of each statement varied only slightly from the opinions of the hearing aid owner group. Hearing aid owners indicated that all six concepts were of similar importance, whereas clinicians indicated the concept Advanced Hearing Aid Knowledge was significantly less important than the other five concepts.

Conclusion: The results highlight the magnitude of information and skill required to optimally manage hearing aids. Clinical recommendations are made to improve hearing aid handling education and skill acquisition.
6.3 Introduction

The World Health Organization estimates that there are over 360 million people in the world living with a disabling hearing loss (WHO, 2014). Hearing loss is most commonly managed with hearing aids, provided as part of an aural rehabilitation program. The rehabilitation program includes the hearing aid device to optimize hearing function, instruction on the use and management of the device, perceptual training to improve communication, and counselling to enhance social participation and quality of life (Boothroyd, 2007). Where the clinician is primarily responsible for the selection and programming of hearing aids, the hearing aid owner remains responsible for the ongoing use, handling, maintenance and care of hearing aids (described hereafter as hearing aid management). Thus, education and training regarding hearing aid management is an essential component of any hearing rehabilitation program (Boothroyd, 2007; Meister et al., 2002; Solheim et al., 2012).

Such training is generally delivered verbally by the clinician on the day of the hearing aid fitting (initial programming session) and throughout subsequent follow-up appointments if indicated (Ferguson et al., 2015). Supplemental written information is rarely provided (Kochkin et al., 2010). It is recommended that hearing aid training include how to maintain and operate a hearing aid effectively, how to troubleshoot common problems, counselling on the potential benefits and limitations of hearing aid technology, and techniques to enhance communication (Boothroyd, 2007; Reese & Hnath-Chisolm, 2005; West & Smith, 2007). Although clinical guidelines stipulate that hearing aid management training should be included as part of the rehabilitation program (American Speech-Language-Hearing Association, 1998; Audiology Australia, 2013), studies investigating management skills suggest that current training is insufficient (Bertoli et al., 2009; El-Molla et al., 2012; Ferrari et al., 2015; Reese & Hnath-Chisolm, 2005; Upfold et al., 1990; West & Smith, 2007). The high incidence of hearing aid management difficulty reported is of concern as poor handling skills are associated with low hearing aid use (Kumar et al., 2000; Mulrow et al., 1992; Popelka et al., 1998), benefit (Campos et al., 2014) and satisfaction (Bennett et al., 2017; Kumar et al., 2000). As such, there are distinct patient benefits to ensuring hearing aid management skills are acquired at the time of receiving the hearing aid.

The low level of hearing aid knowledge and management skill observed in hearing aid owners is likely influenced by the irregularity in training provided, specifically the varied content and modes of delivery used by clinicians and clinics (Kochkin, 2012). Although studies have demonstrated that
hearing aid owners are unable to recall between 25-65% of information provided during the consultations four weeks later (El-Molla et al., 2012; Reese & Hnath-Chisolm, 2005), one study demonstrated that targeted one-on-one training can result in improved device management skills immediately and two to three weeks following the retraining session (Bennett et al., 2015a). However, the surveys used to measure hearing aid handling skills have only included a portion of the skills needed for hearing aid use (Bennett et al., 2015b). To date, the number of tasks and the detailed level of knowledge and training required for optimal hearing aid management has not been defined. Availability of a complete list of the knowledge, skills and tasks required for hearing aid management would benefit both clinicians and hearing aid owners as it could be used as: (1) a training guide to be followed during initial hearing aid management training sessions; (2) a checklist to review at the end of the training program to ensure all necessary information and training was provided and (3) an assessment tool to evaluate whether the knowledge and skills were adequately learned and retained.

Qualitative research can provide insight into how both clients and clinicians view the range of tasks required for hearing aid management by recording their experiences and perspectives (Knudsen, Laplante-Lévesque, Jones, Preminger et al., 2012). There is a growing body of literature utilising qualitative techniques in audiological research to increase our understanding of patient driven concepts and improve clinical processes (Grenness et al., 2014; Knudsen et al., 2012; Laplante-Lévesque et al., 2010; Laplante-Lévesque et al., 2012; Laplante-Lévesque et al., 2006; Linssen et al., 2013). Whereas the majority of these studies have used semi-structured interview or focus group techniques, this study used a mixed methods approach, concept mapping. Concept mapping combines qualitative approaches to data collection with quantitative data analyses to produce visual maps of how participants view a particular topic. Participants put forward statements describing their experiences, perceptions, thoughts or ideas about a specific topic, and then give meaning to these statements through grouping and ranking activities (Trochim, 1989). Concept mapping has been used to understand the context surrounding health related outcomes (Burke et al., 2005) and in audiology research to understand factors involved in the client-clinician interaction that affect hearing aid adoption (Poost-Foroosh et al., 2015; Poost-Foroosh et al., 2011), as well as to investigate problems associated with hearing aid use (Bennett et al., 2018).

The purpose of this study was to generate a conceptual framework for understanding perceived skill required to optimally manage hearing aids and how these skills are acquired; in doing so,
identifying key aspects of the hearing aid fitting process that could be improved. To undertake this, concept mapping techniques were employed to describe: 1) the knowledge, skills and tasks required for hearing aid management and the importance of each of these to overall success with hearing aids and 2) how these skills are acquired; from the perspectives of both hearing aid owners and clinicians. The knowledge gained will inform the development of clinical training and evaluation tools to improve hearing aid management skills, which may subsequently improve hearing aid use, benefit and satisfaction. Although participants in this study generated the data for the two research questions (identification of the skills required for hearing aid use, and how these skills are acquired), only the first will be presented here with the latter to be published in a subsequent paper.

6.4 Methods

Concept mapping techniques were used to generate and analyse the data, and include: a) brainstorming, b) grouping and rating, c) data analysis, and d) interpretation (Burke et al., 2005; Trochim & Kane 2005). The methods used in this study followed those described in Bennett et al. (2018) and are summarized below.

6.4.1 Participants

The beliefs and behaviours of both hearing aid owners and clinicians with experience in fitting and adjusting hearing aids were sought in this study. Hearing aid owners were recruited via email or post through two participating clinics in Perth and Brisbane, Australia, and via the Communication Research Registry (a database of volunteers in Australia who have consented to being contacted about research projects related to communication disability, including adults with hearing loss). All adult hearing aid owners were invited to participate. Clinicians were recruited via email through a hearing aid manufacturers’ database of Australian clientele. All of the clinicians on this database were invited to participate.

The literature describing Concept Mapping processes does not specify a minimum number of participants for the brainstorming activity, although Trochim (1989) describe preferring groups of 10 to 20 people to insure a variety of opinions and still enable group discussion. Participants should be diverse and represent all stakeholders involved in a topic, in this case, both hearing aid owners and clinicians. The minimum number of participants recommended for the grouping
activity is 15, as studies with fewer than 15 participants are more likely to generate less reliable concept maps (indicated by the stress value; described in detail below) (Rosas & Kane, 2012). There is no recommendation for a minimum number of participants for the rating activity; however, large numbers are required for generalizability to the wider population.

The hearing aid owner group (n=24) included persons between 56 and 91 years of age and the clinician group (n=22) included persons between 32 and 69 years of age. Both groups were heterogeneous in age, gender, and experience with hearing aids as described in Table 6.1. Hearing aid owners were based in the Australian states of Western Australia (n=17) and Queensland (n=7), and reported owning hearing aids from seven different manufacturers. Participating clinicians were based in Queensland (n=3), Victoria (n=1), Tasmania (n=1) and Western Australia (n=17), and worked in a range of different clinical environments. Only one of the participants worked for a clinic aligned with the hearing aid manufacturer through which clinicians were recruited.

Table 6.1. Descriptive statistics for participant demographics.

<table>
<thead>
<tr>
<th>Cohort Description</th>
<th>Hearing aid owners (n = 24)</th>
<th>Clinicians (n = 22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD) (years)</td>
<td>78.46 ± 8.93</td>
<td>42.95 ± 9.64</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male: n (%)</td>
<td>15 (68.18)</td>
<td>2 (9.09)</td>
</tr>
<tr>
<td>Female: n (%)</td>
<td>9 (31.82)</td>
<td>20 (90.91)</td>
</tr>
<tr>
<td>Self-reported severity of hearing loss (when not wearing hearing aids)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild: n (%)</td>
<td>1 (4.17)</td>
<td></td>
</tr>
<tr>
<td>Moderate: n (%)</td>
<td>13 (54.17)</td>
<td></td>
</tr>
<tr>
<td>Severe: n (%)</td>
<td>5 (20.83)</td>
<td></td>
</tr>
<tr>
<td>Profound: n (%)</td>
<td>1 (4.17)</td>
<td></td>
</tr>
<tr>
<td>Number of years wearing hearing aids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 year: n (%)</td>
<td>2 (8.33)</td>
<td></td>
</tr>
<tr>
<td>1-5 years: n (%)</td>
<td>7 (29.17)</td>
<td></td>
</tr>
<tr>
<td>5-10 years: n (%)</td>
<td>8 (33.33)</td>
<td></td>
</tr>
<tr>
<td>&gt;10 years: n (%)</td>
<td>3 (12.50)</td>
<td></td>
</tr>
<tr>
<td>Style of hearing aids worn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITE: n (%)</td>
<td>2 (8.33)</td>
<td></td>
</tr>
<tr>
<td>BTE: n (%)</td>
<td>14 (58.33)</td>
<td></td>
</tr>
<tr>
<td>Satisfaction with hearing aids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highly Satisfied: n (%)</td>
<td>3 (12.50)</td>
<td></td>
</tr>
<tr>
<td>Satisfied: n (%)</td>
<td>13 (54.17)</td>
<td></td>
</tr>
<tr>
<td>Neutral: n (%)</td>
<td>2 (8.33)</td>
<td></td>
</tr>
<tr>
<td>Dissatisfied: n (%)</td>
<td>1 (4.17)</td>
<td></td>
</tr>
<tr>
<td>Highly Dissatisfied: n (%)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
### Daily hearing Aid use

<table>
<thead>
<tr>
<th>Daily Use</th>
<th>n (%)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>None: n (%)</td>
<td>2</td>
<td>8.33</td>
</tr>
<tr>
<td>&lt;1 hour per day: n (%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1-4 hours per day: n (%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4-8 hours per day: n (%)</td>
<td>3</td>
<td>12.50</td>
</tr>
<tr>
<td>&gt;8 hours per day: n (%)</td>
<td>14</td>
<td>58.33</td>
</tr>
</tbody>
</table>

### Years of experience dispensing hearing aids

<table>
<thead>
<tr>
<th>Experience</th>
<th>n (%)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5 years: n (%)</td>
<td>3</td>
<td>13.64</td>
</tr>
<tr>
<td>5-10 years: n (%)</td>
<td>2</td>
<td>9.09</td>
</tr>
<tr>
<td>10-20 years: n (%)</td>
<td>16</td>
<td>72.73</td>
</tr>
<tr>
<td>&gt;20 years: n (%)</td>
<td>1</td>
<td>4.55</td>
</tr>
</tbody>
</table>

### Highest level of audiological qualifications completed

<table>
<thead>
<tr>
<th>Qualification</th>
<th>n (%)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate 5 in audiometry: n (%)</td>
<td>3</td>
<td>13.64</td>
</tr>
<tr>
<td>Graduate diploma in audiology: n (%)</td>
<td>2</td>
<td>9.09</td>
</tr>
<tr>
<td>Masters in audiology: n (%)</td>
<td>16</td>
<td>72.73</td>
</tr>
<tr>
<td>Clinical Doctorate in audiology: n (%)</td>
<td>1</td>
<td>4.55</td>
</tr>
</tbody>
</table>

### Predominant type of employment

<table>
<thead>
<tr>
<th>Type of Employment</th>
<th>n (%)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government funded chain: n (%)</td>
<td>1</td>
<td>4.55</td>
</tr>
<tr>
<td>Independent private clinic: n (%)</td>
<td>10</td>
<td>45.45</td>
</tr>
<tr>
<td>Private chain of clinics: n (%)</td>
<td>2</td>
<td>9.09</td>
</tr>
<tr>
<td>Not-for-profit organization: n (%)</td>
<td>6</td>
<td>27.27</td>
</tr>
<tr>
<td>Hospital: n (%)</td>
<td>1</td>
<td>4.55</td>
</tr>
<tr>
<td>University: n (%)</td>
<td>2</td>
<td>9.09</td>
</tr>
</tbody>
</table>

*Note: ITE: in-the-ear hearing aid; BTE: behind-the-ear hearing aid.*

### 6.4.2 Procedures

Ethical approval for this study was granted by the Human Research Ethics Office of The University of Western Australia and The University of Queensland’s Behavioural and Social Sciences Ethical Review Committee. All participants provided written consent to participate.

All participants were required to attend two data collection sessions; the first consisted of a brainstorming activity and the second included completing grouping and rating tasks. Sessions were held separately for hearing aid owners and clinicians to allow them to speak freely about their experiences without having to consider the other party in a client-clinician relationship. For participating hearing aid owners, data collection was conducted through face-to-face group sessions (between 1 and 19 in each group) across two sites (Perth and in Brisbane) to increase transferability (Guba, 1981). For participating clinicians, data collection was conducted via an online portal (version 4, Ithica, NY: Concept Systems Incorporated). The benefit afforded to hearing aid owners from the face-to-face brainstorming activity included the ability to interact...
with each other and build on the statements put forward by other participants. Participating clinicians were not able to interact with each other in the same manner, although they were able to view each other’s statements. While participating clinicians had the opportunity to log into the system multiple times and submit additional statements, clinicians only logged into the brainstorming session once. As such, the first few clinicians to log into the brainstorming session missed the opportunity to build on the statements put forward by subsequent entries. The sessions were conducted in October and November 2015 and were not recorded.

6.4.2.1 Brainstorming

For hearing aid owners, this first session was split into two 45 minute periods with a 15 minute break in-between. Participants were first asked to generate statements that described “what hearing aid owners must do in order to use, handle, manage, maintain and care for their hearing aids appropriately, for example, turn it on or change the battery.” Participating hearing aid owners were prompted to include statements regarding their personal experiences as well as things that they have heard from other people, such as family or friends with hearing aids. During the second period participants were asked to generate statements that described “how hearing aid owners learn the skills required to use, handle, manage, maintain and care for their hearing aids”. Data from this second period will be presented in a subsequent manuscript. Statements put forward by participants were entered into a Microsoft Excel spreadsheet and projected on a screen as they were generated for all to see. In this way, participants could build on each other’s statements. Participant instructions were delivered in a neutral tone and participants were not prompted beyond asking for clarification if the participants’ statement was not clear or re-asking the research question using the same wording when there was a lull in contributions. The research team accepted all statements during the brainstorming activity so as not to deter contributions. The individual statements put forward by participants were not discussed, and only new ones added. All members of the group were given equal opportunity to provide input.

For the clinician group, the brainstorming session took place via the online portal available in the concept mapping software Concept Systems (version 4, Ithica, NY: Concept Systems Incorporated). Clinicians were asked to generate statements in response to the same two research questions, and were provided using the exact same wording as the hearing aid owner group. Participating clinicians were able to enter statements into the system, which were then available for the other
clinicians to see; in this way clinicians could enter new statements that built on existing statements or enter completely new concepts. The clinicians were not able to change or comment directly on each other’s statements, only add new statements to the list. Clinicians were not able to see the statements put forward by the hearing aid owners’ at this stage, or vice versa. The clinicians were not identifiable to each other.

Following the brainstorming session, members of the research team (RB, CM and RE) pooled and refined all of the statements from both cohorts (all hearing aid owners and clinicians). The statements were edited for clarity to ensure that participants had a clear, understandable and relevant list of statements for the grouping and rating tasks. Statements that were identical to each other were eliminated (Poost-Foroosh et al., 2011), as well as statements that did not directly relate to the brainstorming question (for example, “pressure from grandchildren if still not hearing well”) or were considered inaccurate so as not to confuse or mislead participants (for example, “rechargeable batteries are cheaper”). Furthermore, some sentences were split into single concept phrases (for example, the following statement was split into its six components “understand how the hearing aid battery works, i.e. learn how to tell the positive side from the negative side of the hearing aid battery, how to insert the battery, not to be afraid of touching the hearing aid batteries with their fingers, know that the battery will go flat after the sticker is removed regardless of hours of use, and how to dispose of hearing aid batteries”) (Jackson & Trochim, 2002). All statements were reworded with a neutral tone and to be in the third person (for example “I was never shown how to change the wax filter”, “I don’t know how to change the wax protector”, “they don’t bother learning how to change the wax filter” were combined and reworded to be statement 74. Know when to change the wax filter/protector). The resulting set of statements served as the core content for the grouping and rating tasks.

6.4.2.2 Grouping and rating of the statements

During the second session participants grouped the brainstormed statements to identify common themes. For the rating task, participants were given the list of all the statements and asked to rate the importance of each statement to a hearing aid owner’s overall success with hearing aids, using a 5-point Likert scale (1 = minimally important to 5 = extremely important).
For the hearing aid owners, the grouping and rating tasks took place via face-to-face group sessions (Brisbane and Perth). Two hours was allocated for the session, although many finished the task early and were free to leave. Statements were printed on individual cards. Participants were asked to sort the cards into groups based on how similar in meaning they were to one another, and to provide a title for each group. For the rating task, hearing aid owners were provided with a list of the statements and asked to rate them as described above (paper based survey). Although hearing aid owners attended this session as a group, participants were instructed to work independently. Most participants completed the tasks alone; a few discussed the task with other participants during the grouping task, but mainly to clarify a statement rather than discuss which group it belonged to.

For the clinicians, grouping and rating tasks took place via the online portal (version 4, Ithica, NY: Concept Systems Incorporated), wherein clinicians logged in and completed the tasks at any time within a six week period. For the online grouping task, the software displayed all of the statements on one side of the screen and instructed the clinicians to move the statements across to the other side of the screen into folders, as many folders as required, and then to name the folders accordingly. Participants were unable to see each other’s’ grouping and rating tasks. See Bennett et al. (2018) for further details on how grouping and rating tasks were conducted.

All participants attended the brainstorming sessions and contributed to the generation of statements for both research questions: 1) identification of what needs to be learned for successful hearing aid use and 2) how this knowledge and skill is acquired. Participants were then randomly allocated into two groups using a random number generator in Microsoft Excel. Each group was randomly assigned to one of the two research questions for the Session 2 grouping and rating tasks. All participants were invited to complete grouping and rating for both research questions and directed to start with the question for which they were randomly allocated to. Of the 24 hearing aid owners who participated in the brainstorming session, 16 (including the 12 allocated to this research question; 100% retention rate) completed the rating activity for the first research question (identification of what needs to be learned for successful hearing aid use) and nine completed the grouping activity (75% retention rate). Twenty-two clinicians participated in the brainstorming session, 17 of which (including the 11 allocated to this research question; 100% retention rate) completed the rating activity for the first research question (identification of what...
needs to be learned for successful hearing aid use) and nine completed the grouping activity (82%
retention rate).

6.4.2.3 Data analysis and interpretation
Data generated by the hearing aid owners were entered into the Concept Systems software
(version 4, Ithica, NY: Concept Systems Incorporated). The data from participating clinicians was
captured as they performed their tasks within the Concept Systems software.

Multidimensional scaling was used to generate a point map to graphically display the relationship
between statements as indicated by the grouping task. In Concept Mapping, each point on the
map represents one brainstormed statement. The proximity of two points indicates how often
these statements were grouped together by participants; the smaller the distance between two
points, the more often participants grouped the two statements together. The position of each
point on the map (i.e. top or bottom, left or right) is not important, only the distance between
each point. The reliability of the multidimensional scaling analysis was tested by computing a
stress index, indicating the goodness of fit of the two dimensional configuration to the sort data. A
stress value between 0.205 and 0.365 was considered acceptable (Kane & Trochim, 2007).

Hierarchical cluster analysis performed within the Concept Systems software used the participant
grouping data to generate cluster maps. The cluster map graphically depicts clusters of points
(statements) based on a consensus of how the participants grouped the individual statements.
Selecting the appropriate number of clusters was achieved primarily through reviewing the
statements within each cluster and discussing whether the merging or splitting of clusters is
appropriate; that is, it has to make sense that the statement is allocated to a particular cluster
(Jackson & Trochim, 2002). These decisions were also informed using bridging scores (Jackson &
Trochim, 2002), indicating whether the statements contained within a cluster were more often
grouped together by participants (lower bridging score), or less likely to be grouped together
(higher bridging score). Bridging scores can be used to indicate whether the cluster may be
improved if separated into two clusters. It is important to note here that only the number of
clusters is being influenced by the researchers. Researcher judgment is required with cluster
analysis as there is no sensible mathematical criterion available to select the number of clusters
because the “best” number of clusters depends on the level of specificity desired and the context
at hand, factors that can only be judged subjectively (Jackson & Trochim, 2002). See Bennett et al. (2018) for details on how the bridging score and cluster content are used to determine the number of clusters.

After examining 14 different possible cluster solutions, two of the authors (RB & CM) reached a consensus about the best number of clusters to represent the data. Each cluster represents a concept. Concept names were based on the grouping labels put forward by the participants during data collection. The resulting map is the concept map. The research team generated a description of each concept identified by the concept map based on the statements it contains and the labels indicated by the participants. For example, the names put forward by participants for the concept Working with Your Clinician included “clinician”, “communication with the clinician”, “find a good clinician”, “clinician-related”, “comfort and confidence in service provider”, “clinician assistance”, “quality of clinician”, and Working with Your Clinician.

A concept map was generated for each cohort (clinicians and hearing aid owners). To determine whether the cohort concept maps differed significantly a split-half reliability measure (comparing the data from each cohort) was conducted using the concept mapping software (version 4, Ithica, NY: Concept Systems Incorporated) and Spearman-Brown Prophecy Formula correction applied using SPSS Statistics (version21.0, Armonk, NY: IBM Corp). A correlation above 0.70 was considered high (Hinkle et al., 2003) and indicated sufficient consensus between the clinicians’ and hearing aid owners’ data and that they could be combined to create one concept map for further analyses.

A similar reliability analysis was conducted for this final concept map (clinician and hearing aid owner data combined). The participant cohort was randomly split into two sub-cohorts, and then separate similarity matrices and cluster maps were generated for each (based on the number of clusters selected for the final map) (Trochim, 1993). Correlation between the two maps was evaluated by applying the Spearman-Brown correction correlation to the split half correlation (Trochim, 1993) using SPSS Statistics (version21.0, Armonk, NY: IBM Corp). A correlation above 0.70 was considered high (Hinkle et al., 2003) and indicated that the two cohort maps were similar, i.e. that the concept maps accurately represented the participants’ grouping activity data and thus that the data were reliable (Trochim, 1993).
To validate the interpretation of the data, the final concept map generated was sent to all participants (hearing aid owners and clinicians) via post for feedback. Participants were asked to reflect on whether they felt: 1) the concept map accurately represented the concepts informed by the statements; 2) the name of each of the concepts accurately represented the statements it contained and 3) the description of each of the concepts accurately represented the statements it contained. Participant feedback informed whether the concept map(s) needed to be redefined or labelled and described differently.

Participants’ rating scores were used to identify the importance of each concept to overall success with hearing aids. Internal consistency of the ratings data were calculated using Cronbach’s alpha for each concept to determine reliability of the concept map (Rosas & Kane, 2012). Welch’s t test was used to compare the mean importance ratings for the same cluster across two groups (hearing aid owners and clinicians), and between two clusters for the same participant group.

6.5 Results

Brainstorming sessions yielded a total of 208 statements across all three sessions describing what hearing aid owners must do to use, handle, manage, maintain and care for their hearing aid. Reducing and editing the statements resulted in a final list of 111 statements used for the grouping and rating tasks (Appendix B). The statements generated by the participants varied in nature; some were knowledge based (for example, 32. Know where to buy puffers or vacuum for cleaning wax), some were tasks (for example, 41. Practice using the phone with the hearing aid), and others were psychosocial in nature (for example, 33. Be motivated to wear the hearing aids and 29. be happy with the little achievements, e.g. being pleased with hearing and localizing the rustling of the leaves when bush walking).

The concepts identified through concept map generation for the hearing aid owners group and the clinician group did not differ greatly (split-half correlation for the grouping task was 0.75 and application of the Spearman-Brown correction resulted in a reliability of 0.86), and as such a combined concept map was generated and used for the remainder of the analyses. The final concept map selected (cohorts combined) had a stress index of 0.24, suggesting a very good fit of the concept map to the similarity matrix (Trochim, 1993). Reliability testing of the grouping tasks
suggested high consistency between how participants sorted the data; split-half correlation of 0.75 and 0.86 following Spearman-Brown correction (Trochim, 1993).

The concept map generated revealed two overarching themes: the *device* and the *person*. The *device* theme contained 65 of the 111 statements and described knowledge or practical skills specifically related to the hearing aid. The *person* theme contained 46 of the 111 statements and described knowledge, skills or personal attributes relating to the individual obtaining hearing aids. Six concepts were identified: 1) Daily Hearing Aid Use; 2) Hearing Aid Maintenance and Repairs; 3) Learning to Come to Terms with Hearing Aids; 4) Communication Strategies; 5) Working with Your Clinician and 6) Advanced Hearing Aid Knowledge (Figure 6.1). Descriptions of the six concepts generated by the researchers reflected the statements contained within each concept and the group names put forward by participants during the grouping activity (Table 6.2). The example statements included in Table 6.2 are those with the smaller bridging scores, that is, those statements that were most often placed in each concept group by the participants, thus best representing the core meaning of the concept.
Eighteen (n = 12 hearing aid owners and n = 6 clinicians) of the 46 participants (39% response rate) provided feedback on the final concept map generated from the data. All respondents indicated that they agreed with the concepts, the concept names and descriptions. Until this point the concept Hearing Aid Maintenance and Repairs had been called “Hearing Aid Care and Maintenance”. However, two respondents commented that although tasks associated with hearing aid handling, damages and repairs were included in this concept, the title did not provide sufficient emphasis and they suggested that these tasks be separated into a category of its own.

Due to the nature of concept mapping, researchers are not able to influence which statements are contained within each concept, only the concept’s name and description. Therefore the concept was renamed to Hearing Aid Maintenance and Repairs.
Table 6.2. Six concepts describing what hearing aid owners must do in order to use, handle, manage, maintain and care for their hearing aid(s).

<table>
<thead>
<tr>
<th>Theme</th>
<th>Concepts</th>
<th>Concept description</th>
<th>Representative statements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device</strong></td>
<td><strong>Hearing Aid Maintenance and Repairs (0.17; 3.83)</strong></td>
<td>Knowledge and skills required for ongoing hearing aid maintenance and care, including preventing and troubleshooting common problems experienced with hearing aids.</td>
<td>73. Know when and how hearing aid tubing should be replaced (0.00; 3.85)</td>
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<td></td>
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<td>42. Know how and when to clean the hearing aid moulds, including the vents (0.02; 4.32)</td>
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<td></td>
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<td></td>
<td>109. Know when to use a dry aid kit, such as when it is humid, after sweating/exercising, wet ears from showering/swimming (0.02; 4.00)</td>
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<tr>
<td></td>
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<td></td>
<td>50. Clean microphones ports and/or replace microphone covers (0.02; 3.68)</td>
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<td></td>
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<td></td>
<td>15. Know how to remove the wax from the hearing aid (different for different types of hearing aids) (0.08; 4.44)</td>
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<td></td>
<td></td>
<td></td>
<td>23. Know how to troubleshoot for causes of feedback e.g. wax/moisture in the ear/speaker, cracked tubing, inaccurate insertion (0.10; 3.88)</td>
</tr>
<tr>
<td><strong>Daily Hearing Aid Use</strong></td>
<td><strong>(0.32; 3.79)</strong></td>
<td>Knowledge and skills required for daily hearing aid handling and use.</td>
<td>1. Learn how and when to change (or charge) the battery (0.18; 4.68)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>99. Check that the hearing aids are working by cupping it in the hand and listening to whether it whistles/feedback (0.19; 3.65)</td>
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<td></td>
<td></td>
<td></td>
<td>12. Know which program to use for which situation (0.24; 3.76)</td>
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<tr>
<td></td>
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<td></td>
<td>105. Learn how to use the volume control (0.25; 3.64)</td>
</tr>
<tr>
<td><strong>Advanced Hearing Aid</strong></td>
<td><strong>Knowledge (0.61; 3.50)</strong></td>
<td>Knowledge and understanding required for optimal hearing aid use and management, beyond that required for daily hearing aid handling and maintenance.</td>
<td>67. Know that it is ok to collect extra batteries before going away, rather than running out or having to find a place to buy batteries while away (0.34; 3.91)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>32. Know where to buy puffers or vacuums for cleaning wax (0.36; 3.18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>110. Understand how ear wax in the ear canal can cause problems with the hearing aids (0.39; 4.15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60. Know to ask for a dry box (dry aid kit) as clinicians don’t always give them out or mention them (0.56; 3.26)</td>
</tr>
<tr>
<td>Person</td>
<td>Learning to Come to Terms with Hearing Aids (0.31; 3.97)</td>
<td></td>
<td></td>
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<td>--------</td>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Acceptance and understanding of the personal journey one has to take after obtaining a hearing aid.</td>
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<td></td>
<td>46. Use hearing aids on a regular basis in order to ‘retrain’ the brain and to accept amplified sounds as ‘normal’ (0.10; 4.56)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>35. Set up a reminder to encourage daily hearing aid use (0.10; 2.19)</td>
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<td></td>
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<tr>
<td></td>
<td>33. Be motivated to encourage daily hearing aid use (0.12; 4.58)</td>
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<tr>
<td></td>
<td>64. Understand that getting used to hearing aids can be emotional to start with (0.12; 3.97)</td>
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<tr>
<td></td>
<td>62. Understand that it takes a long time to get used to sounds – it can be scary at first, there is so much noise in the world (0.13; 3.94)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication Strategies (0.39; 3.91)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies for hearing aid owners and their communication partners to improve communication when wearing or not wearing hearing aids.</td>
</tr>
<tr>
<td>92. Teach family/friends to look at you when they speak (0.23; 3.94)</td>
</tr>
<tr>
<td>96. Learn not to be afraid to ask people to repeat themselves if you don’t hear them the first time (0.26; 4.18)</td>
</tr>
<tr>
<td>95. Try to speak one-on-one when talking with people in a noisy place (0.29; 4.06)</td>
</tr>
<tr>
<td>94. Know to speak face-to-face when talking with people, to watch their lips (0.29; 3.94)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Working with Your Clinician (0.44; 3.93)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinician skills and clinic procedures that facilitate an optimal client-clinician relationship, wherein the client can receive the information and training required for hearing aid use and management.</td>
</tr>
<tr>
<td>37. Find a clinician who is aware of the impact of different health problems on hearing aid use (0.17; 3.55)</td>
</tr>
<tr>
<td>36. Ask to see the same clinician so that they can get to know you (0.20; 3.48)</td>
</tr>
<tr>
<td>87. Find a clinician who is always willing to discuss and fix problems (0.21; 4.50)</td>
</tr>
<tr>
<td>14. Know what questions to ask their clinician to get all of the information (0.26; 3.65)</td>
</tr>
</tbody>
</table>
Reliability estimates of the rating data, evaluated with the cohorts combined, demonstrated high internal consistency for all six concepts: Daily Hearing Aid Use ($\alpha = 0.91$), Hearing Aid Maintenance and Repairs ($\alpha = 0.95$), Learning to Come to Terms with Hearing Aids ($\alpha = 0.93$), Communication Strategies ($\alpha = 0.94$), Working with Your Clinician ($\alpha = 0.90$), and Advanced Hearing Aid Knowledge ($\alpha = 0.91$).

Participants’ mean ratings for the importance of each individual statement ranged from 2.55 to 4.74; thus none of the statements were deemed unimportant. The importance of each concept, as indicated by the participant rating scores, is reported in Table 6.3. It should be noted that the items contributing to the six concepts were generated by both hearing aid owner and clinician groups and were not adjusted for any expected directionality of importance weightings. Thus, it is possible that the importance of individual statements may differ to the importance indicated for the concept. There were no significant between-cohort differences for the mean ratings for each of the concepts, with the exception of the concept Learning to Come to Terms with Hearing Aids (Table 6.3), which was deemed more important by the clinician group. There was a difference in the order in which the concepts were rated between the two cohorts. The hearing aid owner group indicated all six concepts to be of similar importance, that is, the mean ratings for each concept did not differ significantly. In contrast, the clinician group indicated five of the six concepts to be of similar importance, but the concept Advanced Hearing Aid Knowledge was deemed to be significantly less important than the other five concepts (Table 6.4).
Table 6.3. Mean importance ratings for each of the six concepts as rated by the hearing aid owner and clinician groups, and the between cohort differences.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Hearing aid owner’s mean rating Mean (SD)</th>
<th>Clinician’s mean rating Mean (SD)</th>
<th>Between cohort differences t</th>
<th>Degrees of Freedom</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Hearing Aid Use</td>
<td>3.64 (1.21)</td>
<td>3.94 (1.08)</td>
<td>1.7837</td>
<td>40</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Hearing Aid Maintenance and Repairs</td>
<td>3.76 (1.09)</td>
<td>3.89 (1.12)</td>
<td>1.0135</td>
<td>62</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Learning to Come to Terms with Hearing Aids</td>
<td>3.77 (1.16)</td>
<td>4.17 (1.03)</td>
<td>2.6965*</td>
<td>46</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Communication Strategies</td>
<td>3.74 (1.27)</td>
<td>4.06 (1.15)</td>
<td>2.0269</td>
<td>14</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Working with Your Clinician</td>
<td>3.91 (1.13)</td>
<td>3.96 (1.25)</td>
<td>0.2107</td>
<td>26</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Advanced Hearing Aid Knowledge</td>
<td>3.64 (1.18)</td>
<td>3.37 (1.28)</td>
<td>-1.2253</td>
<td>22</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level
Table 6.4. Welch’s t-test was used to determine significant differences between the mean ratings for the importance of each concept. This was performed separately for each cohort. It can be seen that the hearing aid owners did not indicate any of the concepts to be of significantly different importance than any others. While the clinicians agreed for four of the five concepts, they indicated that the concept Advanced Hearing Aid Knowledge was significantly less important than the other four concepts identified.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Hearing aid owners</th>
<th>Clinicians</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Welch’s t (Degrees of freedom)]</td>
<td>[Welch’s t (Degrees of freedom)]</td>
</tr>
<tr>
<td>1. Daily Hearing Aid Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Hearing Aid Maintenance and Repairs</td>
<td>-0.8495 (51)</td>
<td>0.3011 (51)</td>
</tr>
<tr>
<td>3. Learning to Come to Terms with Hearing Aids</td>
<td>-0.8929 (43)</td>
<td>-1.3641 (43)</td>
</tr>
<tr>
<td>4. Communication Strategies</td>
<td>-0.6499 (27)</td>
<td>-0.7530 (27)</td>
</tr>
<tr>
<td>5. Working with Your Clinician</td>
<td>-1.4636 (33)</td>
<td>-0.1050 (33)</td>
</tr>
<tr>
<td>6. Advanced Hearing Aid Knowledge</td>
<td>0.0006 (31)</td>
<td>2.7291 (31)*</td>
</tr>
</tbody>
</table>

* * Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level
6.6 Discussion

The challenges associated with getting used to hearing aids have been described as multifactorial, and include adjustment to altered sensory input, learning the practical skills associated with hearing aid use, and managing the psychosocial impact of hearing loss (Boothroyd, 2007; Dawes et al., 2014; Hogan, 2001; Knudsen et al., 2010). Typically, the hearing health professional provides informational- and emotion-based counselling in these areas throughout the hearing rehabilitation program. However, the quality, mode of delivery and extent of counselling required for being able to manage hearing aids adequately has not fully been examined. The amount of time spent on hearing aid management during clinical consultations is limited, with hearing aid owners reporting having received less than one hour of hearing aid-related counselling during their entire rehabilitation program (Kochkin et al., 2012), but the relationship with hearing aid management skills were not reported. Furthermore, much of the hearing aid information is delivered verbally (Ferguson et al., 2015), with hearing aid owners unable to recall between 25-65% of information provided during the consultation four weeks later (El-Molla et al., 2012; Reese & Hnath-Chisolm, 2005). It is therefore not surprising that up to 90% of hearing aid owners demonstrate difficulty with basic hearing aid management tasks (Ferrari et al., 2015; Bennett et al., 2017) and almost 50% of hearing aid owners report not receiving enough practical help regarding hearing aid use (Kelly et al., 2013). The informational and training needs of hearing aid owners appear not to be met by current clinical practices.

Focused on providing evidence to improve clinical practices, this study generated an itemized list of the knowledge, skills and tasks required for hearing aid management through engaging both hearing aid owners and clinicians. Participants identified six concepts required for hearing aid management, with two overarching themes: the device and the person. Delineating the device from the person is an important construct often overlooked by clinicians (Boothroyd, 2007; Erdman et al., 1994; Sweetow, 2007; Sweetow & Sabes, 2007), but continually emphasized by hearing aid owners in qualitative studies (Grenness et al., 2014; Kelly et al., 2013; Knudsen et al., 2013; Laplante-Lévesque et al., 2010; Laplante-Lévesque et al., 2012; Laplante-Lévesque et al., 2012; Lockey et al., 2010; Poost-Fороosh et al., 2011). Some argue that the focus on hearing aids over rehabilitation of the person may
be due to the increased promotion and marketing of hearing aids by the manufacturers and the misplaced belief that hearing aids alone could overcome hearing loss concerns (Sweetow, 2007; Sweetow & Sabes, 2007).

The majority of the statements generated in this study were associated with the device rather than the person. This may be due to the wording of the question specifying requirements for hearing aid management, but may also echo the historical dominance of the biomedical model of service delivery in audiology practices, focusing on pathology, impairment and treatment (Erdman et al., 1994), described as a deficit-based, device-centric model with little emphasis on the role of the person with hearing impairment (Hogan, 2015). Device-related items described by participants in this study included practical tasks as well as knowledge items describing the process of learning how and when to use different hearing aid features, across three key concepts: Daily Hearing Aid Use, Hearing Aid Maintenance and Repairs and Advanced Hearing Aid Knowledge. It is interesting to note that when generating the statements, participants delineated the physical ability to manipulate the hearing aid from the cognitive understanding of how, where and when to use the hearing aid feature. These results are interesting in light of the findings of Bennett et al. (2017) which demonstrated that hearing aid owners were significantly better at self-reporting practical tasks (e.g. physical manipulation of the volume control) than understanding-based tasks (e.g. knowing when to adjust the volume and by how much). Bennett et al. (2017) also found that participants demonstrated fewer difficulties for basic and frequently performed tasks (e.g. hearing aid removal/insertion and changing the battery), than more complex and infrequently performed tasks (e.g. volume control and telephone use). Thus, the role of the clinician should not be to simply provide instructions for hearing aid handling, but to establish whether hearing aid owners have learned the skills necessary, with special attention to understanding based tasks and those more complex or less frequently performed. Surveys provide a medium for clinicians to ensure they have provided all the necessary information and training, and also to systematically evaluate whether the hearing aid owner has in fact learned what was taught (Bennett et al., 2015b).

Although hearing aids have been demonstrated to improve hearing sensitivity and subsequently quality of life (Ferguson et al., 2017; Chisolm et al., 2007; Kochkin & Regin,
hearing aids alone are often not enough to overcome the disability imposed by hearing impairment (Sweetow & Sabes, 2007). The psychosocial consequences of untreated hearing loss are widely recognized in both research and clinical practices, and include distress, anxiety, depression, loneliness and smaller social network size (Arlinger, 2003; Kramer et al., 2002; Mener et al., 2013; Nachtegaal et al., 2009; Pronk et al., 2014; Tambs, 2004). Due to the impact of hearing loss on communication, both the person with hearing loss and the significant other will experience effects as a result of the hearing loss and subsequent rehabilitation (Kamil & Lin, 2015; Stark & Hickson, 2004; Wallhagen et al., 2004). Participants in this study recognized the personal experiences and personal investment required by the hearing aid owner when acquiring hearing aids through the theme Person; this theme included the three concepts: Learning to Come to Terms with Hearing Aids, Communication Strategies and Working with Your Clinician.

For the most part, statements included in the concept Learning to Come to Terms with Hearing Aids described the acceptance and determination required to get used to hearing aids. The importance of hearing aid owners expectations, attitudes and adjustment to hearing aids is evidenced in their relationship to hearing aid outcomes (Jerram & Purdy, 2001; Saunders et al., 2013; Saunders et al., 2009). However, opportunities for hearing aid owners to discuss their personal experiences with the clinician may be limited in the clinical setting. A recent study by Ekberg et al. (2014) investigated the way in which clinicians currently address hearing aid owners’ psychosocial concerns during clinical appointments by recording 63 patient-clinician interactions live in the clinical setting. Analysing the discourse between audiologists and patients revealed that audiologists frequently disregard emotional content in the patients talk. Audiologists did not easily engage in discussions with ambiguous or negative themes and hearing aids were quickly presented following a diagnosis of hearing impairment as a problem-solving attempt. It appears that audiologists may require further training in discussing the thoughts feelings and behaviours associated with hearing loss and hearing aid use. The IDA institute (idainstitute.com) provide clinical tools to help audiologists address the psychological and social challenges of hearing loss. The psychological and psychosocial aspects of hearing aid use identified by participants in this study could be used to inform application of such tools in the clinical setting, and to inform development of clinician training programs.
Participants in this study noted the importance of the working relationship between the hearing aid owner and the clinician through the concept Working with Your Clinician. This concept included statements that described both clinician and hearing aid owner traits and actions required for hearing aid management skills training, such as 87. Find a clinician who is always willing to discuss and fix problems and 90. Be comfortable admitting to the clinician how little you have used the hearing aid. Clinician traits included awareness, willingness, knowledge, and understanding. These traits are in line with facilitators of a good therapeutic relationship as outlined by Grenness et al. (2014). Hearing aid owner traits included proactive behaviour (finding, seeking, asking and attending), knowledge (knowing what questions to ask), and being comfortable with the clinician (divulging information and asking for help). These traits are in line with studies describing aspects of personality found to be associated with successful hearing aid use (Cox et al., 2007; Jerram & Purdy, 2001).

Participants (hearing aid owners and clinicians) in this study generated statements that described building a long term relationship between the hearing aid owner and the clinician, specifically returning to the clinic for help and attending ongoing appointments. In contrast, other qualitative studies involving hearing aid owners have described the client-clinician interaction in the early stages of hearing aid acquisition only, rather than as an ongoing relationship (Dawes et al., 2014; Laplante-Lévesque et al., 2013; Laplante-Lévesque et al., 2012). Given the chronic nature of hearing loss and that treatment with hearing aids must be sustained over a lifetime, there is clear benefit to actively engaging the patient in their rehabilitation program and forging a long term relationship.

There is growing evidence that aural rehabilitation services beyond the fitting of hearing aids result in better outcomes, such as Communication Strategies training (Hickson et al., 2007b). Although the research question employed in this study asked what is required for hearing aid management, participants put forward statements that described how to be a better communicator and the importance of teaching others how to be better communicators (primarily family members). The inclusion of Communication Strategies as a concept highlights the importance of communication training to the participants involved in this study.
6.6.1 Clinical implications

Participants identified 111 individual statements describing the knowledge, skills or tasks required for hearing aid management, highlighting the magnitude of information that clinicians are required to impart, and the overwhelming amount of information that hearing aid owners are expected to learn when obtaining hearing aids. The itemized list of hearing aid management tasks identified in this study could assist clinicians in realizing the large amount of information that must be transferred from clinician to hearing aid owner, and may prompt clinicians to change their clinical protocols to include checklists, alternative training methods, supplemental materials, and modes of skill evaluation to address the hearing aid management deficits that are currently observed.

The concept Hearing Aid Maintenance and Repairs included tasks that may be considered more complex than the tasks included in the Daily Hearing Aid Use concept (Goggins & Day, 2009; West & Smith, 2007). The complexity may be due to the physical requirements of the task, for example, microphone covers can be small and fiddly to manage (Bennett et al, 2015a). Additionally, tasks may be considered complex due to how infrequently they are performed, thus increasing the chance that hearing aid owners may forget how to perform the task or forget that the task is even necessary. To address this, clinicians should ensure that hearing aid owners have sufficient training and support at initial hearing aid fitting appointments and at intervals thereafter. For example, given that several maintenance tasks are required to be performed for the first time approximately three months after the initial hearing aid fitting appointment (such as wax protector/ microphone cover/ slim tube and dome replacement) it may be beneficial for clinicians to make contact with hearing aid owners at this time to remind them about these maintenance tasks and offer additional training and support. These sorts of additional services may be more necessary in older populations, as older adults have been found to be less knowledgeable about the complex features on their hearing devices than the basic features (Dullard & Cienkowski, 2014).

Whereas the concepts Daily Hearing Aid Use and Hearing Aid Maintenance and Repairs included the majority of the device-related tasks, participants indicated a related but separate category named Advanced Hearing Aid Knowledge. This concept demonstrated the highest bridging score of all concepts, suggesting that some participants placed the included
statements in other groups, or in some cases, statements were placed in a group of their own. For example, such was often the case for 7. Know about insurance for hearing aids and 72. Know to still use protection to prevent further hearing loss. It could be argued that some of the statements contained within the Advanced Hearing Aid Knowledge concept may fit in the other two device-related concepts, being either daily tasks or ongoing maintenance tasks. Ultimately, however, through the concept mapping process participants’ grouped these statements together, generating a specific category named Advanced Hearing Aid Knowledge. Initially it was unclear why these items were grouped together; however, the rating data shed some light. Where hearing aid owners rated the concept Advanced Hearing Aid Knowledge as similarly important to the other five concepts, the clinicians rated it as significantly less important than the other five concepts. It is possible that due to the large amount of information and training that audiologists are currently expected to administer in a very small time period, clinicians make a judgement call as to those hearing aid owners who require certain items of information or training and those who do not. It is possible then that the category Advanced Hearing Aid Knowledge reflects the additional information that some hearing aid owners do not receive, but would like to. As previously reported by other studies involving hearing aid owners (Kelly et al., 2013; Laplante-Lévesque et al., 2013), participants in this study highlighted their desire for greater access to information.

6.6.2 Limitations and future research

One of the limitations of this study was that participants self-selected to volunteer for the study which may have biased the content and the rating scales. Although clinicians were recruited from the database of a hearing aid manufacturer, it is unlikely that this would have biased the findings as participating clinicians worked in a variety of organizations, only one of whom was from a clinic aligned with that particular manufacturer. Sample sizes were small which may have influenced the contents of the statements provided; other hearing aid owners and clinicians may have generated additional statements not included in this study. Nevertheless, the number of statements generated was large and this is the most comprehensive study to date looking at hearing aid management. Additionally, given the small sample size, the rating scale results should not be assumed representative of the population. Only 35% of participants provided feedback on the final concept map generated
from the data. None the less, findings are informative and provide a framework for development of clinical tools for training and evaluation of hearing aid management skills.

6.7 Conclusion

Over 111 unique statements describing the knowledge, skills or tasks required for hearing aid management were identified, highlighting the magnitude of information and training required to optimally manage hearing aids. The six concepts identified by participants provide a framework for future clinical tools for training and evaluation of hearing aid management skills. Clinicians and hearing aid owners generally agreed on the importance of concepts, with the exception of one, Advanced Hearing Aid Knowledge, indicating that statements in this category require closer consideration.


6.8 References


CHAPTER SEVEN

Evaluating hearing aid management: Development of the Hearing Aid Skills and Knowledge Inventory (HASKI)

(American Journal Audiology. Accepted May 2018)

7.1 Foreword to Chapter Seven

The previous chapter identified 111 individual items of knowledge or skill required for hearing aid use. These items were used to develop a comprehensive survey evaluating the skills and knowledge required in order to handle, use and maintain a hearing aid; described hereafter as hearing aid management. The study described in this chapter developed, pilot tested and investigated the psychometric properties of the survey using a multicentre convenience cohort design.
7.2 Abstract

Objective: Although hearing healthcare clinicians provide training on hearing aid handling and management as part of the rehabilitation program, clinical studies suggest that the level of management skill demonstrated by hearing aid owners is low. In the absence of a comprehensive clinical survey to identify these shortfalls in clinical training, the objective of this study was to develop and report the psychometric properties of the Hearing Aid Skills and Knowledge Inventory (HASKI: a self-administered version and a clinician-administered version). The HASKI evaluates the knowledge and skills required for hearing aid management. A secondary aim was to report the prevalence of hearing aid management difficulties in an Australian population.

Design: Development of the HASKI and investigation of its psychometric properties in a prospective convenience cohort of 518 adult hearing aid owners, ranging in age from 18 to 97 years (M = 71 years, SD = 14), 60% male, 38% female and 2% undisclosed, recruited from seven hearing clinics across Australia.

Results: The Hearing Aid Skills and Knowledge Inventory (both the self-administered and clinician-administered) demonstrated high internal consistency, interdimensional relationships, construct validity, test-retest reliability, inter-observer reliability and criterion validity. A range of aptitudes were observed from low to full competency, with 99% of participants indicating difficulty with at least one item on the survey.

Conclusions: The Hearing Aid Skills and Knowledge Inventories are valid and reliable measures of hearing aid handling and management skills with good potential for use in clinical settings. Hearing aid management is an area of difficulty for the majority of hearing aid owners indicating the need for clinicians to improve the efficacy of hearing aid management training delivered.

7.3 Introduction

The World Health Organization estimates that there are over 360 million people in the world living with disabling hearing loss (WHO, 2014). Hearing loss can affect an individual’s ability to communicate with others, resulting in significant social and emotional impacts on
everyday life, such as causing feelings of loneliness, isolation and frustration (Pronk et al., 2011; Solheim et al., 2011). Treating hearing loss with hearing aids can result in significant improvements in social activity and quality of life (Ferguson et al., 2017; Chisolm et al., 2007). However, a large proportion of individuals who self-identify as having hearing loss do not seek treatment, discontinue treatment programmes, or fail to use the hearing aids they have acquired (Hickson et al., 2010; Hickson et al., 2014; Kochkin, 2010; Staehelin et al., 2011).

Typically, hearing aids are provided as part of an aural rehabilitation program, where the hearing healthcare clinician sets up the hearing aid (physically and acoustically) to suit the individual needs of the hearing aid owner. During this appointment the clinician has the opportunity to provide education and training on the practical use of hearing aids, as well as affective counselling on the personal experiences of acquiring hearing aids. Affective counselling may include discussions on how the hearing aid will address their personal communication difficulties, what the hearing aid owner can expect from their hearing aid, the process of acclimatising to the new sounds they will hear, and how personal motivation and involvement influence the outcome of the rehabilitation program (Vestergaard Knudsen et al., 2010). The hearing aid is then reviewed and adjusted over subsequent appointments as the hearing aid owner adjusts to the new sounds and provides the clinician with feedback on their personal experiences when wearing the hearing aid in their normal environment (such as at home, work or socialising) (Dillon et al., 2006). This process is takes 2-10 sessions (Kochkin et al., 2012; Bennett et al., 2016).

While the clinician is primarily responsible for the physical set up and acoustic settings of the hearing aid, the hearing aid owner is responsible for the ongoing use, daily handling (such as inserting the hearing aid and changing the battery) and ongoing management (such as replacing tubing or domes). Thus, education and training in the handling and management of hearing aids is an essential component of any rehabilitation program (Boothroyd, 2007). The importance of good hearing aid management skills is evidenced by their association with hearing aid use (Kumar et al., 2000), increased benefits from hearing
aids (Campos et al., 2014) and higher self-reported hearing aid satisfaction (Bennett et al., 2017a; Kumar et al., 2000). Although it is recommended that hearing healthcare professionals provide training on hearing aid handling and management as part of the rehabilitation program (American Speech-Language-Hearing Association, 1998; Audiology Australia, 2013), research suggests that the level of handling skills demonstrated by hearing aid owners remains low (Bennett et al., 2017a; Bertoli et al., 2009; Desjardins & Doherty, 2009; Upfold et al., 1990).

The administration of a client survey is one means by which clinicians could assess and address gaps in hearing aid skill and knowledge. A recent review (Bennett et al., 2015a) identified three clinician-administered surveys specifically designed to evaluate hearing aid handling skill (Desjardins & Doherty, 2009; Oberg et al., 2009; Pothier & Bredenkamp, 2006); however, the surveys were not comprehensive in that aspects of hearing aid management were not included, such as the use of a dehumidifier and replacement of domes, tubes or microphone covers. While statistical procedures, such as factor analysis and internal consistency, provide opportunity for survey developers to systematically reduce the number of items informed by the population for which the survey is designed, the process of item development and decisions surrounding item inclusion is often left to the developers (as was the case for the hearing aid surveys reviewed by Bennett et al., 2015a) and thus, without clear conceptual grounding, the content domain may not accurately represent the phenomenon under investigation (Rosas & Camphausen, 2007; Sheatsley, 1983).

Concept mapping provides a systematic mechanism for generating and identifying the conceptual framework of a phenomenon of interest and thus is an ideal platform for survey item development (Rosas & Camphausen, 2007). Concept mapping integrates qualitative and quantitative approaches in a multistep process that elicits the perspectives of key stakeholders (in this case hearing aid owners and clinicians) on a desired topic, followed by activities that involve grouping and rating the perspectives put forward by participants; thus these stakeholders play a valuable role in not only generating, but also interpreting the data (Trochim, 1989). Through involvement of key stakeholders, concept mapping identifies the
survey items pertinent to the population for which it is intended to be used, thereby addressing face and content validity of the subsequent scale (Rosas & Camphausen, 2007).

Bennett et al. (2018a) used a group concept mapping approach to engage hearing aid owners (n = 24) and hearing healthcare clinicians (n = 22) to generate a comprehensive list of the knowledge, tasks and skills required to use and manage a hearing aid. Participants identified 111 unique items describing hearing aid management within six concepts: 1) Daily Hearing Aid Use; 2) Hearing Aid Maintenance and Repairs; 3) Advanced Hearing Aid Knowledge; 4) Learning to Come to Terms with Hearing Aids; 5) Working With Your Clinician and 6) Communication Strategies. Items from the first three clusters above describe the physical aspects of hearing aid management and have subsequently formed the basis of the Hearing Aid Skills and Knowledge Inventory (HASKI), a 73-item questionnaire that can be self-administered (HASKI-self) or clinician-administered (HASKI-clin). The aims of this study were twofold: 1) to examine the psychometric properties of the Hearing Aid Skills and Knowledge Inventories, both the HASKI-self and HASKI-clin; and 2) to identify deficiencies in hearing aid skills and knowledge in an Australian population.

7.4 Methods

7.4.1 Research design
Survey developers demonstrate the clinical usefulness of a survey through reports of psychometric evaluation, specifically whether the survey actually measures what it purports to measure (validity) and whether the different scores represent differences between (or changes within) participants (reliability) (Fitzpatrick et al, 1998). A multicentre cohort study was conducted to evaluate the psychometric properties of the HASKI-self and HASKI-clin. Potential participants identified from seven hearing clinics in Australia were sent a survey set including the HASKI-self via post or email. A random sample of participants were selected and provided a second copy of the HASKI-self, enabling evaluation of test-retest reliability. Another random sample of participants were invited to attend a face-to-face session and administered the HASKI-clin, enabling evaluation of criterion reliability.
Additional psychometric properties investigated included internal consistency, interdimensional relationships, construct validity, inter-observer reliability and effect sizes.

Ethical approval for this study was granted by the Human Research Ethics Office of The University of Western Australia and The University of Queensland’s Human Research Ethics Committee. All participants provided written consent to participate.

7.4.2 Materials
Participants completed a survey set comprising a short clinical history form, the International Outcome Inventory for Hearing Aids (IOI-HA) (Cox & Alexander, 2002), and the HASKI-self (amended following the pilot study as described below). The survey set was available in paper and electronic format.

The short clinical history form included demographic and hearing aid device data, including participant age, gender, age of current hearing aid, duration of hearing aid use (total number of years of experience), style of hearing aid (Behind-the-ear or In-the-ear), hearing aid funding source (whether they paid in full for their hearing services: private; or received government subsidies through the Australian Office of Hearing Services: OHS), and satisfaction with hearing aids (with the response options “very dissatisfied”, “dissatisfied”, “neutral”, “satisfied” and “very satisfied”).

The IOI-HA is a seven-item survey developed to assess the effectiveness of hearing aids in improving hearing and general life enjoyment in real-life situations (Cox & Alexander, 2002). It was designed to be administered in conjunction with other related surveys in order to provide a common platform to facilitate comparison of results between different audiological studies. The IOI-HA was included in this survey set to enable investigation into whether hearing aid management skills and knowledge were associated with daily hours of hearing aid use (IOI-HA item 1) and hearing aid benefit (IOI-HA item 2).

7.4.2.1 Survey development
Two versions of the HASKI survey were developed. First, a self-administered version (HASKI-self: Appendix C) was developed to enable hearing aid owners to self-report hearing aid management skills and knowledge. A group concept mapping study by Bennett et al. (2018a) identified 64 statements describing hearing aid management across three domains: Daily Hearing Aid Use, Hearing Aid Maintenance And Repairs, and Advanced Hearing Aid Knowledge. Participants (hearing aid owners and clinicians) in the group concept mapping study were asked to indicate the importance of each of these statements for successful hearing aid use. The cohort’s mean ratings for each statement fell within the top half of the rating scale indicating that they were very important for the successful use of hearing aids. As every item was deemed important to successful hearing aid use by participants, all items within these three domains were included in the HASKI-self. Then a clinician-administered version (HASKI-clin: Appendix D) was based on the first to enable clinicians to evaluate hearing aid management skills. Creation of a clinician-administered version enabled investigation into whether hearing aid owners are able to accurately self-evaluate hearing aid skills as compared to clinician evaluation of hearing aid skills, that is, comparisons between HASKI-self and HASKI-clin scores. Both versions of the HASKI were pilot tested by hearing aid owners and clinicians to inform appropriateness and feasibility of the surveys.

**Self-administered HASKI (HASKI-self).** The HASKI-self consists of 14 questions across the three domains, with many of the questions having multiple parts, resulting in a total of 73 items describing skills or knowledge required for hearing aid use. For skill-based items participants were required to rate their ability on a four point Likert scale: “Never”, “Sometimes”, “Most of the time”, “Always”. For knowledge-based items, participants were required to identify whether they were aware of the item or not using a 3-point Likert scale: “Yes, I am aware”, “I now recall receiving this information, but had forgotten” and “I do not recall receiving this information”. A “not applicable” option is also available for many of the items.

Scoring of the HASKI-self was calculated by summing the total number of items identified as competent (not problematic) and converting it to a percentage of competency. Each
individual item was classified as a pass where “Always” or “Yes, I am aware” was selected (allocated one point); all other responses were considered a fail (allocated zero points). To calculate the percentage competency, the points were summed and then divided by the total number of items for which a response was given. Items for which “Not applicable” was selected were not included in the calculation of the score. A higher overall score indicated greater competency (i.e. a score of 100% represents full competency).

Items are equally weighted. Although it can be argued that some items may describe more important skills (for example, ability to insert the hearing aid may be considered more important than ability to use the volume control), the difference in importance for each item are difficult to quantify as these may vary across individuals. In this way, the score represents percentage of competency, with a lower score indicating a greater number of areas of difficulty – but may not indicate degree of difficulty. The survey score can be used to compare the extent of management difficulties for a single hearing aid owner before and after additional training, or across individuals.

**Clinician-administered HASKI (HASKI-clin).** The HASKI-clin was primarily developed to enable investigation into whether self-reported hearing aid management skills and knowledge (using the HASKI-self) accurately reflected management skills as evaluated by a trained professional. Thus, the HASKI-clin was designed to be used by a professional trained to administer and score the survey, and therefore requires the administrator to be able to see the hearing aid owner being evaluated, such as face-to-face delivery. As with existing clinician-administered measures of hearing aid skill (Desjardins & Doherty, 2009; Kemker, 1999), it is ideally administered as part of a clinical consultation allowing the administrator to offer retraining at the same time.

Minor modifications were made to the language and scoring of the HASKI-self to generate the HASKI-clin. Given that the purpose of the HASKI-clin was for the clinician to evaluate the hearing aid owner’s demonstrative skills regarding hearing aid management, some
questions from the second domain (Hearing Aid Maintenance and Repairs; Qs 11 and 13) and all questions from the third domain (Advanced Hearing Aid Knowledge) were omitted from the clinician-administered version as they referred to knowledge rather than skill. The resulting survey included 40 items across the two domains: Daily Hearing Aid Use and Hearing Aid Maintenance and Repairs. The wording of each question was altered from “Can you...” to “Please show me how you...”. Where the self-administered survey used a four-point Likert scale, the clinician-administered version used a dichotomous option of “Competent” or “Requires attention”, and includes a “Not Applicable” option. A dichotomous scale was chosen because a pilot study (Bennett et al., 2017a) suggested that a client requires additional support regardless of whether they show complete or partial incompetence. Additionally, a recent tutorial on inter-observer concordance suggested that the low inter-rater reliability observed with currently available hearing aid skills survey is likely due to: 1) having a greater number of possible responses to an item; 2) use of survey items that are unclear and require the administrator to provide explanation throughout testing and 3) where response items are not defined and require the administrator to make their own interpretation of whether the participants response is sufficient (Bennett et al., 2017b). For example, when asking a participant to demonstrate how they clean their hearing aid, administrators may have differing concepts of what specific tasks are required to fulfil this request. As such, the HASKI-clin provides limited response options and includes detailed descriptions of what is required to fulfil each item accurately as guidance for the administrator to specify exactly what tasks are required to be demonstrated to award a “pass” for that item. These definitions of what is required to achieve competency also appear on the HASKI-self.

Scoring of the HASKI-clin is the same as for the HASKI-self in that the overall score is calculated by summing the total number of items identified as competent and converting it to a percentage of competency.

7.4.2.1 Pilot testing
All 24 hearing aid owners who had participated in the group concept mapping study (Bennett et al., 2018a), used to inform the development of the HASKI surveys, were invited to pilot-test the HASKI-self. They were asked to complete a paper version of the survey and to provide feedback using open ended questions on 1) how long the survey took to complete, 2) the appropriateness of the content, and 3) whether they felt the survey was beneficial or worthwhile. Eleven participants returned a completed survey (response rate of 46%; six males (55%) and five females (45%), ranging in age from 67 to 89 years (M = 78, SD = 8 years)). Participants reported taking between 7 to 40 minutes to complete the survey (M = 20, SD = 11 mins). Participants reported positive experiences with completing the survey, and did not suggest any changes. One participant wrote “I found some of the tips quite educational”. Another wrote “Very useful, section three contained a lot of information that was new to me, but now I know it all thanks to the survey”. A third wrote “It’s a great survey, quite informative, I learned a lot just by completing it, thank you”.

The HASKI-clin was pilot tested by eight clinical audiologists: two male and six female, ranging in age from 26 to 51 years (M = 36, SD = 8), with a range of clinical experience (three to 28 years). They were asked to administer the survey with hearing aid users where appropriate in their daily clinical practice over the course of two weeks and provide feedback on the content and usability of the survey. Minor changes to the survey were made based on the clinicians’ feedback, such as inclusion of alternative names for the wax guard and rewording of some items for clarity. Clinicians reported taking approximately 10-15 minutes to administer the survey, including providing retraining on items failed.

### 7.4.3 Participants

Hearing aid owners were recruited from seven hearing clinics across Australia. Clinics were based in Queensland (n = 2), New South Wales (n = 3), and Western Australia (n = 2). Six of the participating clinics provided access to government funded services (OHS) and privately paid services, and one provided only the latter. Within each clinic, services were provided by a mix of both audiologists (university trained with a postgraduate-level qualification) and audiometrists (non-university trained hearing aid technicians). There are no universal or
standardised clinical processes in Australia, and therefore the number of appointments provided for a hearing aid fitting, the time allowance for these appointments, and what occurred during these appointments differed across participants. The participating clinics varied in their preferences for hearing aid brands, their pricing structures and their business models (e.g. single clinician, small chain, not-for-profit). Therefore, the participants’ experiences during the process of obtaining hearing aids, and the actual hearing aid they obtained, varied across participants in this study.

All clients aged 18 years or older recorded in the clinics’ databases who had received hearing aids prior to the date of data collection were identified as potential participants. No inclusion or exclusion criteria were placed on duration of hearing aid use. Each clinic generated a list of potential participants. The research team used a random number generator to select the 400 potential participants from each of the larger four clinics. The entire list of the smaller three were included. Participants were contacted via email (to complete the survey online) or post (to complete the survey on paper), depending on their preferred method of contact and whether they provided a valid email and/or postal address. The total number of potential participants contacted was 2,400 (1000 via post and 1,400 via email). The response rates were 22% for the postal group and 21% for the email group.

Hearing health care clinicians participated as survey administrators for one part of this experiment, to calculate inter-observer reliability for the clinician-administered version of the survey (HASKI-clin). A random selection of three clinicians, from a pool of eight, participated at each data collection session. Clinicians ranged in age from 23 to 35 years (M = 25, SD = 4), one was male and seven were female. Only one of the clinicians was a researcher involved in the design of the HASKI, whilst the other seven were all unfamiliar with the survey and each other’s clinical methods of hearing aid management evaluation.
7.4.4 Procedure

All potential participants received a copy of the survey set in their preferred format (e.g., online or paper version) and were given two months to complete the survey. Reminders were not sent. Participants returned completed surveys in the stamped, self-addressed envelopes provided. The psychometric properties commonly reported in scale development were evaluated as described in Table 7.1.

To evaluate test-retest reliability of the HASKI-self, 100 participants (randomly selected from three of the participating clinics whose proprietors or managers gave permission for the research team to contact the participants a second time) were sent the self-administered survey set a second time, in the same format as the first, 1-2 weeks after their initial survey responses were received (response rate of 38%). This time the survey also included a question pertaining to whether or not they had received any support or advice from a professional regarding their hearing aids in the previous week to ensure skills had not changed due to clinical intervention. Any participants reporting having received services in the meantime would have been excluded from this part of the experiment as their skills may have changed between test and retest; however, none of the participants reported receiving support.
Table 7.1. Psychometric properties assessed for the both the HASKI-self and HASKI-clin.

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<tr>
<th>Psychometric property</th>
<th>Description</th>
<th>Method of assessment</th>
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<tr>
<td>Face and content validity</td>
<td>Examines the extent to which the concepts of interest are represented by the items on the survey.</td>
<td>Item development was based on the results of the concept mapping study (Bennett et al., 2017b). Pilot testing was conducted with members of the target population.</td>
</tr>
<tr>
<td>Internal consistency</td>
<td>Examines the extent to which survey items correlate and thus measure the same concept (Terwee et al., 2007).</td>
<td>Chonbach’s α reliability coefficient.</td>
</tr>
<tr>
<td>Interdimensional relationships</td>
<td>Examines the relationships amongst survey domains.</td>
<td>Pearson’s correlation coefficients.</td>
</tr>
<tr>
<td>Construct validity</td>
<td>Evaluates the extent to which scores on a survey relate to characteristics of participants and subgroups of participants, in a way that is consistent with theoretically derived hypotheses (Terwee et al., 2007).</td>
<td>Assessed using Pearson’s correlations (for continuous and ordinal data) and independent sample t-test (for categorical data) for the following hypotheses: 1. Survey scores will be positively correlated with overall satisfaction with the hearing aid (Campos et al., 2014); 2. Survey scores will be positively correlated with perceived benefit received from the hearing aid (based on IOI-HA item 2) (Campos et al., 2014); 3. Survey scores will be positively correlated with overall hearing aid use; 4. Survey scores will be negatively correlated with age (Desjardins &amp; Doherty, 2009); 5. Survey scores will not be associated with gender (Desjardins &amp; Doherty, 2009).</td>
</tr>
<tr>
<td>Metric</td>
<td>Description</td>
<td>Methodology</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Test-retest reliability</td>
<td>Determines whether participants’ scores are stable over time (Terwee et al., 2007).</td>
<td>Intraclass correlation (ICC) between participants’ first and second HASKI-self survey scores, with a minimum of one and a maximum of two weeks between test and retest. The guidelines of Landis and Koch (1977) were used to classify the results: less than 0 indicating ‘no concordance’ (agreement/reliability), 0 to 0.20 ‘slight concordance’, 0.21 to 0.40 ‘fair concordance’, 0.41 to 0.60 ‘moderate concordance’, 0.61 to 0.80 ‘substantial concordance’, and 0.81 to 1.0 ‘almost perfect concordance’. ICC values exceeding 0.80 were deemed high and to suggest that the survey is stable over time (Bennett et al., 2017c; Hyde, 2000).</td>
</tr>
<tr>
<td>Inter-observer reliability</td>
<td>The degree of similarity between survey scores obtained by two or more administrators (Bennett et al., 2017c).</td>
<td>Intraclass correlation (ICC) between the three clinician observers.</td>
</tr>
<tr>
<td>Criterion validity</td>
<td>Indicates whether the survey measures what it purports to measure (Terwee et al., 2007).</td>
<td>Intraclass correlation (ICC) to compare self-administered evaluation of management skills (HASKI-self) to clinician-administered evaluation of management skills (HASKI-clin) for survey scores (each domain and overall score).</td>
</tr>
<tr>
<td>Effect size</td>
<td>A quantitative measure of the strength of a phenomenon and can be used to demonstrate correlation between two variables, the mean difference, or even the risk with which something happens (Kelley &amp; Preacher, 2012). An effect size estimate provides a value on the direction and magnitude of an effect of a treatment.</td>
<td>One way ANOVA comparing survey scores across the seven clinics involved in the study.</td>
</tr>
</tbody>
</table>
To evaluate inter-observer reliability of the HASKI-clin, 80 randomly-selected participants were invited to a 30-minute, individual, face-to-face data collection session (response rate of 40%). The participants first completed the self-administered version of the HASKI, followed by the clinician-administered version. Three clinicians (from a pool of eight) were allocated to each session. During these sessions, one clinician-administered the HASKI-clin, reading the exact wording of each item, while all three clinicians assessed the participant’s responses independently of each other. This data were also used to determine criterion reliability, by comparing participants’ perceived level of hearing aid management skill (HASKI-self scores) to the clinicians’ evaluation of level of skill (HASKI-clin scores).

7.4.5 Data Analysis
Data were entered into Microsoft Excel and analysed using SPSS Statistics (version 21.0, Armonk, NY: IBM Corp). All data were inspected for outliers (i.e. visual inspection of boxplots and |z| score calculations using a cut-off point of 2.58), after which tests of normality and skewness (i.e. Shapiro-Wilk test of normality and Q-Q plots) were conducted. As per Osborne & Overbay (2004), all outliers were removed to avoid errors in statistical analyses. To address Aim 1, a variety of methods were used to evaluate the psychometric properties of the HASKI-self and HASKI-clin, as described in Table 7.1. To address Aim 2, deficiencies in hearing aid skills and knowledge were reported by tabulating the frequency of how often each problem occurred in the population sampled.

7.5 Results
Participants (n = 518) ranged in age from 18 to 97 years (M = 71 years, SD = 14) and included 310 (60%) males and 193 (38%) females (2% of participants did not specify their gender). Over half of the participants completed the survey electronically (58%), with 42% completing the paper version. Almost all of the participants reported being fit binaurally (93%), with the remainder (7%) reporting monaural amplification. Most of the participants wore behind-the-ear (BTE) style hearing aids (84%), one of whom had a cochlear implant on the contra-lateral ear, and 16% wore in-the-ear (ITE) style hearing aids. More than half (57%) of participants had owned a hearing aid prior to their current one. Two thirds of the
participants had owned their current hearing aid for more than 12 months (66%), with 34% having owned their hearing aid for less than 12 months (as little as two weeks in one case). Two thirds of the participants paid for their hearing aids and hearing services privately (65%), with 35% receiving government subsidies for their hearing aid and associated services.

Participants reported high levels of hearing aid use with 84% reporting more than four hours of use per day. However, not all participants regularly used their hearing aids with 2% reporting using their hearing aid for less than one hour per day, and an additional 2% reporting never using their hearing aid. Satisfaction was high, with 78% of participants indicating they were “Satisfied” or “Very Satisfied” with their current hearing aids. IOI-HA scores ranged from 1.2 to 5.0 (M = 3.97, SD = 0.65). Self-reported hearing aid benefit was high, with 70% indicating that their hearing was “Quite a lot” or “Very much” better when using their hearing aid on the IOI-HA (item 2). IOI-HA item One (hearing aid use), item Two (hearing aid benefit) and IOI-HA scores were consistent with reported scores from other Australian and internationally reported populations (Cox & Alexander, 2002; Heuermann et al., 2005; Hickson et al., 2010).

7.5.1 Psychometric properties
Reliability estimates of the HASKI-self exceeded the recommended internal consistency alpha levels of 0.60 (Gliem & Gliem, 2003), indicating acceptable internal consistency for the survey total scores (α = 0.785) and for each of the three domains: Daily Hearing Aid Management (α = 0.842), Hearing Aid Repairs and Maintenance (α = 0.671) and Advanced Hearing Aid Knowledge (α = 0.814). Similarly, reliability estimates of the HASKI-clin demonstrated acceptable internal consistency for the survey total scores (α = 0.775) and for each of the two domains: Daily Hearing Aid Management (α = 0.749) and Hearing Aid Repairs and Maintenance (α = 0.674). These results suggest that there is a strong relationship among the subscale items and that the set of items for the total survey are well integrated (Gliem & Gliem, 2003).
Interdimensional relationships reported in Table 7.2 show significant, moderate correlations between domains, demonstrating that the different domains are somewhat related. Relationships were stronger within the HASKI-self than the HASKI-clin.

Table 7.2. Interdimensional relationships explored using Pearson’s correlation coefficient provide insight into the relationships between survey domains.

<table>
<thead>
<tr>
<th>Survey sub-sections</th>
<th>df</th>
<th>r</th>
<th>p</th>
<th>df</th>
<th>r</th>
<th>p</th>
<th>df</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>HASKI-self</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part One: Daily hearing aid use</td>
<td>498</td>
<td>0.496</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part Two: Hearing aid maintenance and repairs</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part three: Advanced hearing aid knowledge</td>
<td>496</td>
<td>0.430</td>
<td>&lt;0.001</td>
<td>496</td>
<td>0.454</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total HASKI score</td>
<td>500</td>
<td>0.782</td>
<td>&lt;0.001</td>
<td>498</td>
<td>0.862</td>
<td>&lt;0.001</td>
<td>496</td>
<td>0.749</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HASKI-clin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part One: Daily hearing aid use</td>
<td>32</td>
<td>0.998</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part Two: Hearing aid maintenance and repairs</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part Three: Advanced hearing aid knowledge</td>
<td>32</td>
<td>0.536</td>
<td>0.002</td>
<td>32</td>
<td>0.829</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Four of the five hypotheses tested for construct validity of the HASKI-self were met (Table 7.3). The hypothesis related to gender was not met, with HASKI-self scores of males (M = 68%, SD = 17) being significantly greater than the scores of females (M = 64%, SD = 18) \[t(492)= 2.602, p = 0.010\]. Three of the five hypotheses tested for construct validity of the HASKI-clin were met (Table 7.3). No correlation was identified for the hypotheses related to age \[t=-0.236(32), p=0.194\] and daily hours of hearing aid use \[t=0.195(16), p=0.469\].
Table 7.3. Associations between HASKI scores and participant demographic and self-report outcome factors to establish construct validity of the HASKI.

<table>
<thead>
<tr>
<th>Participant variables</th>
<th>Pearson's Correlation analysis</th>
<th>Independent samples t-test</th>
<th>Pearson's Correlation analysis</th>
<th>Independent samples t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>r</td>
<td>p</td>
<td>df</td>
</tr>
<tr>
<td>Overall satisfaction with the hearing aid</td>
<td>416</td>
<td>0.225</td>
<td>&lt;0.001</td>
<td>16</td>
</tr>
<tr>
<td>Perceived benefit received from the hearing aid</td>
<td>482</td>
<td>0.209</td>
<td>&lt;0.001</td>
<td>16</td>
</tr>
<tr>
<td>Overall hearing aid use</td>
<td>485</td>
<td>0.109</td>
<td>0.017</td>
<td>16</td>
</tr>
<tr>
<td>Age</td>
<td>477</td>
<td>-0.132</td>
<td>0.004</td>
<td>32</td>
</tr>
<tr>
<td>Gender</td>
<td>492</td>
<td>2.602</td>
<td>0.010</td>
<td>30</td>
</tr>
</tbody>
</table>

Inter-observer reliability of the HASKI-clin was established, with an ICC across three observers (selected from a pool of eight clinicians) being “almost perfect” (ICC = 0.933, p < 0.001; CI 95%: 0.879 to 0.965).

The test-retest reliability of the HASKI-self survey was performed on a sample of 38 participants, 23 males and 15 females, with a mean age of 81 years (SD = 9). It is important to note that the test-retest cohort was significantly older than the full cohort [t(442)= 5.022, p < 0.001]. Intra-observer reliability between test (M = 66%, SD = 18) and retest (M = 67%, SD = 22) HASKI-self total survey scores was “almost perfect” (ICC = 0.869, p < 0.001; CI 95%: 0.748 to 0.932).

Criterion validity (whether the survey measures what it purports to measure) was assessed by comparing self-administered evaluation of hearing aid skills and knowledge (HASKI-self
scores) to clinician-administered evaluation of handling skills (HASKI-clin scores). Inter-
observer reliability between HASKI-clin and HASKI-self scores was “fair” and not significant
for the first domain (Daily Hearing Aid Use: ICC=0.233 p=0.248, 95%CI: -0.658 to 0.645),
“substantial” and significant for the second domain (Hearing Aid Maintenance And Repairs:
ICC=0.713 p=0.001, 95%CI: 0.380 to 0.867), and “moderate” and significant for total scores
(ICC=0.578 p=0.014, 95%CI: 0.088 to 0.805).

Effect sizes (measuring the strength of correlation between HASKI-self scores and the clinic
from which participants were recruited) was evaluated using one-way ANOVAs. Sample size
requirements for the one-way ANOVA calculations were 13.31 for each clinic, based on a
90% power, effect size of 0.5 and significance of 0.05. As such, only the five clinics with
more than 13 participants were included in the ANOVA. Data were normally distributed
following "reflect and inverse" transformation, and there was homogeneity of variances, as
assessed by Levene's test of homogeneity of variances (p = 0.120). HASKI-self scores were
significantly different between the clinics, with clinic 5 (M = 72%, SD = 15) demonstrating
significantly higher HASKI-self scores than clinics 1 (M = 64%, SD = 18) and 3 (M = 62%, SD =
19), $F(4, 396) = 4.129, p = 0.003$. This was confirmed with Bonferroni corrections
demonstrating a mean difference of 8.164 ($p = 0.025$) between clinics 5 and 1, and a mean
difference of 9.557 ($p = 0.003$) between clinics 5 and 3. Effect sizes were low but significant
($\eta^2 = 0.04$), suggesting that 4% of the variance in HASKI-self scores were accounted for by
the clinic visited. Given the association between age and hearing aid handling skills reported
in the literature (Desjardins & Doherty, 2009), associations between client age and clinic
attended was investigated using one way ANOVA to identify whether participant age
contributed to the higher HASKI-self scores observed from clinic 5. Results indicated that
participants from clinic 5 were significantly younger than each of the other four clinics, $F(4,
383) = 18.372, p < 0.001$.

7.5.2 Prevalence of hearing aid management skill and knowledge deficiency
HASKI-self scores ranged from 14 to 100%, with a mean score of 66% (SD = 17), which
approximates to difficulty with an average of 25 of the 74 items of the HASKI. The mean
score for the top performing 50 participants was 80%, or 15 individual items of difficulty. Scores differed across the three domains: Daily Hearing Aid Use (M = 73%, SD = 20), Hearing Aid Maintenance and Repairs (M = 54%, SD = 24); and Advanced Hearing Aid Knowledge (M = 72%, SD = 21). Section Two of the HASKI-self, describing hearing aid maintenance and repairs, was generally the most problematic for participants, with participants reporting difficulty with an average of 12 of the 26 items in this section. No participants scored zero and only three achieved 100%.

HASKI-clin total scores ranged from 4 to 88%, with a mean score of 73% (SD = 10), which equates to observed difficulty performing 11 of the 40 tasks of the HASKI-clin. There was a significant difference between mean scores for the two domains of the HASKI-clin, with participants performing better on tasks associated with Daily Hearing Aid Use (M = 86%, SD = 9) than Hearing Aid Maintenance and Repairs (M = 50%, SD = 22). All participants demonstrated difficulty with at least one item on the HASKI-clin.

The HASKI-self requires the hearing aid owner to first identify whether their hearing aid has manually adjustable features, followed by self-evaluation of how well they manage each feature. Two thirds of participants reported having access to a volume control, one third used manual programs and one quarter owned hearing aid accessories (such as remote control, FM or Bluetooth streamer) (Table 7.4). Regarding telephone use, 76% (n = 266) of participants reported using the telephone; however, 69% (n = 184) of telephone users reported being unsure how to use their hearing aids appropriately with the telephone.
Table 7.4. Percentage of participants with access to manually adjustable volume control, programs or remote controls.

<table>
<thead>
<tr>
<th>Hearing aid feature</th>
<th>Yes</th>
<th>No</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustable volume control</td>
<td>67.15% (n=274)</td>
<td>25.74% (n=105)</td>
<td>7.11% (n=29)</td>
</tr>
<tr>
<td>Manually adjustable program control</td>
<td>36.98% (n=152)</td>
<td>44.04% (n=181)</td>
<td>18.98% (n=78)</td>
</tr>
<tr>
<td>Additional hearing aid accessories</td>
<td>23.34% (n=95)</td>
<td>72.92% (n=297)</td>
<td>3.69% (n=15)</td>
</tr>
</tbody>
</table>

The prevalence of hearing aid management skill and knowledge deficiencies are reported as mean responses for each individual item of the two HASKIs (Table 7.5). The items relating to batteries and hearing aid insertion were the least problematic for participants. The hearing aid management skills identified to be most problematic on the HASKI-self and the HASKI-clin included: Q5c “Do you know what volume level to set your hearing aid(s) at in different situations?”, Q6c “Do you know which program to select in different situations?”, Q7a “Do you know how to hold the phone in the optimal position when using the telephone program on your hearing aid(s)?”, and most of the items describing hearing aid cleaning tasks.

Table 7.5. Percent (and number) of participants reporting or demonstrating difficulty on each individual item of the HASKI.

<table>
<thead>
<tr>
<th>HASKI Items</th>
<th>HASKI-self % (n)</th>
<th>HASKI-clin % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Part One: Daily hearing aid use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Can you identify whether your hearing aid(s) is working?</td>
<td>31.95 (131)</td>
<td>6.25 (32)</td>
</tr>
<tr>
<td>2. Can you turn your hearing aid(s) off and on?</td>
<td>17.32 (71)</td>
<td>0 (32)</td>
</tr>
<tr>
<td>3a Regarding hearing aid batteries, can you change the battery?</td>
<td>4.93 (20)</td>
<td>0 (32)</td>
</tr>
<tr>
<td>3b Regarding hearing aid batteries, do you know when to change your battery?</td>
<td>13.22 (53)</td>
<td>3.13 (31)</td>
</tr>
<tr>
<td>3c Regarding hearing aid batteries, do you know where to purchase/collect additional batteries?</td>
<td>2.23 (9)</td>
<td>0 (32)</td>
</tr>
<tr>
<td>3d Regarding hearing aid batteries, do you know how to store and dispose of batteries safely?</td>
<td>6.42 (26)</td>
<td>9.38 (32)</td>
</tr>
<tr>
<td>4a Regarding hearing aid insertion and removal, can you identify the Left from the Right hearing aid?</td>
<td>5.80 (22)</td>
<td>0 (29)</td>
</tr>
</tbody>
</table>
4b Regarding hearing aid insertion and removal, can you insert your hearing aid with ease? 11.52 (47) 0 (32)
4c Regarding hearing aid insertion and removal, is your hearing aid comfortable when sitting in the ear? 42.44 (174) 6.25 (32)
4d Regarding hearing aid insertion and removal, does your hearing aid stay in/on your ear (i.e., not fall out/off)? 31.94 (130) 3.13 (32)
4e Regarding hearing aid insertion and removal, can you remove your hearing aid comfortably and without damaging... 6.57 (27) 3.13 (32)
5a Regarding the volume control on your hearing aid(s), can you make adjustments to the volume of your hearing aid(s)? 28.72 (83) 36.84 (19)
5b Regarding the volume control on your hearing aid(s), can you hear and recognise the different beeps that alert you to the changes you are making to the volume setting? 31.83 (92) 47.37 (19)
5c Regarding the volume control on your hearing aid(s), do you know what volume level to set your hearing aid(s) at in different situations? 62.46 (178) 61.11 (18)
6a Regarding the program control on your hearing aid(s), can you make adjustments to the program setting of your hearing aid(s)? 52.11 (99) 81.82 (11)
6b Regarding the program control on your hearing aid(s), are you able to hear and recognise the different beeps that alert you to the program changes you are making? 45.60 (88) 81.82 (11)
6c Regarding the program control on your hearing aid(s), do you know which program to select in different situations? 57.98 (109) 63.64 (11)
7a Do you know how to hold the phone in the optimal position when using the telephone program on your hearing aid(s)? 62.50 (185) 48.28 (29)
7c Can you turn on the telephone program on your hearing aid? 78.48 (124) 75 (4)
8a Regarding the program control on your hearing aid(s), do you know how to use your hearing aid accessory? 32.43 (36) 0 (5)
8b Regarding the program control on your hearing aid(s), do you know when to use your hearing aid accessory, in what situations? 35.19 (38) 0 (5)
9c Regarding your dry aid kit, do you know how to use the dry aid kit? 20.24 (83) 0 (7)
9d Regarding your dry aid kit, do you know when to use the dry aid kit? 25.82 (47) 28.57 (7)
Tip: Such as when it is humid, after sweating/exercising, wet ears from showering/swimming
10 When cleaning your hearing aid, do you do the following:
10a Wipe the externals with a dry (or moist, but never wet) cloth/tissue 46.42 (188) 51.61 (31)
10b Wipe inside the battery compartment with a dry cloth/tissue 77.56 (311) 77.42 (31)
10c Wipe/brush the microphone port/cover 67.58 (271) 70.97 (31)
10d Wipe/brush the speaker 70.30 (277) 35.48 (31)
10e Clean the vent with a brush or puffer 69.97 (268) 21.74 (23)
10f Clean the tubing and moulds/domes 66.95 (235) 41.67 (24)

Part Two: Hearing aid maintenance and repairs

11a Do you know where to purchase cleaning products from, such as puffers and brushes? 26.96 (103)
11b Do you know where to purchase hearing aid parts from, such as battery doors, wax protection systems, microphone covers, tubes, domes or moulds? 16.54 (64)
11c Do you know how to change the wax protection system? (also called the wax buster, wax guard or cerustop)? 40.56 (144)
11d Do you know how often to clean your hearing aid? 39.55 (159)
11e Do you know how often to change the wax protection system? 52.84 (186)
11f Do you know how often to change the tubes and domes/moulds? 60.35 (207)
11g Do you know how often to change the microphone covers? 75.91 (249)
12a Do you know how to overcome feedback/whistling? 56.23 (230) 70 (30)
12b Do you know what to do if the hearing aid sounds dull or stops working? 25.74 (105) 15.63 (32)
12c Do you know what to do if the hearing aid gets wet? 52.57 (215) 22.58 (31)
13a Are you aware you need to complete personal grooming prior to putting the hearing aid in (shower, dry ears/hair, apply hair spray)? 9.44 (39)
13b Are you informed of the servicing, batteries and maintenance programs available from your clinic? 12.59 (52)
13c Are you aware of the importance and benefits of regular hearing assessments and hearing aid adjustments? 9.69 (40)
13d Are you aware of the importance of wiping hearing aids with alcohol wipes before inserting them in your ear if you are experiencing outer ear infections? 56.20 (231)

Part 3: Advanced hearing aid knowledge
14a It can be useful to collect extra batteries before going away, rather than running out or having to find a place to buy batteries while away. 3.14 (13)
14b Having your hearing aids serviced before going away can prevent problems occurring while away. 34.94 (145)
14c There are a range of rechargeable battery options available. 73.22 (298)
14d Hearing aid batteries will go flat after the battery sticker is removed, regardless of whether it has been used or not. 47.95 (199)
14e Hearing aid batteries can leak if left in a hearing aid for extended periods of time (months/years). This can permanently damage the hearing aid. 32.13 (133)
14f The life of a hearing aid battery can fluctuate. Batteries go flat faster if the hearing aid is used in noisy environments, used for Bluetooth streaming, used for longer hours each day or if the batteries are of a lesser quality. 35.18 (146)
14g Hearing aid battery life can be slightly extended if you wait one minute after removing the battery sticker before inserting it into the hearing aid. 61.93 (257)
It is possible to get a faulty battery and/or packet. It will need to be discarded and a new battery placed in the hearing aid.

Hearing aid batteries pose a danger to animals and children if swallowed and should be disposed of safely.

Having ear wax regularly removed prevents build up in the ear canals, and reduces the amount of wax and debris that may clog up the hearing aid.

Softening the ear wax before seeing your doctor/hearing professional for wax removal can make it a quicker, safer and more comfortable experience. Appropriate options for softening ear wax include chemist purchased sprays and drops as well as olive oil.

Hearing aids should be comfortable when sitting in your ear. If the hearing aid is uncomfortable, there are things your clinician can do to improve the comfort for you.

The sound delivered by the hearing aid should always be comfortable. There are things your clinician can do to improve the comfort for you.

Hearing aids should not fall off/out of the ear regularly. If the hearing aid continuously falls off/out, there are things your clinician can do to improve this for you.

Some home insurance policies will cover hearing aids.

Even people with hearing loss are susceptible to further noise induced hearing loss and tinnitus. It is important to always wear hearing protection (ear muffs or plugs) when exposed to loud sounds.

Hearing aids aren’t the only solution for people with hearing loss. Sometimes people just need hearing assistance only in a specific situation, such as when watching TV or on the phone. Assistive Listening Devices (ALDs) encompass a broad range of technologies designed to assist people with a hearing impairment which may be used either independently or in conjunction with hearing aids.

Hearing aids increase the volume of sounds but may not always improve the ability to understand speech due to severe damage in the inner ear. A cochlear implant bypasses the damaged parts of the inner ear by stimulating auditory nerve fibres directly and can provide better hearing for some people with this type of hearing loss.

The three knowledge items that participants were most often aware of included: Q14a “It can be useful to collect extra batteries before going away, rather than running out or having to find a place to buy batteries while away”; Q14i “Hearing aid batteries pose a danger to animals and children if swallowed and should be disposed of safely”; and Q14m “The sound delivered by the hearing aid should always be comfortable. There are things your clinician can do to improve the comfort for you”. The four knowledge based items that participants
most often reported not being aware of included: Q14c “There are a range of rechargeable battery options available”; Q14d “Hearing aid batteries will go flat after the battery sticker is removed, regardless of whether it has been used or not”; Q14g “Hearing aid battery life can be slightly extended if you wait one minute after removing the battery sticker before inserting it into the hearing aid”; and Q14r “Hearing aids increase the volume of sounds but may not always improve the ability to understand speech due to severe damage in the inner ear. A cochlear implant bypasses the damaged parts of the inner ear by stimulating auditory nerve fibres directly and can provide better hearing for some people with this type of hearing loss.”

7.6 Discussion

The aims of this study were twofold: 1) to report the development and psychometric properties of the Hearing Aid Skills and Knowledge Inventory, both the HASKI-self and the HASKI-clin; and 2) to report common deficiencies in hearing aid skills and knowledge in an Australian population.

The HASKI-self is the only comprehensive self-administered survey designed to measure hearing aid management skills and knowledge. Where clinician-administered surveys require face-to-face administration, the development of a self-administered survey evaluating hearing aid management skills may reduce the clinical load, save consultation time, and facilitate more frequent use than face-to-face consultations allow. The HASKI-clin was developed for the purpose of investigating the validity of the HASKI-self in identifying hearing aid management skill deficiency. Development of a clinician-administered survey using identical wording as the HASKI-self enabled demonstration that hearing aid owners were able to accurately self-evaluate and report hearing aid management skills via use of the HASKI-self. Although the sample of 32 adult hearing aid owners who completed the HASKI-clin was sufficient for this measure of criterion validity, a sample size of 32 is insufficient to draw conclusions on the performance of the HASKI-clin in clinical populations. None-the-less, the HASKI-clin shows promise as a comprehensive clinical tool. Although similar clinician-administered tools exist, the Practical Hearing Aid Skills Test (PHAST:
Desjardins & Doherty, 2009) evaluates 8 items pertaining to hearing aid management skill, the Hearing Instrument Operation Checklist (HIOC: Kemker, 1999) evaluates 6 items and the recently published Hearing Aid Skills and Knowledge (Saunders et al., 2018) evaluates 32 items, making the HASKI-clin (evaluating 40 items) the most comprehensive clinician-administered survey designed to evaluate hearing aid management skills. Furthermore, where item development for the other surveys was based on hearing aid user manuals and existing surveys, the HASKI-clin was developed using participatory methods, wherein hearing aid owners and clinicians developed a framework describing what is required for hearing aid management, including generation of a list of the skills and knowledge required for hearing aid management. Thus the HASKI surveys have high content and face validity as item development and the language used within the surveys was developed by the population for which they were intended to be used (i.e. hearing aid owners).

7.6.1 Psychometric properties
Reliability estimates of the HASKIs were high. Internal consistency and interdimensional relationship estimates suggested there was a strong relationship among the subscale items and between domains. Test-retest reliability coefficients suggested low measurement error and that the HASKI-self was a stable measure of hearing aid management skills and knowledge. The high inter-observer reliability observed for the HASKI-clin suggests that it has low observer bias and is effective at distinguishing individuals with good handling skills from those with poor handling skills. The HASKI-clin exhibited higher inter-observer reliability (ICC = 0.93) than existing clinician-administered measures of hearing aid handling skills (ICC = 0.77: Ferrari et al., 2015), likely due to the design of the surveys, the language used and the number of response options provided (Bennett et al., 2017b). The HASKI-clin specifies exactly what the administrator is to say when administering the survey and includes a description of what must be performed in order to pass each item to reduce observer bias. The high reliability observed in this study supports the clinical use of the HASKIs for evaluation of hearing aid management skills and knowledge.
Construct validity testing indicated that for the most part, the HASKIs performed as expected based on existing literature describing associations between hearing aid management skills and participant factors. The positive association between hearing aid skill and self-report benefit of and satisfaction with hearing aids supports previous reports (Campos et al., 2014) and highlights the importance of addressing gaps in hearing aid skills and knowledge to obtain optimal rehabilitation outcomes. Where previous studies reported no association between hearing aid skills and participant gender (Campos et al., 2014; Desjardins & Doherty, 2009), the current study found HASKI-self scores of males to be significantly greater than the scores of females. Contributing factors may include males' superior spatial abilities (Voyer et al., 1995) or female’s predisposition to rate their health as poorer than men with the same health status (Waldron, 1983). The possible gender effect identified here warrant further investigation as it may inform how hearing aid skills should be taught to men and women.

Criterion validity was found to be moderate with hearing aid owners self-reporting more difficulties than clinicians observed. This disparity was greater for Hearing Aid Maintenance and Repairs than for Daily Hearing Aid Use. The observed difference in skills may be due to the complexity of maintenance tasks (Bennett et al., 2015b) or a by-product of the focus placed by clinicians on daily tasks, offering less training and advice on maintenance and repair tasks. Participants’ tendency to over report hearing aid management difficulties was also observed in a pilot study comparing self-report hearing aid handling skills to clinician evaluation of skills (Bennett et al., 2017a). This pilot study suggested the discrepancy was possibly influenced by the involvement of self-efficacy in skill acquisition. That is, to self-perceive the ability to perform a task a person needs to not only have the skill, but also the confidence in their ability to complete the task; described as self-efficacy. Hickson et al. (2014) reported hearing aid self-efficacy to influence older adults’ success with aural rehabilitation, specifically daily hours of hearing aid use and self-reported benefit from hearing aids. Therefore, the HASKI-self could play an important role in identifying not only competency, but also self-efficacy for hearing aid tasks. Arguably, the nature of the HASKI-self, being self-administered, does not allow for delineation of competency from self-efficacy. Thus, individuals with low self-efficacy may indicate low skill on the HASKI-self.
despite having adequate skill for certain tasks. When these individuals present to the clinic, the clinician can spend time on training (for skill deficiencies) or counselling and support (for areas for which the client has low self-efficacy). To evaluate only competency, one could use the HASKI-clin. To evaluate only self-efficacy, one could use the Measure of Audiologic Rehabilitation Self-efficacy for Hearing Aids MARS-HA (West & Smith, 2007).

7.6.2 Prevalence of hearing aid management skill and knowledge

The individual items of skill reported to have the greatest deficit by participants in this study included those relating to use and understanding of the hearing aid’s volume control, program control, telephone compatibility, and the questions relating to hearing aid cleaning, in line with previous clinical reports of hearing aid skills (Campos et al., 2014; Desjardins & Doherty, 2009). It is likely that these items were more problematic than the others as they tend to be more challenging to perform due to the small size of the features or the additional cognitive element of knowing when and how to use these features. For example, some of the tasks required for hearing aid cleaning can be difficult due to the small size and fragility of the pieces requiring replacing, such as microphone covers or wax guards (Bennett et al., 2015b). Less frequently performed tasks, such as use of customised programs or replacing the dome or microphone covers, appeared to be more problematic than the other items in the survey. Although comprehensive training may assist in reducing the high prevalence of hearing aid handling difficulties, for some users the size and design of the device is the obstacle (Bennett et al., 2015b). Hearing aid manufacturers may want to consider improving the design of their devices to improve the useability, especially for older populations with poorer dexterity and vision (Singh et al., 2013).

Participants reported difficulty not only with physical manipulation of the volume control and use of manual programs, but also with when and how to use it in different situations. Furthermore, almost 20% of the participants reported being unsure whether they had a volume control or access to programs with their current device. When setting up manually adjustable features for hearing aid owners (such as manually accessible programs), clinicians need to be sure that the feature is not only required, but that hearing aid owners
understand how to use them appropriately. The HASKI surveys can assist by evaluating the hearing aid owners’ knowledge and skills regarding their hearing aid.

Participants in this study reported on whether they were aware of individual items of knowledge relating to hearing aid management. Each item listed in this section of the survey was problematic for at least one participant. Participants most often identified as “I do not recall receiving this information” for items relating to the hearing aid battery and cochlear implants. While it is possible that hearing aid owners forgot some of the information provided by the clinic (Ferguson et al., 2015; Reese & Hnath-Chisolm, 2005), it is also possible that clinicians are not providing the necessary information to every patient they see (Bennett et al., 2018a). It is possible that information regarding the three items relating to the hearing aid battery (availability of rechargeable batteries; that the battery will drain following removal of the sticker irrespective of whether the battery is in use; and extension of battery life by waiting one minute following removal of the sticker before using the battery) are not often imparted to clients as clinicians assume that it is common knowledge, that they are unaware of the information themselves, or that they assume the client will read the battery packet to learn about its use. However, reliance on these assumptions is not ideal as consumers do not routinely read instructions, especially for products frequently used (Wright et al., 1982). Also, hearing aid owners often report wanting to be more informed about the devices they own and how to use them most effectively (Bennett et al., 2018a; Laplante-Lévesque et al., 2010; Laplante-Lévesque et al., 2013). Simultaneously though, they also report receiving too much information and that the information received is too technical (Bennett et al., 2018a; English, 2008). Information delivery in this setting is most commonly verbal, with little use of written or electronic supplemental materials (Kochkin et al., 2010). Hearing aid owners describe receiving little benefit from the written materials currently provided (Bennett et al., 2018b), most likely due to the the low quality and poor readability of hearing aid user manuals (Caposecco et al., 2014) and the high level of health literacy required to understand the content of written information concerning hearing aids (Brooke et al., 2012; Nair & Cienkowski, 2010). Furthermore, given the time constraints put on clinicians to deliver the large amount of information and training associated with hearing aid use, it is possible that clinicians make a judgement call and omit...
certain aspects of information for certain people (Bennett et al., 2018a). Thus, clinicians face a balancing act of managing the individual hearing aid owners preferred amount and technicality of information exchanged, their ability to understand and retain information, and the conflicting aspects of time management and clinical requirements for an appointment. The HASKI-self offers clinicians a novel alternative to hearing aid education. Clinicians can administer the HASKI-self towards the end of the rehabilitation program, allowing hearing aid owners to self-evaluate their level of skill and knowledge, and simultaneously learn these items of skill and knowledge through the detailed descriptions provided in the survey.

The fourth item of knowledge that participants were most often unaware of related to the benefits of cochlear implantation. While it is possible that clinicians only discuss implantable options with patients who they deem to be candidates, it has been suggested that in general, clinicians lack awareness of cochlear implant candidacy and often don’t discuss cochlear implants as an option (Athalye et al., 2014). Nonetheless, patients have expressed a desire for more information relating to their condition and thus clinicians may want to consider providing patients with information regarding all options relating to their hearing aids and beyond (Ong et al., 1995).

7.6.3 Clinical implications
Surveys evaluating hearing aid management skills (including the HASKIs) are basic in design and some may question whether they are necessary in the clinical setting. Although clinicians currently provide hearing aid training as part of the rehabilitation program, clinical reports suggest that the level of handling skills demonstrated by hearing aid owners remains low (Bennett et al., 2017a; Campos et al., 2014; Desjardins & Doherty, 2009). This has led research groups to investigate alternative or supplemental training techniques, such as digital materials demonstrating how to perform hearing aid management tasks (Ferguson et al., 2015), and internet based training programs (Thorén et al., 2014). An important aspect of a training program is the evaluation of skill, specifically whether the hearing aid owner has learned the skills necessary for hearing aid use and management. Although clinician-
administered surveys evaluating hearing aid management skill exist, they have been developed based on hearing aid user manuals or existing surveys and thus evaluate fewer items of skill than the HASKIs, which were developed using participatory methods. Furthermore, this is the first study to report levels of knowledge relating to hearing aid use, specifically whether hearing aid owners recall receiving the information from their hearing aid providers. Participants in this study reported and demonstrated a diverse range of skills and knowledge, highlighting the diverse competencies of hearing aid owners and the need for greater attention to be placed on hearing aid management training. In this way, the HASKI-self and HASKI-clin offer clinicians comprehensive evaluation of hearing aid management skills and knowledge.

The HASKI-self is the first self-administered survey evaluating hearing aid management skills and knowledge. It takes approximately 20 minutes to complete in a pen and paper format and can be self-administered without requiring clinician input, thus reducing the clinician load. The variation in completion time reported by participants is likely due to manual dexterity, with those reporting longer completion times commenting on the difficulty their arthritis or Parkinson’s causes them to complete paper surveys. It is possible that the length of the HASKI-self deterred some potential participants from completing the survey. However, those that did complete the survey often noted their gratitude for being provided the survey as it facilitated their learning. In the clinical setting, the HASKI-self could be completed by hearing aid owners prior to their appointments (either at home or in the waiting room) informing the clinician of possible areas of concern. The process of systematically evaluating whether a hearing aid owner possesses the skills and knowledge necessary for hearing aid management would normally be a time consuming exercise during a clinical appointment, and subsequently aspects of skill and knowledge important to the individual patient may be overlooked by the clinician (Bennett et al., 2018a). Thus the HASKI-self could be considered a time saving measure, as clinicians will no longer need to reiterate all aspects of hearing aid handling and management, but use the HASKI-self results as a guide, identifying those areas that require attention. Although the hearing aid owners would be required to spend additional time completing the survey themselves, it is
ultimately time saving for them too, as deficiencies in skill and knowledge will be identified and addressed in a timelier manner.

Although the HASKI-clin was primarily developed to assist with validation of the HASKI-self, the high inter-observer reliability recorded support its use as a clinical tool evaluating hearing aid skills. The HASKI-clin is the most comprehensive clinician-administered survey evaluating hearing aid skills and thus may be preferred over existing surveys where clinicians want to ensure hearing aid owners have a thorough grasp on the wide range of skills required for hearing aid use. Conversely, researchers may prefer a brief survey evaluating only the basic skills required for hearing aid use, such as the PHAST (Desjardins & Doherty, 2009). Although no randomised control trials exist demonstrating the clinical benefits of the PHAST, HIOC or HASKIs, a randomised intervention study involving cochlear implant users demonstrated that targeted training following identification of cochlear implant handling difficulties using client survey resulted in an improvement in skills, immediately and two weeks following (Bennett et al., 2015b). Thus, it is likely that provision of hearing aid training facilitated by client survey (such as the HASKI) may result in increased handling skills. The benefits of which have been suggested to include increased hearing aid use, benefit and satisfaction (Desjardins & Doherty, 2009; Campos et al., 2014; Kumar et al., 2000).

Both versions of the HASKI offer additional clinical applications. For example, completing the HASKIs in the years following hearing aid acquisition may identify changes in hearing aid handling skills that may have arisen due to age-related changes in health status, such as those arising from reduced cognitive function (Pichora-Fuller & Singh, 2006), vision (Erber, 2003), or finger dexterity (Kumar et al., 2000; Singh et al., 2013). Another potential application may be to monitor hearing aid skills for patients receiving services from individual clinics or individual clinicians as a quality control measure. Managers could compare HASKI scores for hearing aid owners under the care of individual clinicians, or clinics against the data presented here to assist with setting performance goals in order to motivate staff to provide extensive and effective hearing aid training. Additionally, third
party payers (such as Government bodies or insurance groups) may be interested in reports of hearing aid management skills to know that their financial contributions are achieving the best possible outcomes.

7.6.4 Limitations and future research

While the psychometric properties of the HASKIs were evaluated on a large and diverse multicentre sample of hearing aid owners, all participants were adult hearing aid owners from Australia and thus psychometric performance of the HASKI in other settings is unknown. Additionally, 96% of participants self-reported using their hearing aids for more than one hour per day. It would be interesting to survey hearing aid non-users to investigate whether low hearing aid handling skills influenced their decision to reject their hearing aids. Responsiveness of the HASKI to intervention (such as retraining) was not established in this study, thus it is difficult to determine what change in score would be considered sufficient to indicate clinical improvement in knowledge and skill, or whether the HASKI is sensitive enough to detect such changes. Future research investigating the responsiveness of the HASKIs may identify the minimal clinically important difference, described as the smallest change in survey score that an individual patient would identify as important and which would require a change in the patient’s management (Fitzpatrick et al., 1998; Juniper et al., 1994). Participants’ cognitive function was not evaluated in this study, so we are unable to determine whether all participants were able to complete the survey accurately. Investigations into whether baseline cognitive function affects hearing aid management skills and knowledge, or ability to complete the HASKIs would be useful for the clinical application of the HASKIs. Evaluation of the psychometric properties of the HASKI-clin with a larger sample would allow investigation into factors associated with HASKI-clin scores. Despite these limitations, the findings of this study suggest that the HASKIs show promise as valid and reliable measures to quantify hearing aid management skills and knowledge.

7.7 Conclusion

The finding that 99% of participants in this study reported difficulty with some aspect of hearing aid management skill or knowledge and that on average participants reported
difficulty with one third of the items suggests that the informational and training needs of hearing aid owners are not being met by current clinical practices. The HASKIs are the most extensive clinical surveys currently available to evaluate the skills and knowledge required for hearing aid management. The psychometric evaluations presented in this study demonstrate that the HASKIs are valid and reliable tools for hearing aid management evaluation. Clinical use of the HASKIs have the potential to improve hearing aid fitting outcomes, specifically hearing aid use, benefit and satisfaction.

The HASKI-self and HASKI-clin are freely available and can be downloaded from www.earscience.org.au/research/clinical-research
7.8 References


CHAPTER EIGHT

Factors associated with self-reported hearing aid management skills and knowledge

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8.1 Foreword to Chapter Eight

Where the previous chapter reported the development and psychometric properties of the HASKI clinical surveys, this chapter explores the relationship between hearing aid skills and knowledge (as evaluated by the HASKI) and participant factors. Identification of those groups of hearing aid owners who are at greater risk for low hearing aid management skills will enable clinicians to recognise and meet the additional training needs for these groups with respect to hearing aid management. Additionally, highlighting the negative impact of poor hearing aid skills and knowledge on hearing aid outcomes may motivate clinicians to recognise the importance of hearing aid management and place greater emphasis on the delivery of hearing aid training during the process of hearing aid acquisition. The two studies reported in Chapters Seven and Eight are based on the one data set; 500 hearing aid owners from seven hearing companies across Australia.
8.2 Abstract

Objective: Hearing aid management describes the skills and knowledge required for the handling, use, care and maintenance of the hearing aid. The importance of hearing aid management skills and knowledge is evidenced by their association with hearing aid outcomes. However, the nature of this association and the influence of participant factors on this association are unknown. Accordingly, the aims of the current study were to: 1) investigate participant factors that influence hearing aid management skills and knowledge and 2) investigate the impact of hearing aid management skills and knowledge on hearing aid outcomes.

Design: Factors associated with hearing aid management skills and knowledge were investigated through an email and paper based self-report survey, including the Hearing Aid Skills and Knowledge Inventory (HASKI-self: Bennett et al., 2018b) and the International Outcomes Inventory for Hearing Aids (IOI-HA: Cox & Alexander, 2002). The study sample included 518 adult hearing aid owners, ranging in age from 18 to 97 years (M = 71 years, SD = 14), 61% male and 39% female, recruited from seven hearing clinics across Australia.

Results: Participant factors found to be associated with hearing aid skills and knowledge included participants’ age, gender, style of hearing aid, age of current hearing aid, and total years of hearing aid ownership. Higher levels of hearing aid management skills and knowledge were found to be associated with better hearing aid outcomes, specifically higher self-reported satisfaction with hearing aids, perceived benefit from hearing aids, and overall outcome of the hearing aid fitting as evaluated by the IOI-HA.

Conclusions: Hearing aid management difficulties were greatest for older people, women, and owners of behind-the-ear style hearing aids, suggesting that clinicians need to be cognisant of the additional needs for these three groups. The positive association between hearing aid outcomes and hearing aid skills and knowledge emphasises the importance of education and training on hearing aid management for successful aural rehabilitation.
8.3 Introduction

Hearing aids are the primary clinical intervention for people with hearing impairment. Although hearing aids do not restore normal hearing function, they amplify sounds to provide improved hearing sensitivity, and subsequently lead to improvements in communication, sound localisation, speech clarity and understanding (Gatehouse & Noble, 2004; Heine & Browning, 2004; McArdle et al., 2005). Use of hearing aids has also been shown to improve health related quality of life for adults by reducing the psychosocial and emotional effects of hearing impairment (Ferguson et al., 2017; Chisolm et al., 2007), including improved self-esteem, independence, social engagement and mental health (Dawes et al., 2015; Pronk, Deeg, & Kramer, 2013; Seniors Research Group, 1999; Weinstein et al., 2016). Despite these benefits, up to one third of hearing aid owners report using their hearing aid less than four hours per day, with up to one quarter reporting never using their hearing aid (Hartley et al., 2010; Hickson et al., 2010; Heuermann et al., 2005) and thus are living in the community with unresolved hearing and communication difficulties.

Importantly, some of the most commonly cited reasons for hearing aid non-use pertain to problems stemming from poor management of the device, such as discomfort when in use, difficulty cleaning the device, or frequent breakdowns (Bertoli et al., 2009; Kochkin, 2000a). As part of the aural rehabilitation program, clinicians provide information, training and user manuals on hearing aid handling (such as how to insert the hearing aid), use (such as when to wear the hearing aid or how to change the volume), care (such as cleaning) and maintenance (such as replacing tubing) of the hearing aid, described hereafter as “hearing aid management”. A recent group concept mapping study involving 24 hearing aid owners and 22 hearing healthcare clinicians generated a comprehensive list of the knowledge and skills required for hearing aid management (Bennett et al., 2018a). Participants identified 111 unique items describing hearing aid management within six concepts: 1) Daily Hearing Aid Use; 2) Hearing Aid Maintenance and Repairs; 3) Advanced Hearing Aid Knowledge; 4) Learning to Come to Terms with Hearing Aids; 5) Working With Your Clinician and 6) Communication Strategies. Items of knowledge included knowing where to purchase accessories and parts and knowing when to use hearing aid features in specific situations.
Items of skill included being able to insert the hearing aid, change the battery and perform cleaning and maintenance tasks (such as replacing microphone covers).

Despite hearing healthcare professionals providing training on hearing aid management as part of the rehabilitation program, clinical studies that have evaluated basic hearing aid management skills using the Practical Hearing Aid Skills Test (PHAST; Desjardins & Doherty, 2009) suggest that the level of skills demonstrated by hearing aid owners is low (Bennett et al., 2017a; Campos et al., 2014; Desjardins & Doherty, 2009). Between 80-90% of hearing aid owners participating in these studies demonstrated difficulty with at least one aspect of hearing aid management (e.g., cleaning or use of a volume control), indicating a high prevalence of hearing aid management problems in the community (Bennett et al., 2017a; Campos et al., 2014; Desjardins & Doherty, 2009).

The subgroups of individuals who are at risk of exhibiting poorer hearing aid management skills is unclear. Despite all of these studies using the same measure, the PHAST, to evaluate hearing aid management, reported associations between hearing aid management skills and some client factors (e.g., age, gender and years of hearing aid ownership) differed across studies (Campos et al., 2014; Desjardins & Doherty, 2009; Ferrari et al., 2015). The conflicting findings may be due to the small sample sizes used in these studies (n = 37 to 60) and the participant cohorts recruited (i.e. new hearing aid owners, experienced owners, or a combination of both). Our understanding of the factors associated with hearing aid management skills is further thwarted by the narrow focus of the survey used to report hearing aid management in these studies. The PHAST evaluates only nine aspects of basic hearing aid management skill (Desjardins and Doherty, 2009). However, the recently developed Hearing Aid Skills and Knowledge Inventory (HASKI) survey (Bennett et al., 2018b) evaluates 74 items of skill and knowledge required for hearing aid management. These include basic skills, advanced skills, maintenance tasks and knowledge requirements for successful hearing aid use. There have been no reports in the literature regarding whether participant factors affect the acquisition of these additional items of skill or knowledge.
Similarly, the relationship between hearing aid skills and hearing aid outcomes is unclear. Several studies have reported a positive relationship between hearing aid skills and hours of daily hearing aid use (Kumar et al., 2000; Mulrow et al., 1992), self-reported hearing aid benefit (Campos et al., 2014) and satisfaction with hearing aids (Bennett et al., 2017b; Campos et al., 2014; Kumar et al., 2000). However, different studies have reported no association between hours of hearing aid use, self-reported benefit, or satisfaction (Desjardins & Doherty, 2009; Campos et al., 2014; Bennett et al., 2017a). The discrepancies between these studies may be due to the varied methods by which hearing aid outcomes were measured, or the small sample sizes used. As with the studies described above, these studies also predominantly used the PHAST to report management skills. Investigation using a more comprehensive survey evaluating hearing aid management skills and knowledge (such as the HASKI; Bennett et al., 2018b) would provide insight into the impact of a wider range of hearing aid skills and knowledge on hearing aid outcomes. An understanding of the impact that hearing aid management skills have on hearing aid outcomes may motivate both clinicians and hearing aid owners to place greater emphasis on the development of these skills. Accordingly, the aims of the current study were to: 1) investigate participant factors that influence hearing aid management skills and knowledge and 2) investigate the impact of hearing aid management skills and knowledge on hearing aid outcomes.

### 8.4 Methods

Ethical approval for this study was granted by the Human Research Ethics Office of The University of Western Australia and The University of Queensland’s Human Research Ethics Committee. All participants provided consent to participate.

### 8.4.1 Materials

Participants completed a survey set comprising a short clinical history form, the self-administered version of the Hearing Aid Skills and Knowledge Inventory (HASKI-self)
(Bennett et al., 2018b), and the International Outcome Inventory for Hearing Aids (IOI-HA) (Cox & Alexander, 2002). The survey set was made available in paper or electronic format.

The short clinical history form was included to collect the following information: age, gender, style of hearing aid (Behind-the-ear or In-the-ear), fitting configuration (monaural or binaural), age of current hearing aid (< 12 months old or > 12 months old), total years of hearing aid ownership, and hearing aid funding source (whether they paid in full for their hearing services: private; or received government subsidies through the Australian Office of Hearing Services: OHS). An additional question was adopted from the MarkeTrak consumer survey (Kochkin, 2000b) evaluating satisfaction with hearing aids using a five-point Likert scale (“Very dissatisfied” to “Very satisfied”).

The Hearing Aid Skills and Knowledge Inventory (HASKI: Bennett et al., 2018b) was developed based on the results of a group concept mapping study by Bennett et al. (2018a), wherein 24 hearing aid owners and 22 clinicians identified 111 statements describing the skills and knowledge required to manage a hearing aid. Two versions of the HASKI were developed. A self-administered version (HASKI-self) was developed to enable hearing aid owners to self-report hearing aid management skills and knowledge. A clinician-administered version (HASKI-clin) was subsequently developed, based on the HASKI-self, to evaluate hearing aid management skills in the clinic. The HASKI-self evaluates 73 items of hearing aid skill and knowledge across three domains: 1) Daily hearing aid use; 2) Hearing aid maintenance and repairs; and 3) Advanced hearing aid knowledge. The HASKI-self asks respondents to rate their ability to perform tasks based on a four point Likert scale: “Never”, “Sometimes”, “Most of the time”, and “Always”; and to identify whether they are aware of knowledge based items using a 3-point Likert scale: “Yes, I am aware”, “I now recall receiving this information, but had forgotten” and “I do not recall receiving this information”. A “Not applicable” option is also available for many of the items. Scoring of the HASKI-self is calculated by summing the total number of items identified as competent and converting it to a percentage of competency. A higher score indicates greater competency (i.e., a score of 100% represents full competency).
The IOI-HA is a seven item, multi-dimensional measurement of hearing aid daily use, benefit, residual activity limitations, satisfaction, residual participation restrictions, impact on others, and quality of life (Cox and Alexander, 2002; Cox et al., 2003). The IOI-HA was used to evaluate overall hearing aid outcomes in this study as it is a valid and reliable measure, commonly used in audiology clinical practice, and is considered the gold standard for evaluation of patient outcomes following hearing aid fitting (Cox and Alexander, 2002; Heuermann et al., 2005).

8.4.2 Participants
Hearing aid owners were recruited from seven privately funded hearing clinics across Australia, based in Queensland (n=2), New South Wales (n=3) and Western Australia (n=2). The participating clinics varied in their preferences for hearing aid brands they dispensed, their pricing structures and their business models (e.g. single clinician, small chain, and not-for-profit). Therefore, the individual hearing aids owned by participants and their individual experiences of obtaining hearing aids would likely have varied greatly among participants in this study. All clients aged 18 years or older who had received hearing aids prior to the date of data collection were identified as potential participants. No inclusion or exclusion criteria were placed on duration of hearing aid use so as to ensure a mix of experienced users and new users with little experience. Each clinic generated a list of potential participants, and the research team used a random number generator to select the required number of potential participants to be contacted with larger samples included from the larger clinics.

8.4.3 Procedure
Participants were contacted via email (to complete the survey online) or post (to complete paper version of the survey), depending on their preferred method of contact and whether they provided a valid email and/or postal address. Potential participants were contacted only once. No reminder letters were sent as the research team did not have access to the personal details of the potential participants. As a result, we were unable to make cohort comparisons between non-participants and participants. The survey set took approximately
40 minutes to complete. The total number of potential participants contacted was 1,950 (800 via post and 1,150 via email). The response rates were 35% for the postal group and 21% for the email group. Response rates across participating clinics ranged from 15 to 35%, which were smaller than those reported in similar studies using self-report survey in clinical cohorts of hearing aid owners: 44- 56% (Williams, Johnson, Danhauer, 2009; Hickson et al., 2010; Bertoli et al., 2009).

8.4.4 Data analysis
Data were entered into Microsoft Excel and analysed using SPSS Statistics (version 21.0, Armonk, NY: IBM Corp). Prior to conducting statistical analyses, all data were inspected for outliers (i.e. visual inspection of boxplots and $|z|$ score calculations using a cut-off point of 2.58), after which tests of normality and skewness (i.e. Shapiro-Wilk test of normality and Q-Q plots) were conducted.

8.4.4.1 Participant demographic and hearing aid factors associated with hearing aid skills and knowledge
Associations between HASKI-self scores (treated as the dependant variable, in continuous data format) and seven participant factors (treated as independent variables, in categorical data format) were evaluated using a series of univariate one-way ANOVAs, conducted for each variable separately. Participant demographic and hearing aid data that was continuous in nature was transformed to categorical data for univariate analyses of variance (ANOVA). Participant age was categorised as 1 = ≤ 55, 2 = 56-65, 3 = 66-75, 4 = 76-85, and 5 = ≥ 86 years. Total years of hearing aid ownership was categorised as 1 = ≤ 1, 2 = 2-6, 3 = 7-11, 4 = 12-16, and 5 = ≥ 17 years. This was performed independently for each of the three sections of the HASKI-self. Possible interactions between participant demographic and device factors were investigated using individual Chi square analyses to assist with interpretation of the ANOVA results.
Effect sizes were evaluated and interpreted as small ≤ 0.2, medium = 0.2 to 0.5, and large ≥ 0.5 (Cohen, 1988). Given the large number of variables being investigated in this study, post hoc comparisons using Bonferroni corrections were used to investigate the possibility of Type I errors for all variables found to be significantly associated with HASKI-self scores.

### 8.3.4.2 The impact of hearing aid skills and knowledge on hearing aid outcomes

Four ordinal logistic regression analyses were used to explore the relationship between hearing aid skills and knowledge (treated as the independent variable) and hearing aid outcomes (treated as dependant variables). Aspects of hearing aid skills and knowledge investigated included total HASKI-self scores, skills for daily hearing aid use (HASKI-self Part One scores), skills for hearing aid maintenance and repairs (HASKI-self Part Two scores), and hearing aid knowledge (HASKI-self Part Three scores). Hearing aid outcomes included perceived hearing aid benefit (IOI-HA item 2), hours of daily hearing aid use (IOI-HA item 1), IOI-HA total score, and self-reported satisfaction with hearing aids. Factors included in each analysis were first tested for multicollinearity (tolerance values greater than 0.1 and variance inflation factors values less than 10) and the assumption of proportional odd (that the effect of the independent variable on the ordinal dependant variable is uniform over all of the categories or levels of the dependant variable) (Chatterjee & Hadi, 2015).

### 8.5 Results

Participants (n = 518) ranged in age from 18 to 97 years (M = 71 years, SD = 14), with 61% male and 39% female. Demographic information, hearing aid information, and hearing aid outcome data for the cohort is presented in Table 8.1. Three outliers in the HASKI-self data were identified from box-plots and removed as they had completed fewer than 20% of the survey questions. All other respondents had completed more than 70% of survey questions. No other outliers were identified in the other data. Data were normally distributed and positively skewed.
Table 8.1. Cohort description (n=500)

<table>
<thead>
<tr>
<th>Participant factors</th>
<th>Cohort description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (range, mean ± SD) (years)</td>
<td>17 to 97, 17 ± 15</td>
</tr>
<tr>
<td>Gender (n, %)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>301 (61)</td>
</tr>
<tr>
<td>Female</td>
<td>193 (39)</td>
</tr>
<tr>
<td>Style of hearing aid (n, %)</td>
<td></td>
</tr>
<tr>
<td>BTE</td>
<td>417 (84)</td>
</tr>
<tr>
<td>ITE</td>
<td>78 (16)</td>
</tr>
<tr>
<td>Fitting configuration (n, %)</td>
<td></td>
</tr>
<tr>
<td>Monaural</td>
<td>33 (7)</td>
</tr>
<tr>
<td>Binaural</td>
<td>466 (93)</td>
</tr>
<tr>
<td>Age of current hearing aid (n, %)</td>
<td></td>
</tr>
<tr>
<td>&gt;12 months</td>
<td>318 (69)</td>
</tr>
<tr>
<td>&lt;12 months</td>
<td>144 (31)</td>
</tr>
<tr>
<td>Total years of hearing aid ownership (range, mean ± SD)</td>
<td>0 to 61, 9 ± 11</td>
</tr>
<tr>
<td>Funding for services (n, %)</td>
<td></td>
</tr>
<tr>
<td>OHS</td>
<td>167 (35)</td>
</tr>
<tr>
<td>Private</td>
<td>304 (65)</td>
</tr>
<tr>
<td>Hearing aid outcomes</td>
<td></td>
</tr>
<tr>
<td>Benefit from hearing aids (based on IOI-HA item 2) (n, %)</td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>18 (4)</td>
</tr>
<tr>
<td>Slightly</td>
<td>28 (6)</td>
</tr>
<tr>
<td>Moderately</td>
<td>92 (19)</td>
</tr>
<tr>
<td>Quite a lot</td>
<td>191 (39)</td>
</tr>
<tr>
<td>Very much</td>
<td>153 (32)</td>
</tr>
<tr>
<td>Hours of use per day (based on IOI-HA item 1) (n, %)</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>8 (2)</td>
</tr>
<tr>
<td>Less than 1 hour a day</td>
<td>9 (2)</td>
</tr>
<tr>
<td>1 to 4 hours a day</td>
<td>67 (14)</td>
</tr>
<tr>
<td>5 to 8 hours a day</td>
<td>116 (24)</td>
</tr>
<tr>
<td>More than 8 hours a day</td>
<td>285 (58)</td>
</tr>
<tr>
<td>IOI-HA total score (range, mean ± SD)</td>
<td>1.2 to 5, 3.97 ± 0.65</td>
</tr>
<tr>
<td>Overall satisfaction with hearing aids (n, %)</td>
<td></td>
</tr>
<tr>
<td>Very Satisfied</td>
<td>111 (27)</td>
</tr>
<tr>
<td>Satisfied</td>
<td>207 (51)</td>
</tr>
</tbody>
</table>
Neutral 57 (14)
Dissatisfied 26 (7)
Very Dissatisfied 5 (1)

Note: BTE: Behind-The-Ear; ITE: In-The-Ear; OHS: Office of Hearing Services; IOI-HA: International Outcomes Inventory for Hearing Aids.

8.5.1 Participant demographic and hearing aid factors associated with hearing aid skills and knowledge

Associations between HASKI-self scores and participant demographic and device factors are reported in Table 8.2. Age was found to be associated with skill-based tasks (Daily Hearing Aid Use and Hearing Aid Maintenance and Repairs), but not knowledge based items (Advanced Hearing Aid Knowledge), with younger participants self-reporting better management skills (higher HASKI-self scores) than older participants (small effect size) (Table 8.3). Gender was associated with Daily Hearing Aid Use and Advanced Hearing Aid Knowledge, but not with Hearing Aid Maintenance and Repairs; males reported higher HASKI-self scores than females (small effect size). The style of hearing aid was associated with Hearing Aid Maintenance and Repairs, but not with Daily Hearing Aid Use and Advanced Hearing Aid Knowledge; owners of ITE style hearing aids scored higher than BTE owners (small effect size). Age of current hearing aid was associated with Daily Hearing Aid Use, but not Hearing Aid Maintenance and Repairs or Advanced Hearing Aid Knowledge; those participants who had owned their hearing aids for less than 12 months reported higher levels of skill than those with older hearing aids (small effect size). Total years of hearing aid ownership was associated with Advanced Hearing Aid Knowledge, but not skill-based tasks (Daily Hearing Aid Use and Hearing Aid Maintenance and Repairs).

Chi square analyses identified no interactions between participant demographic and device factors, with the exception of age and gender. Although there was no significant difference in mean age between males (M = 72, SD = 11) and females (M = 71, SD = 14), there was a greater distribution of females in the older age categories than there were for males, resulting in a measurable interaction between age and gender, $[\chi^2 (4) = 17.953, p = 0.001]$. 
Table 8.2. Multivariate ANOVA for client demographic and hearing aid factors associated with hearing aid management skills and knowledge (HASKI-self).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>F</td>
<td>p</td>
</tr>
<tr>
<td><strong>Personal demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (&lt;55, 56-65, 66-75, 76-75, &gt;86)</td>
<td>4</td>
<td>9.137</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender (Male, Female)</td>
<td>1</td>
<td>8.091</td>
<td>0.050</td>
</tr>
<tr>
<td><strong>Hearing aid factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style of hearing aid (BTE, ITE)</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitting configuration (Monaural, Binaural)</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of current hearing aid (&gt;12 months, &gt;12 months)</td>
<td>1</td>
<td>12.674</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total years of hearing aid ownership</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding for services (OHS, Private)</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: BTE: Behind-The-Ear; ITE: In-The-Ear; OHS: Office of Hearing Services; IOI-HA: International Outcomes Inventory for Hearing Aids; ns: not significant.*
Table 8.3. Bonferroni post hoc tests comparing HASKI-self scores across age categories

<table>
<thead>
<tr>
<th>Age category (n)</th>
<th>Mean HASKI-self Part 1 score (SD)</th>
<th>HASKI-self Part 1 (daily hearing aid use) scores across age categories</th>
<th>Mean HASKI-self Part 2 score (SD)</th>
<th>HASKI-self Part 2 (hearing aid maintenance and repairs) scores across age categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (49)</td>
<td>78 (18)</td>
<td>ns ns ns 0.005</td>
<td>59 (24)</td>
<td>ns ns ns 0.043</td>
</tr>
<tr>
<td>2 (79)</td>
<td>80 (17)</td>
<td>ns ns 0.004 &lt;0.001</td>
<td>59 (25)</td>
<td>ns ns ns 0.036</td>
</tr>
<tr>
<td>3 (174)</td>
<td>74 (20)</td>
<td>ns ns ns 0.018</td>
<td>56 (23)</td>
<td>ns ns ns ns ns</td>
</tr>
<tr>
<td>4 (134)</td>
<td>70 (21)</td>
<td>0.004 ns ns</td>
<td>51 (24)</td>
<td>ns ns ns ns ns</td>
</tr>
<tr>
<td>5 (54)</td>
<td>64 (20)</td>
<td>0.005 &lt;0.001 0.018 ns</td>
<td>47 (24)</td>
<td>0.043 0.036 ns ns</td>
</tr>
</tbody>
</table>

Note: HASKI: Hearing Aid Skills and Knowledge Inventory; ns: not significant.
8.5.2 The impact of hearing aid skills and knowledge on hearing aid outcomes

There was no multicollinearity found between the variables for each of the dependant variables (all tolerance values were > 0.7 and variance inflation factors were < 2). The assumption of proportional odds was met for each of the four outcome measures investigated, as assessed by a full likelihood ratio test. Logistic regression analyses revealed that higher HASKI-self scores (all three sub-sections) were associated with an increased odds of self-reporting higher perceived benefit from hearing aids, scoring higher on the IOI-HA, and self-reporting higher satisfaction with hearing aids (Table 8.4).
Table 8.4. Logistic regression analyses for association between hearing aid management skills and knowledge (HASKI-self score) and hearing aid outcomes.

<table>
<thead>
<tr>
<th>Participant data</th>
<th>HASKI-self Part One</th>
<th>HASKI-self Part Two</th>
<th>HASKI-self Part Three</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily hearing aid use</td>
<td>Hearing aid maintenance and repairs</td>
<td>Advanced hearing aid knowledge</td>
</tr>
<tr>
<td></td>
<td>Wald Chi-Square</td>
<td>Wald Chi-Square</td>
<td>Wald Chi-Square</td>
</tr>
<tr>
<td></td>
<td>Df</td>
<td>Df</td>
<td>Df</td>
</tr>
<tr>
<td></td>
<td>P (Sig.)</td>
<td>P (Sig.)</td>
<td>P (Sig.)</td>
</tr>
<tr>
<td>Benefit from hearing aids (based on IOI-HA item 2)</td>
<td>11.148</td>
<td>14.321</td>
<td>12.018</td>
</tr>
<tr>
<td></td>
<td>0.001</td>
<td>&lt; 0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Hours of use per day (based on IOI-HA item 1)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>IOI-HA total score</td>
<td>29.964</td>
<td>30.498</td>
<td>18.023</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Overall satisfaction with hearing aids</td>
<td>26.455</td>
<td>13.366</td>
<td>11.192</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Note: IOI-HA: International Outcomes Inventory for Hearing Aids; HASKI: Hearing Aid Skills and Knowledge Inventory; ns: not significant.
8.6 Discussion

The first aim of this study was to investigate the participant factors that influence hearing aid management skills and knowledge; these included age, gender, hearing aid style and age of current device. The second aim of this study was to investigate the impact of hearing aid management skills and knowledge on hearing aid outcomes. The results demonstrate a strong relationship between self-reported hearing aid skills and knowledge and self-reported hearing aid outcomes, benefit and satisfaction. These findings highlight the importance of hearing aid skills and knowledge to the success of the rehabilitation program.

When interpreting the effects of age on hearing aid management skill it is important to note that the mean age of participants in this study was 71 years. Thus, the effects of age on hearing aid management skill pertain to variations in age in an older population; specifically, adults aged 76 years and older self-reported greater difficulties with hearing aid management than did adults aged 65 years and younger. Although previous studies have indicated a relationship between participant age and basic hearing aid skills (Desjardins & Doherty, 2009; Ferrari et al., 2015), this is the first study to demonstrate an association between age and the ability to manage the ongoing maintenance tasks required for hearing aid use, such as changing the tubes, domes, or moulds. Where some have attributed this association to the working memory deficit related to age possibly hindering cognitive processing and storage of the hearing aid training content provided during consultations (Ferrari et al., 2015), the finding that age was not associated with self-report knowledge acquisition and retention in the current study suggests that perhaps the effects of age on hearing aid skill acquisition may have less to do with cognitive loading, and more to do with changes in dexterity or vision associated with aging, as suggested by Singh et al. (2013). Singh et al. (2013) investigated the effects on haptic (touch) sensitivity in the fingertips, manual dexterity, and joint stiffness of the hand on the successful operation of a hearing aid, and observed that older adults performed significantly more poorly than younger adults on eight of the 11 manual tests relating to hearing aid management. They attributed such age-related differences to age-related declines in a number of physical systems, including the muscles, bones, joints, tendons, skin, or the central and peripheral nervous system.
Physical deficits, such as dexterity, haptic sensitivity and vision impairment were not measured in this study and further research is required to clarify the impact of these on hearing aid management skills and knowledge.

Although our results identified gender to be associated with hearing aid skills and knowledge, subsequent analyses revealed that female participants were significantly older than male participants. Thus it is likely that the gender effect was confounded by participant age. Where Bennett et al. (2017b) and Desjardins and Doherty (2009) found no association between gender and hearing aid management skills (low samples of 19 and 50, respectively), Upfold, May, and Battaglia (1990) found that females demonstrated greater difficulties in hearing aid manipulation than males when evaluated by a clinician (n = 244). This phenomenon requires further investigation before conclusions can be made.

Where the gender effect on hearing aid management skill observed may have been confounded by participant age, only gender (and not age) was found to be associated with hearing aid knowledge, with males self-reporting significantly higher levels of familiarity with the knowledge content provided in the HASKI-self survey than females. Gender differences in knowledge acquisition have been demonstrated in other health related fields, but appear to be confounded by education level and socioeconomic status (Parmenter et al., 2000). While data on education level was not collected in this study, typically, males in this age group have higher levels of education than females (Australian Bureau of Statistics, 2017), which may have contributed to the gender effects observed for hearing aid knowledge. An alternative explanation may be that the gender difference observed is caused not only by the receiver of the information (the hearing aid owner), but by the giver of information (the clinician). Studies have reported gender bias with medical practitioners more likely to “talk down” to, withhold information from, and order fewer diagnostic tests for female patients than for male patients (Chafetz, 2006; Weiss & Lonnquist, 2015). It would be interesting to explore whether the level of detail and the method of knowledge transfer employed by audiologists differs based on the gender of the patient they are addressing. The possible gender effects observed in this study warrant further investigation.
The age of the current hearing aid was associated with hearing aid management skills (Daily Hearing Aid Use), with owners of newer devices (<12 months) self-reporting higher levels of skill than those who had owned their hearing aid for more than 12 months. It is likely that owners of newer hearing aids have higher levels of skills due to how recently they learned the skills. They may have better recall of the skills taught during the rehabilitation program, and still be in the good habits of performing the necessary tasks recommended by their clinician. In contrast, owners of older hearing aids (>12 months) may have forgotten some of the tasks, especially those performed less frequently. This was demonstrated by Bennett et al. (2017b) wherein participants self-reported and demonstrated higher levels of hearing aid management skill for those tasks more frequently performed than for those less frequently performed. Total years of hearing aid ownership was found to be associated with hearing aid knowledge, but not skill. This is not surprising, as knowledge of hearing aids and how to trouble shoot hearing aid related problems (as assessed by this section of the HASKI-self) are likely to increase with years of experience using hearing aids. Conversely, hearing aid skill may not necessarily coincide with years of hearing aid ownership as hearing aid shape and features change rapidly, such that it is likely that a person’s new hearing aid will differ from their previous hearing aid, requiring them to re-learn how to use it. It is possible that this process of having to change habits and learn new methods of hearing aid management may in itself become a source of confusion for some people.

Arguably, without the skills and knowledge to use a hearing aid one cannot gain benefit from its use. Accordingly, the second aim of this study was to measure the impact of poor hearing aid skills and knowledge on hearing aid outcomes. In agreement with previous reports (Bennett et al., 2017b; Campos et al., 2014) the present study found no association between daily hours of hearing aid use and hearing aid skills or knowledge. These findings suggest that those participants who used their hearing aid more often did not necessarily have the skills to be using it optimally. The finding that hearing aid skills and knowledge impact on self-reported hearing aid benefit, satisfaction and overall outcomes (based on IOI-HA score) is of clinical significance, as it suggest that clinicians have the ability to improve outcomes by addressing hearing aid management deficits and emphasises the importance
of effective hearing aid training during the aural rehabilitation program. Clinicians could use
clinical tools like the HASKI-self (Bennett et al., 2018b) to ensure that hearing aid owners are
aware of and competent in all aspects of hearing aid management.

8.6.1 Clinical implications
Overall, hearing aid skills and knowledge was low with participants reporting deficiency in
an average of one third of the items of the HASKI, and almost all of the participants
reporting difficulty with at least one item on the HASKI. These results indicate the need for
improved education and training pertaining to hearing aid use and maintenance in clinical
appointments. Importantly, previous studies have demonstrated that hearing aid
management skills can be learned. Ferrari et al. (2015) demonstrated a significant
improvement in hearing aid management skills between the initial day of hearing aid fitting
and ten days following. Similarly, Bennett et al. (2015) and Upfold (1990) both
demonstrated an improvement in skill acquisition following personalised training and a
period of at-home practice over a two to four week time period. However, both studies
found that some participants who were able to demonstrate competence at the initial
session, were no longer able to demonstrate the same level of competence at the
subsequent session. The reasons for skill deterioration over the 2-4 weeks were not able to
be established by these studies. Bennett et al. (2015) suggested that skill deterioration may
have been affected by baseline cognition skills, or participant personal investment in
retaining the new skills learned. Another barrier to skill acquisition may be the complex way
in which information and training are delivered in the audiology setting, with verbal and
written communication during routine hearing aid appointments typically requiring higher
levels of health literacy than hearing aid owners possess, likely impacting understanding of
both one-on-one counselling and hearing aid instruction guides (Caposecco et al., 2014; Nair
& Cienkowski, 2010). Furthermore, knowledge acquisition is a complex process and can be
affected by recipients’ preferred learning styles (visual, auditory, tactile); thus, clinicians
should consider employing all three methods during the provision of information and
training. Recipients’ familiarity with the topic, interest in the content and motivation to
learn the information and training provided may also be a factor (Krapp, 1999; Russell,
The magnitude of the variables involved in the acquisition of hearing aid knowledge and skill highlight the need for a personal approach to training.

A working paper reviewing skill gain and loss over the lifespan and overtime highlighted the multifaceted impacts that age can have on skill acquisition, including genetic factors, stage of life effects, neurological maturation effects, behavioural and practice effects, and social factors (Desjardins & Warnke, 2012). Most relevant to hearing aid skill acquisition is possibly the behavioural and practice effects described in the review. Based on the Practice Engagement Theory, engaging in activities on a recurring basis reinforces and develops the skills required to perform these activities (Reder, 1994). These cognitive and physical skills can be learned and maintained in older persons; however, a lack of exposure may lead to a deterioration of skills, often termed colloquially as “use it or lose it”. The clinical implications of this in the audiology setting suggests the need for repetition when providing manual hearing aid training for older persons; repetition in the delivery, but more importantly getting the client to repeatedly perform the tasks. As such, setting up a personalised program requiring the new hearing aid owner to practice techniques at home. For tasks performed less frequently, such as those relating to maintenance and repairs (e.g. replacing domes or tubes), older patients may benefit from reminders including when and how to perform these tasks. The clinical implications of these findings highlight the need for clinicians to be cognisant of the changes that can occur for hearing aid owners over their lifetime. Clinicians need to ensure that clients have the skills necessary for hearing aid use and management, not only immediately following hearing aid acquisition, but in the years that follow. Detection of changes in management skills throughout the years following hearing aid acquisition might be achieved using client survey, such as the HASKI-self.

8.6.2 Limitations and future studies

The results of the present study need to be interpreted in the context of following methodological limitations. First, a low response rate was observed and therefore it is possible that respondents are not representative of the larger population. A number of factors may have contributed to the low participant response rate, including: the single
point of contact (no reminders sent to potential participants), the length of the survey (12 pages, taking approximately 40 minutes to complete), the mode of survey delivery (smaller response rate for emailed surveys), the timing of the survey (coincided with the holiday season in Australia), and that participants in this study did not receive financial reimbursement for participating. Another limitation of this study was the evaluation of hearing aid knowledge and skill via self-report, increasing the likelihood of response bias. However, psychometric testing of the HASKI-self (Bennett et al., 2018b) demonstrated that for the most part participants were able to accurately self-report difficulties, with a tendency to over report problems rather than underreport them. From a clinical perspective, identification of individuals who perceive that they are experiencing difficulties with the use and maintenance of their hearing aids, despite being able to demonstrate full competence, will enable the clinician to provide additional support and reassurance to these clients.

Although older participants self-reported lower hearing aid skills in this study, longitudinal studies are required to determine whether this represents a deterioration in skills over time. Fitting configuration, whether the participant owned one hearing aid (monaural) or two (binaural), was not found to be associated with HASKI-self scores. However, data on the hearing aid model for each ear was not collected. It is possible that people using two different devices may have had more difficulties. This aspect requires further investigation. Future studies may also consider factors that might account for hearing aid management beyond age and experience, such as hearing aid model, features or settings, or the hearing aid owners’ cognitive ability, dexterity, physical deficits, visual acuity, ability to learn new tasks, motivation to learn hearing aid management tasks, or self-efficacy for completing tasks.

8.7 Conclusion
Participant factors found to impact on hearing aid skills and knowledge included participant age, gender, style of hearing aid, age of current hearing aid, and total years of hearing aid ownership. Hearing aid management difficulties were greatest for older people and for
women, suggesting that clinicians need to be cognisant of the additional needs for these two groups. The odds of self-reporting better hearing aid outcomes (perceived benefit, IOI-HA score, and satisfaction) was greater for those with higher hearing aid skills and knowledge (HASKI-self scores), emphasising the importance of education and training on hearing aid management.
8.8 References


Desjardins, R., & Warnke, A. J. (2012). Ageing and skills: a review and analysis of skill gain and skill loss over the lifespan and over time: OECD Education Working Papers. Retreived 27th
February 2018,


CHAPTER NINE

General Discussion

9.1 Foreword to Chapter Nine
This chapter brings together the findings of the research contained in this thesis and discusses how these contribute to the audiology literature and implications for clinical practice. It addresses these points in four sections: 1) Problems associated with hearing aid use, 2) Development of a clinical survey evaluating hearing aid management skills and knowledge, 3) Clinical Implications, and 4) Research translation. Methodological limitations and future research directions are also discussed.

9.2 Problems associated with hearing aid use
This thesis significantly expands the current knowledge of individuals’ experiences when using hearing aids through the development of a conceptual framework describing problems associated with hearing aid use. This was achieved using concept mapping, a participatory mixed methods approach that combines qualitative approaches to data collection with quantitative analyses to produce visual maps of how people view a particular topic (Burke et al., 2005; Trochim & Kane 2005; Trochim 1989). Concept mapping methodology has only recently been applied to audiology (Poost-Foroosh et al., 2011) and this is the first time it has been applied to understanding problems associated with hearing aid use (Bennett et al., 2018b: Chapter Three). Concept mapping techniques were employed
due to their involvement of the participants in not just generating the data, but also synthesising and interpreting the data. The participants first put forward statements describing their experiences, perceptions and thoughts regarding problems associated with hearing aid use, and then gave meaning to these statements through grouping and ranking activities. The resultant quantitative maps represent how the group discerns the interrelationships between hearing aid problems and overarching concepts, thus providing a basis for further discussion, interpretation and action (Rosas & Kane, 2012).

Although several studies had described some of the problems associated with hearing aid use, this was the first study to describe the magnitude, diversity and impact of problems associated with hearing aid use. The individual problems described by participants in this study included those previously described, such as issues relating to physical fit (Hartley et al., 2010; Gianopoulos et al., 2002), hearing aid handling difficulties (such as inserting batteries) (Kochkin, 2000; Gianopoulos et al., 2002), poor sound quality (Bertoli et al., 2009) and issues with ongoing maintenance requirements (such as cleaning and basic repairs) (Kochkin, 2000). Participants in the concept mapping study (Chapter Three) also described hearing aid problems not previously reported in the literature, such as a lack of understanding regarding why one hearing aid would be more difficult to insert than the other, that the hearing aid doesn’t sit well when worn with glasses, or experiencing frustration with the difference in clarity between the left and right hearing aid. The comprehensive list of hearing aid related problems generated in this study could be used 1) to inform item development for a clinical survey to identify hearing aid related problems, 2) to assist development of a clinical training tool to provide new hearing aid owners with an overview of the common problems experienced by hearing aid owners and the skills to prevent or overcome them, and 3) as a checklist for developers of training materials to ensure that they encapsulate the problematic aspects of hearing aid management as described by hearing aid owners and hearing healthcare clinicians. Clinical applications of this knowledge may include incorporation into tools, such as the workbooks developed by Kramer et al. (2005), the Group Support Programs developed by Kricos (2000), and the multimedia educational program developed by Ferguson et al. (2016).
One of the strengths of our study (Chapter Three) was that it included the perspectives of both hearing aid owners and clinicians who were diverse in age, gender and experiences with hearing loss and hearing aids, thus increasing the face validity and clinical relevance of the findings. The results of this study further improve our understanding of the problems hearing aid owners face and the impact of these problems on the overall success of the rehabilitation program. Specifically, the individual statements deemed to have the greatest impact on hearing aid success and to be the most preventable/solvable were mostly from the concept Hearing Aid Management, suggesting that it is a good starting point when addressing hearing aid related problems.

9.3 A clinical survey evaluating hearing aid management skills and knowledge
Clinicians currently provide hearing aid training as part of the rehabilitation program; however, clinical reports suggest that the level of handling skills demonstrated by hearing aid owners remains low (Bennett et al., 2017; Campos et al., 2014; Desjardins & Doherty, 2009). This has led research groups to investigate alternative or supplemental training techniques, such as digital materials demonstrating how to perform hearing aid management tasks (Ferguson et al., 2016), and internet based training programs (Thorén et al., 2014). An important aspect of a training program is the evaluation of skill, specifically whether the hearing aid owner has learned the skills necessary for hearing aid use and management. Although surveys evaluating hearing aid skills exist, a systematic review conducted as part of this thesis (Bennett et al., 2015: Chapter Four) identified that these surveys contained only a low number of hearing aid tasks. Fifteen aspects of hearing aid management were identified across the surveys, but none of the surveys included all 15 aspects. Furthermore, there were additional items of hearing aid management that were not included in any of the surveys, such as the use of a dehumidifier and replacement of domes, tubes or microphone covers (Bennett et al., 2015). Subsequently, the purpose of the studies described in Chapters Five, Six and Seven was to inform, develop, and evaluate a comprehensive survey evaluating hearing aid skills and knowledge; the Hearing Aid Skills and Knowledge Inventory (HASKI).
It is worth noting that while the manuscript describing the HASKIs (Chapter Seven) was under review with the American Journal of Audiology, a research group in the USA published a paper describing the development and validation of a clinician-administered survey evaluating 32 items of hearing aid skill and knowledge; the Hearing Aid Skills and Knowledge survey (Saunders et al., 2018). The fact that multiple research groups are working on similar topics confirms the importance of evaluating hearing aid handling abilities, particularly within the context of the evolving role of the audiologist. The survey developed by Saunders et al. (2018) is more comprehensive (evaluating 32 items) than the surveys included in the aforementioned systematic review (each evaluating less than 12 items), yet less comprehensive than the HASKI-clin (40 items) or the HASKI-self (74 items) described in this thesis. Where abridged measures of hearing aid skill may be required for research purposes, more comprehensive measures are required for clinical applications to ensure that hearing aid owners have all of the skills and knowledge necessary to use and maintain a hearing aid.

Methods used for survey development can influence the clinical utility of a survey, particularly how survey developers decide what items to include and exclude in a survey. Previously published surveys designed to identify gaps in hearing aid skill were developed on the basis of literature searches, perusal of the hearing aid manufacturer guides, existing surveys and the authors’ clinical experiences (Desjardins & Doherty, 2009; Kemker, 1999; Saunders et al. 2018). While these methods of item development and decisions surrounding item inclusion are well accepted, some argue that without clear conceptual grounding, the resulting survey may not accurately represent the phenomenon under investigation (Rosas & Camphausen, 2007; Sheatsley, 1983). Accordingly, this thesis developed the HASKI-self and HASKI-clin using a robust method of survey item development, namely concept mapping. Although the concept mapping methodology in Chapters Three and Six were the same, the purposes differed. Concept mapping techniques were used in Chapter Three to develop a framework for understanding hearing aid problems and inform areas of future research. On the other hand, concept mapping techniques were used in Chapter Six to engage key stakeholders using a structured conceptualization process to provide input on survey item development through identification of the survey items pertinent to the
population for which it is intended to be used (Rosas & Camphausen, 2007). Although concept mapping methods have been employed for survey development in other health related fields, the study described in Chapter Six was the first to use this technique for survey development in the audiology literature.

Chapter Seven of this thesis described the development and psychometric evaluation of two clinical surveys evaluating the skills and knowledge required for hearing aid handling and maintenance: the HASKI-self and the HASKI-clin. Participatory methods were used, involving both clinicians and hearing aid owners in a concept mapping study to develop the survey items, as well as in pilot testing early versions of the surveys. Psychometric evaluation of the surveys were performed using clinical cohorts from seven clinics across Australia. The psychometric properties commonly reported in scale development were evaluated and are described in Chapter Seven. One common method of psychometric analysis not included was item reduction, often conducted using factor analysis (based on classical test theories) or Rasch analysis (based on latent trait theories) (Cano & Hobart, 2011). Surveys that are designed to measure a single construct will use item reduction to ensure that only the necessary items (contributing to the measure of the construct under investigation) are included in the final version of the survey. However, the purpose of the HASKI-self is to identify any problem that a patient may be experiencing, thus removal of an item may result in this problem being overlooked. As such, we decided to retain all items generated by the concept mapping study and to retain the three concept domains indicated by the grouping data generated by the hearing aid owners and clinicians participating in the concept mapping study used for item generation (Bennett et al., 2018a). The HASKI-self demonstrated high internal consistency, interdimensional relationships, construct validity, and test-retest reliability. Criterion validity (evaluated by comparing self-administered HASKI scores to clinician-administered HASKI scores) was found to be moderate with hearing aid owners self-reporting more difficulties than clinicians observed.

The HASKI-self is the first self-administered survey evaluating hearing aid skills. Where clinician-administered surveys require face-to-face administration, the development of a self-administered survey evaluating hearing aid management skills may reduce the clinical
load, save consultation time, and facilitate more frequent use than face-to-face consultations allow. Additionally, the HASKI-clin, HASKI-self and the recently published survey by Saunders et al. (2018) are the first clinical surveys evaluating hearing aid knowledge, rather than just skill. Hearing aid owners often report wanting to be more informed about the devices they own and how to use them most effectively (Bennett et al., 2018a; Laplante-Lévesque et al., 2010; Laplante-Lévesque et al., 2012). Clinicians, however, face a balancing act of managing the individual hearing aid owner’s preferred amount and technicality of information desired, their ability to understand and retain information and the conflicting aspects of time management. The HASKI-self offers clinicians a novel alternative to hearing aid education. Clinicians can provide their clients with the HASKI-self towards the end of the rehabilitation program, allowing hearing aid owners to self-evaluate their level of skill and knowledge, and simultaneously learn these items of skill and knowledge through the detailed descriptions provided in the survey (described in Chapter Seven).

Previous studies using self-report methods with hearing aid owners suggest involvement of response bias, such as social desirability. Specifically, it has been reported that hearing aid users tended to over-report their daily amount of hearing aid use when compared to objective measures (such as data logging) (Laplante-Lévesque et al., 2014a). Thus, during development of the HASKIs we considered that social desirability response bias may prevent hearing aid owners from accurately reporting shortcomings with their hearing aid knowledge and skill. However, this is not what we found; both of our studies comparing self-assessment to clinician-assessment of hearing aid skills found that participants self-reported more difficulty than was observed by clinician administrators (Chapters Five & Seven). The discrepancy between self-perceived and clinician-evaluated hearing aid skills may be influenced by the involvement of self-efficacy in skill acquisition. That is, to self-perceive the ability to perform a task, a person needs to not only have the skill, but also the confidence in their ability to complete the task; described as self-efficacy (Bandura, 1986). The importance of hearing aid self-efficacy is evidenced by its relationship with hearing aid outcomes, with participants who reported higher levels of self-efficacy more likely to be successful hearing aid owners (Meyer et al., 2014; West & Smith, 2007).
Studies have reported levels of hearing aid self-efficacy to be low in clinical populations, with up to 40% of hearing aid users reporting low confidence in managing their hearing aids (Kelly et al., 2013; West & Smith, 2007). However, the relationship between hearing aid self-efficacy and hearing aid skills is not fully understood. Dullard (2014) reported no correlation between hearing aid self-efficacy (measured using the Measure of Audiologic Rehabilitation Self-efficacy for Hearing Aids; West & Smith, 2007) and hearing aid skill (measured using the PHAST-R; Doherty & Desjardins, 2012), with some participants indicating greater self-efficacy than skill and others indicating greater skill than self-efficacy. Where the aforementioned studies evaluated hearing aid skill using clinician-administered survey, the HASKI-self (described in Chapter Seven) is self-administered. Given that self-efficacy is required in order to self-perceive ability, it is likely that hearing aid self-efficacy affects one’s ability to accurately self-report hearing aid management skills. Therefore the HASKI-self is likely to measure a combination of skill and self-efficacy. However, the effects of self-efficacy on self-reported skill and knowledge requires further investigation. Clark and Dodge (1999) provide a model to describe the process of developing self-efficacy for disease management behaviour. They highlight the role of internal resources (e.g. knowledge and beliefs), external resources (e.g. advice from experts and role models), and self-regulation (observations and judgements of ones’ own behaviour when attempting to manage the disease and their own reactions to these experiences). If one focuses only on the individual tasks or behaviours that they are less capable of performing, self-efficacy is reduced and it is less likely that the individual will attempt to do the task or behaviour (e.g. clean their hearing aid). This scenario likely occurs regularly in audiology clinical consultations as clinicians focus on tasks that are problematic and try to fix problems for clients; thus, highlighting the client’s incompetency and reinforcing low self-efficacy.

While it is necessary for clinicians to discuss client incompetence’s in order to address them, clinicians could also acknowledge client competencies in order to promote self-efficacy for hearing aid use. Clinicians could use tools such as the HASKIs to not only identify problem areas but to also highlight the many competencies of the individual. Discussing acquisition or improvements in skill and knowledge demonstrates to the client how much they have
learned regarding their hearing aids, which in turn will likely increase self-efficacy for these and related tasks, such as those for which skills are still developing. Smith and West (2006) provide a tutorial outlining this process and other tips for promoting self-efficacy in audiology rehabilitation for adults with hearing aids.

The importance of good hearing aid management skills is evidenced by their association with improved hearing aid use (Kumar et al., 2000), increased benefits from hearing aids (Campos et al., 2014) and higher self-reported hearing aid satisfaction (Campos et al., 2014; Kumar et al., 2000). Contributing to this body of work, the studies described in Chapters Five, Seven and Eight reported a relationship between hearing aid management skills and aural rehabilitation outcomes, specifically self-reported hearing aid benefit, self-reported satisfaction with hearing aids and total score on the International Outcomes Inventory for Hearing Aids (Cox & Alexander, 2002). These findings are of clinical significance, as they suggest that clinicians have the ability to improve hearing aid outcomes by addressing hearing aid management deficits and emphasising the importance of effective hearing aid training during the aural rehabilitation program. Clinicians could use clinical tools like the HASKI-self and HASKI-clin to ensure that hearing aid owners are aware of and competent in the necessary aspects of hearing aid management.

9.4 Clinical Implications
The two clinical studies described in Chapters Five and Seven of this thesis indicated that hearing aid owners do not possess all of the hearing aid skills and knowledge required to manage a hearing aid. Specifically, up to 99% of participants self-reported difficulty with at least one item. Additionally, the mean HASKI-self score was 66%; on average, participants self-reported difficulty with one third of the questions evaluating hearing aid management skills and knowledge. One reason for this may be the large number of skills and knowledge required for hearing aid management, with hearing aid owners and clinicians identifying 111 individual items of skill or knowledge required for hearing aid management (Bennett et al., 2018a: Chapter Six). Additionally, hearing aid owners have indicated that the amount and technicality of information they prefer when acquiring hearing aids may differ between
individuals (Grenness et al., 2014a; Laplante-Lévesque et al., 2012; Bennett et al., 2018a: Chapter Six). For these reasons, a patient-centred care (PCC) approach to hearing aid training would allow clinicians to personalise their approach to training for each individual client.

PCC is increasingly acknowledged by health professionals as an important platform for the care of people with hearing health impairment (Grenness et al., 2014a; Laplante-Lévesque et al., 2014b; Poost-Foroosh et al., 2011). In contrast to the traditional medical model of healthcare, where the health professional is the expert administering treatment to the passive recipient, PCC focuses on patients’ lived experiences of the illness, wherein each patient is seen as having individual needs relating to being informed and involved in health decisions (Grenness et al., 2014b; Michie et al., 2003; Bastiaens et al., 2007). Although the body of work presented in this thesis did not evaluate PCC directly, the knowledge gained and clinical tools developed could be used by clinicians to promote patient-centered practices. Potential applications of the knowledge gained and clinical tools developed throughout this thesis include provision of information and training in a way that matches the amount and technicality of information desired by the client, treating each client as an individual with individual needs, developing the client-clinician relationship, and encouraging self-management of the condition.

9.4.1 Amount and technicality of information desired by the client
Clinical studies have found that up to 90% of hearing aid owners demonstrate difficulty with basic hearing aid management tasks (Desjardins & Doherty, 2009; Ferrari et al., 2015; Bennett et al., 2017; Bennett et al., 2018e). It is therefore not surprising that almost 50% of hearing aid owners report not receiving enough practical help from their clinician regarding how to use their hearing aid (Kelly et al., 2013). The study described in Chapter Three of this thesis deepens and contextualises our understanding of the relationship between information and training and problems associated with hearing aid use. When asked to describe problems associated with hearing aid use, participants described the quality and quantity of information provided by the clinician as problematic, including the provision of
insufficient as well as excessive or overly complex information (Bennett et al., 2018b: Chapter Three). These findings are consistent with previous qualitative studies wherein hearing aid owners described receiving insufficient information, and that the information provided is difficult to understand (English, 2008; Grenness et al., 2014a; Kelly et al., 2013; Laplante-Lévesque et al., 2012). Although it is not surprising that individual patients will prefer different amounts of information and different levels of detail or technicality, these results support the need for a patient-centred approach to information provision. Specifically, clinicians could improve the transfer of hearing aid knowledge by asking their clients how much detail they would prefer to receive, checking to ensure they understand what is being discussed, providing written information and using simple language (Bennett et al., 2018c).

Further contributing to this body of work, the study described in Chapter Six of this thesis suggested that clinicians may (consciously or subconsciously) withhold aspects of hearing aid information from certain clients. Hearing aid owners and clinicians participated in group concept mapping sessions to describe the skills and knowledge required to use and maintain a hearing aid, and identified six concepts. Statements contained within the concept “Advanced Hearing Aid Knowledge” were regarded equally important as the other five concepts by hearing aid owners, but less important by clinician participants. It is possible that due to the large amount of information and training that audiologists are currently expected to administer in a very small time period, clinicians make a judgement call as to those hearing aid owners who require certain items of information or training and those who do not. It is possible then that the category “Advanced Hearing Aid Knowledge” reflects the additional information that some hearing aid owners do not receive, but would like to. This notion was further supported by the findings of the study documented in Chapter Seven wherein all 500 participating hearing aid owners reported not knowing at least one item of knowledge included on the HASKI-self survey. Furthermore, on average, participants reported not knowing almost one quarter of the knowledge items listed in the survey.
It therefore appears that the informational needs of hearing aid owners are not currently being met. The HASKI-self and HASKI-clin (Chapter Seven) could be used by clinicians to evaluate individual hearing aid owners’ level of knowledge and skill, thereby identifying areas of deficiency and facilitating personalisation of information provision and training.

9.4.2 Treating each client as an individual with individual needs
Until recently, participant factors that influenced hearing aid management skills and knowledge received little empirical attention. While previous research highlighted this as an area worthy of attention (Campos et al., 2014; Desjardins & Doherty, 2009), no investigations with large or diverse sample sizes had been reported. The study described in Chapter Eight of this thesis identified age, gender, hearing aid style and age of current device to potentially influence hearing aid management skills and knowledge. The knowledge that older persons, females and owners of BTE style hearing aids are more likely to have low hearing aid skills and/or knowledge is helpful to clinicians when designing rehabilitation programs for these patients. Although previous studies have indicated a relationship between participant age and hearing aid handling skills (Desjardins & Doherty, 2009; Ferrari et al., 2015), this is the first study to demonstrate an association between age and the ability to manage the ongoing maintenance tasks required for hearing aid use, such as changing the tubes, domes, or moulds.

Additionally, this was the first study to explore participant factors associated with the knowledge required to use and maintain a hearing aid, expanding and deepening our understanding of the interactions between age and hearing aid skills and knowledge. Where previous studies attributed the association between age and hearing aid skills to the working memory deficit related to age possibly hindering cognitive processing and storage of the hearing aid training content provided during consultations (Ferrari et al., 2015), the finding that age was not associated with self-reported knowledge acquisition and retention (Chapter Eight) supports the notion that perhaps the effects of age on hearing aid skill acquisition has less to do with cognitive loading and may have more to do with age related changes in dexterity (Singh et al., 2013). The HASKI-self and HASKI-clin (Chapter Seven)
could assist clinicians with the identification of the individual areas of skill deficiency, informing the need for modifications to the hearing aid (physical or acoustic) or provision of additional skills training to overcome these personal obstacles to hearing aid skill acquisition.

### 9.4.3 Developing the client-clinician relationship

The personal relationship that develops between the client and clinician is termed the therapeutic relationship, and in the case of aural rehabilitation it is fostered by trust and loyalty (Grenness et al., 2014b). Recent studies have explored the nature of the client-clinician interaction to better understand their impact on client outcomes (Poost-Faroosh et al., 2011; Laplante-Lévesque et al., 2010; Ekberg et al., 2014; Grenness et al., 2014a; Bennett et al., 2016). The findings of this PhD project contribute to this growing body of work with the identification of the client-clinician interactions as playing a key role in the acquisition of hearing aid skills and knowledge (Chapter Six) and in addressing hearing aid problems (Chapter Three).

A recent study by Bennett et al. (2018d) suggested that despite the ongoing support offered to clients after they acquire hearing aids, they appear hesitant to seek help from their clinician and instead engage in a myriad of helpful and unhelpful behaviours in response to problems that arise with their hearing aid. These findings are not surprising in light of those reported by Ekberg et al. (2014), who analysed the discourse between hearing health clinicians and their clients, and found that when clients expressed concerns regarding psychosocial aspects of obtaining hearing aids, clinicians often ignored their concerns or provided hearing aid specific information and rarely provided empathic responses, despite clients persistently re-raising their concerns (Ekberg et al., 2014). The results from these studies suggest that clinicians need to be more understanding and supportive of the emotional status of their clients and that clinicians may require further training in identifying patient needs and providing emotion-based counselling regarding the psychosocial aspects of hearing aid use (Poost-Faroosh et al., 2011; Ekberg et al., 2014; Grenness et al., 2014; Bennett et al., 2018d).
The statements relating to the client-clinician relationship from the concept mapping studies within this thesis (Chapters Three and Six) may be helpful when designing clinical programs that support and encourage development of the client-clinician relationship, such as statement 36. *Ask to see the same clinician so that they can get to know you*, statement 37. *Find a clinician who is aware of the impact of different health problems on hearing aid use*, and statement 28. *Be comfortable informing their clinician if the clinician has made incorrect assumptions.*

9.4.4 Encouraging self-management of the condition

An important component of PCC for the management of chronic illness is the enabling and encouragement of self-management of the condition (Holman & Lorig, 2004). Whereas traditional hearing aid education offers information and technical skills (Reese & Hnath-Chisolm, 2005), in contrast, self-management education teaches problem-solving skills, where the objective is to empower and prepare individuals to self-manage their hearing impairment and associated problems (Handscomb et al., 2017).

The benefits of self-management skills are demonstrated in their association with successful hearing aid outcomes (Barker, Mackenzie, Elliott, Jones and de Lusignan, 2016). Where the study described in Chapter Six identified the skills and knowledge required for hearing aid management, participants also described how these skills are acquired (Bennett et al, 2018c). Participants identified 75 unique items describing acquisition of hearing aid management skills across six concepts: 1) Relationship with the Clinician, 2) Clinician as a Source of Knowledge and Support, 3) Hands on Experience, 4) Seeking Additional Information, 5) Asking Support People for Help, and 6) External Resources.

The use of self-management skills were reported by participants, including the gaining of practical experience, using trial and error techniques, being self-motivated, asking for help and sourcing additional information. To promote self-management of the condition,
clinicians could provide their clients with the HASKI-self. The HASKI-self facilitates self-management as it is self-administered and enables self-assessment of hearing aid skill and knowledge, and subsequent identification of areas requiring additional training. Furthermore, the HASKI-self includes information and tips on how to perform each of the items of skill it assesses, and thus can be used as a self-educational tool. The tips also include descriptions of how to troubleshoot hearing aid related problems as they arise. Participants involved in the study describing the psychometric properties of the HASKI-self, reported positive experiences with completing the survey. One participant wrote “I found some of the tips quite educational”, another wrote “Very useful, section three contained a lot of information that was new to me, but now I know it all thanks to the survey”, and a third wrote “It’s a great survey, quite informative, I learned a lot just by completing it, thank you” (Chapter Seven).

9.5 Research Translation
Research translation is the process whereby knowledge gained from research activities is passed on to inform future activities, such as translation into clinical practice, policy or further research (Davidson, 2011). Conversely, translational research is research that explores how best to translate research into practice and/or policy.

An important aspect of research translation identified by translational research studies is the identification and engagement of stakeholders (Hiscock et al., 2013). The success of new clinical tools rely on the extent to which the design and implementation is appropriate and feasible for the end user, in this case, hearing aid owners and clinicians. A Cochrane review assessing the effects of consumer involvement in developing healthcare materials found that involvement of end users during the development of education materials and surveys resulted in materials that were more relevant, reliable and understandable (Nilsen et al., 2006). Accordingly, studies contained within this thesis used participatory approaches to engage key stakeholder groups (both clinicians and hearing aid owners) at every step in the process of survey development.
An important step in the research translation process is knowledge dissemination (Barwick, 2008; Barwick et al., 2005). This was achieved throughout this PhD project via several platforms. All participants involved in our studies received an email or letter of thanks for their contributions, including an overview of the study findings. My peers (clinicians, administration staff, managers and researchers) were involved not only in impromptu discussions, but I regularly presented my findings at team meetings. As for the broader community, the work contained within this thesis has been published or submitted for publication in peer reviewed journals. Additionally, the work has been presented at eight state, four national and two international conferences, at a manufacturer’s national clinician training event and at two nationally streamed webinar for audiologists.

To increase the effectiveness of research dissemination as recommended by translational research studies (Barwick, 2008; Barwick et al., 2005; Moodie et al., 2011), the four recent conference presentations included not only an overview of the research findings, but attendees were also provided with 1) printed and electronic versions of the both the HASKI-self and HASKI-clin surveys, 2) demonstrations on how to use the surveys in clinical practice, 3) information regarding the potential benefits to patients, clinicians, and clinics associated with using the survey, and 4) ongoing support on request (personalised training sessions to clinicians across Australia). Additionally, the surveys are freely available for public use online (www.earscience.org.au/research/clinical-research).

To date, these modes of knowledge translation have resulted in only minimal changes to clinical practice. Over 1000 Australian clinicians were provided with paper versions of the HASKI via the presentations mentioned above. I am aware of five clinics in Australia that have adopted its use in clinical practice, one of which is a national chain with over 100 clinicians. Additionally, three international research groups have contacted us to seek permission to use the HASKI-self for research projects. While this may appear to be a promising penetration rate at this early stage, further work is needed to promote the use of the HASKIs in clinical and research groups around the world.
Reported barriers to survey use in clinical practice include uncertainty regarding what measure should be used (Taylor, 2007), lack of awareness, motivation, or willingness to change habits (Moodie et al., 2011), the perception of insufficient time during appointments to incorporate additional protocols (Grol & Grimshaw, 2003), and undervaluing of the benefits of employing evidence-based practices such as client survey (Moodie et al., 2011; Squires et al., 2011). Thus, further research is required to investigate the benefits of the HASKI-self and HASKI-clin to clinical practice.

Although the HASKI-self was designed to evaluate hearing aid management skill and knowledge, it is possible that its use may extend beyond this. As an extension of my PhD I am currently working on two projects investigating the possible use of the HASKI-self to: 1) promote help-seeking for hearing aid problems and 2) facilitate more effective hearing aid review appointments. Demonstrating a range of uses and benefits of the HASKI-self may promote clinical uptake and support the translation of my work into clinical practice. In addition to exploring the clinical benefits of the HASKI-self and HASKI-clin, more work is needed to motivate clinicians and clinic managers to implement the HASKIs. The COM-B model is a behaviour change framework that recognises that barriers and facilitators of behaviour change relating to Capability, Opportunity, or Motivation (Michie et al., 2014; Michie et al., 2011). It would be interesting to use the COM-B model to explore clinicians and managers perspectives on the barriers and facilitators to clinical uptake of the HASKI-self and HASKI-clin, and to develop a translation plan to improve their use in clinical practise.

9.6 General limitations and further research
Concept mapping techniques were employed to produce visual maps representing how both hearing aid owners and clinicians discern the interrelationships between the concepts describing hearing aid problems (Chapter Three) and hearing aid management skills (Chapter Six), thus providing a basis for further discussion, interpretation and action (Rosas & Kane, 2012). Wording of the questions used to prompt statement generation during brainstorming sessions are likely to influence the statements put forward. Although careful
consideration was taken when devising the questions used in these studies, it could be argued that the question put to participants in Chapter Three (“What hearing aid related problems arise following hearing aid fitting?”) is loaded as it assumes that the participants have experienced a problem. In hindsight, rephrasing to “What hearing aid related problems may arise following hearing aid fitting?” may have been more appropriate. Additionally, the use of an open question for the brainstorming sessions (for example, “What hearing aid owners must do in order to use, handle, manage and maintain their hearing aid”: Chapter Six) may have contributed to the large number of (seemingly) unrelated responses. The use of a focus prompt (such as “In my experience, one skill I require to use/manage/handle my hearing aid is...”) may have helped participants to provide statements that more closely addressed the research question. Although some of the items included in the final set of statements may be considered to be describing hearing loss management skills, as opposed to hearing aid management skills, their inclusion by participants suggests that they are still important aspects of the whole process and worthy of documentation. Although it was not the aim of the study, recognition of the skills required to manage ones hearing loss underlines the importance of attention to the person and need for not only device-related management skills but also development of skills/attitudes that support the person in managing their hearing loss.

The studies described within this thesis involved participants residing in Australia and thus interpretation of the results should be made within the Australian context. Aural rehabilitation services are provided in Australia by both audiologists (university trained with a postgraduate-level qualification) and audiometrists (non-university trained hearing aid technicians); this variable was not investigated when evaluating hearing aid management skills and knowledge. Additionally, there are no universal or standardised clinical processes in Australia and therefore the number of appointments provided for a hearing aid fitting, the time allowance for these appointments and what occurs during these appointments differs between hearing aid recipients. It would be interesting to explore how these factors influence the acquisition of hearing aid skills and knowledge.
Participants involved in these studies were recruited based only on their ownership of hearing aids. While this enabled investigations into the prevalence and impact of problems associated with hearing aid use for the wider population of Australian hearing aid owners, further research is needed to identify the prevalence and impact of these problems in sub-populations of hearing aid owners, such as those with poor dexterity or haptic touch, vision impairment, low working memory, language barriers, or rural access or funding restrictions. Participants’ cognitive function was not evaluated in these studies, so we are unable to determine whether all participants were able to complete the surveys accurately. Investigations into whether baseline cognitive function affects hearing aid management skills and knowledge, or ability to complete self-administered survey would be useful for the clinical application of the HASKI-self.

While the psychometric properties of the HASKI-self and HASKI-clin suggest that they are valid and reliable tools for the evaluation of the hearing aid management skills and knowledge, there is insufficient evidence to support their sensitivity to changes in skills and knowledge. A responsiveness study comparing HASKI scores before and after retraining would provide useful information regarding the sensitivity of the HASKIs and provide clinicians with the confidence that use of the HASKIs can increase client skills and knowledge. It would also be interesting to include evaluation of cognitive function to investigate not only whether handling skills are associated with cognitive impairment, but whether ability to complete a self-report survey is affected by cognitive function. Additionally, a better understanding of the role of self-efficacy in the development of and ability to accurately self-report hearing aid management skills would facilitate improved processes for hearing aid training and evaluation.

9.7 Conclusions and final comments
The novel findings produced by the series of investigations reported in this thesis highlight the importance of hearing aid management skills and knowledge by: 1) identifying the large amount of information that must be transferred from clinician to hearing aid owner, and the overwhelming amount of information that hearing aid owners are expected to learn when
obtaining hearing aids (111 individual items of skill and knowledge), 2) reporting the low rates of hearing aid skill and knowledge in Australian hearing aid owners, and 3) describing the association between hearing aid skills and knowledge and levels of hearing aid benefit and satisfaction.

The vast number of hearing aid owners reporting difficulties with hearing aid management skill and knowledge (99% of participants), the magnitude of the deficiency (incompetent or unaware of one third of the items of skill and knowledge assessed), and the relationship between poor management skills and low self-reported hearing aid benefit and satisfaction reported throughout this PhD project highlights the need for clinicians to designate more time and resources towards ensuring hearing aid owners have the skills and knowledge to adequately use and care for their hearing aids. The knowledge that simply improving hearing aid handling and management through client training may result in improved hearing aid outcomes should motivate clinicians to employ clinical tools to assist with the evaluation and delivery of hearing aid skills.

The HASKI-self and HASKI-clin developed in this thesis are the most extensive clinical surveys currently available evaluating the skills and knowledge required for hearing aid management. The psychometric evaluations presented demonstrate that the HASKI-self and HASKI-clin are valid and reliable tools for hearing aid management evaluation. They are freely available for clinicians to download and use in their clinical practice (www.earscience.org.au/research/clinical-research). Clinical use of the HASKI-self and HASKI-clin have the potential to improve hearing aid fitting outcomes, specifically hearing aid use, benefit and satisfaction.
9.8 References


Appendix A – Hearing aid Handling Skills (HHS) survey items

Q1. Can you remove your hearing aid(s)?

Q2. Can you turn your hearing aid(s) off and on?  
(Opening the battery door, use of a program button or off switch are all acceptable methods)

Q3. Can you change your hearing aid battery?

Q4. Can you clean your hearing aid(s)?
   a. The part where the sound comes out, that is, the part that sits deep in your ear
   b. The main part of the hearing aid, that is, the body or workings

Q5. Can you insert your hearing aid(s)?
   a. Identifying the Left from the Right hearing aid
   b. Inserting with comfort
   c. The hearing aid(s) is secure and not likely to fall out

Q6. Is your hearing aid(s) set up with a volume control?
   a. Can you make adjustments to the volume of your hearing aid(s)?
   b. Do you know what volume level to set your hearing aid(s) at in different situations?

Q7. Is your hearing aid(s) set up with multiple programs?
   a. Can you make adjustments to the program setting of your hearing aid(s)?
   b. Do you know which program to select in different situations?

Q8. Is your hearing aid(s) set up with a telephone program?
   a. Can you access the telephone setting on your hearing aid(s)?
   b. Do you know how you hold the phone in the optimal position when using the telephone program on your hearing aid(s)?

Q9. Do you own any accessories for your hearing aid(s)?  
(includes remote controls, charger units, TV streamers, Bluetooth systems, FM systems)
   a. Do you know how you use your hearing aid accessory?
   b. Do you know when to use your hearing aid accessory?
Appendix B – Statements describing hearing aid skills and knowledge grouped by concepts

N.B. Bridging scores and importance ratings are indicated in brackets, respectively.

**Daily Hearing Aid Use (0.32; 3.79)**

1. learn how and when to change (or charge) the battery (0.18; 4.68)
99. check that the hearing aids are working by cupping it in the hand and listening to whether it whistles/feedback (0.19; 3.65)
79. always put the hearing aid in the box provided to avoid losing it; not in a tissue, on the bench, in your pocket, in the car (0.22; 3.88)
70. know that turning the hearing aid off resets the volume and program settings (0.23; 3.94)
12. know which program to use for which situation (0.24; 3.76)
11. know how to recognize the different tones for each program (0.24; 3.65)
105. learn how to use the volume control (0.25; 3.64)
106. know to store the hearing aids in a small case when not in use, so as not to lose them (0.27; 3.79)
24. to know that hearing aids should never fall out if fitted and inserted correctly (0.27; 3.94)
20. know not to be afraid of touching the hearing aid batteries with their fingers (0.30; 2.88)
82. learn how to use the blue tooth options available with the hearing aid, if applicable (0.30; 2.85)
91. know to put the whisker (retention line) in the ear and not to leave it hanging out (0.31; 3.21)
31. learn how to mute and unmute the hearing aid while in the ear, e.g. such as at the football stadium (0.35; 3.30)
100. check that the hearing aids are working by pressing the button and listening to whether it beeps (0.35; 3.38)
3. learn how to put the BTE on the ear so that it doesn’t fall off (0.36; 4.44)
53. be able to distinguish the right from the left hearing aid (0.36; 4.44)
55. learn how to overcome noise/whistle/feedback (0.39; 3.97)
2. learn how to insert the hearing aid in a way that is comfortable and so that it does not fall out or hang off the ear (0.44; 4.71)
103. know whether to take hearing aids out when using headphones or not (0.51; 3.44)
41. practice using the phone with the hearing aid (0.52; 3.56)
86. learn how to use the hearing aids on the phone (0.54; 4.12)

**Hearing Aid Maintenance and Repairs (0.17; 3.83)**

73. know when and how hearing aid tubing should be replaced (0.00; 3.85)
49. know how to safely remove and reattach the ear mould/tubing for cleaning in warm soapy water if wax/dirt build-up occurs (0.01; 3.62)
48. know of and how to use the air puffer to clean out the ear mould tubing and vents (0.01; 3.68)
43. know how and when to clean the hearing aid tubing with cleaning wire (0.02; 4.15)
50. clean microphones ports and/or replace microphone covers (0.02; 3.68)
109. know when to use a dry aid kit, such as when it is humid, after sweating/exercising, wet ears from showering/swimming (0.02; 4.00)
42. know how and when to clean the hearing aid moulds, including the vents (0.02; 4.32)
74. know when to change the wax filter/protector (0.07; 4.03)
75. know how to troubleshoot when the hearing aid isn't working, e.g. check for wax, change battery (0.07; 4.41)
65. know that the wires in the plastic tube (RIC) are very fragile - if the hearing aid stops working it may be because the wire has bent/snapped/cracked and needs replacing (0.07; 3.74)
15. know how to remove the wax from the hearing aid (different for different types of hearing aids) (0.08; 4.44)
23. know how to troubleshoot for causes of feedback, e.g. wax/moisture in the ear/speaker, cracked tubing, inaccurate insertion (0.10; 3.88)
21. understand how the hearing aid battery works, i.e. the battery will go flat after the sticker is removed regardless of hours of use (0.13; 3.32)
111. know how to dry the hearing aid appropriately if they are accidently worn in the water, i.e. remove and discard the battery, dry with dry kit or hair dryer on cold air function, and ensure fully dry before switching on again to avoid shorting the circuitry (0.14; 4.12)
51. know to complete personal grooming prior to putting the hearing aid in (shower, dry ears/hair, apply hair spray) (0.15; 3.97)
77. know that batteries can leak if left in a hearing aid for extended periods of time (months/years) and can damage the hearing aid (0.16; 3.88)
56. remember to take hearing aids out prior to showering (0.18; 4.68)
38. ensure spare batteries are kept in different locations, such as in the car/wallet/holiday house (0.19; 3.36)
69. understand why battery life fluctuates, e.g. hearing aid use in noisy environments, duration of use and battery quality (0.19; 3.21)
44. become familiar with the different components of the hearing aid to be able to troubleshoot if a problem arises (0.21; 3.53)
22. learn how to tell the positive side from the negative side of the hearing aid battery (0.22; 3.97)
108. use a magnifying glass with light (obtained from newsagents) to see smaller parts of the hearing aid, such as to assess if microphones or wax protectors are blocked (0.22; 3.33)
47. know to wipe hearing aids with alcohol wipes if experiencing outer ear infections (0.23; 3.74)
16. know about the servicing, batteries and maintenance programs available (0.23; 4.03)
76. be aware that hearing aids can be a danger to animals and small children (if swallowed) and so to keep the hearing aids in a safe place, out of reach of animals and small children (0.24; 4.12)
78. know that battery life is extended if you wait one minute after removing the battery sticker before inserting it into the hearing aid (0.25; 3.62)
13. be aware that when you buy your batteries that there is no guarantee that every battery will work (0.30; 2.94)
81. understand the need for preventative maintenance, i.e. that all hearing aids require some maintenance over their lifespan (0.31; 4.18)
19. know how to dispose of hearing aid batteries (0.34; 3.32)
39. know to purchase and learn how to use a battery tester to trouble-shoot when no amplification with a new battery (0.35; 2.55)
18. know where to order/purchase/collect hearing aid batteries, domes, tubes, wax protectors, cleaning items, etc. (0.38; 4.21)
4. make sure they have the right equipment (mould/dome/whiskers/retention line) so that the hearing aid stays in the ear (0.41; 4.56)

Advanced Hearing Aid Knowledge (0.61; 3.50)

67. know that its ok to collect extra batteries before going away, rather than running out or having to find a place to buy batteries while away (0.34; 3.91)
32. know where to buy puffers or vacuums for cleaning wax (0.36; 3.18)
110. understand how ear wax in the ear canal can cause problems with the hearing aids (0.39; 4.15)
66. get the hearing aids serviced before going away to prevent problems while away (0.39; 3.38)
67. get ear wax flushed or syringed out (0.43; 3.29)
68. know to ask for a dry box (dry aid kit) as clinicians don't always give them out or mention them (0.56; 3.26)
69. if they feel pressure in their ear canals, they must know to ask their clinician to open up the vents to allow more air in (0.68; 3.00)
70. know that they can go back for adjustments if the sound is too high/loud (0.72; 4.50)
71. know the different options for softening ear wax to make it easier for the clinician/doctor to remove (0.74; 3.15)
72. know to ask about rechargeable battery options before buying the hearing aid, as clinicians don't usually mention them (0.81; 2.85)
73. know about insurance for hearing aids (0.91; 3.21)
74. know to still use hearing protection to prevent further hearing loss (1.00; 4.09)

Learning to Come to Terms with Hearing Aids (0.31; 3.97)

34. wear the hearing aids regularly, even if you feel you don't need to wear them all the time (0.05; 4.18)
35. set up a reminder to encourage daily hearing aid use (0.10; 2.91)
36. use hearing aids on a regular basis in order to 'retrain' the brain and to accept amplified sounds as 'normal' (0.10; 4.56)
37. understand that getting used to hearing aids can be emotional to start with (0.12; 3.79)
38. be motivated to wear the hearing aids (0.12; 4.58)
39. understand that it takes a long time to get used to sounds - it can be scary at first, there is so much noise in the world (0.13; 3.94)
40. wear the hearing aids for longer periods each day to get used to the annoying feeling in the ear (0.16; 3.65)
41. remember to use the hearing aid (0.16; 4.41)
42. commit to using the hearing aid (0.16; 4.59)
43. not to be bothered by the cosmetics of the hearing aid (0.17; 3.21)
44. persevere with the hearing aid (i.e. put up with it and be patient) (0.24; 4.26)
45. trust that the brain will adjust to the strange sounds of the hearing aid (0.29; 3.82)
46. to understand the effects of noise on hearing speech (0.33; 4.24)
47. be happy with the little achievements (e.g. being pleased with hearing and localizing the rustling of the leaves when bush walking) (0.37; 3.74)
48. understand how hearing loss can impact others, e.g. frustration with having to speak face to face (0.37; 4.03)
49. be aware of the limitations of hearing aids and have realistic expectations from the outset (0.40; 4.18)
50. understand that hearing aids are not like glasses, it doesn’t just happen - it takes a long time for the brain to relearn the sounds (0.42; 4.21)
51. be prepared for loud sounds like the clicking of the car noises when they first leave the clinic with their hearing aids in (0.43; 3.79)
52. set a routine so that hearing aid use and management becomes a habit, e.g. when to take it out and put it in (0.49; 3.82)
53. give it another go if they have given up on the hearing aid (0.52; 4.38)
54. develop confidence in own ability to manage hearing aids (0.56; 4.47)
55. know how to optimize directional microphones by sitting with your back to the noise, where possible, and ensuring the speaker is within 3 meters in front (0.59; 3.64)
56. understand how wind noise can affect hearing aids and that turning the head slightly can stop the wind noise (0.61; 3.65)
57. use subtitles when watching the TV, even if wearing hearing aids (0.62; 2.97)
**Communication Strategies (0.39; 3.91)**

92. teach family/friends to look at you when they speak (0.23; 3.94)
96. learn not to be afraid to ask people to repeat themselves if you don't hear them the first time (0.26; 4.18)
95. try to speak one-on-one when talking with people in a noisy place (0.29; 4.06)
94. know to speak face-to-face when talking with people, to watch their lips (0.29; 3.94)
93. know to use eye contact when talking with people (0.29; 3.97)
97. realize that it can be frustrating when people do not use communication strategies, e.g. face to face (0.46; 4.00)
107. know and use hearing tactics to improve outcomes of hearing aid use, e.g. subtitles on the TV, reducing background noise, or sitting with the noise behind them (0.51; 4.06)
89. know to order safety alerts for the hearing impaired, e.g. strobe and vibrating fire/door alarms (0.82; 3.21)

**Working with Your Clinician (0.44; 3.93)**

37. find a clinician who is aware of the impact of different health problems on hearing aid use (0.17; 3.55)
36. ask to see the same clinician so that they can get to know you (0.20; 3.48)
87. find a clinician who is always willing to discuss and fix problems (0.21; 4.50)
14. know what questions to ask their clinician to get all of the information (0.26; 3.65)
54. find a good clinician who knows what they are doing (0.28; 4.59)
28. be comfortable informing their clinician if the clinician has made incorrect assumptions (0.38; 4.35)
90. be comfortable admitting to the clinician how little you have used the hearing aid (0.42; 3.38)
25. know how to explain what the problem is in a way that the clinician can understand (0.44; 3.41)
102. ask their clinician for a simple model of hearing aid if they prefer not to have the gadgets or multiple settings (0.45; 3.21)
17. know to return to the clinician if hearing aids cause soreness or ear pain (0.51; 4.62)
6. go back to their clinician and ask for help if the hearing aid is not fitting/working properly (0.56; 4.74)
59. know that if their own voice sounds horrible, they don't have to put up with it, they can ask their clinician to drill bigger holes (0.60; 3.15)
80. attend follow up appointments to have the hearing aids adjusted (0.77; 4.32)
30. ask for training on hearing aid use and maintenance (0.87; 3.88)
Appendix C – Self-administered Hearing Aid Skills and Knowledge Inventory (HASKI-self)


**Administration:** The HASKI-self can be administered in a paper based or electronic format. Instructions are included on the top of the survey. Participants are required to rate their ability to perform tasks based on items on a four point Likert scale: “Never”, “Sometimes”, “Most of the time”, “Always” and to identify whether they are aware of knowledge based items or not using a 3-point Likert scale: “Yes, I am aware”, “I now recall receiving this information, but had forgotten” and “I do not recall receiving this information”. A “Not Applicable” option is available for some of the items.

**Scoring:** Scoring of the HASKI-self is designed to provide a percentage of competency. Each individual item is classified as a pass when “Always” is selected, and is allocated one point; or fail when “Most of the time”, “Sometimes” or “Never” is selected, and zero points are allocated. To calculate the percentage competency, the points are summed and then divided by the total number of items for which a response was given (not including items for which “Not Applicable” was selected), and divided by 100. Items are equally weighted. A higher overall score indicates greater competency (i.e., a score of 100% represents full competency).

**Interpretation:** The survey score can be used to compare the extent of management difficulties for a single hearing aid owner before and after additional training. Additionally, overall scores might be compared across two hearing aid types, such as between styles (whether a hearing aid owner finds behind-the-ear or in-the-ear style easier to manage), or technical features (whether a hearing aid owner can manage a new set of hearing aids with a more complex system and accessories, as compared to their previous model). The overall score may also be used to compare management skills between hearing aid owners or group of owners (such as used for research purposes).

The overall pass/fail (whether the participant scored 100% or less on the survey) can be used to indicate whether a hearing aid owner has a problem with at least one task and thus would benefit from additional training. The clinician can then peruse each item on the survey to ascertain specifically which item(s) require additional training, in essence, using the survey as a training guide. Clinical applications of this might include use of the HASKI-self in the few months following hearing aid acquisition. This may identify gaps in training that were omitted or not fully understood by the hearing aid owner, in essence, using the HASKI-self as a screening tool to identify the need for additional support.

# Hearing Aid Skills and Knowledge Inventory – Self-administered

**Name:** ______________________________  
**Date of Birth:** __________________________

**Clinic:** __________________________________________  
**Today’s date:** __________________________

Please mark the response that best reflects your ability to perform each task. Please select one response for each question.

## Part 1: Daily hearing aid use

<table>
<thead>
<tr>
<th>Question</th>
<th>Method</th>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Can you identify whether your hearing aid(s) is working?</td>
<td>Cupping the hearing aid in your hand, rubbing the microphone, or making changes to the volume or programing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>Q2. Can you turn your hearing aid(s) off and on?</td>
<td>Opening the battery door, use of a program button, off switch, remote control or placing it in a charger are all acceptable methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>Q3. Batteries</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>a. Can you change the battery?</td>
<td>Remove old battery from hearing aid, remove new battery from packet, identify positive/negative side, insert into the hearing aid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>b. Do you know when to change your battery?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>c. Do you know where to purchase/collect additional batteries?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
d. Do you know how to dispose of batteries safely?  

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
</tr>
</thead>
</table>

Comments:

Q4. Hearing aid insertion and removal

a. Can you identify the Left from the Right hearing aid  

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
</tr>
</thead>
</table>

b. Can you insert your hearing aid with comfort?  

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
</tr>
</thead>
</table>

c. Does your hearing aid stay in/on your ear, that is, not fall out/off?  

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
</tr>
</thead>
</table>

d. Can you remove your hearing aid comfortably?  

<table>
<thead>
<tr>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
</tr>
</thead>
</table>

Comments:

Q5. Is your hearing aid(s) set up with a volume control?  

<table>
<thead>
<tr>
<th>Yes</th>
<th>No (go to Q6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Never</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>a. Can you make adjustments to the volume of your hearing aid(s)?</td>
<td></td>
</tr>
<tr>
<td>b. Can you hear and recognise the different beeps that alert you to the volume setting?</td>
<td></td>
</tr>
<tr>
<td>c. Do you know what volume level to set your hearing aid(s) at in different situations?</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>Q6. Is your hearing aid(s) set up with different listening programs?</td>
<td></td>
</tr>
<tr>
<td>a. Can you make adjustments to the program setting of your hearing aid(s)?</td>
<td></td>
</tr>
<tr>
<td>b. Are you able to hear and recognise the different beeps that alert you to the program changes you are making?</td>
<td></td>
</tr>
<tr>
<td>c. Do you know which program to select in different situations?</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>
Q7. Do you use your hearing aid(s) with a telephone?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No (go to Q8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Can you turn on the telephone program on your hearing aid?</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>b. Do you know how to hold the phone in the optimal position when using the telephone program on your hearing aid(s)?</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
</tbody>
</table>

Acceptable methods: use of speaker phone, video conferencing, Bluetooth streaming, holding phone to concha for open fit/ITEs, phone to BTE where t-coil is enabled

Comments:

Q8. Do you own any accessories for your hearing aid(s)?

Includes remote control, Bluetooth streamer, charger unit, TV streamer, FM system

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No (go to Q9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Do you know how you use your hearing aid accessory?</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>b. Do you know when to use your hearing aid accessory, in what situations?</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
</tbody>
</table>

Comments:
<table>
<thead>
<tr>
<th>Q9. Hearing aid storage</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>a. Do you store your hearing aid in a safe place?</td>
<td>Away from heat, moisture, animals and children</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
<td>Always</td>
</tr>
<tr>
<td>b. Do you own a dry aid kit?</td>
<td>Also called a dry store or dehumidifier</td>
<td>Yes</td>
<td>No (go to Q10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Do you know how to use the dry aid kit?</td>
<td></td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
<td>Always</td>
</tr>
<tr>
<td>d. Do you know when to use the dry aid kit?</td>
<td>Such as when it is humid, after sweating/exercising, wet ears from showering/swimming</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
<td>Always</td>
</tr>
<tr>
<td>e. Do you know how often to replace the tablets/crystals in the dry aid kit?</td>
<td></td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
<td>Always</td>
</tr>
<tr>
<td>f. Do you know where to purchase additional tablets/crystals for the dry aid kit?</td>
<td></td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
<td>Always</td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
<td></td>
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</table>
### Part 2: Hearing aid maintenance and repairs

#### Q10. When cleaning your hearing aid, do you do the following:

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</tr>
</thead>
<tbody>
<tr>
<td><strong>a.</strong> Wipe the externals with a dry (or moist, but never wet) cloth/tissue</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
</tr>
<tr>
<td><strong>b.</strong> Wipe inside the battery compartment with a dry cloth/tissue</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
</tr>
<tr>
<td><strong>c.</strong> Wipe/brush the microphone port/cover</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
</tr>
<tr>
<td><strong>d.</strong> Wipe/brush the speaker (where the sound comes out - also called the receiver port), including cleaning out the wax system (if applicable)</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
</tr>
<tr>
<td><strong>e.</strong> Clean the vent with a brush or puffer</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
</tr>
<tr>
<td><strong>f.</strong> Do you own a behind-the-ear style hearing aid?</td>
<td></td>
<td>Yes</td>
<td>No (go to Q11)</td>
</tr>
<tr>
<td><strong>g.</strong> Do you detach the mould tubing / slim tube and clean with cleaning wire/puffer (ensuring the right mould tubing or slim tube goes back on the right hearing aid) and wipe down the moulds / domes?</td>
<td>Never</td>
<td>Sometimes</td>
<td>Most of the time</td>
</tr>
</tbody>
</table>

Comments:
Q11. Maintenance

<p>| | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>a.</td>
<td>Do you know where to purchase cleaning products from, such as puffers and brushes?</td>
<td>Yes</td>
</tr>
<tr>
<td>b.</td>
<td>Do you know how often to clean your hearing aid?</td>
<td>Yes</td>
</tr>
<tr>
<td>c.</td>
<td>Do you know how to change the wax protection system? (also called the wax buster or wax guard)</td>
<td>Yes</td>
</tr>
<tr>
<td>d.</td>
<td>Do you know how often to change the wax protection system?</td>
<td>Yes</td>
</tr>
<tr>
<td>e.</td>
<td>Do you know where to purchase additional wax protection systems?</td>
<td>Yes</td>
</tr>
<tr>
<td>f.</td>
<td>Do you know how to change the tubes and domes/moulds?</td>
<td>Yes</td>
</tr>
<tr>
<td>g.</td>
<td>Do you know how often to change the tubes and domes/moulds?</td>
<td>Yes</td>
</tr>
<tr>
<td>h.</td>
<td>Do you know where to purchase additional tubes and domes/moulds?</td>
<td>Yes</td>
</tr>
<tr>
<td>i.</td>
<td>Do you know how to change the microphone covers?</td>
<td>Yes</td>
</tr>
</tbody>
</table>
j. Do you know how often to change the microphone covers?

k. Do you know where to purchase additional microphone covers?

Comments:

Q12. Repairs

<p>| | | |</p>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Do you know how to overcome feedback/whistling?</td>
<td>Such as clean the hearing aid thoroughly, get your ears checked for wax, ensure the hearing aid is sitting in the ear (sufficiently deep and comfortable), and check for cracks/holes/moisture in the tube/mould/ear hook.</td>
<td>Never</td>
</tr>
<tr>
<td>b. Do you know what to do if the hearing aid sounds dull or stops working?</td>
<td>Change the battery, turn the hearing aid off and on again, check if the wire/tubing has bent/snapped/cracked as it may need replacing, clean blockages from the hearing aid microphone/speaker.</td>
<td>Never</td>
</tr>
<tr>
<td>c. Do you know what to do if the hearing aid gets wet?</td>
<td>Remove and discard battery, remove mould/tube/dome if applicable, dry hearing aid overnight using the dry aid kit, wait 24 hours before inserting a new battery.</td>
<td>Never</td>
</tr>
</tbody>
</table>

Comments:
Q13. Preventing problems

<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Sometimes</th>
<th>Most of the time</th>
<th>Always</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Are you familiar with the different components of the hearing aid? Can you locate the microphone(s), speaker, battery compartment, and vent?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Are you aware to complete personal grooming prior to putting the hearing aid in (shower, dry ears/hair, apply hair spray)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Do you ensure that you remove your hearing aids prior to showering?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Are you informed of the servicing, batteries and maintenance programs available from your clinic?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Are you aware of the importance of wiping hearing aids with alcohol wipes before inserting them in your ear if you are experiencing outer ear infections?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Do you understand the need for preventative maintenance, i.e. that all hearing aids require some maintenance over their lifespan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:
Part 3: Advanced hearing aid knowledge

<table>
<thead>
<tr>
<th>Please indicate whether you are aware of the below</th>
<th>Yes, I am aware</th>
<th>I now recall receiving this information, but had forgotten</th>
<th>I do not recall receiving this information</th>
</tr>
</thead>
<tbody>
<tr>
<td>It can be useful to collect extra batteries before going away, rather than running out or having to find a place to buy batteries while away.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Having your hearing aids serviced before going away can prevent problems occurring while away.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>There are a range of rechargeable battery options available.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aid batteries will go flat after the battery sticker is removed, regardless of whether it has been used or not.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aid batteries can leak if left in a hearing aid for extended periods of time (months/years). This can permanently damage the hearing aid.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>The life of a hearing aid battery can fluctuate. Batteries go flat faster if the hearing aid is used in noisy environments, used for longer hours each day or if the batteries are of a lesser quality.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aid battery life can be slightly extended if you wait one minute after removing the battery sticker before inserting it into the hearing aid.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>It is possible to get a faulty battery in a new packet. It will need to be discarded and a new battery placed in the hearing aid.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aid batteries pose a danger to animals and children if swallowed and should be dispose of safely.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Having ear wax regularly removed prevents build up in the ear canals, and reduced the amount of wax and debris that may clog up the hearing aid.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Softening the ear wax before seeing your doctor/hearing professional for wax removal can make it a quicker, safer and more comfortable experience. Appropriate options for softening ear wax include chemist purchased sprays and drops as well as olive oil.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>When sitting in the ear, a hearing aid should be comfortable. If the hearing aid is uncomfortable, there are things your clinician can do to improve the comfort for you.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>The sound delivered by the hearing aid should always be comfortable. There are things your clinician can do to improve the comfort for you.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aids should NOT fall off/out of the ear regularly. If the hearing aid continuously falls off/out, there are things your clinician can do to improve this for you.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Some home insurance policies will cover hearing aids as an out of home extra.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Even people with hearing loss are susceptible to noise induced hearing loss and tinnitus. It is important to always wear hearing protection (ear muffs or plugs) when exposed to loud sounds.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aids aren’t the only solution for people with hearing loss. Assistive Listening Devices (ALDs) include a range of technologies designed to assist people to hear in a specific situations, such as when watching TV or on the phone, and may be used either independently or in conjunction with hearing aids.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
<tr>
<td>Hearing aids increase the volume of sounds but may not always improve one’s ability to understand speech due to severe damage in the inner ear. A cochlear implant bypasses the damaged parts of the inner ear by stimulating the hearing nerves directly and can provide better hearing for some people with this type of hearing loss.</td>
<td>I am aware</td>
<td>I now recall</td>
<td>Not received</td>
</tr>
</tbody>
</table>
Appendix D – Clinician-administered Hearing Aid Skills and Knowledge Inventory (HASKI-clin)

Description: The HASKI-clin evaluates 35 items of hearing aid skill required by a hearing user (the client) for daily hearing aid use as well as hearing aid maintenance and repairs.

Administration: The HASKI-clin is administered in a paper-based format. Instructions are included at the top of the survey. The clinician (or trained professional) is required to read aloud the shaded sections to instruct the client as to which task to perform. The tips are provided to identify whether the client has completed all of the skills necessary for each task. The boxes provided should be used to indicate whether the client has demonstrated competence for each task or whether they would benefit from hearing aid modification, additional training or support. A “Not Applicable” option is available for some of the items.

Scoring: Scoring of the HASKI-clin is calculated by summing the total number of items identified as competent (not problematic), dividing this by the number of items for which a response was given (i.e. excluding the “Not Applicable responses) and multiplying 100 to give percentage of competency. Items are equally weighted. A higher overall score indicates greater competency (i.e., a score of 100% represents full competency).

Interpretation and clinical use: The competency score can be used to give an overall indication of how well the client is going with managing their hearing aids. Furthermore, any score other than 100% indicates that a hearing aid owner has a problem with at least one task and thus would benefit from additional training. The clinician can then peruse each item on the survey to ascertain specifically which item(s) require additional training, in essence, using the survey as a training guide.

The HASKI-clin may also be used at the end of the initial fitting consultation as a check-list to assess whether the hearing aid owner has the skills necessary to use and maintain their hearing aid before leaving the clinic.

**Hearing Aid Skills and Knowledge Inventory – Clinician-administered (HASKI-clin)**

| Name: ______________________________ | Date of Birth: ______________________________ |
| Clinic: ______________________________ | Today’s date: ______________________________ |

Read aloud the shaded sections to instruct the client. Use the tips provided to ensure that the client is completing all of the skills necessary for each task. Use the boxes provided to indicate whether the client has demonstrated competence for each task or whether they would benefit from hearing aid modification, additional training or support.

<table>
<thead>
<tr>
<th>Q1. How do you know if your hearing aid is working? Please show me what you do to identify whether your hearing aid(s) is working</th>
<th>Tip: Cupping the hearing aid in your hand, rubbing the microphone, making changes to the volume or programing, turning the device off and on to hear the start-up tune are all acceptable methods.</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2. Please show me how you turn your hearing aid(s) off and on</td>
<td>Tip: Opening the battery door, use of a program button, off switch, remote control or placing it in a charger are all acceptable methods.</td>
<td>Competent</td>
<td>Requires attention</td>
</tr>
<tr>
<td>Q3. Batteries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Please show me how you change the battery</td>
<td>Tip: Remove old battery from hearing aid, remove new battery from packet, identify the positive/negative side, insert into the hearing aid.</td>
<td>Competent</td>
<td>Requires attention</td>
</tr>
<tr>
<td>b. How do you know when to change or charge your battery?</td>
<td>Tip: Listening out for the battery beeps, when it is flat/dead or at regular intervals (e.g. every second Sunday) are all acceptable methods.</td>
<td>Competent</td>
<td>Requires attention</td>
</tr>
</tbody>
</table>
### Q4. Hearing aid insertion and removal (request demonstration of both hearing aids if they are different models)

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Please show me how you identify the Left from the Right hearing aid</td>
<td></td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Please show me how you insert your hearing aid comfortably and without damaging the hearing aid</td>
<td>Tip: Ensure the device is not being twisted or bent, that the action is not rough or likely to damage the ear or the hearing aid.</td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Is your hearing aid comfortable when sitting in the ear?</td>
<td>No discomfort</td>
<td>Requires attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Please tilt your head for me. Does your hearing aid stay in/on your ear (i.e., not fall out/off)?</td>
<td>Tip: Check retention and that, where applicable, the helix/concha lock or retention line is being used appropriately.</td>
<td>Competent</td>
<td>Requires attention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Please show me how you remove your hearing aid comfortably and without damaging the hearing aid</td>
<td>Tip: Ensure the device is not being twisted or bent, that the action is not likely to damage the ear or the hearing aid.</td>
<td>Competent</td>
<td>Requires attention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----</td>
<td>-----</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Q5. Is your hearing aid(s) set up with a volume control?</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Please show me how you make adjustments to the volume of your hearing aid(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Please describe for me the different beeps that alert you to the changes you are making to the volume setting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. In what situations do you change the volume level?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Q6. Is your hearing aid(s) set up with different listening programs for you to manually adjust?</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Please show me how you make adjustments to the program setting of your hearing aid(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Please describe for me the different beeps that alert you to the program changes you are making</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. In what situations do you use each program?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Q7. Do you use a telephone?</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tip: Ensure the participants’ response is accurate according to the hearing aid settings.
<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>Competent</th>
<th>Requires attention</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Please show (or describe for me) me how you use the telephone</td>
<td>Tip: Acceptable methods include the use of speaker phone, video conferencing,</td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
</tr>
<tr>
<td>with your hearing aid(s)</td>
<td>Bluetooth streaming, holding the phone to the hearing aid microphone or t-coil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Do you have a phone program?</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Not applicable</td>
</tr>
<tr>
<td>c. Please show me how you use the telephone program on your</td>
<td></td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
</tr>
<tr>
<td>hearing aid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q8. Do you own any accessories for your hearing aid(s)?</td>
<td>Yes</td>
<td>No</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Includes remote control, Bluetooth streamer, charger unit, TV streamer,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM system, Rodger pen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Please show me how you use your hearing aid accessory</td>
<td></td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
</tr>
<tr>
<td>b. In what situations do you use your hearing aid accessory?</td>
<td>Tip: Ensure the participants’ response is accurate according to the hearing</td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>aid aid settings.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q9. Hearing aid storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Where do you store your hearing aid when you are not using it?</td>
<td>Tip: Away from heat, moisture, animals and children</td>
<td>Competent</td>
<td>Requires attention</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
b. Do you own a dry aid kit? (Also called a dry store or dehumidifier)  

<table>
<thead>
<tr>
<th>Yes</th>
<th>No (go to Q10)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>c. Please show me how you use the dry aid kit</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>d. Please describe for me when you use the dry aid kit</th>
<th>Tip: Such as every night, when it is humid, after sweating/exercising, if the ears are wet from swimming.</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
</table>

**Q10. Please show me what you do when you clean your hearing aid**  

Tip: Request demonstration of both hearing aids if they are different models. Only select Competent Overall if they performed all of the items listed below.

<table>
<thead>
<tr>
<th>a. Please show me how you wipe the externals with a dry (or moist, but never wet) cloth/tissue</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>b. Please show me how you wipe inside the battery compartment with a dry cloth/tissue</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>c. Please show me how you wipe/brush/replace the microphone port/cover</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>d. Please show me how you wipe/brush the speaker and/or replace the wax guard</th>
<th>Competent</th>
<th>Requires attention</th>
</tr>
</thead>
</table>

| Attends the clinic regularly or relies on their significant other | | |
|--------------------|--------------------------|

Not applicable

Not applicable
<table>
<thead>
<tr>
<th>Q12. Repairs (if they say that they would call the clinic, then select Requires attention)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. What would you do if your hearing aid started to feedback/whistle?</strong></td>
</tr>
<tr>
<td>Tip: Clean the hearing aid thoroughly, get your ears checked for wax, ensure the hearing aid is sitting in the ear (sufficiently deep and comfortable), and check for cracks/holes/moisture in the tube/mould/ear hook.</td>
</tr>
<tr>
<td>Competent</td>
</tr>
<tr>
<td><strong>b. What would you do if your hearing aid sounded dull or stopped working?</strong></td>
</tr>
<tr>
<td>Tip: Change the battery, turn the hearing aid off and on again, check if the wire/tubing has bent/snapped/cracked as it may need replacing, replace the wax guard, and clean blockages from the hearing aid microphone/speaker.</td>
</tr>
<tr>
<td>Competent</td>
</tr>
<tr>
<td><strong>c. What would you do if your hearing aid was to get wet?</strong></td>
</tr>
<tr>
<td>Tip: Remove and discard battery, dry hearing aid overnight using the dry aid kit, and wait 24 hours before inserting a new battery.</td>
</tr>
<tr>
<td>Competent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>e. Please show me how you clean the vent with a brush or puffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tip: Detach the tubing to clean with a cleaning wire, puffer or warm soapy water?</td>
</tr>
<tr>
<td>Competent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>f. Please show me how you clean the tubing and moulds/domes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tip: Detach the tubing to clean with a cleaning wire, puffer or warm soapy water?</td>
</tr>
<tr>
<td>Competent</td>
</tr>
</tbody>
</table>

| Not applicable | Not applicable | Not applicable |