Health Literacy, Instruction Materials, and Hearing Aid Management in Older Adults

Andrea Caposecco
BA, BSpPath (Hons), MPhil (Audiology)

A thesis submitted for the degree of Doctor of Philosophy at
The University of Queensland in 2015

School of Health and Rehabilitation Sciences
Abstract
Approximately 11 million hearing aids were dispensed worldwide in 2012, and of these over 60% were fitted to older adults. All were accompanied by a printed user guide containing information on hearing aid management and troubleshooting. The user guide should play an integral role in the transfer of information on hearing aids particularly as many older adults experience difficulty with aid management tasks, such as cleaning the device or changing the battery. However, it is only effective if it can be read and understood by the client. Many older adults have deficits in vision and/or cognition which may affect their ability to read and use healthcare materials, such as hearing aid user guides, and at least 30% have low health literacy. Health literacy refers to the ability to obtain, process, and comprehend health information and services. To-date there has been limited research on health literacy and/or the design and suitability of instruction materials in the field of rehabilitation audiology. Hence, the overarching aim of this thesis was to determine the appropriateness of currently available hearing aid user guides for older adults and to explore the potential benefits of designing hearing aid instruction materials based on best practice guidelines for health literacy.

The thesis is comprised of four studies. The first study analysed the content and design of a sample of printed hearing aid user guides to determine their suitability for older adults. Thirty six user guides from nine different hearing aid manufacturers were examined using a standardised assessment, the Suitability Assessment of Materials, along with four readability formulae. The results showed that hearing aid user guides are not optimal for older adults. Problems included frequent use of uncommon vocabulary, small text size and graphics, and high reading level.

The second study involved a review of the literature to determine features that should be incorporated into written healthcare materials and factors to consider in the design process when developing written instructions for a target audience of older adults. The findings were applied to the design and development of a set of written instructions for a self-fitting hearing aid and also informed development of the modified hearing aid user guide used in the final two studies of this thesis.

The next two studies explored the benefits of using best practice design principles in the development of hearing aid instruction materials. The studies involved 89 participants, with
a mean age of 72 years, living in the community, and with no experience of hearing aid use or management. The aim of the third study was to investigate if a hearing aid user guide modified using best practice guidelines for health literacy resulted in superior ability to perform aid management tasks, compared to the user guide in the original form. Half the participants were randomly assigned the original user guide and half were assigned the modified user guide. All participants were administered the Hearing Aid Management Test, (developed for this research) which assessed their ability to perform seven management tasks (e.g., change hearing aid battery) with their assigned user guide. The regression analysis indicated that the type of user guide was significantly associated with the score on the Hearing Aid Management Test, adjusting for eight potential co-variates.

The final study sought to determine if the type of user guide (original versus modified) was associated with the ability of older adults to understand troubleshooting information and also to examine older adults’ preferences for user guides. It utilized the Hearing Aid Troubleshooting Test (developed for this research) which comprised seven items that assessed the ability of participants to find and comprehend information relating to troubleshooting. The study found that performance was significantly better, on all but one item, for participants assigned the modified guide. In addition, 80% of participants preferred the modified guide when shown both.

In summary, this research indicates that hearing aid user guides are not optimal for older adults which may impact on hearing aid outcomes and success. It highlights the association between the quality and type of hearing aid instruction materials and the ability of older adults to perform aid management tasks, and to find and understand troubleshooting information. It is therefore recommended that hearing aid user guides and other hearing healthcare materials be designed according to health literacy principles.
Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

I acknowledge that an electronic copy of my thesis must be lodged with the University Library and, subject to the General Award Rules of The University of Queensland, immediately made available for research and study in accordance with the Copyright Act 1968.

I acknowledge that copyright of all material contained in my thesis resides with the copyright holder(s) of that material. Where appropriate I have obtained copyright permission from the copyright holder to reproduce material in this thesis.

Andrea Caposecco
Publications during candidature

Peer-reviewed papers


Conference presentations

(Author underlined presented the paper)


Other presentations

Publications included in this thesis

Two published journal articles, one submitted, and one prepared are incorporated in their entirety in the thesis. Authors of each article are shown below along with contributions to the articles.


<table>
<thead>
<tr>
<th>Contributor</th>
<th>Statement of contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reviewed literature</td>
</tr>
<tr>
<td>Andrea Caposecco (candidate)</td>
<td>100%</td>
</tr>
<tr>
<td>Louise Hickson</td>
<td>0%</td>
</tr>
<tr>
<td>Carly Meyer</td>
<td>0%</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Contributor</th>
<th>Statement of contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reviewed literature</td>
</tr>
<tr>
<td>Andrea Caposecco (candidate)</td>
<td>100%</td>
</tr>
<tr>
<td>Louise Hickson</td>
<td>0%</td>
</tr>
<tr>
<td>Carly Meyer</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Statement of contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reviewed literature</td>
</tr>
<tr>
<td>Andrea Caposecco (candidate)</td>
<td>100%</td>
</tr>
<tr>
<td>Louise Hickson</td>
<td>0%</td>
</tr>
<tr>
<td>Carly Meyer</td>
<td>0%</td>
</tr>
<tr>
<td>Asad Khan</td>
<td>0%</td>
</tr>
</tbody>
</table>
Contributions by others to the thesis

The PhD candidate was primarily responsible for the study design, recruitment, data collection, statistical analysis, interpretation, and writing.

Professor Hickson and Dr Meyer had input into the concept and design of the research, interpretation of data, and critical appraisal of the written work.

Dr Khan contributed to the statistical analysis of the data for the studies described in Chapter 5 and 6.

Mr Bunn assisted with the collection and analysis of the user guides discussed in Chapter 3. He also collected a portion of the data discussed in Chapter 5 and 6.

Ms Convery designed and produced the diagrams in the user guide developed for the study discussed in Chapter 4.
Statement of parts of the thesis submitted to qualify for the award of another degree

None
Acknowledgements

I have many friends, family members, colleagues, and organizations to thank for helping me to achieve a long held dream, to complete a PhD. First and foremost, I owe a debt of gratitude to my wonderful supervisors and inspirational mentors, Professor Louise Hickson and Dr Carly Meyer. As a young audiologist, I heard Louise present at a conference and was so inspired that I decided to I would return to the University of Queensland to pursue research under her guidance, at some point in the future. I am so glad that I made this decision. Louise is a great role model, being a world leader in hearing rehabilitation research, and an exceptional teacher. She has taught me the intricacies of conducting research; skills and knowledge I will have for a lifetime and which in turn I hope I can impart onto others. In addition, Louise has carved out unique opportunities and learning experiences which have enriched my PhD journey and has instilled in me the importance of translating research findings into the clinic. Against this backdrop, Louise is always friendly, positive, generous with her time, and open to new ideas.

My second supervisor, Carly, is an outstanding researcher, having published in numerous peer-reviewed journals. I have benefitted from her expertise in so many ways. Carly provided invaluable input into the design of the tests developed as part of this PhD and detailed, constructive feedback into all aspects of the research. I have always appreciated her enthusiastic and encouraging manner, and her supportive and patient guidance. I could not have hoped for more and I feel so fortunate to have been one of her doctoral students – thank you!

I thank my colleagues in the Communication Disability Centre, at the University of Queensland for their friendship, encouragement, and guidance; in particular Dr Nerina Scarinci, Dr Tanya Rose, and Professor Linda Worrall. I also owe a debt of gratitude to Dr Asad Khan for helping and guiding me with the statistical analyses; his assistance was invaluable and greatly appreciated.

I am exceptionally grateful to my mum and dad for their endless support, constant encouragement, and for instilling in me a lifelong love of learning. I wish my dad could still be here to share in this. I thank my husband, Mauro, for standing beside me during this journey. Living with a PhD candidate is not easy. Mauro has encouraged me every step of the way, particularly during tough times. In addition, he entertained our daughter, Sophia, on Sunday afternoons, allowing me to work on the thesis.
I express my great appreciation to the HEARing Cooperative Research Centre for their generous scholarship and extend special thanks to Oticon, for providing me with the hearing aids, necessary to carry out this research. Finally, I acknowledge the adults who kindly gave of their time to participate in this research. Without them, this thesis would not be possible.
Keywords

hearing impairment, hearing aid, self-fitting hearing aid, hearing aid management, older adults, health literacy, instructions, user guide, patient education
Australian and New Zealand Standard Research Classifications (ANZSRC)
ANZSRC code: 110321, Rehabilitation and Therapy (excl. Physiotherapy), 100%

Fields of Research (FoR) Classification
FoR code: 1103, Clinical Sciences, 100%
Contents

Abstract ...................................................................................................................................... ii
Declaration by author ................................................................................................................ iv
Publications during candidature ............................................................................................... v
  Peer-reviewed papers ............................................................................................................. v
  Conference presentations ...................................................................................................... vi
  Other presentations ............................................................................................................... vii
Publications included in this thesis ........................................................................................ viii
Contributions by others to the thesis ........................................................................................ x
Statement of parts of the thesis submitted to qualify for the award of another degree .......... xi
Acknowledgements .................................................................................................................. xii
Keywords ................................................................................................................................ xiv
Australian and New Zealand Standard Research Classifications (ANZSRC) ......................... xv
List of Figures and Tables ....................................................................................................... xxi
  List of Figures ..................................................................................................................... xxi
  List of Tables ...................................................................................................................... xxii
List of Abbreviations ............................................................................................................. xxv
Chapter 1 – Introduction ............................................................................................................ 1
  1.1 Significance ...................................................................................................................... 1
  1.2 Aims ................................................................................................................................ 3
  1.3 Overview of thesis chapters ............................................................................................. 3
  1.4 References ........................................................................................................................ 6
Chapter 2 – Literature Review ................................................................................................... 9
  2.1 The older adult ................................................................................................................. 9
    2.1.1 General concepts of ageing ........................................................................................ 9
      2.1.1.1 Epidemiology ..................................................................................................... 9
      2.1.1.2 Types of ageing ................................................................................................ 10
Chapter 5: Best Practice Hearing Aid User Guide Assists Adults with Troubleshooting

5.1 Abstract ........................................................................................................................ 129
5.2 Introduction .................................................................................................................. 130
  5.2.1 Aim ........................................................................................................................ 133
5.3 Materials and methods ............................................................................................... 133
  5.3.1 Participants ............................................................................................................ 133
  5.3.2 Assessment measures ............................................................................................ 133
  5.3.3 Procedure ............................................................................................................... 140
  5.3.4 Data analysis .......................................................................................................... 141
5.4 Results .......................................................................................................................... 142
  5.4.1 Sample description ................................................................................................ 142
  5.4.2 Performance on the HAM Test .............................................................................. 146
5.5 Discussion .................................................................................................................... 152
  5.5.1 Limitations and future directions ........................................................................... 155
  5.5.2 Clinical implications .............................................................................................. 156
5.6 Conclusions .................................................................................................................. 156
5.7 References .................................................................................................................... 158

Chapter 6: Best Practice Hearing Aid User Guide Assists Adults with Troubleshooting

6.1 Abstract ....................................................................................................................... 164
6.2 Introduction .................................................................................................................. 165
  6.2.1 Aims ....................................................................................................................... 167
6.3 Materials and methods ............................................................................................... 167
  6.3.1 Participants ............................................................................................................ 167
  6.3.2 Assessment measures ............................................................................................ 168
  6.3.3 Procedure ............................................................................................................... 171
  6.3.4 Data analysis .......................................................................................................... 172
6.4 Results .......................................................................................................................... 172
  6.4.1 Hearing Aid Troubleshooting Test ........................................................................ 172
List of Figures and Tables

List of Figures

Figure 2-1............................................................................................................................. 18
Global pattern of hearing impairment by age
Figure 4-1.............................................................................................................................102
Four steps in the development of written healthcare materials
Figure 4-2............................................................................................................................ 103
Example pages taken from the SFHA instructions
Figure 5-1………………………………………………………………………………… 143
Flow of participants through the study
Figure 5-2………………………………………………………………………………….148
Percentage of participants able to perform each hearing aid task correctly, without prompts
(** significant p<0.05)
List of Tables

Table 2-1........................................................................................................................................ 15
Normal age-related changes in vision
Table 2-2........................................................................................................................................ 16
Details on the most common eye diseases in older adults
Table 2-3........................................................................................................................................ 20
Communication difficulties experienced as a function of degree of hearing impairment
Table 2-4........................................................................................................................................ 23
Clinical model of attention
Table 2-5........................................................................................................................................ 31
Summary of health literacy measurement tools
Table 2-6........................................................................................................................................ 32
Summary of commonly used indirect (self-report) health literacy measurement tools
Table 2-7........................................................................................................................................ 40
Summary of studies on the prevalence of low health literacy and associated demographic factors
Table 2-8........................................................................................................................................ 46
Summary of studies of associations between health literacy and cognition in older adults
Table 2-9........................................................................................................................................ 55
Summary of factors that have been found to be associated with hearing aid management
Table 3-1........................................................................................................................................ 76
Overview of formal assessment tools for healthcare materials
Table 3-2........................................................................................................................................ 79
Readability grade levels and Suitability Assessment of Materials Instrument (SAM) score for each user guide (ranked based on mean readability grade level score for F-K, Fry & Fog)
Table 3-3........................................................................................................................................ 82
Total number of ratings for each factor on the Suitability Assessment of Materials Instrument
Table 3-4........................................................................................................................................ 89
Major weaknesses of hearing aid user guides and suggestions for improvement
Table 4-1........................................................................................................................................ 106
Details of the self-fitting hearing aid instructions
Table 4-2........................................................................................................................................ 107
Recommendations for designing written healthcare education materials for older adults
Table 4-3..............................................................................................................................112
The self-fitting hearing aid instructions readability grade levels
Table 4-4..............................................................................................................................114
Recommendations for typography and layout of written healthcare education materials
Table 5-1..............................................................................................................................137
Procedure followed to modify the original hearing aid user guide to create a best practice user guide
Table 5-2..............................................................................................................................138
Details of the original and the modified user guides for the Oticon Acto BTE hearing aid
Table 5-3..............................................................................................................................139
The Hearing Aid Management Test score sheet
Table 5-4..............................................................................................................................144
Demographic information for participants assigned the original user guide and the modified user guide
Table 5-5..............................................................................................................................147
Factors associated with the Hearing Aid Management Test score
Table 5-6..............................................................................................................................150
Median time taken for task completion by participants able to perform tasks correctly on the Hearing Aid Management Test with their assigned user guide and no prompts
Table 5-7..............................................................................................................................151
Number of prompts required by participants who performed tasks correctly on the Hearing Aid Management Test
Table 6-1..............................................................................................................................169
Demographic information for participants (N = 89)
Table 6-2..............................................................................................................................174
Number of participants who were able to find the correct page in their user guide for each item on the Hearing Aid Troubleshooting Test
Table 6-3..............................................................................................................................175
Number of participants who were able to find the correct page and answer the question accurately for each item on the Hearing Aid Troubleshooting Test
Table 6-4..............................................................................................................................178
Main aspects participants liked and disliked about their assigned user guide
Table 6-5………………………………………………………………………………………………………..179

Responses from the User Guide Attitude Survey
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ALLS</td>
<td>Adult Literacy and Life Skills Survey</td>
</tr>
<tr>
<td>BIDS</td>
<td>Bernier Instructional Design Scale</td>
</tr>
<tr>
<td>BTE</td>
<td>Behind-the-ear</td>
</tr>
<tr>
<td>CIC</td>
<td>Completely-in-the-canal</td>
</tr>
<tr>
<td>F-K</td>
<td>Flesch-Kincaid Readability Formula</td>
</tr>
<tr>
<td>Fog</td>
<td>Fog Index</td>
</tr>
<tr>
<td>FRE</td>
<td>Flesch Reading Ease Scale</td>
</tr>
<tr>
<td>Fry</td>
<td>Fry Readability Graph</td>
</tr>
<tr>
<td>GPT</td>
<td>Grooved Pegboard Test</td>
</tr>
<tr>
<td>HA</td>
<td>Hearing aid</td>
</tr>
<tr>
<td>HAM Test</td>
<td>Hearing Aid Management Test</td>
</tr>
<tr>
<td>HATT</td>
<td>Hearing Aid Troubleshooting Test</td>
</tr>
<tr>
<td>HeLMS</td>
<td>Health Literacy Measurement Scale</td>
</tr>
<tr>
<td>HL</td>
<td>Hearing level</td>
</tr>
<tr>
<td>HLSI</td>
<td>Health Literacy Skills Instrument</td>
</tr>
<tr>
<td>HLSI-SF</td>
<td>Health Literacy Skills Instrument – short form</td>
</tr>
<tr>
<td>IRSAD</td>
<td>Index of Relative Socio-economic Advantage and Disadvantage</td>
</tr>
<tr>
<td>ITC</td>
<td>In-the-canal</td>
</tr>
<tr>
<td>ITE</td>
<td>In-the-ear</td>
</tr>
<tr>
<td>MARS-HA</td>
<td>Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids</td>
</tr>
<tr>
<td>MMSE</td>
<td>Mini-Mental State Examination</td>
</tr>
<tr>
<td>MoCA</td>
<td>Montreal Cognitive Assessment</td>
</tr>
<tr>
<td>NAAL</td>
<td>National Assessment of Adult Literacy</td>
</tr>
<tr>
<td>NAL</td>
<td>National Acoustic Laboratories’</td>
</tr>
<tr>
<td>NVS</td>
<td>Newest Vital Sign</td>
</tr>
<tr>
<td>PHAST</td>
<td>Practical Hearing Aid Skills Test</td>
</tr>
<tr>
<td>REALM</td>
<td>Rapid Estimate of Adult Literacy in Medicine</td>
</tr>
<tr>
<td>REALM-R</td>
<td>Rapid Estimate of Adult Literacy in Medicine-Revised</td>
</tr>
<tr>
<td>RGL</td>
<td>Reading grade level</td>
</tr>
<tr>
<td>S-TOFHLA</td>
<td>Short Test of Functional Health Literacy in Adults</td>
</tr>
<tr>
<td>SAM</td>
<td>Suitability Assessment of Materials</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>SES</td>
<td>Socio-economic status</td>
</tr>
<tr>
<td>SFHA</td>
<td>Self-fitting hearing aid</td>
</tr>
<tr>
<td>SILS</td>
<td>Single Item Literacy Screener</td>
</tr>
<tr>
<td>SMOG</td>
<td>Simple Measure of Gobbledygook Index</td>
</tr>
<tr>
<td>SO</td>
<td>Significant other</td>
</tr>
<tr>
<td>TOFHLA</td>
<td>Test of Functional Health Literacy in Adults</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>4FAHL</td>
<td>Four-frequency average hearing loss</td>
</tr>
</tbody>
</table>
Chapter 1 – Introduction

1.1 Significance

Numerous studies show that the prevalence of hearing impairment increases with age. Based on data from 42 studies conducted in 29 countries, Stevens et al. (2013) found that on average 10% of people aged 50 years or younger have a moderate hearing impairment or worse, compared to more than 40% of people aged 70 years and over. In Australia over one third of adults in their sixties and over half of those in their seventies live with a mild hearing impairment or worse (Chia et al., 2007; Wilson et al., 1999). Hearing aids (HAs) are currently the most common therapeutic treatment for age-related hearing impairment and approximately two-thirds of aids are fitted to people aged over 60 years (e.g., Strom, 2006). Research indicates that HAs can provide substantial benefits to older adults both in terms of quality of life and the ability to understand speech (e.g., Humes & Krull, 2012).

All HAs come with a printed user guide, which can also be downloaded from the manufacturer’s website. A typical HA user guide contains information on: 1) use of the device, 2) functions and features, 3) care and maintenance, and 4) troubleshooting. The HA user guide is an important resource, as a common reason cited for limited aid use in older adults is difficulty with HA management (e.g., Desjardins & Doherty, 2009; Hickson, Hamilton, & Orange, 1986). HA management refers to the activities one must perform to wear, adjust, and maintain the device/s and includes inserting the aid in the ear, adjusting the volume, changing the battery, cleaning the aid, and troubleshooting when problems occur (Dillon 2001).

A HA user guide is only useful if the client can find, understand, and apply the information contained in it. Hence, it is important that there is a match between the content, design, and readability of the user guide and the literacy and cognitive requirements of the reader (Doak, Doak, & Root, 1996; Friedman & Hoffman-Goetz, 2006). Many older adults have deficits in vision and cognition that may affect their ability to read and use healthcare materials and instructions (Australian Institute of Health and Welfare, 2005; Krauss Whitbourne, 2005; Watson, 2009). In addition, at least 30% have limited health literacy (Australian Bureau of Statistics, 2006; Kutner, Greenberg, Jin, & Paulsen, 2006; Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd, 2005). Health literacy refers to “the degree to
which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000, p. 3). Over the past 25 years, a large body of research has investigated the association between low health literacy and health outcomes and it has been consistently associated with poorer health related knowledge, differential use of healthcare services, poorer overall health, and higher mortality (e.g., Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; DeWalt, Berkman, Sheridan, Lohr, & Pignone, 2004).

In order to ensure healthcare material, such as HA user guides, are easy-to-read and use it is recommended that they are developed based on best practice guidelines for health literacy. The guidelines encompass content, language, layout and typography, organization, and graphics (e.g., Centers for Disease Control and Prevention, 2009; Houts, Doak, Doak, & Loscalzo, 2006; National Cancer Institute, 2003). Examples include: 1) write at 3rd to 6th grade reading level, 2) use dark text on a white background, 3) select a font size between 12 and 14 points, and 4) use simple line drawings accompanied by text captions. Research indicates that most adults prefer easy-to-read healthcare material, regardless of their literacy level, and easy-to-read healthcare material facilitates comprehension (Davis et al., 1996; Freed et al., 2013).

There is growing recognition of the importance of developing healthcare materials based on best practice guidelines for health literacy (Koh, Baur, Brach, Harris, & Rowden, 2013). Despite this, there is no research on the application of these guidelines in the field of rehabilitative audiology and there are only two published studies (Kelly, 1996; Nair & Cienkowski, 2010) that have evaluated the suitability of printed materials for older adults in audiology clinics. Both studies examined the readability of a selection of HA user guides and found that the reading grade level was too high for healthcare material. However, these studies did not consider other design elements, such as organization, layout, diagrams, writing style, and the amount of information presented. A body of research has highlighted the importance of evaluating these factors, in addition to readability, when assessing healthcare materials (e.g., Doak, Doak, Friedell, & Meade, 1998; Seligman et al., 2007).
1.2 Aims

The aims of this research were to:

1. Analyse the content, design, and readability of printed HA user guides to determine their suitability for older adults.
2. Review the literature on best practice guidelines for written healthcare materials and to apply the information to the design of written instructions for a self-fitting HA.
3. Investigate if a HA user guide modified using best practice guidelines for health literacy results in superior ability to perform HA management tasks, compared to the user guide in the original form.
4. Investigate if the type of user guide (modified versus original) is associated with the ability to find and understand HA troubleshooting information and to determine older adults’ preferences for HA user guides.

1.3 Overview of thesis chapters

This thesis takes the form of a literature review, followed by a series of published, submitted, and prepared articles. The literature review focuses on three topic areas central to the thesis: the older adult, health literacy, and HA management. In particular, it includes information on the ageing process and discusses the impact of age on vision, hearing, and cognitive functions. This information is important to consider when developing healthcare materials for older adults.

Chapter 3 describes a study that addressed the first aim of this thesis: to investigate if the content, design, and readability of printed HA user guides is suitable for older adults. A sample of 36 HA user guides, including four user guides from nine HA manufacturers, was examined. Each user guide was analysed using a standardised assessment of content and design, and four readability formulae. The study found that the design of HA user guides is not optimal for older adults and thus may serve as a barrier to successful HA outcomes for this population. This study was published in 2014 in the *International Journal of Audiology* and is included here in its entirety.

Chapter 4 includes a literature review of published peer reviewed research on best practice guidelines for written healthcare material. The findings were applied to the development of written instructions for a self-fitting HA and informed the development of the modified user
guide discussed in Chapters 5 and 6 of this thesis. The paper in Chapter 4 also provides a practical resource for HA manufacturers and hearing care professionals and includes step-by-step instructions on how to develop written instruction material for HA management. This study was published in 2012 in Trends in Amplification and is included here in its entirety.

Chapter 5 describes a study designed to investigate if a HA user guide modified using best practice guidelines for health literacy resulted in superior ability to perform HA management tasks, compared to the user guide in its original form. Eighty nine participants with a mean age of 72 years were included in the trial; none had experience with HA use or management. Participants were randomly assigned to two groups: half received the original manufacturer’s user guide and half received the modified user guide. Both were for the same HA; a behind-the-ear (BTE) aid with a dome earpiece. Participants were required to perform HA management tasks (e.g., change the battery) with the help of their assigned user guide. Task management was recorded and scored using the Hearing Aid Management (HAM) Test which was designed for this study. At the time of thesis submission this paper was under consideration for publication in Ear and Hearing.

Chapter 6 addresses aim four of this thesis. The study described in this chapter included the same participants, user guides, and HAs as described for the previous study. It investigated if older adults could find and understand troubleshooting information in a HA user guide and if the type of user guide (modified versus original) was associated with performance. In addition, it examined older adults’ preferences for user guides. Troubleshooting ability was assessed using the HA Troubleshooting Test (HATT) which was designed for this study. The test has seven items which cover a range of scenarios that require troubleshooting, such as a whistling HA. Following the test, the user guide attitude survey was administered. It was designed to: 1) elicit feedback on the quality of the user guide that the participant was assigned, including what they liked and did not like about it; and 2) to determine, if given a choice, which user guide (modified versus original) the participant would select and why. This paper has been prepared for submission to the International Journal of Audiology.

Finally, Chapter 7 presents a summary of the key findings from this research, along with clinical implications, methodological limitations, and directions for further research. The references for each chapter are located at the end of the chapter. Chapters that take the form of a published article, an article under consideration, or a prepared article, have had changes
made to formatting and referencing, where necessary, to provide consistency throughout. It should be noted that as all articles were published or submitted separately, there is some repetition particularly with regard to the background information in the introduction of each article. All studies were granted ethical clearance by the University of Queensland Behavioural and Social Sciences Ethics Review Committee (see Appendix A).
1.4 References


Chapter 2 –Literature Review
This chapter contains a review of research conducted in three topic areas central to the thesis: the older adult, health literacy, and hearing aid (HA) management.

2.1 The older adult
Given the high prevalence of hearing impairment in older adults, it is important to consider it in the context of other age-related changes. Hence, this section provides general information on the ageing process and discusses the impact of age on vision, hearing, and cognitive function. The information is highly relevant to this thesis because two-thirds of HAs are fitted to adults over 60 years of age, and thus many HA recipients experience age-related changes, such as a decline in short-term memory, which can affect their ability to manage HAs and to understand written healthcare information.

2.1.1 General concepts of ageing

2.1.1.1 Epidemiology
The older population is traditionally defined as people aged 65 years and over (Krauss Whitbourne, 2005). However, it is widely accepted that adults aged close to 65 years face different issues and challenges compared to adults aged 85 years and over, and for this reason, a categorization system is often used to differentiate among the older population. Some terminology used for the different groups are the ‘young-old’ which includes ages 65 to 74, the ‘old-old’ which includes ages 75 to 84, and the ‘oldest-old’ incorporating people aged 85 and over (Krauss Whitbourne, 2005).

Both the number and the proportion of older adults in Australia is growing as a result of sustained low fertility and increasing life expectancy. According to the Australian Bureau of Statistics (ABS), in the past 2 decades, the proportion of people aged 65 years and over has increased from 11% to 13.3%, and the proportion of people aged 85 years has doubled from .9% to 1.8% (Australian Bureau of Statistics, 2010). In the same period, the number of centenarians increased by 206% compared to a total population growth of 30.1%. There are significantly more females aged over 65 years and, with each older age group, the imbalance
between females and males increases. In 2009 there were twice as many females aged 85 years and over and more than three times as many females aged 100 years and over.

Population projections published by the ABS (Australian Bureau of Statistics, 2008) show that the ageing of Australia’s population is expected to continue. In 2007, 13% of Australia’s population were aged 65 years and over and this figure is predicted to increase to between 23% and 25% by 2056. Both in America and Australia, the highest rate of increase within the 65 and over population are those aged 85 years and over (Krauss Whitbourne, 2005). There were 344,100 people aged 85 years and over in Australia in 2007, making up 1.6% of the population. This group is predicted to increase to between 4.9% and 7.3% of the population by 2056 (Australian Bureau of Statistics, 2008).

The World Health Organization (WHO) (World Health Organization, 2011) reported that ageing of the population is a worldwide phenomenon. The United Nations estimated that, between the years 2000 and 2050, the number of people aged 60 years and over will more than triple from 600 million to 2 billion. Most of the increase is occurring in developing countries where the number of older adults will rise from 400 million in 2000 to 1.7 billion in 2050 due to increasing life expectancy. According to the WHO, “It is important to prepare health providers and societies to meet the specific needs of older populations. This includes training for health professionals on old-age care; preventing and managing age-associated chronic diseases; designing sustainable policies on long-term and palliative care; and developing age-friendly services and settings.” (World Health Organization, 2007, p. 1).

**2.1.1.2 Types of ageing**

The cascade model developed by Birren and Cunningham (1985) is frequently used to define the types of ageing and is based on a separation of primary, secondary, and tertiary ageing effects. Primary ageing, also termed normal ageing, refers to the progressive and intrinsic changes associated with chronological age that occur in all individuals albeit at different rates (Birren & Cunningham, 1985; Rowe & Kahn, 1987). An example of the effects of primary ageing on cognition includes a decline in mental speed, short-term memory, and aspects of long-term memory (Johansson, 2008; Krauss Whitbourne, 2005). Secondary ageing, also termed impaired ageing, refers to changes due to illness or pathology that do not occur in all individuals (Birren & Cunningham, 1985; Rowe & Kahn, 1987). Examples include
cardiovascular disease and dementia. Tertiary ageing refers to the increase in physical and cognitive deterioration in the years prior to death and encompasses subclinical neurobehavioral changes that may present long before the clinical manifestation of disease (Birren & Cunningham, 1985). Although it is important to consider these different forms of ageing, in a clinical setting it is often impossible to disentangle the three types of ageing proposed by the model. The likelihood of primary ageing effects occurring in isolation, as defined by an absence of subclinical or clinical illness, decreases considerably with age (Johansson, 2008).

### 2.1.1.3 Major factors that influence ageing

Research projects that have focused on ageing show substantial inter-subject variability on measures of physical and psychological functioning (Krauss Whitbourne, 2005; Rowe & Kahn, 1987). In fact, the degree of variability on cognitive test scores is larger in older adults than in any other age group (Krauss Whitbourne, 2005) and the differences can be attributed to both personal and social factors. Personal factors refer to changes within the individual, such as illness and disability, and are often linked to lifestyle, diet, and genetic predisposition; social factors refer to those extrinsic to the individual, such as available healthcare and education (Krauss Whitbourne, 2005).

Baltes (1979) identified three major social factors that impact on development across the lifespan and, hence, on ageing: normative age-graded influences, normative history-graded influences, and non-normative influences. Normative age-graded influences are experiences that one’s culture and historical period attach to certain age groups. For example, they relate to the typical age of graduation, marriage, parenthood, and retirement in a particular society. Normative history-graded influences are historical events that influence entire age cohorts such as economic depressions, wars, social movements, technological changes, and major epidemics. Their effects may differ depending on a person's age at the time of the event, but most people of a given age will have similar experiences. Non-normative influences are random, chance factors that impact on an individual and may include an accident, divorce, developing a chronic disease, or acquiring a large sum of money.

Social factors, such as those described by Baltes (1979), are also linked to differences in scores on cognitive tests between older and younger adults. For example, people currently aged 80 years and over experienced very different normative history-graded influences
compared to today’s youth. They grew up in a depression, lived through a World War, and many only received a primary school education; healthcare was inferior and access to information was considerably more limited. Hence, a comparison of older and younger adults living today is not just a comparison of age differences, but also of social change, education levels, provision of healthcare, technological change, and amount of disposable income. When these “cohort effects” are even partially controlled in cross sectional studies, age differences are significantly less (Stuart-Hamilton, 2006). Longitudinal studies overcome cohort effects because age differences in scores cannot be due to differences in upbringing or background; the participants act as their own control. These studies have traditionally found significantly smaller age differences and a later onset of decline in cognitive tests results (Stuart-Hamilton, 2006).

2.1.1.4 Disability and health conditions in older adults

The impact of single and multiple chronic health conditions, as well as potential synergistic effects of these conditions, are best evaluated through measures of disability (Guralnik & Ferrucci, 2009). The ABS defines disability as “a limitation, restriction or impairment which has lasted, or is likely to last, for at least six months and restricts everyday activities” (Australian Bureau of Statistics, 2003, p. 1). The Australian Institute of Health and Welfare published a comprehensive document on disability and health conditions in older Australians in 2007 and this is the primary source of information outlined in the following section (Australian Institute of Health and Welfare, 2007).

In 2003, 56% of Australians aged 65 years and over had at least one form of disability and 90% of those with a disability had a core activity limitation, which is defined as needing assistance or having difficulties with self-care, mobility, and/or communication. There are four levels of core activity limitation ranging from mild to profound; a severe or profound classification indicates that assistance is sometimes or always needed, respectively. Almost one quarter of all people aged over 65 years have a severe or profound core activity limitation, with the figure increasing to 58% for those aged 85 years and over (Australian Bureau of Statistics, 2003; Australian Institute of Health and Welfare, 2007). The conditions most commonly associated with severe or profound limitation for older Australians in 2003 were arthritis, hearing impairment, hypertension, heart disease, and stroke. In the same year, arthritis, heart disease, hearing impairment, and visual impairment were the conditions reported to be most responsible for activity limitations in general for older Americans.
Co-morbidity, defined as the co-occurrence of multiple chronic conditions (Guralnik & Ferrucci, 2009), also tends to be associated with more severe disability. People aged 65 years and over in Australia have, on average, approximately three health conditions.

The ‘burden of disease’ refers to “the amount of ill health, disability, and premature death caused by individual diseases or health conditions” (Australian Institute of Health and Welfare, 2007, p. 63). It is measured by ‘disability-adjusted life years’ which are the years of healthy life lost to premature death, illness, or injury due to a disability (Begg et al., 2007). Adults aged 65-74 years made up 7% of the Australian population in 2003 and experienced 16% of the total burden of disease and injury; those aged 75 years and over made up 6% of the total population and accounted for 25% of the total burden (Begg et al., 2007). Cancer and cardiovascular disease accounted for over half of the total ‘burden of disease’ in both age groups. Ischaemic heart disease, stroke, and dementia were the leading causes of burden for both males and females aged 75 years and over. The leading causes of burden for those aged 65 – 74 years were ischaemic heart disease, type 2 diabetes, and lung cancer for males; and ischaemic heart disease, type 2 diabetes, and breast cancer for females (Krauss Whitbourne, 2005).

### 2.1.2 Impact of ageing on vision and hearing

#### 2.1.2.1 Vision

A visual impairment may impact on the ability to successfully manage HAs because hearing devices and the controls on them (e.g., volume control) are small. A person with poor vision may also have difficulty reading the text and interpreting relevant diagrams in the accompanying HA user guide. These difficulties may be as a result of pathological and/or age-related changes in vision. Age-related changes in vision are linked to the normal ageing process and includes myopia (difficulty focusing on close targets). All older adults experience age-related changes in vision and these are outlined in Table 2-1. Pathological changes in vision encompasses eye diseases, such as glaucoma. Although eye diseases can be experienced by individuals of all ages, they are more common in the older population. The major eye diseases that cause visual impairment in older adults are outlined in Table 2-2. Both age-related and pathological visual impairments are discussed in this section.
**Age-related visual impairments**

The most common age-related change in vision is myopia and is experienced by almost all adults from approximately 45 years of age. This can usually be corrected through glasses well into the ninth decade of life (Watson, 2009). In a longitudinal study of 70 Swedish adults, followed from the ages of 70 to 97 years, Bergman and Sjostrand (2002) found that 92% of those aged in their eighties were able to read newspaper print with ‘best corrected’ glasses. However, research suggests that many older adults are not wearing optimally fitted lenses. For example, the Australian Institute of Health and Welfare (2005) reported that approximately 5% of Australians aged 55 years and over have vision problems due primarily to refractive errors in their lenses.

Unlike myopia, the remaining age-related changes in vision cannot be detected on a routine eye examination. They include: loss of colour discrimination, decline in low-contrast acuity, and increased sensitivity to glare (Watson, 2009). Although subtle, research shows that these changes impact on reading ability. According to Watson (2009) the reading speed of older adults is reduced by approximately one third and text navigation skills are significantly worse than those of younger adults due to a combination of age-related changes in vision.

**Pathological visual impairments**

In 2005 the Australian Institute of Health and Welfare (2005) published data on the prevalence of visual problems among Australians aged 55 years and over. They pooled data from three large population based clinical studies that included eye examinations and self-report data on vision: The Melbourne Visual Impairment Project, The Blue Mountains Eye Study, and The Australian Diabetes, Obesity, and Lifestyle study. The findings showed that approximately 4% of Australians aged 55 years and over have a visual impairment or blindness caused by eye disease. The major eye diseases found to cause visual impairment in older adults were cataracts, macular degeneration, glaucoma, and diabetic retinopathy. Cataracts were the primary cause of visual impairment and accounted for 40% of eye diseases in this age group. The prevalence of each eye condition increased with age. For example, it was estimated that 75% of adults aged 80 years and over have a cataract, compared to 18% of adults aged between 60 and 69 years. Similarly, estimates from the data indicate that 12% of adults aged 80 and over have macular degeneration, compared to 1% aged between 60 and 69 years.
Table 2-1. Normal age-related changes in vision

<table>
<thead>
<tr>
<th>Change</th>
<th>Definition</th>
<th>Implications for daily life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decline in visual acuity (Myopia).</td>
<td>Decline in ability to resolve fine spatial detail.</td>
<td>Inability to focus on close targets. Can be corrected by reading glasses in almost all adults up until age ≥ 90 years.</td>
</tr>
<tr>
<td>Decline in low-contrast acuity.</td>
<td>Functional loss of acuity under glare or low lighting.</td>
<td>Reduced reading rate. Inability to see some low lying objects when moving around. Difficulty seeing traffic lights, cars, and other objects when driving in low light.</td>
</tr>
<tr>
<td>Increased sensitivity to glare.</td>
<td></td>
<td>Discomfort even in low glare conditions such as a cloudy day. Decreased acuity and difficulty seeing objects in environment in high glare conditions. Extended time to recover from glare exposure.</td>
</tr>
<tr>
<td>Loss of colour discrimination.</td>
<td>Decline in ability to detect differences in colour.</td>
<td>Difficulty detecting differences in colour, particularly dark colours (e.g., brown versus black), and pastel colours.</td>
</tr>
<tr>
<td>Decline in attentional visual field.</td>
<td>Decline in the visual field over which one can process rapidly presented visual information.</td>
<td>Poorer driving performance. Difficulty with some general activities of daily living, such as reading food cans.</td>
</tr>
<tr>
<td>Increased difficulty with reading.</td>
<td>Reduced reading rate and text navigation skills.</td>
<td>Increased difficulty reading.</td>
</tr>
</tbody>
</table>

Table 2-2. Details on the most common eye diseases in older adults

<table>
<thead>
<tr>
<th>Name</th>
<th>Detail</th>
<th>Symptoms and implications for daily life</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cataract</td>
<td>Clouding of the eye’s lens. As a result images cannot be correctly focused on the retina which sits at the back of the eye.</td>
<td>Blurred or distorted vision. Difficulty seeing under condition of either low light or bright light. Reduced contrast perception. Sensitivity to glare. Colours appear faded or yelowed. Increased difficulty reading, watching TV, and recognising faces.</td>
<td>Surgery- cloudy lens is removed and replaced with a clear, intra-ocular lens.</td>
</tr>
<tr>
<td>Age-related macular degeneration</td>
<td>Progressive condition that affects the macula which is the central part of the retina. The macula provides fine vision for tasks such as reading and recognising faces. If the disease progresses, irreversible loss of central vision occurs, usually in both eyes.</td>
<td>Blurred or distorted vision. Reduced contrast perception. Loss of colour perception. Increased difficulty reading, watching TV, and recognising faces. Mobility difficulties related to loss of depth and contrast cues. Later stage Blindness (no central vision).</td>
<td>No cure but treatment, such as laser therapies, may delay progress of the disease.</td>
</tr>
</tbody>
</table>
Table 2-2 Details on the most common eye diseases in older adults (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>Detail</th>
<th>Symptoms and implications for daily life</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glaucoma</td>
<td>Damage to the optic nerve. Typically associated with increased intra-ocular pressure resulting from malformation of the eye’s drainage system.</td>
<td>Slight loss of peripheral vision in early stage. Later stage Blurred or distorted vision. Sensitivity to light and/or ‘haloes’ may appear around lights. Tunnel vision – only objects straight ahead can be seen. Increased difficulty reading. Mobility difficulties related to restricted visual field.</td>
<td>Laser treatment or surgery but any vision loss cannot be restored.</td>
</tr>
</tbody>
</table>

2.1.2.2 Hearing

Numerous studies show that the prevalence of hearing impairment increases significantly with age. Stevens et al. (2013) used data from 42 studies carried out in 29 countries to estimate the global prevalence of hearing impairment and found that it was positively related to age; higher in males than females; and highest in developing regions of the world, as compared to developed regions. Figure 2-1 shows the global prevalence of a moderate hearing impairment or worse, by age. On average, less than 10% of people aged 50 years and younger have a hearing impairment of this degree, compared to more than 40% of people aged 70 years and older. Lee, Matthews, Dubno, and Mills (2005) conducted a longitudinal study of hearing threshold levels in older adults, involving 88 participants who were aged from 60 to 81 years at the beginning of the study. They reported, that overall, hearing threshold levels decreased on average 1dB per year.


Note. Hearing level is the average of 0.5, 1, 2, and 4kHz in the better ear.]
The term used for hearing impairment related to the ageing process is Presbycusis. Presbycusis is the most common cause of hearing impairment in adults and is characterised by a sloping, bilateral, high frequency, sensorineural loss (Kramer, 2014). It is caused by a loss of outer hair cell function and later inner hair cell function in the cochlear, and can also involve the central auditory pathways including the auditory nerve, brainstem, and cortex. It typically starts around the sixth decade of life and usually gets progressively worse over time (Kramer, 2014; Stach, 2010). The hearing impairment results in decreased understanding of speech, particularly in noisy situations (Kramer, 2014; Stach, 2010), and effects the ability to detect, identify, and localise sounds (Arlinger, 2003). Table 2-3 provides information on the typical communication difficulties experienced, based on the degree of hearing impairment.

Hearing impairment in older adults is not due solely to the ageing process. Other factors that can contribute to a hearing impairment in this population include noise exposure, genetic predisposition, vascular disease, environmental toxins, and ototoxic drugs (Kramer, 2014; Stach, 2010). According to Stach (2010, p. 173), it is likely that in older adults “a portion of hearing loss is attributable to the aging process, and a portion is attributable to the exposure of the ears to the world for the number of years it took to become old”.
Table 2-3. Communication difficulties experienced as a function of degree of hearing impairment

<table>
<thead>
<tr>
<th>Degree of loss</th>
<th>Hearing impairment in better ear (dBHL)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Typical communication difficulties (unaided)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hearing in a quiet environment</td>
<td>Hearing in a noisy environment</td>
</tr>
<tr>
<td>Mild</td>
<td>20 to 34</td>
<td>Difficulty following and/or taking part in a conversation.</td>
</tr>
<tr>
<td>Moderate</td>
<td>35 to 49</td>
<td>Difficulty hearing and/or taking part in a conversation.</td>
</tr>
<tr>
<td>Moderately severe</td>
<td>50 to 64</td>
<td>Can hear loud speech only.</td>
</tr>
<tr>
<td>Severe</td>
<td>65 to 79</td>
<td>Extreme difficulty and/or unable to hear or take part in a conversation.</td>
</tr>
<tr>
<td>Profound</td>
<td>&gt;80</td>
<td>Great difficulty hearing any speech.</td>
</tr>
</tbody>
</table>

<sup>a</sup>Hearing impairment is the average of 0.5, 1, 2, & 4kHz in the better ear.

2.1.3 Impact of ageing on cognitive functions

The impacts of ageing on processing speed, attention, and memory are outlined in this section. These cognitive processes are described as separate functions, however, in cognitive activity they rely on, and interact with, each other. For example, in order to solve a problem, both adequate attention and sound working memory are required (Krauss Whitbourne, 2005).

2.1.3.1 Processing speed

The concept of processing speed has been central to research on the impact of ageing on cognition for many decades (Hartley, 1992). Processing speed is investigated using measures of reaction time (Hartley, 2006; Krauss Whitbourne, 2005). Reaction time is defined as the “time calculated for an individual to study a stimulus array and then respond when that stimulus array takes a certain form” (Krauss Whitbourne, 2005, p. 205). It is well established that reaction time increases with age (Hartley, 2006; Krauss Whitbourne, 2005; Stuart-Hamilton, 2003). This forms the basis for the general slowing hypothesis which states that an increase in reaction time reflects a reduction in information processing speed in older adults (Salthouse, 1996).

The causes of the decline in processing speed in older adults have not been established. It was initially thought that there may be a single underlying cause for age-related slowing but this has been dispelled (Hartley, 2006). Researchers are now attempting to determine if there are a few select causes or multiple causes. For example, Cerella (1990) concluded that there were a few select causes all related to degeneration in the central nervous system. Meanwhile, others have proposed numerous causes, including and not limited to changes in the central and/or peripheral nervous system, changes in arousal levels, adoption of different strategies, smaller capacity of working memory, increased cautiousness, and lack of practice (Hartley, 2006).

It was initially believed that reduced processing speed was the principal cause of age-related changes in overall cognitive functioning (Hartley, 2006; Stuart-Hamilton, 2003). However, there has been a paradigm shift in the research and it is now believed that processing speed is only one of a number of important factors that contribute to cognitive decline (Hartley, 2006; Stuart-Hamilton, 2003). According to Hartley (2006, p. 200), “speed of processing lost primacy of place as a cause of age-related decline when it became clear that other, non-cognitive variables, such as sensory acuity, could also account for a large portion of the age-
related variance in cognitive performance”. In summary, although speed of processing accounts for a substantial portion of age-related variance in cognition, it is not the only factor contributing to decline on cognitive tasks.

2.1.3.2 Attention
Attention refers to the “ability to focus or concentrate on a portion of experience while ignoring other features of experience, to be able to shift that focus as demanded by the situation, and to be able to coordinate information from multiple sources” (Krauss Whitbourne, 2005, p. 204). Attention is necessary for information to be processed and stored; hence, it directly impacts on other cognitive tasks including working memory and processing speed (Fleming & Ownsworth, 2006; Krauss Whitbourne, 2005; Sohlberg & Mateer, 2001).

A number of different taxonomies of attention have been developed. A particularly useful clinical model is summarized in Table 2-4 and consists of five different components of attention: focused attention, sustained attention, selective attention, alternating attention, and divided attention (Sohlberg & Mateer, 2001). Research findings show that there is a reduction in the efficiency of these attention processes in older adults (Krauss Whitbourne, 2005; Stuart-Hamilton, 2003). Three of the attention processes are particularly important for successful HA fitting, management, and use: sustained attention, selective attention, and divided attention. For example: sustained attention is likely to be important when learning the tasks involved in HA management, such as changing the battery and inserting the aid in the ear.

2.1.3.3 Memory
The term memory refers to the encoding, storage, and retrieval of information and experiences. Memory problems are likely to impact on HA management and use. An older adult who cannot remember the basic tasks involved in HA management and care, such as how to insert the device and/or clean it, is unlikely to be a successful HA user without assistance from others.
Table 2-4. Clinical model of attention

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Example</th>
<th>Age effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focused Attention</td>
<td>Ability to attend to and respond to a stimulus.</td>
<td>Head turn to an auditory stimulus.</td>
<td>No (except following brain injury)</td>
</tr>
<tr>
<td>Sustained Attention</td>
<td>Ability to maintain attention over time during a continuous or repetitive activity.</td>
<td>Reading a newspaper article.</td>
<td>Yes</td>
</tr>
<tr>
<td>Selective Attention</td>
<td>Ability to maintain a consistent response while ignoring distracting or competing stimuli in the external environment (e.g., noise) or internal environment (e.g., thoughts).</td>
<td>Listening to a person talking in a noisy environment.</td>
<td>Yes</td>
</tr>
<tr>
<td>Alternating Attention</td>
<td>Ability to shift focus of attention and to move between tasks with different cognitive requirements.</td>
<td>Listening to a speaker and taking notes.</td>
<td>Yes</td>
</tr>
<tr>
<td>Divided Attention</td>
<td>Ability to respond simultaneously to multiple tasks or task demands.</td>
<td>Driving and carrying out a conversation with a passenger.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Memory functions can be classified in many different ways, including the duration of storage (e.g., short-term or long-term), the sensory systems involved (e.g., visual or auditory), or the content stored (e.g., knowledge-based or skills-based) (Hoyer & Verhaeghen, 2006; Krauss Whitbourne, 2005; McKenna & Tooth, 2006; Stuart-Hamilton, 2003). Researchers agree that many memory functions are negatively affected by the ageing process. However, not all aspects of memory are affected to the same degree and there are significant differences between individuals (Krauss Whitbourne, 2005; Park et al., 2002; Stuart-Hamilton, 2003). For example, Park et al. (2002) carried out a comprehensive cross sectional study that included composite measures of many aspects of memory across the adult life span. They found that the majority of memory functions significantly decline with increasing age, although some are spared, such as declarative semantic memory (memory based on knowledge of facts and one’s native language).

The exact causes of poorer memory in older adults is not known, however it has been hypothesized that these may include general neurological changes, physiological changes, and the impact of sensory changes. In addition, the same factors hypothesised as resulting in attention deficits have been linked to memory problems, including a reduction in processing speed (speed deficit hypothesis) and a reduction in the ability to inhibit or ignore irrelevant information (inhibitory deficit hypothesis) (Krauss Whitbourne, 2005). The following two sections provide an outline of the main types of memory function and how they are affected in older adults.

**Short-term memory and working memory**

Short-term memory and working memory are two distinguishable, albeit highly related constructs. Short-term memory refers to the capacity to hold a small amount of information in an active state for a short period of time (e.g., listening to and then recalling a list of numbers). Working memory is a more complex construct and refers to the system that keeps information temporarily available and active while it is being used in other cognitive tasks (Engle, Tuholski, Laughlin, & Conway, 1999). For example, working memory is necessary to understand a written document, such as a brochure on the features of different types of hearing aids, or to follow a plan of action, such as when and how to take medications for diabetes. Both short-term memory and working memory decline over the adult life span and the decline is disproportionately greater as the cognitive workload of the task increases. This
is termed the “age times complexity” phenomenon and has been attributed to the fact that older adults have more limited processing space for cognitive functions (Stuart-Hamilton, 2003). Kemper (1987) found a relationship between memory loss in older adults and a decline in the ability to process syntax and semantically complex structures in speech and writing. She attributed this to the fact that older adults have more difficulty holding complex sentences in working memory whilst reading the next section of prose or composing a statement. This impairment is likely to impact on the ability to use and understand written healthcare instructions, particularly if they are difficult to read (e.g., written at a high reading grade level).

**Long-term memory**

The two broad types of long term memory, commonly referred to in the literature, are declarative memory and non-declarative memory. Declarative memory refers to memories that can be consciously recalled, such as events, cultural history, semantic information, and other facts. The two subcategories of declarative memory are episodic and semantic memory. Episodic memory refers to events that an individual has experienced at a specific time and place such as the purchase of a HA at a particular audiology clinic, in a particular year. Semantic memory refers to general knowledge and facts, including one’s native language. Non-declarative memory is often termed procedural memory and refers to acquired learning, not directly available to our conscious memory. It includes skills such as managing a HA, cooking, or sewing on a button (Woods & Clare, 2008).

Research shows that declarative episodic memory is significantly affected by the ageing process, whereas declarative semantic memory (with the exception of word retrieval skills) and non-declarative memory are largely unaffected (Hoyer & Verhaeghen, 2006; Krauss Whitbourne, 2005; Woods & Clare, 2008). For example, although older adults are slower at acquiring new skills, knowledge on how to perform previously acquired skills, such as playing an instrument, is spared from the effects of ageing (Krauss Whitbourne, 2005). In a study on non-declarative memory in healthy adults aged 18 to 95 years of age, it was found that motor learning was slower in participants aged over 62 years, however memory for motor performance was well retained for individuals in all age groups over a 2 year period without further training (Smith et al., 2005).
2.1.4 Summary

The number and proportion of older adults is growing as a result of low fertility and higher life expectancy, and this trend is predicted to continue into the future. The United Nations estimates that worldwide, between the years 2000 and 2050, the number of people aged 60 years and over will more than triple. According to the WHO, it is increasingly important that healthcare providers tailor their services to meet the specific needs of the older population. As such, this chapter described the effects of the ageing process on vision, hearing, and cognition.

There are two types of visual impairments that affect older adults: age-related and pathological. Age-related visual impairments are linked to the normal ageing process and are experienced by all older adults. Examples of these include myopia (difficulty focusing on close targets), loss of colour discrimination, and increased sensitivity to glare. Pathological visual impairments are typically due to eye diseases, such as glaucoma, and are found in approximately 5% of older adults.

The prevalence of hearing impairment increases significantly with age. It is estimated that, worldwide, less than 10% of people aged 50 years and younger have a moderate hearing impairment or worse, compared to over 40% of people aged 70 years and older. Hearing impairment related to the ageing process results in decreased understanding of speech, particularly in noisy situations, and also affects the ability to detect and identify sounds and hence communicate.

The term cognition encompasses processing speed, attention, and memory. Processing speed is investigated using measures of reaction time, and increases with age, particularly for more complex tasks. It is believed that this accounts for a substantial portion of age-related variance in cognition. Attention is the ability to focus on something whilst ignoring competing signals in the environment, and the ability to shift focus as needed. Both skills are negatively affected by the ageing process. Memory refers to the process of encoding, storing, and retrieving information and experiences. Although many aspects of memory are affected by the ageing process, not all are impacted to the same degree, and there are significant individual differences. For example, source memory, which is the recall of where something was seen or heard, is significantly affected by age, whilst non declarative memory, which
refers to unconscious memory such as the ability to sew on a button or cook a meal, is largely spared. This clearly highlights the fact that some cognitive processes decline significantly in older adults whilst others are left untouched.

2.2 Health literacy

Health literacy was a term introduced in a 1974 monograph (Simonds, 1974) that described how health information impacts the healthcare system, education system, and mass communication. The term has evolved to encompass the wide array of skills and abilities people require to meet the demands of the healthcare system (Sorensen et al., 2012). As such, it is a broad and complex concept that has been defined in a number of ways (Baker, 2006). The Institute of Medicine defines health literacy as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000, p. 3). The American Medical Association defines it as “a constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the healthcare environment” (Adhoc Committee on Health Literacy, 1999, p.553). Modern healthcare environments are becoming increasingly complex and, at the same time, people are being asked to take more responsibility for their own healthcare. Against this backdrop, health literacy has become a key priority in public health in the USA and is now considered an integral factor in healthcare delivery and health outcomes (Institute of Medicine, 2004; US Department of Health and Human Services, 2010).

The terms health literacy and literacy are often used interchangeably but have important distinctions. Literacy refers to the general ability to read, write, and compute, whilst health literacy refers to the application of these skills in the context of healthcare (Weiss, 2005). Some individuals with acceptable literacy levels may have difficulty understanding the concepts and language used in specific healthcare situations (Mayer & Villaire, 2007). Individuals who have the skills and knowledge to function successfully in the healthcare system are said to have functional health literacy (Bernhardt, Brownfield, & Parker, 2005). Functional health literacy is associated with a range of individual attributes such as cultural and conceptual knowledge, listening, speaking, numeracy, writing, and computer skills (Nielsen-Bohlman, Panzer, & Kindig, 2004). It also hinges on motivation and the presence or absence of physical or mental impairments, such as a visual impairment.
It is increasingly recognised that if health literacy is the ability to function in the healthcare system, it is dependent on both the individual and the health literacy environment (Baker, 2006). The health literacy environment includes the infrastructure, materials, policies, and processes that exist within the health system that make it easier or more difficult for people to find, understand, and use health information to manage their health. For example, the design and layout of a hospital, the use of shared-decision making processes, or the quality of written healthcare instruction materials (Australian Commission on Safety and Quality in Health Care, 2013). Within the health literacy environment, health information can be delivered through a number of communication channels including print, interpersonal, audio/video, and/or interactive multimedia (Bernhardt et al., 2005). The focus of this thesis is on printed healthcare materials.

2.2.1 Measurement of health literacy

There are two measurement approaches for assessing health literacy: direct testing of individual abilities and self-report measures. Direct testing involves the use of formal standardised tools and a self-report measure typically consists of a single screening question. For example, “How confident are you filling out forms by yourself?” (Chew, Bradley, & Boyko, 2004). In the past, education level was also used as an indicator of health literacy. This is no longer considered sufficient because adults often read several grades lower than their highest grade level achieved at school (Davis, Gazmararian, & Williams, 2005).

There are five commonly used direct tests available to measure health literacy and the details of these are summarised in Table 2-5. The tests vary in the number of domains, number of items, administration time, scoring system, and measurement properties. The Rapid Estimate of Adult Literacy in Medicine (REALM) (Davis et al., 1991), the Test of Functional Health Literacy in Adults (TOFHLA) (Parker, Baker, Williams, & Nurss, 1995), and the Newest Vital Sign (NVS) (Weiss et al., 2005) focus primarily on reading, comprehension, and numeracy skills. In contrast, the Health Literacy Skills Instrument (HLSI) (McCormack et al., 2010) and the Health Literacy Measurement Scale (HeLMS) (Jordan et al., 2013) are multi-dimensional and measure a number of facets of health literacy including verbal communication; internet-based information seeking skills; and the capacity to retain, process, and apply health information.
The health literacy tools reported by Jordan, Osborne, and Buchbinder (2011) to have the strongest psychometric properties are the REALM, TOFHLA, and S-TOFHLA. A number of researchers argue that they do not provide a true measure of health literacy because they only measure selective domains of health literacy (e.g., Al Sayah, Williams, & Johnson, 2012). They assess reading skills but do not assess other skills such as verbal communication and health-related decision making. Despite this, they are typically used as a gold standard in both health literacy research and validation studies of other health literacy tools.

The TOFHLA has been used in numerous studies in both medical and community settings (e.g., Barber et al., 2009; Gazmararian et al., 1999). It consists of a reading comprehension section and a numeracy section, both containing actual materials that an adult might encounter in a healthcare setting, such as instructions for a gastro-intestinal procedure. The reading comprehension section contains three passages of text. It uses a modified cloze procedure, where every fifth to seventh word is missing, and the respondent is required to select the correct word from four options provided. The numeracy section assesses the ability to use numerical skills necessary to understand appointment slips, understand blood glucose results, and interpret instructions on a medication label. The sum of the two sections yields the TOFHLA score which can range from 0 to 100. The raw score is converted to one of three categories: inadequate, marginal, or adequate health literacy. The TOFHLA has excellent validity and reliability and is also highly correlated with reading tests, such as the Wide Range Achievement Test – Revised (Jastak & Wilkinson, 1984). The S-TOFHLA is a short version of the TOFHLA and takes less than 10 minutes to administer. The reading comprehension section uses the first two passages from the TOFHLA and the numeracy section is a shortened form of that used in the TOFHLA. It has comparable validity and reliability to the long version.

The REALM has been used in many studies investigating health literacy (e.g., Barber et al., 2009; Eckman et al., 2012) and consists of a list of words selected from written healthcare materials commonly given to patients. The respondent is required to read the words aloud and a point is allocated for each word that is correctly pronounced. The raw score is converted to one of four reading grade levels (RGL): third grade or lower, fourth to sixth grade, seventh to eighth grade, and ninth grade and above. A cited limitation of the test is that it does not discriminate above ninth grade level (Davis et al., 2005). It has similar validity and reliability to the TOFHLA.
Two large research studies have found that the S-TOFHLA and the REALM provide different estimates of low health literacy (Griffin et al., 2010; Haun, Luther, Dodd, & Donaldson, 2012). Griffin et al. (2010) compared estimates of low health literacy using the S-TOFHLA and the REALM on a sample of 4,868 veterans. After adjusting for non-response bias nearly two times as many veterans were categorized with inadequate skills using the S-TOFHLA and three times as many were categorized with marginal health literacy (7th to 8th grade) using the REALM. Haun et al. (2012) examined variation across three health literacy measures: S-TOFHLA, REALM, and an indirect measure (the BRIEF – see Table 2-6). They found that the agreement between the instruments for categorising health literacy was only 37%. According to the authors “the three instruments concurred most often when categorizing respondents with adequate health literacy and were most susceptible to variation among those in the marginal and inadequate categories” (p. 154). Both Griffin et al. (2010) and Haun et al. (2012) reasoned that the differences could be accounted for in-part, by the fact the tests measure slightly different aspects of health literacy and are therefore not comparable. The S-TOFHLA measures reading fluency whilst the REALM measures vocabulary knowledge. The broad implication is that when selecting any health literacy test it is important to consider the purpose for which it is being used and the type of information that is being sought.

Four commonly used indirect self-report measures of health literacy are outlined in Table 2-6. Tools that directly measure health literacy may not always be suitable in a clinical setting because they can cause embarrassment for those with low health literacy (Baker, 2006; Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Haun et al., 2012; Wolf, Davis, & Parker, 2007). In addition, they require good visual acuity, adequate attention skills, and the availability of time to complete (Al Sayah et al., 2012; Chew et al., 2008). Based on the findings of a systematic review of instruments used to test health literacy, Al Sayah et al. (2012) recommended the use of indirect or self-report health literacy measures because they take less time to administer and are less likely to impose discomfort. In a systematic review investigating the accuracy of brief self-report instruments, Powers, Trinh, and Bosworth (2010) found that single item questions were moderately effective at identifying adults with limited health literacy. An example of such a question is “How confident are you in filling out medical forms by yourself?”
<table>
<thead>
<tr>
<th>Measure</th>
<th>REALM (Davis et al., 1991)</th>
<th>TOFHLA (Parker et al., 1995)</th>
<th>NVS (Weiss et al., 2005)</th>
<th>HLSI (McCormack et al., 2010)</th>
<th>HeLMS (Jordan et al., 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of measure</td>
<td>Word recognition and pronunciation</td>
<td>Reading comprehension and numeracy</td>
<td>Reading comprehension and numeracy</td>
<td>Reading comprehension, numeracy, verbal communication, and Internet-based information seeking skills</td>
<td>Reading comprehension; information seeking skills; verbal communication; capacity to retain, process and apply information.</td>
</tr>
<tr>
<td>Number of items</td>
<td>66 words</td>
<td>50 item reading comprehension section</td>
<td>6 questions about an ice cream nutrition label</td>
<td>25 items</td>
<td>29 items</td>
</tr>
<tr>
<td>Administration Time</td>
<td>3-5 minutes</td>
<td>22 minutes</td>
<td>3 minutes</td>
<td>10 minutes</td>
<td>Not stated</td>
</tr>
<tr>
<td>Scoring</td>
<td>Score range: 0-66</td>
<td>Score range: 0-100</td>
<td>Score range: 0-6</td>
<td>Score range: 0-100</td>
<td>Likert scale 1 to 5 for each item (1 = can do without any difficulty; 5 = unable to do)</td>
</tr>
<tr>
<td>Raw score can be converted to four grade range categories: ≤3rd, 4th to 6th, 7th to 8th, ≥9th</td>
<td>&lt;60 = inadequate</td>
<td>&lt;4 = limited health literacy</td>
<td>&gt;82 = proficient literacy</td>
<td>70-81 = basic literacy</td>
<td>Mean score &lt;4 = may require assistance</td>
</tr>
<tr>
<td>&gt;75 = adequate</td>
<td></td>
<td></td>
<td></td>
<td>&lt;70 = below basic literacy</td>
<td></td>
</tr>
</tbody>
</table>

*Note. REALM = Rapid Estimate of Adult Literacy in Medicine; TOFHLA = Test of Functional Health Literacy in Adults; NVS = The Newest Vital Sign; HLSI = Health Literacy Skills Instrument; HeLMS = The Health Literacy Management Scale; REALM-R = Rapid Estimate of Adult Literacy in Medicine, revised; S-TOFHLA = Test of Functional Health Literacy in Adults, short form; HLSI-SF = Health Literacy Skills Instrument Short Form*
Table 2-6. Summary of commonly used indirect (self-report) health literacy measurement tools

<table>
<thead>
<tr>
<th>Name</th>
<th>Single Item Literacy Screener (SILS)</th>
<th>Health Literacy Screening Question</th>
<th>Health Literacy Screener</th>
<th>BRIEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of items</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Description</td>
<td>A single question to identify limited reading ability. “How often do you need someone to help you when you read instructions, pamphlets, or other written material from your doctor or pharmacy?”</td>
<td>A single question to identify adults with inadequate health literacy. “How confident are you filling out medical forms by yourself?”</td>
<td>3 questions to identify adults with low health literacy. 1. Self-rated reading ability 2. SILS question 3. Highest education level attained</td>
<td>4 questions used to identify adults with low health literacy. For example: “How often do you have someone help you read hospital materials?”</td>
</tr>
<tr>
<td>Scoring</td>
<td>Responses are 1-Never, 2-Rarely, 3-Sometimes, 4-Often, and 5-Always. A score ≥2 is an indication of reading problems.</td>
<td>Responses are 0-Extremely, 1-Quite a bit, 2-Somewhat, 3-A little bit, 4-Not at all. A score of 2 provides an indication of difficulty with printed healthcare material.</td>
<td>Educational attainment of ‘high school or less’, a self-rated reading ability of ‘okay’ or worse, and asking for help with reading materials at least ‘sometimes’ is associated with low health literacy.</td>
<td>Responses are measured using a 5-point Likert scale. Score based on the sum of the answers. It can range from 4 to 20. 4-12 = inadequate literacy 13-16 = marginal literacy 17-20 = adequate literacy</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>54%</td>
<td>80%</td>
<td>49% to 100% (depending on probability cut-off value)</td>
<td>Not reported – (reported: 0.77 Cronbach’s alpha)</td>
</tr>
<tr>
<td>Specificity</td>
<td>83%</td>
<td>77%</td>
<td>50% to 98% (depending on probability cut-off value)</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

Note: S-TOFHLA = Test of Functional Health Literacy in Adults, short form; REALM = Rapid Estimate of Adult Literacy in Medicine
2.2.2 Health literacy and health outcomes

Over the past 25 years, a large body of research has investigated the association between health literacy and health outcomes. This section outlines the findings of systematic reviews conducted on this topic and illustrates key points using relevant studies. There have been six systematic reviews on the topic of health literacy and outcomes (Berkman et al., 2011; Boylston Herndon, Chaney, & Carden, 2011; DeWalt, Berkman, Sheridan, Lohr, & Pignone, 2004; Easton, Entwistle, & Williams, 2010; Eichler, Wieser, & Brugger, 2009; Sanders, Federico, Klass, Abrams, & Dreyer, 2009). Two reviews will not be discussed as they are outside the scope of this thesis; both focused on a narrow patient population, specifically children (Sanders et al., 2009) and working-age adults (Easton et al., 2010).

The first systematic review was conducted by DeWalt et al. (2004) with the stated aim of analysing the association between literacy and health outcomes. Despite using the term ‘literacy’, two of the three main tests used in the studies included in their review were health literacy tests (REALM and TOFHLA). They looked at research published between 1980 and 2003 and found 44 relevant studies, the majority of which were deemed to be of fair to good quality. Many had methodological short-comings, in particular failure to control for potential confounding variables, such as ethnicity.

The review found that low literacy was associated with poorer health related knowledge, higher morbidity, higher rates of hospitalization, and poorer health status. In addition, adults with low literacy were 1.5 to 3 times more likely to experience a poor health outcome compared to those with adequate health literacy. They included a study conducted by Williams, Baker, and Parker (1998) which examined the relationship between functional health literacy and patients’ knowledge about their chronic disease, being either hypertension or diabetes. A total of 516 participants, with a mean age of 56 years, completed the test regime. Mean knowledge scores were significantly lower for those with inadequate or marginal health literacy. For example, 94% of participants with diabetes and adequate health literacy knew the symptoms of hypoglycaemia, compared to 50% of those with inadequate health literacy.

More recently, Berkman et al. (2011) performed a systematic review with the aim of updating the results from the review conducted by DeWalt et al. (2004) and, more specifically, to determine if low health literacy is associated with poorer use of healthcare services, higher
healthcare costs, and poorer health outcomes. They reviewed health literacy research, published between 2003 and 2011; and numeracy research, published between 1966 and 2011. The authors identified 96 relevant studies which were deemed to be of fair or good quality. The studies addressed the methodological shortcomings identified by DeWalt et al. (2004) in as far as the majority used multivariate analyses to control for potential confounding variables. However, many of the studies were relatively small, having been conducted in a single clinic or with a narrowly defined patient population. Nevertheless, the review found that limited health literacy was consistently associated with increased use of hospital and emergency services, lower receipt of screening services and vaccines, poorer ability to understand medication labels and health messages, and poorer ability to demonstrate taking the correct dosage of medicine. In older adults, low health literacy was associated with higher mortality rates and poorer overall health. However, there was insufficient evidence to be conclusive about relationships between low health literacy and healthcare costs or other factors including prevalence of chronic disease, adherence to medication regimens, and health-related quality of life in older adults.

Five studies included in the Berkman et al. (2011) review reported that older adults with low health literacy had poorer health status and the evidence for this was judged to be moderate. One of the studies included a nationally representative sample of 2,668 older adults (Bennett, Chen, Soroui, & White, 2009). Health literacy was found to significantly mediate racial/ethnic and educational disparities in self-rated health status. This means that the importance of race/ethnicity and education level in explaining self-rated health status significantly declined when health literacy was included in the model. A second study (Cho, Lee, Arozullah, & Crittenden, 2008) investigated how health literacy affected health status and health service utilization among 489 older adults (≥65 years) living in Chicago, USA. A direct association was found between health literacy and self-rated health status, rates of hospitalization, disease knowledge, and preventative care such that people with low health literacy were more likely to have poorer self-rated health status and to have been admitted to a hospital in the past year. They were less likely to have had a screening test, such as a mammogram, in the past two years, and had less knowledge about diseases.

Berkman et al. (2011) cited three good-quality studies to substantiate their finding that low health literacy was associated with higher mortality rates. Although the evidence is convincing, they failed to mention that two of the studies were conducted on the same sample
of participants and by many of the same researchers. The sample consisted of 3,260 new Medicare enrollees aged 65 years and over, residing in four cities in the USA. The first study (Baker et al., 2007) reported that after adjustment for potential confounding factors, low health literacy predicted mortality. Over a period of 5 years, 5% of participants with adequate health literacy died compared to 19% of participants with marginal or inadequate health literacy. The second study by the same team of researchers (Baker, Wolf, Feinglass, & Thompson, 2008) found that both low health literacy and low cognitive abilities independently predicted mortality. Cognitive abilities were measured using the Mini Mental Status Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), a standardised test measuring seven different cognitive skills including orientation to place, numeracy, and short-term memory. The authors concluded that “both reading comprehension and cognitive abilities are likely to be important for gaining health information and interacting with the health care system” (Baker et al., 2008, p. 724).

Boylston Herndon et al. (2011) performed a systematic review that examined health literacy and patient outcomes in hospital emergency departments. They reviewed seven studies published between 1980 and 2011. They reported that adults aged 65 years and over with low health literacy visited the emergency department more often and incurred higher costs compared to those in the same age group with adequate health literacy. This was well illustrated in a large study conducted by Baker et al. (2004) which used the same sample of participants involved in the mortality studies previously described (3260 new Medicare enrollees aged 65 years and over, residing in four cities in the USA). A key finding was that individuals with inadequate or marginal health literacy were more likely to visit the emergency department on two or more occasions in a 12 month period, compared to individuals with adequate health literacy.

The stated aims of the final systematic review by Eichler et al. (2009) were to investigate 1) the relationship between health literacy and healthcare costs and 2) the cost-effectiveness of interventions designed to improve health literacy. The research in this area was found to have major limitations including the scarcity of studies on the topic, methodological shortcomings, and heterogeneous results. The authors reviewed research published between 1980 and 2008 and found 10 studies that addressed the first aim and no studies on the cost-effectiveness of interventions. They concluded that the costs of low health literacy for the healthcare system may be substantial with the difference in cost for a person with low literacy
compared to a person with adequate health literacy ranging from US $143 to $7,798. This is in contrast to the review by Berkman et al. (2011) which reported insufficient evidence for a relationship between health literacy and healthcare costs.

In summary, there has been a substantial amount of research on the topic of health literacy and health outcomes. Low health literacy in older adults is consistently associated with poorer health related knowledge, differential use of healthcare services, poorer overall health, and higher mortality. There is insufficient evidence for a relationship between low health literacy and the prevalence of chronic diseases, management and outcomes for some medical conditions (e.g., asthma), and health related quality of life. More research is needed to ascertain if there is an association between low health literacy and higher medical costs, although some studies indicate that this may be the case.

2.2.3 Prevalence and demographics of low health literacy

This section provides an overview of the prevalence of low health literacy and the demographic factors associated with it. The results from two nationally representative, population-based studies and a systematic review are examined, followed by a discussion of eight smaller studies that involved only older adults. A summary of the findings from each of the studies and the systematic review is shown in Table 2-7. The large population based studies investigated health literacy by measuring the ability of participants to carry out health-related tasks, such as following directions on a medicine label. The smaller studies measured health literacy using standardised tests, such as the TOFHLA, which focus on the comprehension of written healthcare information.

The largest study to-date of the prevalence of low health literacy was the National Assessment of Adult Literacy (NAAL) (Kutner, Greenberg, Jin, & Paulsen, 2006). It involved a representative sample of 19,000 American adults, aged 16 years and older and health literacy was measured directly through 28 health-related tasks. Three tasks represented the ‘clinical’ domain and included filling out a patient information form and interpreting dosage instructions for a particular medication. Fourteen tasks represented the ‘prevention’ domain and included identifying signs and symptoms of health problems that should be seen by a health professional. The final 11 tasks represented the ‘navigation of the healthcare system’ domain such as the ability to understand what a health insurance plan will and will not pay for. Results were converted into four health literacy levels: below basic,
basic, intermediate, and proficient. Approximately half of all participants (53%) had intermediate health literacy, 22% had basic health literacy, 14% below basic, and 12% had proficient health literacy. The demographic factors associated with basic or below basic health literacy were gender, race and ethnicity, language spoken before starting school, age, highest level of education attainment, and poverty level. People with basic or below basic health literacy were more likely to be male and from a Black, Hispanic, American Indian, Alaskan Native, or multiracial background. They were less likely to have graduated from high school and more likely to live below the poverty line. The most relevant finding to this thesis is that they were also more likely to be older adults aged 65 years and over. Approximately 60% of older adults had below basic or basic health literacy compared to approximately 32% of adults in all other age groups, and only 3% of older adults were found to have proficient health literacy.

A large representative study of health literacy was conducted in Australia by the ABS (Australian Bureau of Statistics, 2006). It involved 15,105 participants aged 15 to 74 years; 2,422 of whom were aged 60 years and over. The Adult Literacy and Life Skills Survey (ALLs) (Statistics Canada, 2003), developed by ‘Statistics Canada’ in collaboration with a number of international bodies, and coordinated by the Organisation for Economic Co-operation and Development was used. The study found that health literacy levels increased up to the age of 39 years and then gradually decreased from age 40 onwards. Eighty three percent of adults aged 65 to 74 scored below level 3, indicative of low health literacy. This is substantially higher than that found by the NAAL but the authors state that the results cannot be compared because the tests differ in terms of “sampling parameters, performance levels used, and the probability level set for doing a task correctly” (Australian Bureau of Statistics, 2006, p. 6). Other demographic factors associated with low health literacy were fewer years of education, in particular failure to complete high school; unemployment; a history of blue collar occupations; and having not participated in formal or informal learning in the previous 12 months.

Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, and Rudd (2005) conducted the only systematic review of the prevalence of low health literacy. They pooled the results of 85 studies, representing 31,129 adults of which the majority used the REALM, TOFHLA, or the S-TOFHLA. In agreement with the two population based studies, they found that the prevalence of low or marginal health literacy was associated with age, education level, and
ethnicity. Eight studies have investigated the prevalence of low health literacy and/or demographic factors associated with it in samples of predominantly older adults (Baker, Gazmararian, Sudano, & Patterson, 2000; Cordasco, Asch, Franco, & Mangione, 2009; Gausman Benson & Forman, 2002; Gazmararian et al., 1999; Morrow et al., 2006; Wolf et al., 2012; Wolf, Gazmararian, & Baker, 2005). Sample sizes in these studies ranged from 93 to 3,260 and four of the studies involved ≥2,500 participants. The most common tests used to assess health literacy were the TOFHLA and the S-TOFHLA.

The prevalence of inadequate or marginal health literacy in the eight studies ranged from 24% to 92%, however in the majority it was approximately 30%. The study (Cordasco et al., 2009) that reported a prevalence of 92% involved a relatively small sample (n=399) of adults in attendance at a safety net hospital, in a low socio-economic area. The main variables associated with low health literacy in these eight studies were age, years of education, race/ethnicity, and cognition. Likewise, age, years of education, and race/ethnicity were also significant factors in the two population based studies and in the systematic review. Cognition was not measured in the latter studies. Overall, age was the most important demographic marker for low health literacy. It had an inverse relationship with health literacy level in five of the eight studies (Baker et al., 2000; Cordasco et al., 2009; Gausman Benson & Forman, 2002; Gazmararian et al., 1999; Wolf et al., 2005). On average, older participants had lower health literacy even when controlling for factors, such as: years of education (Baker et al., 2000; Cordasco et al., 2009; Gazmararian et al., 1999), race and ethnicity, and gender (Baker et al., 2000; Cordasco et al., 2009). After controlling for all potential confounding factors, Baker et al. (2000) found that the S-TOFHLA score was almost 10 points lower for every decade increase in age.

Years of education was associated with health literacy level in five of the studies (Gausman Benson & Forman, 2002; Gazmararian et al., 1999; Morrow et al., 2006; Sudore et al., 2006; Wolf et al., 2005). For instance, Sudore et al. (2006) found that 17% of the participants who completed high school had low health literacy (<9th grade on REALM) compared to 56% of those who had not completed high school. Race/ethnicity was linked to health literacy in three studies (Gazmararian et al., 1999; Sudore et al., 2006; Wolf et al., 2005). All three reported that African Americans had higher rates of low health literacy compared to Anglo-Saxons. As an illustration, Gazmararian et al. (1999) found 18.9% of Anglo-Saxons had low health literacy as compared to 31.9% of Hispanics and 52.1% of African Americans.
Cognition was a significant factor in three studies (Gazmararian et al., 1999; Morrow et al., 2006; Wolf et al., 2012) and this is discussed in the next section of the thesis which explores the relationship between cognition and health literacy in older adults.

In summary, the results from two large, nationally representative studies indicate that well over half of all older adults have some difficulty with health related tasks such as following the directions on a medicine label or understanding a health insurance plan. The results from research involving older adults suggests that approximately 30% have difficulty reading and comprehending written healthcare information as indicated by results on standardised health literacy tests. Factors found to be associated with low health literacy, including both the ability to carry out health related activities and to comprehend written healthcare information, were age, years of education, and race/ethnicity.
Table 2-7. Summary of studies on the prevalence of low health literacy and associated demographic factors

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Age</th>
<th>Health literacy measure</th>
<th>Prevalence for low health literacy</th>
<th>Demographic factors associated with low health literacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kutner, Greenberg, Jin, and Paulsen (2006)</td>
<td>19,000 American adults</td>
<td>≥16 years</td>
<td>Health-related tasks developed for the study</td>
<td>Basic: 30% Below basic: 29%</td>
<td>Age, gender, race/ethnicity, language spoken before starting school, education level, poverty threshold (for those ≥65 years)</td>
</tr>
<tr>
<td>Australian Bureau of Statistics (2006)</td>
<td>15,105 Australian adults</td>
<td>Range = 15 to 74 years</td>
<td>ALLs</td>
<td>Level 1: 40.2% Level 2: 42.4%</td>
<td>Age, education level, educational participation, parental education, employment status, income, occupation, migrant status (5 levels in total – levels 1 &amp; 2 indicative of low health literacy) (for those ≥60 years)</td>
</tr>
<tr>
<td>Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, and Rudd (2005)</td>
<td>Systematic review (85 studies)</td>
<td>na</td>
<td>na</td>
<td>Marginal: 20% Inadequate: 26%</td>
<td>Age, years of education, ethnicity</td>
</tr>
<tr>
<td>Gazmararian et al. (1999)</td>
<td>3,260 new Medicare enrollees</td>
<td>≥65 years</td>
<td>S-TOFHLA</td>
<td>Marginal: 10.4% Inadequate: 23.5%</td>
<td>Age, postcode, race/language, years of education, occupation, cognition</td>
</tr>
</tbody>
</table>
Table 2-7. Summary of studies on the prevalence of low health literacy and associated demographic factors *(continued)*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample Description</th>
<th>Age Information</th>
<th>Health literacy measure</th>
<th>Prevalence for low health literacy</th>
<th>Demographic factors associated with low health literacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wolf, Gazmararian, and Baker (2005)</td>
<td>2,923 Medicare enrollees</td>
<td>Mean = 71 years</td>
<td>S-TOFHLA</td>
<td>Marginal: 11.3%</td>
<td>Age, race/ethnicity, income, years of education</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inadequate: 22.2%</td>
<td></td>
</tr>
<tr>
<td>Baker, Gazmararian, Sudano, and Patterson</td>
<td>2,774 community dwelling adults</td>
<td>Mean = 73.1 years</td>
<td>S-TOFHLA</td>
<td>Not stated</td>
<td>Age (score declined by .9 points for every year increase in age after adjustment for cognitive impairment).</td>
</tr>
<tr>
<td>(2000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudore et al. (2006)</td>
<td>2,500 community dwelling older adults</td>
<td>Mean = 75.6 years</td>
<td>REALM</td>
<td>&lt;9th grade reading level: 24%</td>
<td>Postcode, gender, ethnicity, years of education, income, self-rated health</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range = 71 to 82 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wolf et al. (2012)</td>
<td>882 adults at a public health centre</td>
<td>Mean = 63.1 years</td>
<td>REALM TOFHLA NVS</td>
<td>TOFHLA</td>
<td>Fluid and crystallized cognitive abilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range = 55 to 74 years</td>
<td></td>
<td>Marginal: 16.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inadequate: 12.5%</td>
<td></td>
</tr>
</tbody>
</table>
Table 2-7. Summary of studies on the prevalence of low health literacy and associated demographic factors *(continued)*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Age</th>
<th>Health literacy measure</th>
<th>Prevalence for low health literacy</th>
<th>Demographic factors associated with low health literacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gausman Benson and Forman (2002)</td>
<td>93 residents in a retirement village</td>
<td>Mean = 83 years</td>
<td>TOFHLA</td>
<td>Marginal &amp; Inadequate: 30%</td>
<td>Age, years of education</td>
</tr>
<tr>
<td>Cordasco, Asch, Franco, and Mangione (2009)</td>
<td>399 adults with heart disease in a public hospital</td>
<td>Mean = 55 years</td>
<td>TOFHLA</td>
<td>Marginal: 5.1%</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inadequate: 87.2%</td>
<td>(Score declined by .6% for every year increase in age after adjustment for education, race/ethnicity, gender, and immigration status)</td>
</tr>
<tr>
<td>Morrow et al. (2006)</td>
<td>314 community dwelling adults with heart disease</td>
<td>Mean = 62.9 years</td>
<td>S-TOFHLA</td>
<td>Not stated</td>
<td>Gender, years of education, cognitive abilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range = 47 to 89 years</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: ALLS: International Adult Literacy and Life Skills Survey; S-TOFHLA: Test of Functional Health Literacy in Adults, short form; REALM: Rapid Estimate of Adult Literacy in Medicine; TOFHLA: Test of Functional Health Literacy in Adults; NVS: The Newest Vital Sign*
2.2.4 Cognition and health literacy in older adults

The cognitive abilities that are negatively impacted by the ageing process are discussed in section 2.1.3 and include processing speed, short-term memory, working memory, and aspects of long-term memory. A number of prominent researchers propose that poorer health literacy in older adults is associated with this decline in cognitive skills. Furthermore, they believe that the association between low health literacy and poorer performance on health-related tasks can be explained, in large, by cognition (e.g., Morrow et al., 2006; Wilson et al., 2010; Wolf et al., 2012). There is a growing body of research to support their claims (see Table 2-8).

The largest study investigating the relationship between cognitive performance and health literacy was conducted by Baker et al. (2002) and involved 2,787 older adults. They used the S-TOFHLA to measure health literacy and the MMSE to measure cognitive ability. The researchers found that health literacy was linearly related to the total MMSE score across the entire range of S-TOFHLA scores. Furthermore, health literacy was correlated to performance on the MMSE even for subscales that were not directly related to reading ability or education level, such as delayed recall. Adjustment for chronic health conditions and self-reported overall health did not change the relationship. According to Baker et al. (2002) the most likely explanation for these findings is that health literacy and many domains of cognitive functioning are associated, although not necessarily causally related.

Two research groups (Levinthal, Morrow, Tu, Wu, & Murray, 2008; Morrow et al., 2006) have investigated the association between results on the S-TOFHLA and a) visual acuity, b) auditory function, and c) scores on standardised tests for working memory and processing speed. In both studies, auditory function was assessed using the Speech Discrimination Screening Task from the Arizona Battery for Communication Disorders of Dementia (Bayles & Tomoeda, 1993). This examines the ability to discriminate word pairs that differ only in the first phoneme (e.g., ‘bare’ and ‘dare’). The study conducted by Morrow et al. (2006) involved 314 older adults living in the community and diagnosed with chronic heart disease. Linear regression analysis showed that education level and cognitive ability were independently correlated with scores on the S-TOFHLA and explained age differences. The study conducted by Levinthal et al. (2008) involved 492 adults (21 to 92 years) living in the community and diagnosed with hypertension. Similarly, they found that when controlling cognitive and sensory factors, scores on the S-TOFHLA had only a marginally significant
association with age. Hence, in both studies, cognitive ability explained much of the variance in health literacy level. According to Levinthal et al. (2008, p. 1176), “age-related differences in functional health literacy reflect general cognitive and sensory abilities. These abilities may also help to explain the association of health literacy with self-care (e.g., medication adherence) and with health outcomes”.

In an interesting study, Murray, Johnson, Wolf, and Deary (2011) examined the extent to which IQ at age 11, and relative cognitive change between ages 11 and 70, contribute to health literacy test performance in 304 healthy older adults. The researchers administered three health literacy tests (REALM, S-TOFHLA, and NVS) and four measures of cognitive ability in the year that the participants turned 70 years of age. The cognitive tests included the MMSE, the Wechsler Adult Intelligence Scale III (Wechsler, 1998), and the same IQ test administered when they were 11 years of age. A key finding was that childhood IQ was significantly correlated with performance on all three health literacy tests. Moreover, relative cognitive change over time was a significant predictor of performance on two of the health literacy tests. This association remained significant even after controlling for social status, education, personality traits, gender, and childhood IQ. According to the researchers “the results suggest that, in addition to the influence of the life-long trait of intelligence, factors associated with specific and relatively recent circumstances that have affected cognitive function may contribute to individual differences in health literacy” (Murray et al., 2011, p. 185).

Both Wolf et al. (2012) and Wilson et al. (2010) took this research one step further. In separate studies, they obtained similar findings about the degree to which cognitive skills explain the association between health literacy level and performance on health-related tasks. The study conducted by Wolf et al. (2012) involved 882 adults aged between 55 and 74 years who were in attendance at one of five Health Centres in Chicago. They measured the participants’ performance on 10 common health tasks, such as comprehending printed healthcare information and working out the dosage for a medication. All participants completed three health literacy tests and a comprehensive cognitive battery that assessed processing speed, working memory, long-term memory, inductive reasoning, and general cognition. Wilson et al. (2010) showed 112 older participants a video on the topic of colorectal cancer screening and asked them to answer a series of questions assessing their functional knowledge of the information contained in it. One week later, each participant
was contacted by phone and asked the same questions a second time. All participants were administered a health literacy test (REALM) and a battery of cognitive tests similar to, but not as extensive, as that used in the study conducted by Wolf et al. (2012). Both studies found a correlation between scores on the health literacy test/s and performance on the health-related task/s. However, the association between health literacy and task performance was substantially reduced once cognitive abilities were accounted for and cognitive abilities explained over 70% of the relationship between health literacy and performance in the two studies.

In summary, a growing body of evidence indicates that performance on health literacy tests is significantly associated with results on cognitive tests in older adults. Hence, results on a health literacy test may be a reflection of one’s cognitive abilities. In addition, two studies have found that cognitive abilities explained a great deal of the variance in the relationship between health literacy and performance on health-related tasks. It would therefore appear important to consider cognitive factors, such as demands on working memory, when developing health-related materials and designing interventions for people with low health literacy.
Table 2-8. Summary of studies of associations between health literacy and cognition in older adults

<table>
<thead>
<tr>
<th>Researchers</th>
<th>Participants</th>
<th>Health literacy measure</th>
<th>Cognitive abilities</th>
<th>Significant findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker et al. (2002)</td>
<td>2,787 adults (65 years and older)</td>
<td>S-TOFHLA</td>
<td>-General cognition</td>
<td>Health literacy correlated with cognition, after adjustment for chronic health conditions and self-reported health.</td>
</tr>
<tr>
<td>Morrow et al. (2006)</td>
<td>314 adults (47 to 89 years)</td>
<td>S-TOFHLA</td>
<td>-Working memory</td>
<td>Cognitive ability and education independently associated with S-TOFHLA and fully explained the age differences in health literacy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Processing speed</td>
<td></td>
</tr>
<tr>
<td>Levinthal et al. (2008)</td>
<td>492 adults (21 to 92 years)</td>
<td>S-TOFHLA</td>
<td>-Working memory</td>
<td>Health literacy only marginally associated with age after adjustment for cognition and sensory variables (vision and hearing).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Processing speed</td>
<td></td>
</tr>
<tr>
<td>Murray, Johnson, Wolf, and Deary (2011)</td>
<td>304 adults (all 72 years)</td>
<td>REALM, S-TOFHLA, NVS</td>
<td>-Processing speed</td>
<td>Health literacy correlated with IQ at 11 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Working memory</td>
<td>Health literacy correlated with relative cognitive change from age 11 to 70 years, after adjustment for gender, IQ at 11 years, personality traits, education, and social status.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-General cognition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-IQ at age 11 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Measure of relative cognitive change from age 11 to 70 years</td>
<td></td>
</tr>
<tr>
<td>Researchers</td>
<td>Participants</td>
<td>Health literacy measure</td>
<td>Cognitive abilities</td>
<td>Significant findings</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------</td>
<td>-------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Wolf et al. (2012)</td>
<td>882 adults (55 to 74 years)</td>
<td>REALM, TOFHLA, NVS</td>
<td>Fluid intelligence - Working memory - Processing speed - Inductive reasoning - Long-term memory - Prospective memory Crystallised intelligence - Verbal memory</td>
<td>Health literacy correlated with scores on all cognitive tests.</td>
</tr>
<tr>
<td>Wilson et al. (2010)</td>
<td>112 adults (40 to 85 years)</td>
<td>REALM</td>
<td>- Processing speed - Working memory - Long-term memory - General cognition</td>
<td>Health literacy correlated with scores on all cognitive tests. In multi-variate analysis, cognition explained 71% of the relationship between health literacy and task performance (asked questions about a video on colorectal cancer screening).</td>
</tr>
</tbody>
</table>

*Note:* REALM = Rapid assessment of Adult Literacy in Medicine; TOFHLA: Test of Functional Health Literacy in Adults; S-TOFHLA: Test of Functional Health Literacy in Adults, short form; NVS: The Newest Vital Sign

^All cognitive abilities assessed using standardised tests.
2.2.5 Interventions designed to improve health outcomes for adults with low health literacy

This section provides a summary of the findings from two systematic reviews that examined interventions designed to improve health outcomes for adults with low health literacy (Clement, Ibrahim, Crichton, Wolf, & Rowlands, 2009; Pignone, DeWalt, Sheridan, Berkman, & Lohr, 2005). There are two types of interventions discussed in these reviews: simple and complex. Simple interventions comprise one element only, such as an audio-visual resource or a printed healthcare pamphlet. In contrast, complex interventions comprise a number of separate elements; for example, a health education program delivered through a combination of verbal presentation, printed materials, and a phone follow-up to check for understanding (Clement et al., 2009). A large number of simple and complex interventions involve the development of written healthcare materials based on best practice guidelines. Research shows that well-designed written materials are preferred by all readers, regardless of health literacy level, and that comprehension is significantly higher for ‘easy-to-read’ materials (e.g., Davis et al., 1996). Relevant studies on this topic are discussed in Chapter 4, along with detailed information on how to design written healthcare materials appropriate for people with low health literacy.

Pignone et al. (2005) performed a systematic review of interventions designed to improve health outcomes for adults with low literacy. A total of 20 studies published between 1980 and 2003 met their inclusion criteria. The most common outcome studied was health knowledge and the primary types of intervention involved easy-to-read printed materials, audio-visual resources, computer programs, and in-person instruction either individually or in a group. The effectiveness of interventions was mixed; some showed positive effects on health outcomes whilst others found no effect. The authors were unable to determine which strategies were the most effective due to limitations in study design and heterogeneity in outcome measures. In addition, too few studies examined each type of intervention (brochure, videotape, computerized tool, or oral presentation). The majority of studies were not designed to measure whether the intervention helped people with low health literacy more or less than people with adequate health literacy. The five studies that did examine this also reported mixed results. Some found that interventions worked similarly for adults with low and high literacy (e.g., Wydra, 2001). Others reported that adults with low literacy gained greater benefit than adults with adequate literacy (Michielutte, Bahnson, Dignan, &
Schroeder, 1992), and one study found the reverse (Davis et al., 1998). The authors concluded that further research is required to understand the types of interventions that are most effective in improving health outcomes for people with low literacy.

Clement et al. (2009) conducted a systematic review of complex interventions designed to improve the health of adults with low health literacy. A total of 15 studies published between 1966 and 2007 met their inclusion criteria and the majority involved younger adults and included verbal presentations and audio-visual materials. The two most common outcome measures were knowledge and health behaviours, such as medication adherence and dietary changes. One intervention focused on literacy training, two were directed at health professionals, and the remainder consisted of health education and management programs. Thirteen reported at least one significant difference in a primary outcome measure for the intervention group. However, similar to the Pignone et al. (2005) review, eight of the 13 had mixed results with positive findings on some outcome measures and no significant difference on others. The review also highlighted the fact that there are large gaps in our knowledge of the types of interventions that are likely to be the most effective. Both reviews found that interventions were highly diverse, outcomes were mixed, and that the quality of research varied greatly.

Koh, Baur, Brach, Harris, and Rowden (2013) cast a different light on interventions to assist adults with low health literacy. They highlighted the fact that the majority of intervention studies focus on the limitations of adults with low health literacy, including their lack of skill and knowledge to obtain and understand health information in order to manage their health in an appropriate manner. Hence, the interventions trialled are tailored solely to individuals with low health literacy. Meanwhile, there is a growing realization that the modern day healthcare system challenges virtually all adults regardless of health literacy level. Hence, they propose a shift to a ‘systems approach’ in health literacy research which involves an entire organization or healthcare system integrating health literacy practices into all aspects of planning and operations. According to Koh et al. (2013 p. 2) “A “health literate” organization ensures that written materials are understandable and relevant; it also trains the workforce to meet the needs of people with a range of health literacy skills and relieves individuals of the challenge of coordinating their own care”. Several large Government Departments in the US support the concept of a ‘systems approach’ including the US
Department of Health and Human Services (US Department of Health and Human Services, 2010).

In summary, there have been two systematic reviews of interventions designed to improve health outcomes for adults with low health literacy. The main outcome measure addressed in the studies was health knowledge and this was also the outcome measure most likely to show improvement following an intervention. Neither review was able to determine the type of interventions that are most effective.

2.2.6 Summary

Health literacy refers to the skills needed to obtain, understand, and use health information and services in order to function effectively in the healthcare environment. A number of standardised measurement tools are available to assess health literacy, such as the TOFHLA and the REALM. Research indicates that low health literacy is associated with poorer health outcomes and poorer use of healthcare services. For example, adults with low health literacy have higher rates of hospitalization, higher morbidity, and poorer ability to understand medication labels and health messages. Research findings indicate that approximately 30% of older adults have low health literacy and factors associated with it include age, years of education, and race/ethnicity. In addition, there is a growing body of evidence to suggest that low health literacy may also be associated with reduced cognitive function in older adults. For example, health literacy, as measured on the S-TOFHLA, was strongly correlated with performance on cognitive tests, such as the MMSE, in a number of studies. Two systematic reviews have investigated interventions designed to improve health outcomes for adults with low health literacy and both reported mixed findings. In recent years, there has been a trend away from targeting interventions solely to individuals with low health literacy. It is now recognised that the healthcare system is increasingly complex and that organizations should make health information and services less complex for everyone, and not just a select few.
2.3 Hearing aids and hearing aid management

Hearing aids are currently the most common therapeutic treatment for age-related hearing impairment and approximately two-thirds of aids are fitted to people aged over 60 years (e.g., Strom, 2006). Many studies have found that HAs can provide substantial benefit to older adults. For example, Humes and Krull (2012) systematically reviewed 33 articles published between 1990 and 2010 about HA effectiveness; the participants in the majority of studies were older adults with a mild to moderate or mild to severe sloping sensorineural hearing impairment. They reported that HAs improved speech understanding and that they provided substantial benefit to those fitted, reducing hearing handicap and/or the frequency of problems in aided versus unaided conditions.

Despite the benefits that amplification can provide, some older adults are dissatisfied with their HAs and consequently do not wear them regularly. The proportion of non-regular HA users varies across studies, depending in part, on the definition of regular use adopted in the research. Knudsen, Oberg, Nielsen, Naylor, and Kramer (2010) conducted a review of the literature and reported that that up to 40% of HAs are not worn on a regular basis. For example, they included a large study conducted by Smeeth et al. (2002) involving 32,656 older adults attending medical centres in the United Kingdom (UK). They surveyed the participants about their HA use and found that HAs were owned by 3,846 participants, however only 60% reported wearing them on a regular basis. More recently, Aazh, Prasher, Nanchahal, and Moore (2015) investigated the rate of HA use in the UK National Health Service using the International Outcome Inventory for Hearing Aids (IOI-HA; Cox & Alexander, 2002). A total of 1023 questionnaires were returned, a response rate of 55%, and almost a third (29%) of respondents reported that they used their HAs for less than 4 hours a day. Kochkin (2010) surveyed older adults in the USA regarding HA use and satisfaction. A total of 3174 surveys were returned representing a response rate of 84% and 12% of respondents reported that they did not use their HAs at all. Hickson, Clutterbuck, and Khan (2010, personal communication) described HA outcomes for 1653 adults residing in Australia. Based on results on the IOI-HA they reported that 4% of participants never used their aids, 6% used them for less than one hour a day, and 17% used them for 1 to 4 hours a day.
A common reason cited for limited aid use is difficulty with management (e.g., Brooks, 1985; Hickson, Hamilton, & Orange, 1986; Sorri, Luotonen, & Laitakari, 1984). HA management refers to the activities one must perform to wear, adjust, and maintain the device/s and includes inserting the aid in the ear, adjusting the volume, changing the battery, cleaning the aid, and troubleshooting when problems occur (Dillon, 2001). Hickson et al. (1986) surveyed 135 older adults 3 months after they had been fitted with their first HA/s and found that poor aid management ability was significantly associated with few or no hours of daily use. Similarly, Brooks (1985) reported that the major reason for non-use in their study was inability to insert the ear mould. Sorri et al. (1984) interviewed 155 older adults 2 years after their HA had been fitted and found that almost a quarter (23%) of the participants seldom, if ever, used their aids and that non-users demonstrated poorer management skills. All three studies were conducted in the mid-1980s with participants who were predominantly fitted with behind-the-ear (BTE) HAs.

Upfold, May, and Battaglia (1990) measured HA management ability at both the fitting and follow-up appointments for 136 new HA users. At the follow-up appointment, the poorest performance was recorded for telecoil use, aid insertion, and adjustment of the volume control. Approximately 11% of participants experienced considerable difficulty inserting the HA correctly in their ear and an additional 5% were unable to perform this task at all. More recently, Desjardins and Doherty (2009) conducted a novel study in which they directly assessed the ability of experienced HA users to manage and use their HAs. The study involved 50 participants, aged between 46 and 89 years, who had worn HA/s for at least a year. Over a third had worn aids for more than 10 years and, as a group, they were fitted with a variety of different aid types. The researchers assessed the participants’ HA skills using a test they developed called the PHAST (Practical Hearing Aid Skills Test). In this test the individual is required to perform eight HA care and use tasks that are typically taught at the device fitting appointment. The tasks include HA insertion, changing the battery, cleaning, and telephone use. Each task is scored on a 5-point Likert scale with values ranging from ‘excellent’ to ‘cannot perform’ and the raw score is converted into a percentage score. Desjardins and Doherty (2009) reported that performance on the PHAST ranged from 48% (poor) to 100% (excellent) and scores were normally distributed around the mean. All participants were able to insert the HA and open the battery door and almost all were able to remove the aid and change the battery. The poorest performance was recorded for telephone use, cleaning the aid, and use of the noise program; over 75% could not use the telephone...
with the aid. In addition, most were not aware they had a noise program/directional microphone or were unable to use it correctly.

A small number of studies have investigated factors associated with HA management skills (see Table 2-9) and although age, gender, and type of HA have been found to significantly influence aid management, there is disagreement between studies. Three studies found a significant correlation between age and HA management ability (Desjardins & Doherty, 2009; Meredith & Stephens, 1993; Ward, Gowers, & Morgan, 1979) with older participants, particularly those over 75 years of age, experiencing more difficulty. Gender was also a significant factor in three studies, all of which reported that females had more difficulty than males with aid management (Meredith & Stephens, 1993; Upfold et al., 1990; Ward et al., 1979). In contrast, Desjardins and Doherty (2009) found no association between gender and aid management. The style of HA has been found to be a significant factor by some (Meredith & Stephens, 1993; Upfold et al., 1990), but not by others (Desjardins & Doherty, 2009) and in addition, there is disagreement as to what style is the easiest to manage. Meredith and Stephens (1993) reported that participants fitted with a BTE aid experienced less management difficulties compared to those fitted with an in-the-ear (ITE) aid, whilst Upfold et al. (1990) found the opposite. No studies have looked at the effect of dexterity, vision, or cognition on HA management. However, it is likely that if any one of these functions is impaired, aid management would be more challenging.

No studies have investigated the association between health literacy or the quality of HA instruction materials and aid management. All HAs are accompanied by a printed user guide and it should play an important role in the transfer of information about the device, troubleshooting, and usage. Research indicates that 40 to 80% of verbal information communicated by health professionals is immediately forgotten after the appointment (Kessels, 2003). In addition, many HAs are managed by significant others or staff in residential care facilities, who are not necessarily in attendance at audiology appointments. Three studies have examined HA user guides and none have found them to be optimal for older adults, the main users of hearing devices. Two studies (Kelly, 1996; Nair & Cienkowski, 2010) assessed the reading level of a sample of user guides and one study (Brooke, Isherwood, Herbert, Raynor, & Knapp, 2012) implemented user testing to investigate if adults could carry out management tasks using two selected user guides. Taken together, the studies found that the reading level is too high, there is substantial use of jargon and complex vocabulary, and the text size is too
small. In addition, it is often difficult to understand and follow the instructions provided. More detailed information is provided on these studies in Chapter 5 (section 5.2).

In summary, a proportion of adults fitted with HAs wear them rarely, if at all and hence, do not receive the benefit they can provide. A major reason cited for this is difficulty with device management. A number of studies have examined factors associated with HA management and age is the only significant factor on which most researchers agree. No studies have investigated the effect of health literacy on HA management which is surprising in view of the evidence indicating that it impacts on many other aspects of healthcare. Likewise, no research has examined if the quality of instruction materials influences aid management.

### 2.4 Gaps in the research

Approximately two-thirds of HAs are fitted to adults aged over 60 years. HAs can provide substantial benefit for individuals with a hearing impairment, however many older adults experience difficulty with aid management which may prevent them from getting maximum benefit from them. All HAs are accompanied by a printed user guide that should play an important role in the transfer of information on HA management. However, a HA user guide is only useful if the client can find, understand, and apply the information contained in it. Two studies have examined the RGL of HA user guides but no research has been conducted on their content and design. Content and design includes, but is not limited to, layout, diagrams, scope, sentence construction, vocabulary, use of colour, and type of paper. It is deemed important to assess these aspects of the user guide alongside the reading level because they also impact on ease of use. There is no research published on how to design, develop, and assess a HA user guide based on best-practice guidelines for older adults and adults with low health literacy. In addition, no-one has investigated if a user guide developed using best-practice guidelines results in a) superior ability to perform HA management tasks, and b) superior ability to attain knowledge about the HA, compared to a typical user guide. Lastly, although extensive research has been carried out on the topic of health literacy in other areas of healthcare, there are no studies in the area of rehabilitative audiology in which health literacy levels have been measured (using a standardised health literacy test) and there is no evidence available as to whether health literacy is associated with HA management and/or troubleshooting.
Table 2-9. Summary of factors that have been found to be associated with hearing aid management

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Factors associated with HA management</th>
<th>Detail (significant findings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desjardins and Doherty (2009)</td>
<td>50 experienced HA users (46 to 89 years)</td>
<td>Age</td>
<td>Older participants obtained poorer scores on the Practical Hearing Aid Skills Test (PHAST).</td>
</tr>
<tr>
<td>Meredith and Stephens (1993)</td>
<td>40 new HA users (65 to 90 years)</td>
<td>Type of HA Age and gender</td>
<td>Participants fitted with a behind-the-ear aid experienced less management difficulties compared to those fitted with an in-the-ear aid (the behind-the-ear aid was attached to a skeleton mould with the helix removed). Females aged &gt;75 years were most likely to experience difficulties with management.</td>
</tr>
<tr>
<td>Stephens and Meredith (1991)</td>
<td>60 new HA users (65 years and older)</td>
<td>Type of ear mould</td>
<td>Participants aged &gt;75 years experienced less difficulties with management if assigned a skeleton mould without a helix as compared to a standard skeleton mould or an ear tip.</td>
</tr>
<tr>
<td>Upfold, May, and Battaglia (1990)</td>
<td>244 new HA users (mean age: 73 years)</td>
<td>Type of HA Gender</td>
<td>Participants assigned an in-the-ear aid demonstrated better management ability compared to those assigned either a behind-the-ear aid or an in-the-canal aid. Females experienced more difficulties with management.</td>
</tr>
<tr>
<td>Ward, Gowers, and Morgan (1979)</td>
<td>136 new HA users (65 years and over)</td>
<td>Age and gender</td>
<td>Both age and gender significantly associated with ability to perform management tasks such as changing volume. Female participants aged &gt;75 years had the most difficulty.</td>
</tr>
</tbody>
</table>
2.5 References


Chapter 3: Hearing Aid User Guides: Suitability for Older Adults


This chapter is inserted as submitted for publication, with the exception of 1) formatting changes to headings, tables, and figures to maintain consistency throughout the thesis; 2) modifications suggested by the thesis examiners (shown in bold).
3.1 Abstract

**Objective:** The aim of this study was to analyse the content, design, and readability of printed hearing aid user guides to determine their suitability for older adults, who are the main users of hearing aids.

**Design:** Hearing aid user guides were assessed using four readability formulae and a standardised tool to assess content and design (SAM - Suitability Assessment of Materials).

**Study Sample:** A sample of 36 hearing aid user guides (four user guides from nine different hearing aid manufacturers) were analysed.

**Results:** All user guides scored “adequate” for their overall suitability. However, many scored poorly for scope, vocabulary, aspects of layout and typography, and learning stimulation and motivation. The mean reading grade level for all user guides was grade 9.6 which is too high for older adults.

**Conclusions:** The content, design, and readability of hearing aid user guides are not optimal for older adults and thus may serve as a barrier to successful hearing aid outcomes for this population.

**Key Words:** Audiology, health literacy, hearing aid, instructions, readability, patient education, older adults
3.2 Introduction

All hearing aids (HA) are accompanied by a set of printed instructions (hereafter referred to as a HA ‘user guide’). A typical HA user guide contains information on: a) use of the device, b) functions and features, c) care and maintenance, and d) troubleshooting. User guides should play an integral role in the transfer of knowledge on HAs because hearing professionals have limited time to spend with each client, and there is a substantial amount of information about the HA that the client needs to know in order to become a successful user. In addition, many users of HAs reside in aged care residential facilities, where in many cases they rely on assistance from staff to manage and use their device/s. These facilities often have very high staff turnover hence it would appear important that hearing aid user guides are succinct, well designed, and clearly written.

It is well established that healthcare information and instruction materials are only effective if they are noticed, read, and understood by the client (Hoffmann and Worrall, 2004). Therefore, it is important that there is a match between the content, design, and readability of printed healthcare materials and the literacy and cognitive requirements of the target audience (Doak, Doak, & Root, 1996; Friedman & Hoffman-Goetz, 2006). The major target group for HAs and therefore HA user guides is older adults because the prevalence of hearing loss is highest in people aged 60 years and above. Hearing loss occurs in approximately 40% of adults in their 60s, 60% of adults in their 70s, and 90% of adults aged 80 and above (Chia et al., 2007; Wilson et al., 1999). The purpose of this research was to investigate the appropriateness of HA user guides for older adults since we considered that appropriate HA user guides may be important for facilitating optimal HA use in this population.

Many older adults have deficits in vision and/or cognition which may affect their ability to read and use healthcare materials and instructions (Australian Institute of Health and Welfare, 2005; Krauss Whitbourne, 2005; Watson, 2009). In addition, at least 30% of older adults have limited health literacy (Kutner, Greenberg, & Paulsen, 2006; Australian Bureau of Statistics, 2006; Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd, 2005). Health literacy refers to “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000, p 3). The terms “literacy” and “health literacy” have important distinctions although they are often used interchangeably. Literacy is more general
and refers to the ability to read, write, and understand in one’s native language; whilst health literacy refers to these skills applied in the context of healthcare (Mayer & Villaire, 2007). Research findings show that adults with low health literacy have poorer health status, less health knowledge, higher healthcare costs, higher utilization of health services, and are less likely to comply with self-management regimens for chronic health conditions (e.g., Howard, Gazmararian, & Parker, 2005; Gazmararian, Williams, Peel, & Baker, 2003; DeWalt, Berkman, Sheridan, Lohr, & Pignone, 2004).

There are many peer-reviewed articles and resources available that outline evidence-based, best-practice guidelines for developing written healthcare materials for older adults and/or adults with low health literacy (e.g., Doak, Doak, Friedell, & Meade, 1998; National Cancer Institute, 2003; Centers for Disease Control and Prevention, 2009; Mayer & Villaire, 2007; Houts, Doak, Doak, & Loscalzo, 2006). Of particular relevance to audiology, Caposecco, Hickson, and Meyer (2012) provides a summary of best practice guidelines and the application of these to the development of a set of printed HA instructions. Examples include: a) write at 3rd to 6th grade reading level, b) use active voice, c) select a font size between 12 and 14 points, d) organise information in the order that the reader will use it, and e) use simple line drawings accompanied by text captions. In addition, it is important to consider cognitive factors such as demands on working memory. According to Wilson and Wolf (2009), “design elements that minimize the amount of working memory necessary to decode new information will allow individuals to siphon more resources toward comprehending the core messages that designers are attempting to convey” (p.319).

There are a number of formal tools available to assess the content, design, and readability of printed healthcare materials. Readability is an objective measurement of the reading skills necessary to understand written text and is usually measured in terms of reading grade level (RGL) (Badarudeen & Sabharwal, 2008). Readability formulae are used to assess reading level and are based on language variables such as sentence length, word length, and syllable count (Doak et al., 1996). Readability formulae that are used extensively in healthcare include the Flesh-Kincaid (Kincaid, Fishburne, Rogers, & Chissom, 1975) and the Fry Readability Graph (Fry, 1968). Content and design refer to elements such as organization, layout, graphics, cultural factors, and the amount of information presented (Doak et al., 1996). Three rating scales have been developed to assess content and design with the most widely used being the SAM (Doak et al., 1996).
Research shows that easy-to-read materials are preferred by all readers regardless of literacy level, with benefits including improved comprehension and shorter reading time (Davis et al., 1996). In addition, well designed healthcare materials that the reader is able to understand enhance self-efficacy (Doak et al., 1996). Self-efficacy refers to an individual’s belief that they have the ability to perform the skills needed to be successful at a particular behaviour (Bandura, 1997). HA self-efficacy refers to “the confidence one has concerning the abilities to care for and to use hearing aids successfully” (West & Smith, 2007, p 759). Findings from over 300 studies show that written healthcare materials often far exceed the average reading ability of the target audience (Friedman & Hoffman-Goetz, 2006; Hill-Briggs & Smith, 2008; Cronin, O’Hanlon, & O’Connor, 2011). Two studies have been published on the RGL and suitability of HA user guides. Kelly (1996) assessed the readability of 55 HA user guides and found that 73% were classified as college RGL on the Flesch Reading Ease Scale (Flesch, 1948). More recently, Nair and Cienkowski (2010) performed an analysis of 12 client HA fitting appointments conducted by three audiologists. The appointments were video-taped and transcribed, and the HA user guides provided to the clients were also transcribed. The Flesch-Kincaid Formula (Kincaid, et al., 1975) was used to determine the approximate RGL of the counselling session and the HA user guides and to predict the clients’ health literacy levels. All 12 clients had a predicted health literacy level below 3rd grade reading level whereas the language used by the audiologists was significantly higher than that used by clients. The mean RGL in the user guides was 7.96 (i.e., between 7th and 8th grade reading level). The findings suggest that clients may not be able to understand at least some of the information provided in HA fitting appointments or HA user guides due to the literacy level being too high. Despite this, there is no research on the content and design of HA user guides. In addition, there have been no studies in the past 15 years that investigate the RGL of a large sample of HA user guides.

3.2.1 Aims
The aim of this study was to analyse the content, design, and readability of printed HA user guides to determine their suitability for older adults.
3.3 Materials and methods

3.3.1 Hearing aid user guides
This study comprised a sample of 36 HA user guides; four user guides from nine HA manufacturers (Bernafon, Oticon, Phonak, Resound, Siemens, Sonic Innovations, Starkey Laboratories, Unitron Hearing, and Widex). User guides accompany the HAs and can also be downloaded from the manufacturers’ websites. The selection process involved identifying two HAs from two price points for every manufacturer. The price points were low-end (approximately $1,400 to $3,000 (USD) for a pair) and mid-end (approximately $4,700 to $7,300 (USD) for a pair). Two aid models were selected at the two price points: a behind-the-ear (BTE) HA with a dome/tip mould and an in-the-canal (ITC) HA. This approach was adopted in order to determine if the quality and readability of a HA user guide varies based on the manufacturer, type, and/or cost of the device.

3.3.2 Assessment measures
Each HA user guide was analysed with a standardised assessment of content and design, and four readability formulae (see Table 3-1). The Suitability Assessment of Materials (SAM) (Doak et al., 1996) instrument was used to assess the content and design of each user guide. The SAM was included as it is one of the few standardized methods for evaluating the content and design of healthcare materials. It was tested and validated with individuals from a variety of cultural backgrounds (Doak et al., 1996) and has been used in a number of studies assessing written healthcare materials (e.g., Weintraub, Maliski, Fink, Choe, & Litwin, 2004).

The SAM rates the suitability of patient education materials on 22 factors, grouped into 6 categories (content, literacy demand, graphics, layout and typography, learning stimulation and motivation, and cultural appropriateness). Each factor is rated according to the criteria outlined by Doak et al. (1996). The ratings are superior (2 points), adequate (1 point), and not suitable (0 points). The overall suitability of a piece of patient education material is based on the total SAM percentage score. This score is calculated by adding the rating scores for each factor and dividing that by the total possible score to obtain a percentage. The percent scores are grouped into three result categories: a) 0-39%, inadequate; b) 40-69%, adequate; and c) 70-100%, superior. The total possible score can vary among materials.
because not all factors are applicable to all materials. For example: ‘cultural appropriateness’
is not relevant if there are no cultural images or examples in a healthcare document because it
is designed for readers from a wide variety of cultural backgrounds. This was the case in the
current study, and therefore the category of ‘cultural appropriateness’ was not included in the
total SAM score for any user guide.

The readability formulae used are shown in Table 3-1. All provide the RGL of the text based
on sentence length, word length, and/or number of syllables. The exception is the FRE which
provides a reading ease score ranging from 0-100, with 0 indicating very difficult to read
(college level) and 100 indicating very easy to read (mid-primary school). These formulae
have been reported to be valid, reliable, and highly correlated (Friedman & Hoffman-Goetz,
2006). In addition, they have been used in numerous research studies to assess the readability
of written healthcare materials (e.g., Aleligay, Worrall, & Rose, 2008; Foster & Rhoney,
2002; Wallace, Rogers, & Weiss, 2008). Four readability formulae were selected because
past research has found that the use of multiple formulae improves reliability (Friedman &
Hoffman-Goetz, 2006; Meade & Smith, 1991). The reliability for a single formula ranges
from 0.74 to 0.97, whilst the reliability for a combination of formulae ranges from 0.89 to
0.99 (Ley & Florio, 1996).
Table 3-1. Overview of formal assessment tools for healthcare materials

<table>
<thead>
<tr>
<th>Area Assessed</th>
<th>Assessment Tool</th>
<th>Reference</th>
<th>Variables</th>
<th>Interpretation / Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readability</td>
<td>Flesch Reading Ease Scale (FRE)</td>
<td>(Flesch, 1948)</td>
<td>Sentence length (number of words) and word length (number of syllables)</td>
<td>Reading Ease Scale (0 = very difficult to read; 100 = very easy to read)</td>
</tr>
<tr>
<td></td>
<td>Fry Readability Graph (Fry)</td>
<td>(Fry, 1968)</td>
<td>Sentence length (number of words) and word length (number of syllables)</td>
<td>Reading grade level</td>
</tr>
<tr>
<td></td>
<td>Flesch-Kincaid Readability Formula (F-K)</td>
<td>(Kincaid et al., 1975)</td>
<td>Sentence length (number of words) and word length (number of syllables)</td>
<td>Reading grade level</td>
</tr>
<tr>
<td></td>
<td>Fog Index (Fog)</td>
<td>(Gunning, 1968)</td>
<td>Sentence length (number of words) and word length (polysyllabic words)</td>
<td>Reading grade level</td>
</tr>
<tr>
<td>Content and Design</td>
<td>Suitability Assessment of Materials (SAM)</td>
<td>(Doak et al., 1996)</td>
<td><strong>Content</strong>: purpose, content topics, scope, and inclusion of a summary.</td>
<td>Percent score</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Literacy demand</strong>: reading grade level, writing style, vocabulary, sentence construction and use of headings.</td>
<td>a) 0-39%, inadequate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Graphics</strong>: cover graphic, type of illustrations, relevance of illustrations, directions accompanying graphics and use of captions.</td>
<td>b) 40-69%, Adequate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Layout &amp; Typography</strong>: layout, typography, number of items in lists.</td>
<td>c) 70-100%, Superior.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Learning stimulation &amp; motivation</strong>: use of interactive learning, modelling of specific behaviours, and enhancement of self-efficacy.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Cultural Appropriateness</strong>: match in logic, language and experience to the intended reader.</td>
<td></td>
</tr>
</tbody>
</table>
3.3.3 Procedure

Readability levels were determined for each user guide using the Windows-based software 'Reading Calculations’ version 7.5 (Readability Formulas Software, 2011). This program is able to evaluate the readability of documents using up to nine different readability formulae, including the formulae selected for this study. For each user guide, three 100-word passages were selected and entered into the readability program. The guidelines for the FRE, Fry, and F-K specify the selection of three, 100-word passages and guidelines for the Fog require at least 100 consecutive words. The three passages were taken from the same three sections in each user guide: 1) the battery section which generally covered handling, insertion, and replacement of batteries; 2) the section providing instruction on how to turn the aid on and off; and 3) the section on care and maintenance of the HA. If there were fewer than 100 words in any section, the remaining words were taken from instructions on volume control use. The specific topic areas were selected because they are included in all HA user guides, and the information contained within them is integral to successful HA use. Similar content material was assessed from each user guide because the reliability of reading formulae is dependent on the homogeneity of the text being assessed. Different samples of text from a manuscript are often written at different levels of difficulty depending on the topic area (Ley & Florio, 1996).

The word count for each passage started at the beginning of the specified section and ended at the sentence that finished nearest to the 100-word mark. Headings, sub-headings, captions, information contained in summary boxes or highlighted as ‘tips’ were not included in the word count. Each bullet point was counted as a sentence, and a full stop was inserted at the end. Words with hyphens (e.g., ear-set) were counted as two separate words. These steps in preparing the text passages were based on instructions provided with the readability tests and were also required for the software program.

Each user guide was rated by two experienced research audiologists using the SAM. Initially, the researchers applied the SAM to five user guides independently and then met to discuss how they rated each factor. From this discussion, a standardised procedure was developed to allow consistent interpretation of each item. The researchers then assessed all the user guides independently as well as re-rating the first five user guides. Any discrepancies in ratings were discussed and 100% concordance in the ratings was achieved. A discrepancy was defined as a different rating score applied to a particular factor by the two
researchers. In over 95% of cases the researchers applied the same rating to each factor (e.g., both applied a rating of 1 or both applied a rating of 2). This procedure is based on that used by Weintraub et al. (2004) in a study examining the suitability of prostate cancer brochures and pamphlets. In addition to formal tests, details of each user guide were recorded. These included, but were not limited to: the number and type of HAs covered in the user guide, number of pages, font size and type, number of graphics, and type of graphics. All topic areas covered in each user guide were also recorded and analysed.

3.3.4 Data analysis

Data were analysed using the Statistical Package for Social Sciences, version 20 (SPSS, 2011). Descriptive statistics were calculated for each readability formula and each user guide. Independent sample t-tests were used to determine if there was a significant difference between the mean readability score for: a) low- and mid-priced HAs and b) ITC and BTE HAs. Descriptive statistics were calculated for the SAM percentage score for the user guides. The percentage and number of user guides with a superior, adequate, and not suitable rating were calculated, and the mean ratings for each SAM category were analysed.

3.4 Results

The mean number of pages in the user guides was 39 (range = 16-66 pages), and the mean number of graphics was 26 (range = 6-82 graphics). Sixty four percent of user guides were printed almost entirely in black and white (some had colour on the front page). Table 3-2 shows the SAM scores and RGLs for each user guide. The mean overall SAM score for all user guides was adequate at 52% (range = 40-68%). No user guides received overall ratings of superior or not suitable. However, according to the test instructions (Doak et al, 1996), if the readability level is rated not suitable, the healthcare material must be considered not suitable regardless of the overall rating. Twenty five of the user guides (69%) received a not suitable rating for the factor of readability because the reading level was equal to or greater than 9th grade. Table 3-3 shows the number of ratings for each factor in each category of the SAM, and a summary of the major results for each of the six categories is presented in the following sections.
Table 3-2. Readability grade levels and Suitability Assessment of Materials Instrument (SAM) score for each user guide (ranked based on mean readability grade level score of F-K, Fry, and Fog)

<table>
<thead>
<tr>
<th>Manufacturer Code</th>
<th>Type of HA &amp; price range</th>
<th>F-K</th>
<th>Fry</th>
<th>Fog</th>
<th>Mean (F-K, Fry &amp; Fog)</th>
<th>FRE (verbal description)</th>
<th>SAM (total percent score)</th>
<th>SAM (verbal description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>ITC-mid</td>
<td>5.8</td>
<td>6.0</td>
<td>8.1</td>
<td>6.6</td>
<td>fairly easy</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>F</td>
<td>ITC-low</td>
<td>5.8</td>
<td>6.0</td>
<td>8.4</td>
<td>6.7</td>
<td>fairly easy</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>F</td>
<td>BTE-low</td>
<td>6.8</td>
<td>7.0</td>
<td>9.9</td>
<td>7.9</td>
<td>fairly easy</td>
<td>63</td>
<td>adequate</td>
</tr>
<tr>
<td>F</td>
<td>BTE-mid</td>
<td>7.3</td>
<td>8.0</td>
<td>9.6</td>
<td>8.3</td>
<td>standard</td>
<td>53</td>
<td>adequate</td>
</tr>
<tr>
<td>A</td>
<td>ITC-mid</td>
<td>6.9</td>
<td>8.0</td>
<td>10.2</td>
<td>8.4</td>
<td>standard</td>
<td>55</td>
<td>adequate</td>
</tr>
<tr>
<td>C</td>
<td>BTE-mid</td>
<td>7.1</td>
<td>8.0</td>
<td>10.1</td>
<td>8.4</td>
<td>standard</td>
<td>53</td>
<td>adequate</td>
</tr>
<tr>
<td>G</td>
<td>BTE-low</td>
<td>7.2</td>
<td>8.0</td>
<td>10.3</td>
<td>8.5</td>
<td>standard</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>I</td>
<td>BTE-mid</td>
<td>7.3</td>
<td>8.0</td>
<td>10.3</td>
<td>8.5</td>
<td>standard</td>
<td>60</td>
<td>adequate</td>
</tr>
<tr>
<td>I</td>
<td>BTE-low</td>
<td>7.3</td>
<td>8.0</td>
<td>10.4</td>
<td>8.6</td>
<td>standard</td>
<td>60</td>
<td>adequate</td>
</tr>
<tr>
<td>I</td>
<td>ITC-mid</td>
<td>7.3</td>
<td>8.0</td>
<td>10.4</td>
<td>8.6</td>
<td>standard</td>
<td>68</td>
<td>adequate</td>
</tr>
<tr>
<td>C</td>
<td>ITC-mid</td>
<td>7.6</td>
<td>8.0</td>
<td>11.1</td>
<td>8.9</td>
<td>standard</td>
<td>53</td>
<td>adequate</td>
</tr>
<tr>
<td>G</td>
<td>ITC-mid</td>
<td>7.5</td>
<td>9.0</td>
<td>10.4</td>
<td>9.0</td>
<td>standard</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>A</td>
<td>BTE-mid</td>
<td>7.3</td>
<td>9.0</td>
<td>11.0</td>
<td>9.1</td>
<td>standard</td>
<td>58</td>
<td>adequate</td>
</tr>
<tr>
<td>G</td>
<td>BTE-mid</td>
<td>7.6</td>
<td>9.0</td>
<td>10.8</td>
<td>9.1</td>
<td>standard</td>
<td>45</td>
<td>adequate</td>
</tr>
<tr>
<td>A</td>
<td>ITC-low</td>
<td>7.6</td>
<td>9.0</td>
<td>11.1</td>
<td>9.2</td>
<td>standard</td>
<td>60</td>
<td>adequate</td>
</tr>
<tr>
<td>C</td>
<td>ITC-low</td>
<td>8.0</td>
<td>10.0</td>
<td>10.5</td>
<td>9.5</td>
<td>standard</td>
<td>50</td>
<td>adequate</td>
</tr>
</tbody>
</table>
Table 3-2. Readability grade levels and Suitability Assessment of Materials Instrument (SAM) score for each user guide (ranked based on mean readability grade level score of F-K, Fry, and Fog) (continued)

<table>
<thead>
<tr>
<th>Manufacturer Code</th>
<th>Type of HA &amp; price range</th>
<th>F-K</th>
<th>Fry</th>
<th>Fog</th>
<th>Mean (F-K, Fry &amp; Fog)</th>
<th>FRE (verbal description)</th>
<th>SAM (total percentage score)</th>
<th>SAM (verbal description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>ITC-low</td>
<td>7.9</td>
<td>10.0</td>
<td>10.8</td>
<td>9.6</td>
<td>standard</td>
<td>53</td>
<td>adequate</td>
</tr>
<tr>
<td>E</td>
<td>ITC-low</td>
<td>8.0</td>
<td>11.0</td>
<td>10.3</td>
<td>9.8</td>
<td>fairly difficult</td>
<td>60</td>
<td>adequate</td>
</tr>
<tr>
<td>H</td>
<td>ITC-low</td>
<td>8.1</td>
<td>10.0</td>
<td>11.3</td>
<td>9.8</td>
<td>standard</td>
<td>40</td>
<td>adequate</td>
</tr>
<tr>
<td>I</td>
<td>ITC-low</td>
<td>8.7</td>
<td>9.0</td>
<td>11.8</td>
<td>9.8</td>
<td>standard</td>
<td>63</td>
<td>adequate</td>
</tr>
<tr>
<td>E</td>
<td>ITC-mid</td>
<td>8.1</td>
<td>11.0</td>
<td>10.8</td>
<td>10.0</td>
<td>fairly difficult</td>
<td>60</td>
<td>adequate</td>
</tr>
<tr>
<td>H</td>
<td>ITC-mid</td>
<td>8.3</td>
<td>10.0</td>
<td>11.7</td>
<td>10.0</td>
<td>standard</td>
<td>43</td>
<td>adequate</td>
</tr>
<tr>
<td>A</td>
<td>BTE-low</td>
<td>8.2</td>
<td>11.0</td>
<td>11.5</td>
<td>10.2</td>
<td>fairly difficult</td>
<td>55</td>
<td>adequate</td>
</tr>
<tr>
<td>H</td>
<td>BTE-low</td>
<td>8.7</td>
<td>10.0</td>
<td>12.1</td>
<td>10.3</td>
<td>fairly difficult</td>
<td>43</td>
<td>adequate</td>
</tr>
<tr>
<td>B</td>
<td>BTE-low</td>
<td>8.8</td>
<td>10.0</td>
<td>12.7</td>
<td>10.5</td>
<td>fairly difficult</td>
<td>43</td>
<td>adequate</td>
</tr>
<tr>
<td>B</td>
<td>BTE-mid</td>
<td>8.9</td>
<td>10.0</td>
<td>12.7</td>
<td>10.5</td>
<td>fairly difficult</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>C</td>
<td>BTE-low</td>
<td>9.2</td>
<td>10.0</td>
<td>12.7</td>
<td>10.6</td>
<td>fairly difficult</td>
<td>48</td>
<td>adequate</td>
</tr>
<tr>
<td>D</td>
<td>ITC-mid</td>
<td>8.9</td>
<td>11.0</td>
<td>12.0</td>
<td>10.6</td>
<td>fairly difficult</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>H</td>
<td>BTE-mid</td>
<td>9.1</td>
<td>11.0</td>
<td>11.9</td>
<td>10.7</td>
<td>fairly difficult</td>
<td>40</td>
<td>adequate</td>
</tr>
</tbody>
</table>
Table 3-2. Readability grade levels and Suitability Assessment of Materials Instrument (SAM) score for each user guide (ranked based on mean readability grade level score of F-K, Fry, and Fog (continued))

<table>
<thead>
<tr>
<th>Manufacturer Code</th>
<th>Type of HA &amp; price range</th>
<th>F-K</th>
<th>Fry</th>
<th>Fog</th>
<th>Mean (F-K, Fry &amp; Fog)</th>
<th>FRE (verbal description)</th>
<th>SAM (total percentage score)</th>
<th>SAM (verbal description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>BTE-mid</td>
<td>9.0</td>
<td>11.0</td>
<td>12.4</td>
<td>10.8</td>
<td>fairly difficult</td>
<td>50</td>
<td>adequate</td>
</tr>
<tr>
<td>D</td>
<td>ITC-low</td>
<td>9.2</td>
<td>11.0</td>
<td>12.6</td>
<td>10.9</td>
<td>fairly difficult</td>
<td>40</td>
<td>adequate</td>
</tr>
<tr>
<td>B</td>
<td>ITC-low</td>
<td>9.1</td>
<td>11.0</td>
<td>13.0</td>
<td>11.0</td>
<td>fairly difficult</td>
<td>58</td>
<td>adequate</td>
</tr>
<tr>
<td>B</td>
<td>ITC-mid</td>
<td>9.1</td>
<td>11.0</td>
<td>13.0</td>
<td>11.0</td>
<td>fairly difficult</td>
<td>65</td>
<td>adequate</td>
</tr>
<tr>
<td>D</td>
<td>BTE-low</td>
<td>9.4</td>
<td>11.0</td>
<td>12.9</td>
<td>11.1</td>
<td>fairly difficult</td>
<td>40</td>
<td>adequate</td>
</tr>
<tr>
<td>E</td>
<td>BTE-mid</td>
<td>9.5</td>
<td>15.0</td>
<td>12.4</td>
<td>12.3</td>
<td>fairly difficult</td>
<td>60</td>
<td>adequate</td>
</tr>
<tr>
<td>E</td>
<td>BTE-low</td>
<td>10.0</td>
<td>15.0</td>
<td>13.2</td>
<td>12.7</td>
<td>difficult</td>
<td>48</td>
<td>adequate</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>8.08</td>
<td>9.67</td>
<td>11.23</td>
<td>9.66</td>
<td></td>
<td>52.42</td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td></td>
<td>1.01</td>
<td>1.96</td>
<td>1.27</td>
<td>1.35</td>
<td></td>
<td>7.69</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>5.8 to 10.0</td>
<td>6.0 to 15.0</td>
<td>8.1 to 13.2</td>
<td>6.6 to 12.7</td>
<td>40 to 68</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3-3. Total number of ratings for each factor on the Suitability of Assessment of Materials Instrument

<table>
<thead>
<tr>
<th>Category</th>
<th>Factor</th>
<th>Superior</th>
<th>Adequate</th>
<th>Not Suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Superior</td>
<td>Adequate</td>
<td>Not Suitable</td>
</tr>
<tr>
<td>Content</td>
<td>Purpose is evident</td>
<td>29</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Content about behaviours</td>
<td>34</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Scope is limited</td>
<td>3</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Summary or review included</td>
<td>9</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Literacy Demand</td>
<td>Reading grade level</td>
<td>0</td>
<td>11</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Writing style, active voice</td>
<td>1</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Vocabulary uses common words</td>
<td>2</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Context is given first</td>
<td>27</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Learning aids via “road signs”</td>
<td>14</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>Graphics</td>
<td>Cover graphic shows purpose</td>
<td>0</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Type of graphics</td>
<td>30</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Relevance of illustrations</td>
<td>7</td>
<td>29</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>List, tables, etc. Explained</td>
<td>12</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Captions used for graphics</td>
<td>0</td>
<td>1</td>
<td>35</td>
</tr>
<tr>
<td>Layout and Typography</td>
<td>Layout factors</td>
<td>17</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Typography</td>
<td>1</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Subheadings (chunking) used</td>
<td>2</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Learning Stimulation,</td>
<td>Interaction used</td>
<td>0</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>Motivation</td>
<td>Behaviours are modelled and specific</td>
<td>16</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Motivation; self-efficacy</td>
<td>0</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Cultural Appropriateness</td>
<td>Match in logic, language experience</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>Cultural images and examples</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>
3.4.1. Content
The majority of user guides stated the purpose in the title, and the content was generally
behaviour based. However, scope was expanded beyond the purpose in 33 user guides
(92%). Ideally, scope should be limited to essential information directly related to the
purpose of the material. In the case of a HA user guide, this should be instruction and
information pertaining to the HA for which the reader is fitted. However, 33 user guides
included information on a variety of models and types of HAs as opposed to a single device.
In regard to BTE HAs, the mean number of aid models with different controls and functions
addressed in the user guides was 2.7 (range = 1-7), and the mean number of different mould
types, such as conventional mould, ear tip, and receiver-in-the-ear, was 2.5 (range = 1-5).

Likewise, for the ITC user guides, the mean number of aid models with different controls and
functions, such as completely-in-the-canal (CIC) and in-the-ear (ITE), was 3.4 (range = 1-5).
The mean number of graphics in all user guides was 26 but the mean number relevant to the
HA was only 19. A summary section, containing important information about the HA (e.g.,
battery size), was included in 67% of user guides but was only rated superior in 38% of these.
The most common information contained in the summary section included details on
listening programs, battery size/type, HA model details, serial number/s, and type of indicator
tones. Only four user guides (all from the same manufacturer - F in Table 3-2) contained a
’quick guide’ providing an overview of basic HA functions such as how to turn the device on
and off.

In addition to the SAM, the topic areas covered in the user guides were analysed. Topic areas
included in all user guides were: a) removal and insertion of HA; b) turning HA off and on;
c) battery indicator tones (e.g., low battery); d) changing the battery; e) battery hazard
warnings; and f) warnings regarding exposure to high humidity, moisture, and extreme heat.
In addition, every user guide contained a section on ‘troubleshooting’. The main topics were
what to do if: a) the HA is dead (94%); b) the volume is too soft (92%); c) the HA whistles in
the ear (83%); d) the HA is intermittent (56%); and e) the sound is distorted or unclear (56%).
There were 17 other troubleshooting topics but the majority were only included in a couple of
user guides (e.g., what to do if the HA is weak on the phone).
3.4.2. Literacy demand
The RGL was rated not suitable in 25 (69%) user guides and was not rated superior in any user guide (see Table 3-3). A superior rating is provided if the RGL is 5th grade or lower. An example of a sentence from a user guide with a RGL of above 12th grade is “Your hearing care professional can program the multi control to have only one function or to operate for program changes on one ear and volume level changes on the other ear, if you find this helpful”. Only two user guides (6%) scored superior for vocabulary because uncommon words, technical words, and jargon were often used in lieu of common words (e.g., “ergonomic designed push-button” for button, “desiccator” for dry-aid kit, “remedied” for fixed, “acclimatize” for get used to, and “spira flex sound tube” for tube).

3.4.3. Graphics
Type of graphics was rated superior for the majority of user guides (83%). Graphics are rated superior if they consist of simple, adult-appropriate line drawings. Approximately three quarters (78%) of the graphics were simple black and white drawings of which approximately a quarter (22%) had small amounts of colour to draw attention to important detail. However, the majority of user guides failed to use captions to explain graphics. According to Doak et al. (1996), captions are important because they tell the reader what the graphic is about and where to focus within the graphic. The cover graphic was rated not suitable in half the user guides (53%) because it did not clearly depict the purpose of the material to the reader.

3.4.4. Layout and typography
Layout factors scored superior or adequate for the majority of user guides. Positive features included the placement of graphics on the same page as related text and the use of visual cuing devices (e.g., shading, boxes, arrows) to direct attention to specific points or key content. Common problem areas included the use of gloss or semi-gloss paper, inadequate white space to reduce the appearance of clutter, too many words per line, and low contrast between the text and paper. Typography scored adequate in all but one user guide. The text was in sentence case for all user guides, and typographic cues, such as bolding or colour, were used to emphasize key points. However, the font size was smaller than 12 point in 86% of user guides, which was the main reason why none received a superior rating on this factor.
3.4.5. Learning stimulation and motivation

Learning stimulation and motivation refers to how well the material equips and motivates the reader to successfully apply the information to their circumstance. In the SAM it comprises three factors: a) interaction included in text and/or graphics, b) modelling of desired behaviour patterns in specific terms, and c) motivation and self-efficacy. According to Doak et al. (1996), interaction encompasses “problems or questions presented for reader responses” (p.57) and enhances retention of information in long-term memory. Although it is important for learning stimulation, it was not used in any user guides, and hence all were rated not suitable for this factor. The second factor (modelling of desired behaviour patterns), scored superior for 44% of user guides and adequate for the remaining 56% of user guides. A major problem was inclusion of excessive amounts of technical information, such as complex mathematical equations, in the section on mobile phone and HA compatibility. The factor ‘motivation and self-efficacy’ scored not suitable for a quarter of user guides and adequate for the remainder. Some HA tasks, such as cleaning the device, were presented in a manner that was difficult to follow which may result in a reduction in motivation, confidence, and self-efficacy for the HA user attempting to learn these skills.

3.4.6. Readability

Table 3-2 shows the user guides tabulated in ascending order according to their mean RGL on the F-K, Fry, and Fog readability tests. The mean RGL for all user guides was grade 9.6 (range = 6.6-12.7). Thirty three (92%) had a mean reading level of grade 8 or higher. The RGL was not significantly different for user guides for low-priced compared to mid-priced HAs (t = .743, df = 34, p = .463, two-tailed) or for ITC compared to BTE HAs (t = 1.081, df = 34, p = .287, two-tailed). The mean readability level was different for each of the three formulae and ranged from 8.1 on the F-K to 11.2 on the Fog. It is well established that although the formulae have high inter-correlations, they assign different grade values to a piece of text. For this reason it is important to use more than one formula and to take the average of the results (Ley & Florio, 1996). On the FRE, almost half of the user guides (44%) were rated as being ‘fairly difficult’ or ‘difficult’ to read. None rated as ‘very easy’ or ‘easy’ to read, and only three rated ‘fairly easy’ to read.
3.5 Discussion

The aim of this study was to analyse the content, design, and readability of printed HA user guides to determine if they are suitable for older adults. On the SAM, the user guides were all rated adequate for overall suitability. Strengths of the user guides included the fact that content was generally behaviour based, and the graphics consisted of simple, line drawings. Research clearly indicates that this type of graphic is best for healthcare materials because it has the least distracting elements (Houts et al., 2006). In addition, there was good use of visual cuing devices (e.g., colour, arrows, and boxes) to emphasize key points in the text or to direct the reader’s attention to important detail in a graphic. The use of visual cuing devices is recommended because poor readers often have difficulty finding the most important information on a page (e.g., Houts et al., 2006; Doak et al., 1996).

The majority of user guides exhibited a number of common weaknesses on the SAM, of which four are discussed: scope, layout and typography, vocabulary, and reading level. The remainder are outlined in Table 3-4. First, scope was expanded beyond the purpose of the material. Over 90% of user guides included instructions for more than one HA with different functions, features, and controls. This may cause confusion for the reader, and it would be better if each user guide was limited to HAs with the same features and controls. Second, aspects of the layout and typography did not adhere to best practise guidelines. In particular, gloss or semi-gloss paper was frequently used, there was often low contrast between the text and paper (e.g., black text on a blue background), and font size was too small. This is problematic because all older adults have subtle changes in their vision which can affect their ability to read printed healthcare material. These include difficulty focusing on close targets, loss of low-contrast acuity, increased sensitivity to glare, and reduced text navigation skills (Watson, 2009). Hence, it is recommended to use matte paper, black text on a white background, and a font size of at least 12 to 14 point (Doak et al., 1996; National Cancer Institute, 2003; Centers for Disease Control and Prevention, 2009). Third, there was frequent use of uncommon words, technical words, and jargon in lieu of common words. Fourth, the reading level was rated not suitable in 25 (69%) of user guides and adequate in the remainder. A not suitable rating applies if the reading level on the Fry is equal to or greater than grade 9. According to Doak et al. (1996) the readability level “must be considered as potential go-no/go signals for suitability regardless of the overall rating” (p.52).
The reading level for the SAM is based on the score calculated using the Fry formula. In this study three other readability formulae were used in addition to the Fry (see Table 3-2), and the mean RGL for these was grade 9.6 (compared to grade 9.7 on the Fry). The mean RGL was not significantly different for user guides for low-priced compared to mid-priced HAs or for ITC compared to BTE HAs. The mean RGL for the user guides is substantially higher than the reading level recommended for healthcare materials which ranges from third to sixth-grade (e.g., Davis et al., 1996; Doak et al., 1996). The mean RGL is lower than that reported by Kelly (1996) who measured the readability of 55 HA user guides using the FRE formula and found that 73% were written at college level. However, it is virtually the same as that reported by Nair and Cienkowski (2010). Their study assessed 12 HA user guides using the F-K formula and found a mean RGL of 7.96. The mean RGL on the F-K for this study was grade 8.08. Taken together, these results indicate that HA user guides produced in 2010/2011 are easier to read (based on RGL) than those produced in 1996. Despite this, the reading level remains too high. HA user guides should be written at mid-primary school level and not mid-high school level, as older adults often have cognitive, visual, and health literacy deficits that impact on their ability to read and comprehend text (Australian Institute of Health and Welfare, 2005; Krauss Whitbourne, 2005; Watson, 2009; Kutner et al., 2006). This is particularly pertinent when the material relates to learning a new skill such as managing a HA.

HA user guides are only effective if they can be easily understood and used by the target reader. A poorly designed HA user guide that is difficult to follow and understand may lead to low HA self-efficacy and reduced hearing aid uptake (Meyer, Hickson, & Fletcher, 2014). HA self-efficacy refers to the degree of confidence one has in their ability to care for and use their HA/s successfully (West & Smith, 2007). A HA user may make additional clinic appointments for issues that could easily be addressed at home using an easy-to-read trouble shooting guide, or may be unable to gain full benefit from the HA because they do not understand how to use it on the phone or how to change a listening program.

Table 3-4 provides information on how to improve HA user guides. There exists scope to implement these suggestions in a cost-effective manner using modern computer technology. A simple modification would be for each page of a HA user guide downloaded from a manufacturer’s web page to print on an entire A4 page rather than just a small section in the middle. This would result in larger graphics and text size, hence improving useability for
older adults. Second, user guides could be computer based, whereby the audiologist or client
selects relevant pages and sections from drop-down lists (e.g., type of aid, type of mould,
listening programs, and relevant functions and features). Based on the information entered, a
personalised user guide with the client’s name and HA type shown on the front cover would
be downloaded and could be read on-line or printed. Third, online user guides could be
linked to short video clips to demonstrate HA functions such as how to turn the device on and
off.

A limitation of this study is that the SAM has a subjective element in that there is latitude
allowed in interpretation of criteria. An attempt was made to minimise this by having two
research audiologists evaluate each user guide and discuss discrepancies until agreement was
reached. This research has highlighted the fact that the content, design, and readability of HA
user guides is not optimal for older adults. In future studies we are investigating whether HA
user guides, developed according to ‘best practice’ guidelines for older adults, result in
improved comprehension and enhanced ability to use the information to successfully manage
a HA. In addition, factors that impact on older adults’ ability to comprehend and use written
HA user guides successfully (e.g., age, dexterity, cognition, vision, and self-efficacy etc) are
being examined.

3.6 Conclusions

The aim of this study was to analyse the content, design, and readability of printed HA user
guides to determine if they are suitable for older adults. The results show that HA user
guides are not optimal for this population, and there is a great deal of scope for improvement.
The findings are of concern because poorly designed HA user guides may impact on HA self
efficacy, outcomes, and success. Major weaknesses of HA user guides based on the SAM
analysis included: inclusion of too many HA models in each user guide, frequent use of
uncommon vocabulary, small text size and graphics, excessive amounts of technical
information, and problems with layout. In addition, the mean reading level was grade 9.6
which is too high for older adults.
Table 3-4. Major weaknesses of hearing aid user guides and suggestions for improvement

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
<th>Suggestion/s for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ scope</td>
<td>Too many aids with different functions, features and controls, in &gt;90% of user guides.</td>
<td>Limit each user guide to aid/s with the same features and controls.</td>
</tr>
<tr>
<td>Content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ summary</td>
<td>No summary section (Hearing Aid Details Page) in 33% of user guides.</td>
<td>Include a summary section in user guide.</td>
</tr>
<tr>
<td>Literacy Demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ Reading Grade Level</td>
<td>Reading grade level too high in all user guides.</td>
<td>Use a reading level of between 3rd and 6th grade.</td>
</tr>
<tr>
<td>Literacy Demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ vocabulary</td>
<td>Uncommon words, technical words and jargon often used in lieu of common words in &gt;90% of user guides.</td>
<td>Use common words where possible. If an uncommon word or technical word must be used, ensure a definition is included.</td>
</tr>
<tr>
<td>Graphics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ captions</td>
<td>Virtually no use of captions to describe graphics.</td>
<td>Insert an explanatory caption under every graphic.</td>
</tr>
</tbody>
</table>
Table 3-4. Major weaknesses of hearing aid user guides and suggestions for improvement (continued)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
<th>Suggestion/s for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout &amp; Typography</td>
<td>Frequent problem: use of gloss or semi-gloss paper; inadequate white space to reduce appearance of clutter; too many words per line; and low contrast between text and paper (e.g., blue text on a gray background).</td>
<td>- Use black text on white background.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Increase size of user guide.</td>
</tr>
<tr>
<td>Layout &amp; Typography</td>
<td>Font was too small in all user guides (&lt;12 point in majority).</td>
<td>- Use a size 12 to 14 point font.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Include options to print user guide from manufacturer’s website in 14 point font for older people with vision problems.</td>
</tr>
<tr>
<td>Learning stimulation and</td>
<td>No interactive learning stimulation in any user guide.</td>
<td>Include interactive learning. For example: Present headings as questions; include a quiz at the end; use a format or questions that encourages the reader to apply the information to his/her own situation; provide a means of keeping track of progress (e.g., number of hours aid worn per day).</td>
</tr>
<tr>
<td>motivation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

90
<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
<th>Suggestion/s for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning stimulation and</td>
<td>Excessive amount of technical information included in many</td>
<td>Include only essential technical information. Any other technical data should be in a separate section at the back of the user guide.</td>
</tr>
<tr>
<td>motivation</td>
<td>user guides.</td>
<td></td>
</tr>
<tr>
<td>→ type of information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning stimulation and</td>
<td>Self-efficacy and motivation likely to be affected by all</td>
<td>-See above.</td>
</tr>
<tr>
<td>motivation</td>
<td>issues outlined in this table.</td>
<td>-Include a testimonial.</td>
</tr>
<tr>
<td>→ self-efficacy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.7 References


SPSS 2011. Chicago, IL: SPSS Inc.


Chapter 4: Assembly and Insertion of a Self-Fitting Hearing Aid: Design of Effective Instruction Materials


This chapter is inserted as submitted for publication, with the exception of 1) formatting changes to headings, tables, and figures to maintain consistency throughout the thesis; 2) modifications suggested by the thesis examiners (shown in bold).
4.1 Abstract

Objectives: A self-fitting hearing aid has been proposed as a viable option to meet the need for rehabilitation in areas where audiology services are unreliable. A successful outcome with a self-fitting hearing aid pivots in part on the clarity of the instructions accompanying the device. The aims of this paper were: 1) review the literature to determine features that should be incorporated into written healthcare materials and factors to consider in the design process when developing written instructions for a target audience of older adults; and 2) to apply this information to the development of a set of written instructions as the first step in self-fitting of a hearing aid; assembling four parts and inserting the aid into the ear.

Design: The method involved a literature review of published peer reviewed research.

Results: The literature revealed four steps in the development of written healthcare materials: planning, design, assessment of suitability, and pilot testing. Best practice design principles for each step were applied in the development of instructions for how to assemble and insert a hearing aid. Separate booklets were developed for the left and right aids and the content of each consisted of simple line drawings accompanied by captions. The reading level was Grade 3.5 equivalent and the Flesch Reading Ease score was 91.1 indicating that the materials were ‘very easy’ to read.

Conclusions: It is essential to follow best practice design principles when developing written healthcare materials in order to motivate the reader, maximize comprehension, and increase the likelihood of successful application of the content.

Keywords: self-fitting hearing aid; written instructions; health literacy; patient education; older adults
4.2 Introduction

This article outlines the process involved in the design and development of written instructions for assembly of a self-fitting hearing aid (SFHA). A SFHA is an amplification device that users can program and fit to themselves without the need for a previous audiogram, access to a computer, or assistance from an audiologist. In the absence of an audiologist, the client and/or significant other is required to assemble the device, fit, and program it using written instructions.

A concept for a SFHA was developed at the National Acoustic Laboratories (NAL) and a comprehensive overview of it is provided by Convery, Keidser, Dillon, and Hartley (2011). The three main components of a SFHA are a) the hearing aid body (part that sits behind the ear), b) a dome (part that sits inside the ear) and, c) a tube (part that hangs over the ear and connects the dome to the hearing aid body). Adults’ ears vary in size, hence the domes and tubes come in different sizes and the correct size must be selected for a comfortable fit. Therefore, the first step of a SFHA is for the end user to select the best size dome and tube for him/her and to assemble the parts to the hearing aid body. The research team was interested to know if older adults with a hearing impairment were able to assemble the parts, insert the device in the ear, and switch on both left and right devices with assistance from a friend or family member (significant other), and using written instructions only. As such, the design, content, and suitability of the written instructions were pivotal to success.

To design effective written instructions it is imperative to consider key characteristics of the target audience including age, race/ethnicity, and health literacy level. The target audience for the current instructions was older, community dwelling adults living in Australia. This is highly relevant as the prevalence of hearing loss is highest in older people aged 60 years and above, and hence the market for SFHAs is likely to be greatest in this population. Hearing loss occurs in approximately 40% of adults in their 60s, 60% of adults in their 70s, and 90% of adults in their 80s and above (Chia et al., 2007; D. H. Wilson et al., 1999). Overall, hearing levels decrease on average 1dB per year for adults aged above 60, depending on gender, age, and initial levels (Lee, Matthews, Dubno, & Mills, 2005). It is also likely that the market for such devices will be greatest in the developing world where the cost of hearing aids is prohibitive; however, designing and testing instructions for this population is beyond the scope of the current study.
A key consideration in developing instructions was the fact that a significant percentage of older adults have limited health literacy (Gausman Benson & Forman, 2002; Gazmararian et al., 1999). Health literacy refers to “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000, p. 1). The terms literacy and health literacy are often used interchangeably but have important distinctions. Literacy is more general and refers to the ability to read, write, and understand in one’s native language whilst health literacy refers to these skills applied in the context of healthcare (Mayer & Villaire, 2007). Research findings show that adults with limited health literacy have poorer health status, less health knowledge, higher healthcare costs, higher utilization of health services, and are less likely to comply with self-management regimes for chronic health conditions (Baker et al., 2002; Baker, Parker, & Williams, 1997; Gazmararian, Williams, Peel, & Baker, 2003; Howard, Gazmararian, & Parker, 2005; Williams, Baker, & Parker, 1998).

Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, and Rudd (2005) conducted a systematic review examining the prevalence of limited health literacy and found that participants’ age was significantly associated with the rate of low literacy. Studies with a mean age above 50 years showed a prevalence of low literacy of 38%. The largest study of health literacy was conducted by the National Assessment of Adult Literacy (NAALs) (Kutner, Greenberg, Jin, and Paulsen, 2006) and involved approximately 19,000 adult participants. It revealed that adults aged 65 years and above had lower average health literacy than adults in younger age groups. Twenty nine percent of adults aged >65 years had ‘below basic’ health literacy compared to approximately 10% in younger age groups, and only 3% had proficient health literacy. It has been postulated that lower health literacy levels in older adults may be associated with fewer years of education (Weiss, Reed, and Kligman, 1995) and/or age-related changes in cognitive performance (e.g., working memory) that can affect reading and comprehension abilities (Van der Linden et al., 1999).

A wealth of information is available on how to design written healthcare materials suitable for people with limited health literacy. Early research in the area focused on improving readability by using short simple words and sentences (Wilson, Mood, & Nordstrom, 2010). More recently, researchers have highlighted the importance of attending to a myriad of other design elements, in addition to readability (Doak, Doak, Friedell, & Meade, 1998; Seligman
et al., 2007). These include text cohesion, organization, layout, graphics, writing style, cultural factors, and the amount of information presented (Doak, Doak, & Root, 1996; Liu, Kemper, & Bovaird, 2009; Meade & Smith, 1991). In addition, it is important to consider cognitive factors such as demands on working memory (Wilson & Wolf, 2009). According to Wilson and Wolf (2009, p. 319) “design elements that minimize the amount of working memory necessary to decode new information will allow individuals to siphon more resources towards comprehending the core messages that designers are attempting to convey”.

Research suggests that well-designed written materials are preferred by all readers, regardless of their literacy level and that comprehension is significantly higher than for less easy-to-read materials (Paul, Redman, & Sanson-Fisher, 1997). For example, Davis et al. (1996) used a randomized trial methodology to compare reading time and comprehension of two vaccine information pamphlets with one designed to be easy-to-read. The easy-to-read pamphlet contained less words, instructional graphics, and was written at a lower reading level compared with the other pamphlet. Mean reading time was significantly shorter and mean comprehension levels were significantly higher for the easy-to-read pamphlet for readers with both high and low health literacy levels. According to Davis et al. (1996, p. 808) readers with good health literacy could comprehend the more complex pamphlet but prefer a simpler pamphlet because “it is easier to understand and can be read in one fourth the time”. Despite these findings, more than 300 research studies indicate that written healthcare materials often far exceed the average reading ability of the target client group (Griffin, McKenna, & Tooth, 2006; Nielsen-Bohlman, Panzer, & Kindig, 2004; Sarma, Alpers, Prideaux, & Kroemer, 1995). For example, Friedman and Hoffman-Goetz (2006) conducted a systematic review on the readability of print and web based cancer information. The mean reading grade level in the 16 studies ranged from grade 6 to 14 despite the recommended reading level of grade 3 to 6 (Davis et al., 1996; Doak et al., 1996; Meade, McKinney, & Barnas, 1994) for printed healthcare material. This has broad implications because “information that is written above the reading level of patients is useless and contributes to loss of time and money” (Meade & Smith, 1991, p. 153).

In summary, success of a SFHA pivots, in part, on the design and content of the written instructions, because an audiologist will not be on-hand to assist. It is important that the instructions are tailored to the target audience which is likely to consist of older adults, of
whom approximately 30% are likely to have limited health literacy. Studies show that well
designed written materials result in higher information recall, comprehension, and
understanding for people with both high and low health literacy.

4.2.1 Aims
The aims of this paper were to:
1) Review the literature to determine features that should be incorporated into written
healthcare materials and factors to consider in the design process when developing written
instructions for a target audience of older adults.
2) Apply this information to the development of a written instruction document for the
SFHA, the purpose of which was to guide the hearing impaired adult and a significant other
through the process of assembling, inserting, and switching on the right and left aids.
Henceforth, this subset of instructions relevant to the SFHA are referred to as the SFHA
instructions.

4.3 Method
Relevant research articles were initially located by conducting searches of PsycINFO, Web of
Science, Medline, and Scopus databases from 2000 to 2010, using the search term ‘health
literacy’. Additional articles were found from the reference lists of retrieved articles. Both
research studies and literature reviews were examined with emphasis placed on studies
including experimental control group comparisons. In addition, information was sourced
from a range of health literacy textbooks (Mayer & Villaire, 2004; Nielsen-Bohlman, Panzer,
& Kindig, 2004; Schwartzberg, VanGeest, & Wang, 2005; Zarcadoolas, Pleasant, & Greer,
2006).

4.4 Results/Discussion
The review of the literature identified four steps in the development of written healthcare
materials (see Figure 4-1). These are planning, design, assessment of suitability, and pilot
testing. This section provides information on each of these steps, including background
theory and application to the SFHA instructions. Some recommendations are not
incorporated into the instructions because they are more suited to longer text documents but
are included in this article for completeness. Five pages from the SFHA instructions for the right ear are shown in Figure 4-2 and will be referred to throughout this article.

Figure 4-1. Four steps in the development of written healthcare materials
1. The parts for the right hearing aid are in the red bag. The parts for the left hearing aid are in the blue bag.
2. Open the red bag and take out the parts. Do not open the blue bag yet.
3. Check you have all the parts:

   - Hearing aid body
   - Three (3) tubes
   - Three (3) domes
   - Battery

4. Now you will put the parts together. Please follow the steps shown on the next few pages. This is how the hearing aid will look when you are finished.

   - Tube
   - Hearing aid body
   - Dome

**Figure 4-2a**

**Figure 4-2b**

**Step 1 – Select the tube**

1. Put the three tubes on the table in front of you. Each tube is a different length. The sizes are short, medium, and long. Place them in order from shortest to longest.
2. Select the medium tube. Put the other tubes away.

**Step 2 – Select the dome**

1. Put the three domes on the table in front of you. Each dome is a different size. The sizes are small, medium, and large. Place them in order from smallest to largest.
2. If you are a woman, select the medium dome. If you are a man, select the large dome. Put the other domes away.

**Figure 4-2c**

**Figure 4-2d**

Figure 4-2 Example pages taken from the SFHA instructions
Figure 4-2e

Figure 4-2 Example pages taken from the SFHA instructions (continued)
4.4.1 Planning

The first stage in the development process is to convene a working team of key stakeholders which may include healthcare providers, topic experts, patients, and/or family members (Seligman et al., 2007). The initial goal for the team is to define the target audience for a SFHA and characteristics of it, including age, education level, race/ethnicity, health literacy, and topic knowledge (Bernier, 1993; Centers for Disease Control and Prevention, 2009; National Cancer Institute, 2003). This may be achieved through checking existing sources of information such as health statistics (National Cancer Institute, 2003), or engaging directly with a sample of the audience through interviews, focus groups, and/or surveys (Centers for Disease Control and Prevention, 2009; National Cancer Institute, 2003). Second, the team must identify the purpose and key objectives for the instructions (Bernier, 1993; National Cancer Institute, 2003; Seligman et al., 2007). Research findings indicate that it is best to limit the scope by focusing on two to three concepts only as this leads to enhanced information recall (Bernier, 1993; Seligman et al., 2007).

A multi-disciplinary team was convened to design the SFHA instructions. Team members included a clinical audiologist, a speech pathologist, and research audiologists. The team communicated weekly by phone and/or in person during the planning and design phases. The target audience was defined as older, community dwelling adults with a hearing impairment, living in Australia. Research was conducted by the team to determine key characteristics of the target audience. Sources of information included research papers and textbooks on both ageing and health literacy. As outlined in the introduction, the main finding was that approximately 30% of older adults have limited health literacy. In addition, a substantial percentage of older adults have age-related deterioration in visual function (Australian Institute of Health and Welfare, 2005; Bergman & Sjostrand, 2002), visual-reading ability (Watson, 2009), processing speed (Salthouse, 1996), attention (Krauss Whitbourne, 2005), and memory (Park et al., 2002) which may impact on their ability to read and use instructions. Each participant was required to bring along a friend or family member to assist, but as the significant other could be of any age or background, key characteristics of the group were likely to be varied. Previous hearing aid experience was not a requirement for either the participant or the significant other, hence it was envisaged that hearing aid knowledge could range from none to quite extensive. The purpose and key objectives for the project, as determined by the team, are included in Table 4-1.
Table 4-1. Details of the self-fitting hearing aid instructions

<table>
<thead>
<tr>
<th><strong>Purpose</strong></th>
<th>To provide written instructions on how to assemble, insert in the ear and turn on both the right and left SFHA.</th>
</tr>
</thead>
</table>
| **Key objectives** | • Recognize and name components of aid  
• Select optimum tube length from a choice of three lengths  
• Select optimum dome size from a choice of three sizes  
• Assemble tube, dome, hearing aid body, and battery  
• Insert assembled device into own ear  
• Press the start button to generate a tone |
| **Number of booklets** | One for the right aid and one for the left aid |
| **Pages in each booklet** | 16 |
| **Page Size** | A4 – printed on 2 sides |
| **Colours** | Black text on white matte paper |
| **Flesch-Kincaid Grade reading level** | Grade level 3.4 |

4.4.2 Design

There are five elements that need to be considered in the design of written materials: content, language, layout/typography, organization, and graphics. Five key recommendations for each element are summarized in Table 4-2.
Table 4-2. Recommendations for designing written healthcare education materials for older adults

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Recommendations</th>
</tr>
</thead>
</table>
| Content                 | • Limit scope – focus on two to three concepts  
  • Give priority to information that is behaviour focused (‘how to’ information).  
  • Highlight the positive (tell reader what they should do rather than what they should not do).  
  • Emphasize small practical steps.  
  • Tailor information to the individual (e.g., use computer generated program to tailor content for the individual). |
| Language                | • Write at 3rd to 6th grade reading level.  
  • Ensure high text cohesion (connections between sentences, topics, and ideas).  
  • Use active voice.  
  • Use short words and sentences.  
  • Use common words and/or explain the meaning of any difficult words. |
| Layout and Typography   | • Use font sizes between 12 and 14 points.  
  • Use serif font for the body of the text.  
  • Use dark letters on a light background.  
  • Frame text in white space.  
  • Use a box, larger font or indent to highlight important information. |
| Organization            | • Present the most important or useful information first.  
  • Organize information in the order the reader will use it.  
  • Use headings and subheadings to chunk information.  
  • Keep paragraphs short and express only one idea per paragraph.  
  • Use bullet points where possible. |
| Graphics                | • Use simple line drawings.  
  • Include an explanatory text caption with each graphic.  
  • Include prompts (arrows, labels etc) within the graphic to explain meaning.  
  • Avoid photographs except to gain attention (e.g., cover).  
  • Ensure the reader understands all elements in the graphic. |
Content
First, it is important to limit learning objectives and to avoid any information that might confuse or overwhelm the reader (Seligman et al., 2007), particularly as it is neither necessary nor advantageous to aim for attainment of high-level knowledge (Davis et al., 1996). According to Doak et al., (1996, p.76) one should ask “What is the least I can include to give the reader the information and motivation needed to change behaviour or perform the procedure?”

Second, research suggests emphasis be placed on practical information that assists the reader to achieve desired behaviours rather than factual information. To do so, provide explicit ‘how to’ information and clearly state the actions the reader needs to take (Centers for Disease Control and Prevention, 2009; Doak et al., 1998; National Cancer Institute, 2003; Seligman et al., 2007). In addition, emphasis on small practical steps is recommended to encourage and motivate the reader (Centers for Disease Control and Prevention, 2009).

Third, one should avoid negatively worded statements, particularly in healthcare materials designed for older adults. Research conducted by Wilson and Park (2008) found that older adults have difficulty remembering negatively worded statements and are inclined to remember the opposite meaning of the statement. For example, “do not stop taking your antibiotic when you feel better” could be remembered as “stop taking your antibiotic when you feel better”. They argued that this is due to the fact that negatively worded statements place additional cognitive demands on the reader relative to positively worded statements, and hence older adults tend to forget the negations present in medical information and remember only the key words. This was found to be the case for older adults with both poor and good health literacy.

Fourth, it is beneficial to tailor information to the individual. Research conducted by Bull, Holt, Kreuter, Clark, and Scharff (2001) indicates that behaviour change is more likely for those who receive tailored healthcare material. In addition, tailored material is more likely to be read and shown to others, which is an important component of social support. There are a number of ways to tailor written healthcare material and these can be achieved using computer generated programs. They include adding a person’s name to the cover (Doak et al., 1998); only printing information relevant to the individual (Bull et al., 2001); and targeting messages to the cultural group by using culturally appropriate images, concepts and
Complimentary strategies include opening the document in the client’s presence and underlining or highlighting the most important information (Doak et al., 1998). One can also stratify the contents of a patient education booklet at different levels of complexity (Badarudeen & Sabharwal, 2008) so it is suitable for people with different interests, levels of health literacy, and/or at different stages along their rehabilitation journey. In summary, one needs to present information that makes sense to the client and is relevant and logical from their perspective. “They need to see how the advice fits into their current lifestyle, is achievable, and is worth their effort to implement it” (Doak et al., 1998, p. 153).

To streamline content for the SFHA, each participant received two SFHA instruction booklets: one for the right aid and one for the left aid. The rationale was to reduce the amount of information in each booklet and to make the instructions easier for the reader to follow. Each booklet was identical with exception of right/left information. In the SFHA instructions, the assembly of the aid was divided into small practical steps with the intent that the reader could experience small successes along the way, leading to an increase in confidence. The actions required to complete each step were explicitly stated and supported by clear graphics as shown in Figure 4-2. The majority of sentences were worded in the positive, and no factual or theoretical information was included such as technical data on the device. In this study, all participants received the same SFHA instructions; however, it is envisaged that future SFHA instructions will be tailored to groups or individuals. This may include printing the user’s name, showing an emblem of cultural significance on the cover, or changing the language depending on the country and/or region.

**Language**

An important aspect of language is readability. This is an objective measurement of the reading skills necessary to understand a written text and is typically measured in terms of grade level (Badarudeen & Sabharwal, 2008). Readability formulae are used to assess reading level and are based on language variables such as sentence length, word length, and syllable counts (Doak et al., 1996; Liu, Kemper, & Bovaird, 2009; Vahabi & Ferris, 1995). The most commonly used formulae include the Flesch Reading Ease (Flesch, 1948), Flesch-Kincaid Formula (Kincaid, Fishburne, Rogers, & Chissom, 1975), Fog Index (Gunning, 1968), Fry Readability Graph (Fry, 1968), and the Simple Measure of Gobbledygook Index (SMOG) ((McLaughlin, 1969). The Flesch-Kincaid Grade is the most widely used
readability formula (Albright et al., 1996) and can be accessed through the Microsoft Word Office package. It is a modified version of the Flesch Reading Ease Formula and is based on the average number of syllables per word and the average number of words per sentence (Badarudeen & Sabharwal, 2008).

Research findings show that readability formulae have high validity, satisfactory reliability, and are highly correlated (Ley & Florio, 1996; Meade & Smith, 1991). However, despite the fact that the formulae show high intercorrelations, they often produce different estimates of reading grade level for a piece of text. This is, in part, due to the fact that they are based on different comprehension levels. For example, the Flesch Reading Ease is based on a criterion of 75% comprehension whereas the Fog Index is based on 90% comprehension (Ley & Florio, 1996). For this reason, it is recommended that one assesses the readability of document using multiple formulae because this will result in a more reliable estimate. One can then select to take either the score that represents the highest estimated reading grade level or the average score (Ley & Florio, 1996).

According to research, people of all literacy levels prefer simple written materials over complex materials and have less difficulty comprehending simple materials (Doak et al., 1996). However, there is mixed opinion regarding the optimal reading level for healthcare information. Recommendations range from third- or fourth-grade level (Davis et al., 1996) to fifth- or sixth-grade level (Doak et al., 1996; Meade et al., 1994). According to Boyd (1987), material should be written at two to four grade levels below the average reading grade level of the end-user. This information cannot be ascertained by simply asking the end user about their highest level of education because comprehension may be 2 to 4 years lower than stated years of school (Doak et al., 1996).

A second important aspect of language is text cohesion. This refers to the use of explicit words, phrases, and sentences to guide the reader through the text and enhance comprehension by making connections between sentences, topics, and ideas (Liu, Kemper, & Bovaird, 2009). Liu et al. (2009) investigated how readability (Flesch Reading Ease) in conjunction with text cohesion affects the ability of older adults to comprehend common health texts. They found that all participants exhibited better comprehension when high readability (reading ease) was combined with high text cohesion. They surmised that increasing text cohesion may benefit older adults, because the repetition of similar words,
phrases, and ideas may reduce processing demands. A second finding revealed that older adults with reduced working memories had more difficulty understanding text with high readability (reading ease) but low text cohesion. This suggests that increasing readability/reading ease through the use of shorter words and sentences can lead to poorer comprehension in older people with smaller working memories if it results in the omission of key information such as “causal and temporal connections among ideas” (p. 664).

There is consensus that one should write in active voice because it improves readability and is more likely to move the reader to action compared to the same message written in passive voice (Centers for Disease Control and Prevention, 2009; Doak et al., 1996; National Cancer Institute, 2003; Vahabi & Ferris, 1995). It is also recommended to use short words that are familiar to the reader (one to two syllables where possible) and short sentences (8 to 10 words). It is important to limit use of jargon, technical language, abbreviations, and unnecessary acronyms; to clearly define any new words; and to be consistent with word use (Centers for Disease Control and Prevention, 2009; Doak et al., 1996; National Cancer Institute, 2003).

According to Doak et al. (1996, 1998), certain types of words are difficult to understand, particularly for people with limited health literacy and include concept, category, and value judgement words. Concept words provide a general idea or abstract range of reference, such as ‘normal range’. Using this example, ‘keep your blood sugar in the normal range’ is better written as ‘keep your blood sugar somewhere between 70 and 120’. Category words are used to classify a group of related entities. It is recommended that the exact term is used rather than the category term (e.g., use chicken rather than poultry). Value judgement words often describe amounts, such as ‘exercise regularly’. Such words can be interpreted in different ways by different people and therefore should be avoided.

The readability level of the SFHA instructions was measured using four different formulae: Flesch Reading Ease, Flesch-Kincaid Formula, Fog Index, and the Fry Readability Graph. The results are shown in Table 4-3. The readability grade level ranged from grade 2.6 for the Flesch-Kincaid Formula to grade 4.9 for the Fog Index. The average readability grade level was Grade 3.5 which is appropriate for older adults with limited health literacy. The Flesch Reading Ease score was 91.1 indicating that the material was ‘very easy’ to read.
The satisfactory readability grade level for the SFHA instructions was achieved, in part, through high usage of short sentences and words. The mean number of words per sentence was 8.9 and the mean number of characters per word was 3.8. Each section was built on the previous section in a sequential manner and included the repetition of core words, terminology, and concepts. Almost all sentences (97%) were written in the active voice, and jargon, abbreviations and/or acronyms were not used. It was necessary to include technical language to describe the parts of the hearing device. Simple technical terms were selected such as ‘tube’ to describe hearing aid tubing and ‘dome’ to describe the dome tips. Each term was introduced to the reader through the use of a line drawing, clearly depicting it (see Figure 4-2b). It was decided to use this approach rather than a written definition which could prove difficult for a person unfamiliar with hearing devices to interpret.

Table 4-3. The self-fitting hearing aid instructions readability grade levels

<table>
<thead>
<tr>
<th>Readability Formulae</th>
<th>Reading Grade Level or Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flesch Reading Ease&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(Score of 91.1 indicating ‘very easy’ to read.)</td>
</tr>
<tr>
<td>Flesch-Kincaid Formula</td>
<td>2.6</td>
</tr>
<tr>
<td>Fog Index</td>
<td>4.9</td>
</tr>
<tr>
<td>Fry Readability Graph</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Average Reading Grade Level</strong></td>
<td><strong>3.5</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup>The formula does not estimate reading grade level but provides a ‘reading ease’ score ranging from 0 (very difficult to read) to 100 (very easy to read).
Layout/Typography
Recommendations for layout and typography for written healthcare information are displayed in Table 4-4. As per these recommendations, a serif font (Times New Roman) in 16 point is used in the SFHA instructions. The headings are in a sans serif font (Arial) to stand out from the body of the document and bold type rather than italics or underlining is used to emphasize important words (refer to Figure 4-2). There is limited text and graphics on each page and the text is printed in black on a white matte background.

Organization
The first paragraph should communicate the benefits that the reader desires because it is one of the most often read parts of a written document and should entice the person to continue reading (Buxton, 1999). In addition, the reader has better recall for information contained in the first part of a document, hence the most important and/or useful content should be placed near the beginning (Boyd, 1987; Doak et al., 1996). The remaining content should be sequenced in the order the reader will use it (Centers for Disease Control and Prevention, 2009; National Cancer Institute, 2003).

It is recommended that information is chunked under simple headings and subheadings so readers are provided with the context and can also easily find the answers to their questions (Boyd, 1987; Centers for Disease Control and Prevention, 2009; National Cancer Institute, 2003). According to Buxton (1999), many people only look at the title, headings, and highlighted information; therefore one should structure information so key points can be obtained by only reading these elements. It is also good to present one complete idea on one page or two facing pages because if a reader has to turn a page in the middle of a message, they may forget the first part of it (Centers for Disease Control and Prevention, 2009).
Table 4-4. Recommendations for typography and layout of written healthcare education materials

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Rationale</th>
<th>Reference/s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typography</strong></td>
<td>Use 12 to 14 point font size.</td>
<td>A percentage of older readers will have visual problems that cannot be corrected by glasses such as Macular Degeneration.</td>
</tr>
<tr>
<td>May need to use &gt;14 point font size for older people or people with visual problems.</td>
<td></td>
<td>Doak, et al. (1996)</td>
</tr>
<tr>
<td>Use a serif font for the body of the text.</td>
<td>Serif font makes individual letters more distinctive and easier for the brain to recognise.</td>
<td>Centers for Disease Control and Prevention (2009)</td>
</tr>
<tr>
<td>Use sans serif font in headings and subheadings.</td>
<td></td>
<td>Doak, et al. (1996)</td>
</tr>
<tr>
<td>Serif font (e.g., Times New Roman) has little bars on the bottoms and tops of letters whilst sans serif (e.g., Arial) does not.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use upper and lower case letters.</td>
<td>Words written in all capital letters are difficult to read as the letters have less distinguishing features (e.g., differences in size).</td>
<td>Centers for Disease Control and Prevention (2009)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Doak, et al. (1996)</td>
</tr>
<tr>
<td>Use bold to emphasize words and limit use of italics and underlining.</td>
<td>Italics and underlining are difficult to read.</td>
<td>Centers for Disease Control and Prevention (2009)</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td><strong>Rationale</strong></td>
<td><strong>Reference/s</strong></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Layout</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Ensure adequate white space (10% to 35% of the page). | White space avoids the appearance of solid text which can be intimidating to the reader. It also allows for more contrast and facilitates the ease of reading. | Centers for Disease Control and Prevention (2009)  
Doak, et al. (1996)  
| Limit the amount of text and visuals on the page. |  |  |
| Use dark letters on a light background. | Older readers have difficulty detecting differences in low contrast colors (Schieber, 2006). | Centers for Disease Control and Prevention (2009)  
Doak, et al. (1996) |
| Use right edge “ragged” or unjustified margins. | This makes the text easier to read. | Centers for Disease Control and Prevention (2009)  
Doak, et al. (1996) |
| Break up text with bullet points, where appropriate. | This results in more white space on the page. | Centers for Disease Control and Prevention (2009)  
Raynor (1998) |
Table 4-4. Recommendations for typography and layout of written healthcare education materials (continued)

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Rationale</th>
<th>Reference/s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Layout</strong></td>
<td>Use a box, larger font, or indent to highlight the most important information.</td>
<td>Poor readers have more difficulty finding the most important information on a page. Their eyes tend to wander about the page and skip principal features whilst focusing on less important detail.</td>
</tr>
<tr>
<td></td>
<td>Do not use glossaries or refer the reader to other pages for more information.</td>
<td>Readers with limited health literacy have difficulty with cross referencing text.</td>
</tr>
</tbody>
</table>
The first sentence in the SFHA instructions clearly outlines the purpose of the material: “This booklet shows you how to put the parts of your hearing aid together and turn it on”. The assembly of the device is then described in discrete steps. Each step is presented under a simple heading which also provides the context (e.g., “Step 1 – Select the tube”). The material is organized so key information can be obtained by just reading the heading and scanning the graphic (e.g., “Step 3 – Attach the dome to the tube”).

**Graphics**

Houts, Doak, Doak, and Loscalzo (2006) conducted a comprehensive literature review on the role of graphics in written healthcare materials. The majority of studies included in the review used an experimental control group design with random assignment to each group. The review found that adding pictures to written health materials can substantially increase patient attention, comprehension, recall, and adherence and that this was particularly true for people with low health literacy. In addition, the research suggested that “pictures can help low literacy people understand relationships, provided that they understand the elements being related” (Houts et al., 2006, p. 188). On the basis of the literature review and their experience working extensively with graphics in health education, Houts et al. (2006) recommend the use of simple line drawings accompanied by simple text captions. Although photographs are good for capturing attention (e.g., on the cover of a brochure), line drawings are better because there are less distracting elements. It is important that health professionals, in partnership with end users, design the drawings rather than artists. Houts et al. (2006) also suggest the use of prompts within the picture (e.g., labels or arrows) to help explain the intended meaning. Lastly, it is important to ensure that the graphics support key points in the text.

In contrast to the findings by Houts et al. (2006), a recent study found that one cannot assume that illustrations will increase older adults’ comprehension of health information (Liu, Kemper, & McDowd, 2009). The research used eye-tracking techniques to compare how young and older adults read and comprehend texts with and without illustrations. It revealed that older adults may not benefit from illustrations that often accompany health-related texts because they may have difficulty integrating the illustrations with the written text information. The difficulties experienced “not only increased total reading times but also affected fixation patterns, and responses to the comprehension tests” (Liu et al., 2009, p.
However, the study had a number of limitations. It used abstract concepts such as a garden hose analogy to explain the relationship between narrowed blood vessels and high blood pressure; eye tracking could not be performed for 7 out of the 26 older adults; white font was used on a dark background to record eye movements but this is difficult for older people to read; and all the participants were well educated and obtained high scores on vocabulary and working memory tests.

A decision was made to include graphics in the SFHA instructions because the majority of studies on this topic suggest that older adults do benefit from illustrations in written healthcare materials. High quality photos were taken to illustrate each step and these were converted to simple but realistic line drawings. The team intended using a computer program to convert the photos to line drawings, but this approach had to be abandoned because the resultant drawings did not have sufficient contrast. The final technique used involved blowing up each photo, placing it face down on a light box, and using a black marker to trace the contours. The line drawings were then scanned and inserted in the SFHA instructions. The graphics were large and each was accompanied by a simple text caption. Research shows that the reader must understand each element in a graphic in order to interpret it correctly. To achieve this, the separate elements which include the hearing aid body, tubes, domes, and battery were introduced to the reader near the beginning of the SFHA instructions. Each was named and illustrated (see Figure 4-2a). The reader was then shown what the device would look like when the parts were correctly assembled (see Figure 4-2b). Prompts, particularly large, black arrows, were often used in the graphics to draw attention to important elements and/or actions. For example, in Figure 4-2e, a large arrow is used to show where and how the dome fits onto the tube. The graphics were designed in such a manner that they could stand alone without the need for written text, if necessary.

4.4.3 Assessment of suitability
Rating scales can be used to assess the content and design of written materials. Three rating scales have been developed that are suitable for use with written healthcare instruction materials: a) TEMPtEd (Clayton, 2009), b) Suitability Assessment of Materials (SAM) (Doak et al., 1996), and, c) Bernier Instructional Design Scale (BIDS) (Bernier, 1996). The SAM was deemed the most appropriate to assess the SFHA instructions, because it has been widely used in research examining the suitability of written healthcare materials (e.g., Weintraub, Maliski, Fink, Choe, & Litwin, 2004).
The SAM has 22 items grouped under six factors (content, literacy demand, graphics, layout and typography, learning stimulation/motivation, and cultural appropriateness) and is used to pinpoint specific deficiencies in an instrument. Each item is rated on an ordinal scale that includes the anchor points of superior, adequate, not suitable, and not applicable. Scores for the items are summed and the total is converted to a percentage with scores of 70 to 100% indicating that the material is superior, 40 to 69% indicating that the material is adequate, and 0 to 39% indicating that the material is not suitable (Doak, et al., 1996).

Two qualified audiologists assessed the SFHA instructions using the SAM. They initially assessed them independently to obtain suitability scores and then met to review any discrepancies and negotiate 100% concordance in the ratings. In over 95% of cases the researchers applied the same rating to each factor (e.g., both applied a rating of 1 or both applied a rating of 2). The final SAM rating was 88%, hence qualifying the SFHA instructions as ‘superior material’. The SAM revealed a number of limitations which will be addressed in future editions of the booklet. First, a summary was not included but it is questionable if this is necessary for this first step of the instruction material. However, a summary section would be beneficial when the final product has been developed and the entire SFHA instructions have been designed. Second, the cover was rated as only adequate. A superior rating is obtained if “The cover graphic is (1) friendly, (2) attracts attention, (3) clearly portrays the purpose of the material to the intended audience”. The cover of the booklet displayed the words “Hearing Aid Instructions – Left (or Right)” and showed the SFHA in the form of a black-and-white line drawing. Although the purpose was clear, it was not particularly friendly and was unlikely to attract attention. The booklet also failed to use any cultural images and was limited to instruction information only. It could be improved with the injection of colour on the cover and/or a photo of an older adult assembling or wearing the aid.

4.4.4 Pilot testing

There are two methods to assess written healthcare material: 1) evaluation of the material with a sample target audience and 2) use of a validated instrument such as the SAM. Experts strongly recommend the use of both. The latter should only be used in isolation if one lacks time and resources (Doak et al., 1996; Raynor, 1998; Vahabi & Ferris, 1995). The goals of
pilot testing are to ensure readers understand the material (Centers for Disease Control and Prevention, 2009; Doak et al., 1996; Vahabi & Ferris, 1995) and to obtain feedback on the overall ‘product’ as well as specific features such as content, layout, format, and graphics (Vahabi & Ferris, 1995). Based on this feedback, revisions can be made so the material is more suitable and attractive to the end user.

The SFHA instructions were not formally assessed using a target audience due to delays and time restrictions. However, they were tested in an informal manner with a small number of non-clinicians including younger and older people. All were presented with the SFHA instructions and asked to follow the directions using the actual devices. No-one experienced problems with either the task or the instruction materials and no suggestions were made for improvements. The fact that a target sample audience was not used to assess the instructions is a limitation of this study.

4.5 Conclusions

This article documented the process of developing written instructions on how to assemble a SFHA and insert it into the ear. The target audience for the SFHA instructions was older, community dwelling adults with a hearing impairment. Research indicates that approximately 30% of older adults have limited health literacy. In addition, a substantial number have age-related deterioration in visual and/or cognitive function which may impact on their ability to read and use instructions. Hence, it was deemed important to follow best practice design principles in developing the SFHA instructions. Research suggests that well-designed written materials are preferred by all readers and result in improved information recall and comprehension, regardless of literacy level.

Four steps were followed in the development process for the SFHA instructions: planning, design, assessment of suitability, and pilot testing. Five key elements were considered in the design phase, including content, language, layout/typography, organization, and graphics. Separate booklets were developed for the left and right aids and the content of each consisted of simple line drawings accompanied by captions. The text was 16 point, Times New Roman, black font printed on A4-size white matte paper. The information was presented in small practical steps and the readability grade level was 3.5 which is appropriate for older adults. The SFHA instructions were assessed using the SAM rating scale and qualified as
‘superior material’. They were also pilot tested on a small sample of non-clinicians, none of whom experienced problems with the quality and/or content of the instructions. In summary, it is recommended that health professionals follow best practice design principals when developing written healthcare materials in order to maximize the readers’ interest, comprehension, and information recall.
4.6 References


123


Griffin, J., McKenna, K., & Tooth, L. (2006). Discrepancy between older clients' ability to read and comprehend and the reading level of written education materials used by occupational therapists. *American Journal of Occupational Therapy, 60*(1), 70-80.


*This chapter is inserted as submitted for publication, with the exception of 1) formatting changes to headings, tables, and figures to maintain consistency throughout the thesis; 2) modifications suggested by the thesis examiners (shown in bold).*
5.1 Abstract

Objectives: This study investigated if a hearing aid user guide modified using best practice principles for health literacy resulted in superior ability to perform hearing aid management tasks, compared to the user guide in the original form.

Design: This research utilised a two arm study design to compare the original manufacturer’s user guide with a modified user guide for the same hearing aid; an Oticon Acto behind-the-ear aid with an open dome. The modified user guide had a lower reading grade level (10.5 versus 4.2), used a larger font size, included more graphics, and had less technical information. Eighty nine adults aged 55 years and over, were included in the study; none had experience with hearing aid use or management. Participants were randomly assigned either the modified guide (n=47) or the original guide (n=42). All participants were administered the Hearing Aid Management Test, designed for this study, which assessed their ability to perform seven management tasks (e.g., change battery) with their assigned user guide.

Results: The regression analysis indicated that the type of user guide was significantly associated with performance on the Hearing Aid Management Test, adjusting for 11 potential co-variates. In addition, participants assigned the modified guide required significantly fewer prompts to perform tasks and were significantly more likely to perform four of the seven tasks without the need for prompts. The median time taken by those assigned the modified guide was also significantly shorter for three of the tasks. Other variables associated with performance on the Hearing Aid Management Test were health literacy level, finger dexterity, and age.

Conclusions: Findings indicate the need to design hearing aid user guides in line with best practice principles of health literacy as a means of facilitating improved hearing aid management in older adults.

Key Words: hearing aid, instructions, hearing aid management, health literacy, older adults
5.2 Introduction

All hearing aids (HAs) are accompanied by a printed user guide which provides information on the aid and how to manage it. The HA user guide is an important resource as difficulty with HA management is a common reason cited for limited aid use in older adults (Brooks 1985; Desjardins & Doherty 2009; Hickson et al. 1986; Sorri et al. 1984). HA management refers to the activities one must perform to wear, adjust, and maintain the device/s and includes inserting the aid in the ear, adjusting the volume, changing the battery, cleaning the aid, and troubleshooting when problems occur (Dillon 2001).

Research shows that even experienced HA users experience difficulties with aspects of aid management. Desjardins and Doherty (2009) assessed the ability of 50 experienced HA users to perform HA management tasks using the Practical Hearing Aid Skills Test (PHAST) which they developed. This test requires the HA user to perform eight tasks with their aid/s, including cleaning the aid, changing the battery, using the noise program, and inserting the aid in their ear. The authors reported that approximately three quarters of participants were unable to use the phone with their HAs, and approximately half could not use the noise program or clean their HAs to a satisfactory level.

A multitude of factors may impact on the ability of older adults to perform HA management tasks correctly, including age, sex, finger dexterity, attitude to HAs, and HA self-efficacy. Research indicates that females over the age of 75 are more likely to experience management difficulties (Desjardins & Doherty 2009; Meredith & Stephens 1993; Stephens & Meredith 1991; Upfold et al.1990; Ward et al. 1979). Similarly, those with poor finger dexterity are less likely to report successful use of the HA (Kumar et al. 2000) and are more likely to return their HA in the trial period (Jacobson et al. 2002). Attitude to HAs and HA self-efficacy are also important factors associated with consultation for hearing impairment, HA uptake, and successful outcomes (Hickson et al. 2014; Meyer et al. 2014). HA self-efficacy refers to a person’s level of confidence in their ability to use and manage a hearing aid (Smith & West 2006). Although Meyer et al. (2014) and Hickson et al. (2014) did not examine associations between HA self-efficacy and HA management specifically, their research found that older adults who had more positive attitudes toward HAs in combination with higher self-efficacy were more likely to be successful HA owners.
Another reason underpinning HA management difficulties may be that the person with hearing impairment cannot access information in the user guide, either because of his/her low health literacy or because of the design of the user guide. Health literacy refers to “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker 2000, p. 3). Over the past 25 years, a large body of research has investigated the association between health literacy and health outcomes, and low health literacy has been consistently associated with poorer health related knowledge, differential use of healthcare services, poorer overall health, and higher mortality (Berkman et al. 2011; DeWalt et al. 2004; Boylston Herndon et al. 2011). At least 30% of older people, the main users of HAs, have low health literacy (Australian Bureau of Statistics 2006b; Kutner et al. 2006). In a study that evaluated the management and feasibility of a self-fitting HA, Convery et al. (2011) investigated the ability of older adults to assemble and insert a HA using written instructions. The three main factors associated with the ability to complete this task without assistance were sex, health literacy, and cognition. Participants who assembled the HA on their own were more likely to be male and have higher levels of cognitive function and health literacy.

The quality of the user guide should determine how easy it is for the user to navigate, read, and understand the content. In order to enhance the readability and clarity of printed healthcare material, research suggests that it should be developed based on best practice guidelines for health literacy (e.g. Davis et al. 1996; Ley & Florio 1996; Freed et al. 2013). There is a wealth of information available on how to apply these guidelines which encompass details on content, language, layout and typography, organization, and graphics (e.g. Doak et al. 1996; National Cancer Institute 2003; Centers for Disease Control and Prevention 2009; Caposecco et al. 2011). For example, healthcare material should be written in active voice, use common words (Centers for Disease Control and Prevention 2009; National Cancer Institute 2003), and be at a reading grade level of between third and sixth grade (Davis et al. 1996; Doak et al. 1996). Graphics should consist of simple line drawings with an explanatory text caption accompanying each figure (Houts et al. 2006), and text should be comprised of dark letters in 12 to 14 font size on a light background (Doak et al. 1996; Centers for Disease Control and Prevention 2009).

Research indicates that most people prefer easy-to-read healthcare material, regardless of their literacy level, and easy-to-read healthcare material facilitates comprehension (Davis et
al. 1996; Freed et al. 2013). Despite this, hundreds of research studies have found that the reading level of healthcare materials often far exceeds that of the reader (e.g. Griffin et al. 2006; Hill-Briggs & Smith 2008; Cronin et al. 2011). Four studies have examined the reading level and/or suitability of HA user guides, with similar findings about the inappropriate nature of the guides (Kelly 1996; Nair & Cienkowski 2010; Brooke, Isherwood, Herbert, Raynor, & Knapp, 2012; Caposecco et al. 2014). Kelly (1996) assessed the reading grade level of 55 HA user guides and reported that 73% were written at college reading level. Nair and Cienkowski (2010) analysed the HA user guides given to clients in 12 HA fitting appointments and found a mean reading grade level of 7.96, which is an improvement compared to Kelly (1996), but still too high. Most recently, Caposecco et al. (2014) examined the content, design, and readability of a sample of 36 HA user guides (four user guides from nine different HA manufacturers). The user guides were analysed using four readability formulae and a standardized tool to assess content and design called the Suitability Assessment of Materials (Doak et al. 1996). The mean reading grade level for all user guides was grade 9.6. In addition, 69% were rated as ‘not suitable’ and 31% were rated as ‘adequate’ on the Suitability Assessment of Materials; many scored poorly for scope, vocabulary, aspects of layout and typography, and learning stimulation and motivation.

In a novel study, Brooke et al. (2012) conducted usability testing to determine whether adults could use a HA user guide to carry out maintenance tasks and find important HA information. Forty participants with a mean age 56 years (range = 46 to 72 years) and no experience with HAs were each assigned either a Danalogic or a Unitron user guide (20 participants each). Participants were asked to follow the instructions in the user guide to complete three HA tasks (i.e., clean the HA, replace the battery, and clean the ear mould) and it was found that between 23% and 68% of participants experienced difficulty on each of these tasks. Cleaning the ear mould caused the most difficulty and 27 participants (68%) were unable to complete this task without prompts. After completing the tasks participants were asked to provide feedback on their assigned user guide. The participants expressed negative views about many aspects of the content and layout of both user guides including use of jargon, unclear diagrams, and small font size.
5.2.1 Aim
The research described thus far indicates that the majority of HA user guides are not optimal for older adults. However, we do not know if improved user guides are associated with improved HA management. Hence, the aim of this study was to investigate if a HA user guide modified using best practice guidelines for health literacy resulted in superior ability to perform HA management tasks, compared to the user guide in the original form.

5.3 Materials and methods

5.3.1 Participants
The selection criteria for the study were that participants had to be age 55 years or older, living in the community, comfortable speaking and reading English, and have no experience using or managing HAs. Participants were excluded from the study if they presented with a severe cognitive or uncorrected visual impairment that could affect their ability to read and comprehend written text. A severe uncorrected visual impairment was defined as visual acuity of less than 20/100 measured on the Sloan letter near vision card and a severe cognitive impairment was defined as a score of 3 or less on a six-item cognitive screener (Callahan et al. 2002). Participants were recruited through the Communication Research Registry (www.crregistry.org.au) at the University of Queensland, flyer drops at retirement villages, and word-of-mouth.

5.3.2 Assessment measures
This study formed part of a larger project investigating HA management in older adults. Other results will be published elsewhere (Caposecco et al. forthcoming).

Demographic questionnaire
The demographic questionnaire was designed specifically for this study and elicited information about the participant’s age, sex, postcode of residence, level of formal education, self-reported health status, and attitude to HAs (How would you rate your general attitude to HAs on a 10-point scale, ranging from -5 indicating very negative to +5 indicating very positive). Self-reported health status was investigated using a 5-point scale: excellent, very good, good, fair, and poor. The participant’s postcode was used to assign a socio-economic
level using the census-based Index of Relative Socio-economic Advantage and Disadvantage (Australian Bureau of Statistics 2006a). A high score (decile) indicates relatively greater advantage and lack of disadvantage and is based on measures such as income, occupation, education level, and cost of housing.

The Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids
The Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids (MARS-HA) (West & Smith 2007) has four subscales: basic handling (e.g., I can insert a battery into a HA with ease), advanced handling (e.g., I think I could stop a HA from squealing), adjustment to HAs (e.g., I could get used to how a HA feels in my ear), and aided listening skills (e.g., I could understand conversation in a small group while in a noisy place if I wore HAs). Only the first two subscales were used because the remaining two were not relevant to the aims of the study and, in addition, were considered too difficult for someone with no HA experience. The wording of each item in the basic handling subscale was modified slightly in the present study; ‘I can’ was replaced with ‘I think I could’ (e.g., ‘I can insert a battery into a HA with ease’ was changed to ‘I think I could insert a battery into a HA with ease’). For all items, the respondent was required to indicate on a scale how confident they felt they could perform particular tasks with a HA. The minimum end point (0%) was ‘cannot do this at all’ and the maximum end point (100%) was ‘I am certain I can do this’. There were seven items in the basic handling subscale and five items in the advanced handling subscale. The average score was calculated with a higher score indicating greater HA self-efficacy.

User guides and hearing aid
The Oticon Acto behind-the-ear (BTE) HA with an open dome was used in the study. It was selected because the HA’s user guide received the median score on the Suitability Assessment of Materials (Doak et al. 1996) in our previous study that analysed the content, design, and readability of a sample of 36 HA user guides (Caposecco et al. 2014). The Acto guide was therefore considered to be representative of a ‘typical’ HA user guide. For this study, a second user guide for the same HA was developed to represent a ‘best practice’ HA user guide. From here-on-in, the user guides will be termed the original guide and the modified guide. The steps taken in modifying the original guide included typing all text from it into a word document, removing information on features not available on the HA, formatting the content based on best practice guidelines, enlarging graphics and inserting a caption/instruction with each, and adding a HA details page at the front (see Table 5-1 which
provides more detail on the procedure followed in modifying the original guide.

Approximately 80% of the graphics were taken directly from the original guide as they met best practice guidelines; they were simple line drawings with no distracting elements. Both user guides contained a quick guide which consisted of two pages with graphics showing how to perform the main hearing aid tasks, such as changing the battery. Table 5-2 provides key information on the original and modified guide. For example, the Suitability Assessment of Materials score for the original guide was 50% (adequate) and 90% (superior) for the modified guide. The reading grade level was grade 10 for the original guide and grade 4 for the modified guide. **Three pages from the modified user guide are shown in Appendix B.**

The Hearing Aid Management Test

The Hearing Aid Management Test (HAM Test) was designed for the study and assesses the ability to perform HA management tasks using a user guide (see Table 5-3 or Appendix C). The test requires the participant to perform seven tasks with a HA: 1) change the battery, 2) turn the HA on and off, 3) insert the HA, 4) hold the phone with the HA, 5) turn up the volume, 6) change the sound program, and 7) clean the tube and put the HA back together. The first two tasks are fairly simple and intuitive, whilst the remaining five are more complex. All tasks were taken from the PHAST (Desjardins & Doherty 2009). The PHAST test could not be used in the original form because it is designed to assess HA management skills without the use of a user guide. For this study the PHAST was modified to include sections to record the parts of the user guide accessed by the participant (e.g., quick guide) and the prompts provided if the participant was unable to perform a task (e.g., open to section in user guide). Each participant was given 2 minutes to look through the user guide they were assigned before starting the HAM Test. The participant was then verbally instructed to perform the first task, using the user guide, and 2 minutes was provided for completion. The participant was not informed that he/she had 2 minutes for task completion. The examiner recorded the sections of the user guide accessed by the participant: nil (doing it on their own without the user guide), the contents page, the quick guide, and/or the body of the user guide. If the participant completed the task correctly the examiner recorded the time taken and continued to the next item. If the participant made errors or was unable to perform the task within 2 minutes, the examiner proceeded to part B of the test which involved a series of prompts in a hierarchical order. The prompts were: a) handing the participant the user guide (if they had not used it), b) opening the user guide to the correct page (if they were unable to
find it), and c) modelling the task (if they were still unable to perform the task after finding
the correct section in the user guide). The participant was moved through the prompts until
they completed the task correctly or reached the last prompt. Final task performance and the
time taken from start to finish were recorded. The same procedure was followed for each of
the seven tasks. Participants’ performance on each task contributed equally to their final
score; a score of 2 indicated correct performance with no prompts, a score of 1 indicated
correct performance with one prompt, and a score of 0 indicated the need for more than one
prompt and/or inability to perform the task correctly. The maximum score on the HAM Test
was 14.

To assess reliability, two audiologists, including the examiner, independently scored a
smartphone recording of the HAM Test administration for 18 of the participants (20%)
selected at random. The test was found to have very high reliability. For both intra-rater and
inter-rater reliability testing there was 100% match for scores on each task with a kappa value
of 1. The intraclass correlation coefficient value for time taken to complete each task was
.999 for both intra-rater and inter-rater testing. These results reflect the objective nature of
this test.

The Short Test of Functional Health Literacy in Adults (S-TOFHLA) (Baker et al. 1999) is a
36 item timed reading comprehension test that consists of two prose passages containing
actual materials that an adult might encounter in a healthcare setting (e.g., instructions for a
gastro-intestinal procedure). It uses a modified cloze procedure, where one or two words are
missing from each sentence, and the respondent is required to select the correct word from
four choices provided. The maximum score is 36, with a score of ≥23 indicating adequate
health literacy, a score between 17 and 22 indicating marginal health literacy, and a score of
≤16 indicating inadequate health literacy. A version of the S-TOFHLA slightly modified to
reflect Australian language and culture (Buchbinder et al. 2006) was used in this study. The
S-TOFHLA has been shown to predict health knowledge, behaviours, and outcomes in
hundreds of studies (e.g. Schillinger et al. 2002; Convery et al. 2011; Peterson et al. 2011).
Table 5-1. Procedure followed to modify the original hearing aid user guide to create a best practice user guide.

<table>
<thead>
<tr>
<th>Step</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Typed all text, verbatim, from the original user guide into a word document.</td>
</tr>
<tr>
<td>2</td>
<td>Removed content that fell into the following categories: a) functions and features not available on the hearing aid; b) information not relevant to adults to with mild to moderate hearing loss (e.g., FM use); c) information directed at the dispenser; d) highly technical information (e.g., formula designed to predict the compatibility between a mobile phone and a hearing aid).</td>
</tr>
<tr>
<td>3</td>
<td>Regrouped topics into a logical order with the most important information at the front of the user guide.</td>
</tr>
<tr>
<td>4</td>
<td>Copied into the Publisher program on Microsoft Office and changed page size to A4.</td>
</tr>
<tr>
<td>5</td>
<td>Formatted content according to best practice guidelines for health literacy as outlined by Caposecco, Hickson, &amp; Meyer (2011). For example: large font size (at least 12 point); large amount of white space to give an uncluttered appearance (10 to 35% of the page); use of text boxes, bolding, larger font, and arrows to highlight important information.</td>
</tr>
<tr>
<td>6</td>
<td>Enlarged each graphic and inserted a short caption/instruction. Highlighted key elements through the use of arrows pointing to where the reader should look. Eighty percent of the graphics were taken directly from the original user guide as they met best practice guidelines; they were simple, line drawings with no distracting elements.</td>
</tr>
<tr>
<td>7</td>
<td>Added a hearing aid details page near the front of the user guide. This contained information about the aid such as model, battery size, dome type, serial number, date fitted, and sound programs. The original guide did not have this.</td>
</tr>
<tr>
<td>8</td>
<td>Pilot tested on a sample of older adults and modified based on their feedback.</td>
</tr>
</tbody>
</table>
Table 5-2. Details of the original and the modified user guides for the Oticon Acto BTE hearing aid

<table>
<thead>
<tr>
<th></th>
<th>Original</th>
<th>Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>14.5 cm(w) x 9.8 cm(h)</td>
<td>A4: 21 cm(w) x 29.7 cm(h)</td>
</tr>
<tr>
<td>Inclusion of quick guide*</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of pages</td>
<td>56</td>
<td>32</td>
</tr>
<tr>
<td>Main font size</td>
<td>9 point</td>
<td>20 point</td>
</tr>
<tr>
<td>Type of graphics</td>
<td>Black and white line drawings</td>
<td>Black and white line drawings</td>
</tr>
<tr>
<td>Number of graphics</td>
<td>48</td>
<td>56</td>
</tr>
<tr>
<td>Number of aid models in</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>user guide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading Grade Level†</td>
<td>10.5</td>
<td>4.2</td>
</tr>
<tr>
<td>SAM score</td>
<td>50%</td>
<td>90%</td>
</tr>
<tr>
<td>SAM rating</td>
<td>Adequate</td>
<td>Superior</td>
</tr>
</tbody>
</table>

*A quick guide consists of simple information and diagrams for the main hearing aid functions, such as how to change a battery. †Average of score obtained on the Fry Readability Graph (Fry, 1968), Flesch-Kincaid Readability Formula (Flesch, 1948), and Fog Index (Gunning, 1968). Calculated on three 100-word passages taken from the battery section, the section providing instruction on how to turn the aid on and off, and the section on care and maintenance.

SAM, Suitability Assessment of Materials
Table 5-3. The Hearing Aid Management Test score sheet

<table>
<thead>
<tr>
<th>Participant Name: ________________________</th>
<th>Study Number: _______</th>
<th>Handedness (circle): Left   Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of testing: _______________</td>
<td>Location: _____________________________</td>
<td>Tester: ________________________________</td>
</tr>
</tbody>
</table>

### Part A

Move to Part B (Prompts) after 2 minutes has elapsed, participant scores 1 or 0, or gives up

<table>
<thead>
<tr>
<th>Item</th>
<th>Used contents page</th>
<th>Nil</th>
<th>Quick Guide</th>
<th>User Guide</th>
<th>Correct section located in user guide</th>
<th>Task Performance</th>
<th>1. Hand user guide to participant (if not used)</th>
<th>2. Open to section in user guide (if correct section not found)</th>
<th>3. Model with verbal instructions (if unable to perform task &amp; correct section found)</th>
<th>Final task performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Change the HA battery</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>2</td>
<td>Turn the HA on and off</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>3</td>
<td>Put the HA in your ear</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>4</td>
<td>Hold the phone with the HA</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>5</td>
<td>Turn up the volume of HA</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>6</td>
<td>Switch the HA to program 2 – noise sound program</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>7</td>
<td>Clean wax from tube and put the HA back together so it is ready to use</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
</tbody>
</table>
Montreal Cognitive Assessment
The Montreal Cognitive Assessment (MoCA) (Nasreddine et al. 2005) is a short cognitive screening test designed to detect mild cognitive impairment. It assesses executive function, visuo-spatial function, memory, attention, language, abstraction, and orientation. The MoCA is more sensitive than the more commonly used Mini-Mental State Examination (MMSE) (Folstein et al. 1975) for distinguishing between mild and normal cognitive function (Olson et al. 2008). The maximum score is 30 and a score of ≥26 is indicative of normal cognitive function and a score of <26 is indicative of cognitive impairment.

Grooved Pegboard Test
Finger dexterity was assessed using the Grooved Pegboard Test (GPT) (Lafayette Instruments Model 32025). Participants were required to insert 25 pegs into a metal grid that contains 25 key-hole shaped slots, each angled slightly differently. Each peg must be rotated to match the hole before it can be inserted properly. Participants completed the test once with the dominant hand and once with the non-dominant hand. The score for this test was the time taken for the participant to complete the task with each hand: a shorter time is indicative of superior finger dexterity.

Pure-tone screening audiogram
Air-conduction thresholds were obtained for both ears at 0.5, 1, 2, and 4 kHz and a four-frequency average hearing loss (4FAHL) was calculated for each ear. Testing was carried out in a quiet room either in the participant’s home or at The University of Queensland.

5.3.3 Procedure
All study tasks were completed in a single appointment at either the participant’s home or the University, with exception of the MARS-HA and demographic questionnaire which were completed by the participant prior to the appointment. The type of user guide was assigned based on the participant’s study number, allocated when they signed up for the project; those with an even number received the original guide and those with an odd number received the modified guide. Two weeks before the appointment the participant was sent the demographic questionnaire and the MARS-HA to complete. At the appointment, the participant’s vision was screened and the six-item cognitive screener administered to ensure they met the inclusion criteria. The study tests were then administered in the following order: HAM Test, S-TOFHLA, MoCA, GPT, and a screening pure-tone audiogram.
5.3.4 Data analysis

Data were analysed using Stata software (version 13.0, 2013). Statistical analyses were conducted to assess the differences in baseline characteristics between the group of participants assigned the original guide and the group of participants assigned the modified guide. The baseline characteristics examined were age, sex, socio-economic status, education level, self-reported health status, attitude to HAs, health literacy level, HA self-efficacy, cognition, finger dexterity, and hearing level. The tests used were the independent-samples t-test, Chi-squared test, Mann-Whitney test, and the Fisher’s exact test; test selection was based on the type (categorical versus continuous) and distribution of the data.

A multivariable linear regression model was employed to determine the association between the type of user guide and the score on the HAM Test, adjusting for age, sex, finger dexterity, attitude to HAs, HA self-efficacy, cognition, health literacy level, and hearing. First, univariate analyses were conducted to examine each factor’s association with the HAM Test score at 10% level of significance. The independent-samples t-test was used when the independent variable was categorical in type (e.g., sex) and Pearson’s r was used when the independent variable was continuous in type (e.g., age). Each variable found to be significant in the univariate analysis was examined for multicollinearity before entering it in the base multivariable model. The final multivariable regression model presents only the significant variables (p<0.05). The standardized residuals of the fitted models were examined to ensure normality and to examine potential outliers.

To further explore performance on the HAM Test, the Mann-Whitney test was used to determine if there was a significant difference between the 2 groups in the median time taken to perform each task. This test was selected because the data did not display a normal distribution. The Chi-squared test and the Fisher’s exact test were used to determine if there was a significant difference between the two groups in the number of prompts required to perform each task correctly on the HAM Test. The Fisher’s exact test was used when requirements of the Chi-squared test were not met.
5.4 Results

5.4.1 Sample description

Figure 5-1 shows the flow of participants through the study. Overall, 103 participants provided informed consent to participate; however, 16 were subsequently excluded or withdrew from the study. This left a sample of 89 participants, 42 of whom were assigned the original guide and 47 were assigned the modified guide. There were no significant differences between the two groups on key demographic indicators or on tests measuring health literacy, HA self-efficacy, cognition, finger dexterity, or hearing (see Table 5-4). Across the two groups the mean age was 72 years and 69% were female. The participants had on average 13 years of education suggesting that many went onto higher education after completing High School. The majority (90%) had adequate health literacy. Although all participants passed the six-item cognitive screener, approximately, one third (36%) failed the MoCA. The six-item cognitive screener was used to rule out severe cognitive impairment, as part of the exclusion criteria, whilst the MoCA is sensitive to mild cognitive impairment. The median score on the MARS-HA was 83% indicating high self-efficacy for HA handling skills and the average 4FAHLM was 26.
Figure 5-1. Flow of participants through the study
Table 5-4. Demographic information for participants assigned the original user guide and the modified user guide

<table>
<thead>
<tr>
<th>Variable</th>
<th>Assigned User Guide</th>
<th>Fisher’s Exact, $\chi^2$, $t$, U</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Original (n = 42)</td>
<td>Modified (n = 47)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>73.2 (8.0)</td>
<td>71.4 (8.9)</td>
<td>.307</td>
</tr>
<tr>
<td>Sex, n(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>28 (67%)</td>
<td>33 (70%)</td>
<td>.129</td>
</tr>
<tr>
<td>Male</td>
<td>14 (33%)</td>
<td>14 (30%)</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic status (IRSAD decile)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>7.0 (3.2)</td>
<td>7.2 (3.2)</td>
<td>.682</td>
</tr>
<tr>
<td>Education level (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>13</td>
<td>13</td>
<td>-.206</td>
</tr>
<tr>
<td>25th-75th percentile</td>
<td>10-15</td>
<td>10-15</td>
<td></td>
</tr>
<tr>
<td>Self-reported health status, n(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent /very good</td>
<td>19 (45%)</td>
<td>21 (45%)</td>
<td>5.513</td>
</tr>
<tr>
<td>Good</td>
<td>15 (36%)</td>
<td>24 (51%)</td>
<td></td>
</tr>
<tr>
<td>Fair/poor</td>
<td>8 (19%)</td>
<td>2 (4%)</td>
<td></td>
</tr>
<tr>
<td>Attitude to hearing aids, n(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>27 (64%)</td>
<td>32 (68%)</td>
<td>.143</td>
</tr>
<tr>
<td>Neutral or negative</td>
<td>15 (36%)</td>
<td>15 (32%)</td>
<td></td>
</tr>
<tr>
<td>S-TOFHLA, n(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>36 (86%)</td>
<td>44 (94%)</td>
<td>na</td>
</tr>
<tr>
<td>Inadequate or marginal</td>
<td>6 (14%)</td>
<td>3 (6%)</td>
<td></td>
</tr>
<tr>
<td>MARS-HA*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>83%</td>
<td>83%</td>
<td>-0.662</td>
</tr>
<tr>
<td>25th-75th percentile</td>
<td>64-92</td>
<td>68-95</td>
<td></td>
</tr>
</tbody>
</table>
Table 5-4. Demographic information for participants assigned the original user guide and the modified user guide (continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Original (n = 42)</th>
<th>Modified (n = 47)</th>
<th>Fisher’s Exact, $\chi^2$, $t$, U</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MoCA, n(%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>25 (60%)</td>
<td>32 (68%)</td>
<td>.706</td>
<td>0.40</td>
</tr>
<tr>
<td>Abnormal</td>
<td>17 (41%)</td>
<td>15 (32%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPT (time: seconds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>110</td>
<td>120</td>
<td>-1.208</td>
<td>0.23</td>
</tr>
<tr>
<td>25th-75th percentile</td>
<td>99-133</td>
<td>105-141</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4FAHL†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>26 (11.0)</td>
<td>25 (8.8)</td>
<td>.456</td>
<td>0.46</td>
</tr>
</tbody>
</table>

*Average of basic handling and advanced handling subscales. †Average of thresholds at 0.5, 1, 2, and 4kHz in the better ear.

4FAHL, four frequency average hearing level; na, not applicable; GPT, Grooved Pegboard Test (dominant hand); IRSAD, Index of Relative Social Advantage and Disadvantage; MARS-HA, Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aid; MoCA, Montreal Cognitive Assessment; S-TOFHLA, Short Test of Functional Health Literacy in Adults
5.4.2 Performance on the HAM Test

The mean score on the HAM Test for those assigned the original guide was 7.1 (SD = 2.57; range: 0 to 13) and for those assigned the modified guide was 10.3 (SD = 2.75; range: 3 to 14); the difference between means was significant ($t = -5.57, p < .0001$). Of the nine independent variables, seven were significantly associated with the score on the HAM Test in univariate analyses ($p<0.10$). Two variables, cognition and hearing, were excluded from any further analyses because they were strongly associated with health literacy and age, respectively. Table 5-5 shows the results of the linear regression comparing the mean score of participants assigned the original guide to those assigned the modified guide, adjusted for the eight potential co-variates. Of the five variables entered into the base multivariable model, sex was unable to attain any significance. The remaining four variables constituted a significant model [$F(4,82)=36.35, p<0.0001$] with an $R^2$ value of 0.64 which means 64% of the variability in the HAM Test score was explained by the estimated regression model. The residual values were examined and found to be normal after omitting one outlier. The HAM Test scores were significantly positively associated with use of the modified guide and adequate health literacy; and significantly negatively associated with better finger dexterity and younger age.

Figure 5-2 shows the percentage of participants able to perform each task correctly on the HAM Test using their assigned user guide, without the need for prompts. Participants with the modified guide were significantly more likely to perform four of the seven tasks correctly without prompts, compared to those with the original guide. These tasks were a) insert the HA ($\chi^2 =14.318; p<0.001$), b) hold phone with the HA ($\chi^2 =7.360; p<0.01$), change the sound program ($\chi^2 =24.196; p<0.001$), and d) clean the tube and put the HA back together ($\chi^2 =10.041; p<0.01$).

Across the two groups, the tasks that participants were more likely to perform correctly, without prompts, were turn the HA on and off, change the battery, turn up the volume, and change the sound program. Over three quarters of participants assigned the modified guide could perform the latter three tasks correctly without prompts. Tasks which the participants were least likely to perform correctly, without prompts, were insert the HA and hold phone with the HA. Less than 40% of those assigned the modified guide and less than 7% of those assigned the original guide were able to do so for either task.
Table 5-5. Factors associated with the Hearing Aid Management Test score

<table>
<thead>
<tr>
<th>Variable</th>
<th>Detail</th>
<th>Regression Coefficient</th>
<th>95% Confidence Interval</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Guide</td>
<td>Modified versus original user guide</td>
<td>3.077</td>
<td>2.2645 - 3.8886</td>
<td>7.54</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Health literacy level</td>
<td>Score on Short Test of Functional Health Literacy for Adults</td>
<td>3.314</td>
<td>1.7368 - 4.8913</td>
<td>4.18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Finger dexterity</td>
<td>Score on Grooved Pegboard Test (dominant hand)</td>
<td>-0.014</td>
<td>-0.0259 - -0.0015</td>
<td>2.23</td>
<td>0.028</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>-0.059</td>
<td>-0.1166 - -0.0004</td>
<td>2.00</td>
<td>0.048</td>
</tr>
</tbody>
</table>
Figure 5-2. Percentage of participants able to perform each hearing aid task correctly, without prompts). “snd prog” = sound program.

** significant p<0.05

Table 5-6 shows the median time taken by participants who could perform the tasks correctly, without prompts. The tasks that were performed in the shortest amount of time by participants assigned the original guide were turn the HA on and off and turn the volume up; both taking a median time of 40 seconds. The task performed in the shortest amount of time by participants assigned the modified guide was turn the volume up (median time = 29 seconds). The task that took the longest time to perform by participants assigned the original guide was to hold the phone with the HA (median time = 105 seconds), and by participants assigned the modified guide, insert the HA (median time = 84 seconds). The Mann Whitney test showed that median time taken on three of the tasks, was significantly shorter for those assigned the modified guide (hold phone with the HA, turn up the volume, change the sound program).

On six of the seven items, over 80% of participants could perform the specified HA management task correctly, after prompts were provided, regardless of their assigned user guide. This is not surprising as the final prompt was modelling the task with verbal
instructions. The exception was task three, which required participants to insert the HA in his or her ear. A quarter of those assigned the modified guide and 40% assigned the original guide were not able to perform this task correctly, even after it was modelled for them.

Table 5-7 shows the average number of prompts required by participants to perform each HA task, based on assigned user guide. It only includes participants who eventually performed the specified task correctly. There were no significant differences in the number of prompts required between those assigned the modified guide and those assigned the original guide on the two simple tasks: change the battery and turn the HA on and off. However, those assigned the modified guide required significantly fewer prompts to perform the five remaining tasks, which were more complex in nature.
Table 5-6. Median time taken for task completion by participants able to perform tasks correctly on the Hearing Aid Management Test with their assigned user guide and no prompts

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)(^a)</td>
<td>Median time (seconds)</td>
<td>Range</td>
<td>n (%)(^a)</td>
<td>Median time (seconds)</td>
<td>Range</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Change the battery</td>
<td>30 (71%)</td>
<td>57</td>
<td>20-167</td>
<td>36 (77%)</td>
<td>67</td>
<td>26-177</td>
</tr>
<tr>
<td>2. Turn the HA on and off</td>
<td>29 (69%)</td>
<td>40</td>
<td>7-120</td>
<td>32 (68%)</td>
<td>39</td>
<td>5-120</td>
</tr>
<tr>
<td>3. Put the HA on</td>
<td>2 (5%)</td>
<td>77</td>
<td>71-82</td>
<td>18 (38%)</td>
<td>84</td>
<td>52-120</td>
</tr>
<tr>
<td>4. Hold phone with HA</td>
<td>3 (7%)</td>
<td>105</td>
<td>85-137</td>
<td>14 (30%)</td>
<td>35</td>
<td>12-64</td>
</tr>
<tr>
<td>5. Turn up volume on HA</td>
<td>27 (64%)</td>
<td>40</td>
<td>16-108</td>
<td>38 (81%)</td>
<td>29</td>
<td>7-84</td>
</tr>
<tr>
<td>6. Change sound program</td>
<td>14 (33%)</td>
<td>58</td>
<td>32-207</td>
<td>40 (85%)</td>
<td>38</td>
<td>13-137</td>
</tr>
<tr>
<td>7. Clean the tube</td>
<td>11 (26%)</td>
<td>91</td>
<td>41-217</td>
<td>28 (60%)</td>
<td>75</td>
<td>47-180</td>
</tr>
</tbody>
</table>

\(^a\)Number allocated this user guide who could perform the task correctly without prompts

HA, hearing aid
Table 5-7. Number of prompts required by participants who performed tasks correctly on the Hearing Aid Management Test

<table>
<thead>
<tr>
<th>Task</th>
<th>Number of Prompts Required</th>
<th>Original n=42</th>
<th>Modified n=47</th>
<th>$\chi^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.Change the battery</td>
<td>0</td>
<td>30 (77%)</td>
<td>36 (80%)</td>
<td>0.683</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>6 (15%)</td>
<td>4 (9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq$2</td>
<td>3 (8%)</td>
<td>5 (11%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.Turn the HA on and off</td>
<td>0</td>
<td>29 (71%)</td>
<td>32 (68%)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>9 (22%)</td>
<td>11 (23%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq$2</td>
<td>3 (7%)</td>
<td>4 (9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.Put the HA on</td>
<td>0</td>
<td>2 (8%)</td>
<td>18 (51%)</td>
<td>19.937</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5 (20%)</td>
<td>11 (31%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq$2</td>
<td>18 (72%)</td>
<td>6 (17%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.Hold phone with HA</td>
<td>0</td>
<td>3 (8%)</td>
<td>14 (31%)</td>
<td>29.644</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5 (13%)</td>
<td>22 (49%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq$2</td>
<td>31 (80%)</td>
<td>9 (20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.Turn up volume on HA</td>
<td>0</td>
<td>27 (69%)</td>
<td>38 (91%)</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>8 (21%)</td>
<td>4 (10%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq$2</td>
<td>4 (10%)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5-7. Number of prompts required by participants who performed tasks correctly on the Hearing Aid Management Test (continued)

<table>
<thead>
<tr>
<th>Task</th>
<th>Number of Prompts Required</th>
<th>Original n=42</th>
<th>Modified n=47</th>
<th>$\chi^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Change sound program</td>
<td>0</td>
<td>14 (37%)</td>
<td>40 (87%)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>15 (40%)</td>
<td>5 (11%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq 2$</td>
<td>9 (24%)</td>
<td>1 (2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Clean the tube</td>
<td>0</td>
<td>11 (32%)</td>
<td>28 (61%)</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>20 (59%)</td>
<td>15 (33%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq 2$</td>
<td>3 (9%)</td>
<td>3 (7%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. The Fisher’s exact test was used when requirements of Chi-squared test ($\chi^2$) not met.
No test statistic produced for the Fisher’s exact test.

HA, hearing aid

5.5 Discussion

The aim of this study was to investigate if a typical HA user guide revised using best practice guidelines for health literacy resulted in superior ability to perform HA management tasks, compared to the user guide in the original form. This was explored using the HAM Test, which required the participant to perform a number of tasks with a HA using a user guide. The regression analysis indicated that the type of user guide was significantly associated with the score on the HAM Test even after adjusting for potential co-variates. In addition, participants assigned the modified guide required significantly fewer prompts to perform all complex tasks correctly and were significantly more likely to perform four of the seven tasks.
correctly, without the need for any prompts. The median time taken by those assigned the modified guide was also significantly shorter for three of the tasks.

There is a paucity of other studies comparing standard versus best practice printed healthcare information. The only comparable study was conducted by Freed et al. (2013) and the findings are consistent with our research. In that study, comprehension of two fact sheets on colorectal cancer screening were compared; a standard fact sheet and one that was modified incorporating aspects of best practice. The latter had a lower reading grade level (7.4 versus 9.6), utilized more tables to present information, and was more focused on addressing barriers to screening. The study involved 60 adults aged 50 to 75 years and each was randomly assigned one of the two fact sheets. Those who received the modified fact sheet showed superior recognition memory, even after adjusting for education level and self-assessed health literacy. Similar to our study, the findings provide evidence that it is beneficial to design printed healthcare materials according to best practice guidelines.

Other variables associated with performance on the HAM Test were health literacy level, finger dexterity, and age. Along with the type of user guide, these factors accounted for 64% of variance in the scores obtained on this test. The three factors will be discussed in turn. Higher health literacy levels, as measured on the S-TOFHLA, were associated with better performance on the HAM Test. This is consistent with a study conducted by Convery et al. (2011) in which health literacy level was found to strongly influence the ability of older adults to assemble and insert a HA, using written instructions. To-date, health literacy is a factor that has been largely overlooked in the field of rehabilitative audiology. This is despite the fact that hundreds of studies have reported an association between health literacy and health outcomes in other areas of healthcare, such as diabetes management (e.g. Berkman et al. 2011). In the present study, there were strong links between health literacy and cognition with the two measures highly correlated; hence only one of them (health literacy) was included in the regression model. Health literacy has also been found to be associated with cognition in numerous other studies (e.g. Wolf et al. 2012; Dahlke et al. 2014; Kaphingst et al. 2014).

The second factor that influenced HAM Test scores was age; older age was associated with lower scores on the test. As mentioned in the introduction, a number of studies have found that older adults have more difficulty with HA management skills (e.g. Ward et al. 1979;
Stephens & Meredith 1991; Desjardins & Doherty 2009). Hence, it is not surprising that older adults would also perform more poorly on HA management tasks following instructions in a user guide. The third factor associated with HAM Test scores was finger dexterity. Participants with better finger dexterity tended to obtain higher scores on the test. Although other studies have found an association between finger dexterity and HA use, this is the first study to measure a direct association between it and HA management. The finding indicates that older adults with poor finger dexterity are likely to experience greater difficulties with HA management.

The variables that showed no significant association with performance on the HAM Test were sex, attitude to HAs, and HA self-efficacy. Although a number of studies have reported that males perform better on HA management tasks (e.g. Meredith & Stephens 1993), Desjardins and Doherty (2009) found no association between sex and performance on management tasks for experienced HA aid users. Convery et al. (2011) reported that males were more likely to independently assemble the HA used in their study, without asking for assistance from a partner, whilst females were more likely to assemble it without errors. In the present study, males did perform better but this effect did not reach statistical significance in the multivariable analysis.

Although HA self-efficacy has been associated with HA outcomes in previous research by Hickson et al. (2014), it was not associated with performance on HA management tasks in our study. The difference in findings may be because of the different nature of the studies. The study by Hickson et al. (2014) was retrospective whilst the participants in our study were attempting each task for the first time. A person with high self-efficacy is more likely to practise and persevere, regardless of success or failure on an initial attempt, which in turn could increase their likelihood of better HA management. Clear, easy-to-follow instructions, adhering to best practice guidelines, will likely assist in their efforts.

Regardless of the user guide assigned, the tasks that participants were least likely to perform correctly were inserting the HA in the ear and holding the phone with the HA. Two additional tasks proved difficult for those assigned the original guide: changing the sound program and cleaning the tube. Less than 35% of participants using the original guide could perform either of the latter two tasks, without the need for prompts. Previous studies that have examined HA management skills in older adults have also found aid/mould insertion to
be the most difficult task (Brooks 1985; Upfold et al. 1990). In addition, other studies have reported that participants experienced problems with using the phone with the HA, cleaning the HA, and changing the sound program (e.g. Desjardins & Doherty 2009; Brooke et al. 2012).

### 5.5.1 Limitations and future directions

A limitation of this study relates to the size and characteristics of the participant group. A large percentage of the participants were from a high socio-economic demographic and only 9 (10%) presented with low health literacy based on results for the S-TOFHLA. In addition, there were substantially more females than males. The study may have been strengthened with the addition of more participants, particularly from lower socio-economic areas, where the prevalence of low health literacy is likely to be higher. However, given evidence that health-care materials designed according to best practice guidelines provide greater benefit to adults with low literacy compared to those with adequate literacy (Michielutte et al. 1992), it is believed that the results from this study can be generalised to all older adults. Second, the study had a target of 103 participants for 7 independent variables but fell short of this with 89 participants. However, the final model (with 89 participants) only contained 4 independent variables which gives adequate power of 80%.

Third, the study only included printed HA instruction materials, hence the results cannot be generalised to web-based health-care materials. Future research could examine the useability of HA instruction materials available on web platforms or delivered through smart technology, such as phone apps. The benefit of electronic instruction material is that the content can be personalised for the user (e.g., only showing features and functions available on the user’s HA) and such personalisation is reported to be associated with increased likelihood of use of instructions (Bull et al. 2001). In addition, future studies could compare performance on the HAM Test for electronic HA instructions and best practice printed HA instructions.

Fourth, it is acknowledged that clients being fitted with HAs receive verbal instruction on device management from their hearing care professional at the time of fitting. In this study no verbal instruction was provided, hence the participants were faced with a more difficult task compared to individuals in a typical clinical setting and it is not known how this would have impacted on the observed differences between the user guides. Nevertheless, we
maintain that the differences are relevant for two reasons. First, Kessels (2003) reports that between 40 and 80% of information communicated in a healthcare appointment is immediately forgotten. Second, HAs are often managed by other people, such as family members or staff at a residential care facility, who may not attend appointments and thus be reliant on the user guide.

5.5.2 Clinical implications

The findings from this study have important implications for hearing care professionals and HA manufacturers. This research provides clear evidence that older adults are better able to comprehend healthcare instructions designed according to best practice guidelines for health literacy. Hence, it is strongly advocated that all hearing healthcare professionals and organizations develop their materials based on such guidelines. Examples of materials that could benefit from this include HA user guides, as well as information brochures on topics such as HA options, communication strategies, assistive listening devices, and clinic policies. The reader is directed to Caposecco et al. (2011)’s overview of how to develop instructions for hearing devices that comply with health literacy principles.

Age and finger dexterity were also found to be associated with the ability to perform HA management tasks with a user guide. Hence, slightly longer appointments or an extra appointment could be provided to older adults and adults who have poor finger dexterity. This would allow more time to describe and demonstrate HA management and to carefully explain what is in the user guide and how to use it at home. Attention should be paid to teaching the client to insert the aid, clean the aid, and use it with the phone as these tasks proved to be the most difficult for participants in this study. It would also be beneficial to involve a significant other who may be able to learn how to manage the HA, alongside the client, and thus support them at home. Work by Hickson et al. (2014) highlights the importance of involving a significant other in hearing rehabilitation, where possible. They found that adults who had greater positive support from friends and family were more likely to have successful HA outcomes.

5.6 Conclusions

This research highlights the association between the quality and type of HA instruction material and the ability of older adults to perform HA management tasks. It shows that a HA
user guide modified using best practice guidelines for health literacy results in superior ability to perform HA management tasks, such as changing the volume, compared to the user guide in the original form. As such, it is recommended that HA user guides and other healthcare instruction materials are designed according to health literacy principles.
5.7 References


Griffin, J., McKenna, K., & Tooth, L. (2006). Discrepancy between older clients' ability to read and comprehend and the reading level of written education materials used by occupational therapists. *American Journal of Occupational Therapy, 60*(1), 70-80.


Chapter 6: Best Practice Hearing Aid User Guide Assists Adults with Troubleshooting


*This chapter is inserted as submitted for publication, with the exception of 1) formatting changes to headings, tables, and figures to maintain consistency throughout the thesis; 2) modifications suggested by the thesis examiners (shown in bold).*
6.1 Abstract

**Objectives:** 1) To determine if a hearing aid user guide modified using best practice guidelines for health literacy results in superior ability to find and understand hearing aid troubleshooting information, compared to the user guide in the original form; 2) To examine older adults’ preferences for user guides.

**Design:** Participants included 89 adults, with a mean age of 72 years, living in the community, and with no experience of hearing aids. Forty seven participants were assigned the modified user guide and 42 were assigned the original user guide and all were assessed with the Hearing Aid Troubleshooting Test.

**Results:** Performance was significantly better, on all but one item, for participants assigned the modified guide with between 45% and 92% of participants able to locate the correct section and provide accurate information on each of the six troubleshooting items with that guide. Overall, 80% of participants preferred the modified user guide when shown both.

**Conclusions:** A best practice hearing aid user guide is associated with superior ability to locate and understand troubleshooting information. Hence, it is recommended that hearing aid user guides are designed based on best practice guidelines to increase the likelihood that older adults will be able to successfully troubleshoot their hearing aid/s at home.

**Key Words:** hearing impairment, hearing aids, older adults, instructions, health literacy
6.2 Introduction

Individuals fitted with hearing aids (HAs) typically receive a printed user guide which contains information on HA management, maintenance, and troubleshooting. Such a guide should play a pivotal role in a client’s rehabilitation program for three key reasons. First, research indicates that between 40 and 80% of information communicated in a healthcare appointment is immediately forgotten (Kessels, 2003) and therefore people need something to refer to after the appointment. Second, HAs are often managed by other people, such as family members or staff at a residential care facility, who may not attend the appointment and are therefore reliant on the user guide. Third, it is generally not possible to cover every aspect of HA troubleshooting in a couple of appointments. In the long term, inability to perform simple troubleshooting tasks when an aid is not working properly will likely impact patient outcomes. In the worst case scenario, the aid/s will be rejected. According to Kochkin (2000) one of the major reasons why HAs are not worn is because they are reported to be broken or no longer working. Other factors linked to dissatisfaction with HAs, that may be addressed using a troubleshooting guide, are feedback, fit, and comfort (Hickson et al., 2010, Kochkin, 2000, Kochkin, 2005).

In order for a user guide to be beneficial for troubleshooting purposes, the client must be able to find and understand information contained within it. Brooke, Isherwood, Herbert, Raynor, and Knapp (2012) conducted user testing to determine if adults were able to locate, comprehend, and apply troubleshooting information from within a HA user guide. The study involved 40 participants with a mean age of 56 years and no experience with HA management. Half the participants were assigned a user guide for a Danalogic HA, and the remaining half were assigned a user guide for a Unitron HA. Participants were asked to answer three troubleshooting-related questions (e.g., what to do if HAs are exposed to high amounts of perspiration), with the help of their assigned user guide. Despite the relatively young age of the participants, between 10% and 33% had difficulty or were unable to find the information needed to answer these questions. The participants were also asked to provide feedback on their assigned user guide, after completing the tasks. Aspects of the content and layout of both user guides were viewed negatively, including unclear diagrams, small font size, confusing or insufficient information for some tasks, difficult language, and use of jargon.
The findings from the Brooke et al. (2012) study are consistent with research indicating that the majority of HA user guides are not easy-to-read and understand (Caposecco et al., 2014, Kelly, 1996, Nair and Cienkowski, 2010). Caposecco et al. (2014) examined the content, design, and readability of a sample of 36 HA user guides (four user guides from nine different HA manufacturers). User guides were assessed using four readability formulae and a standardized tool to assess content and design called the SAM (Suitability Assessment of Materials) (Doak et al., 1996). Sixty nine percent of user guides were rated as ‘not suitable’ and 31% were rated as ‘adequate’ on the SAM; many scored poorly for scope, vocabulary, aspects of layout and typography, and learning stimulation and motivation. The mean reading grade level for all user guides was 9.6 (between 9th and 10th grade). This is considered too high for healthcare material, which should be written at a 6th grade reading level or lower (e.g., Doak et al., 1996). Based on the findings of these studies, a proportion of older adults are likely to experience difficulty finding and understanding troubleshooting information contained in a typical user guide.

The ability to use HA user guides to access troubleshooting information would be further compromised if the reader has low health literacy. Health literacy refers to the ability to find, understand, and use healthcare information and services (e.g., Ratzan and Parker, 2000) and at least 30% of older adults, the main users of HAs, have low health literacy (e.g., Kutner et al., 2006; Australian Bureau of Statistics, 2006). Against this backdrop, research indicates that healthcare material, such as HA user guides, should be designed and developed applying best practice guidelines for health literacy (e.g., Freed et al., 2013; Ley and Florio, 1996). Caposecco et al. (2011) provides a summary of best practice guidelines for health literacy and their application to the development of printed HA instruction materials. The guidelines encompass content, language, layout, typography, organization, and graphics (e.g., use of active voice, short words and sentences, simple line drawings, and dark letters on a light background).

In the first study of its kind, in the field of audiology, we (Caposecco et al., submitted) investigated if a HA user guide revised using best practice guidelines for health literacy resulted in a superior ability to perform HA management tasks, compared to the user guide in the original form. The research involved 89 participants (mean age = 72 years) who had had no experience with HA use or management; half were assigned the manufacturer’s user guide
and half were assigned the modified user guide. Both user guides were developed for the same HA, a behind-the-ear (BTE) aid with an open dome. As part of the test battery, the Hearing Aid Management Test was administered. This test required the participant to perform seven tasks with the HA, using their assigned user guide (e.g., insert the HA, increase the volume, clean the tube). Type of user guide was found to be significantly associated with the score on the Hearing Aid Management Test and this association remained after controlling for factors, such as age, gender, health literacy level, and cognition. The findings showed that older adults were significantly more likely to perform HA tasks correctly with a user guide designed based on best practice guidelines.

6.2.1 Aims
The fore-mentioned research also included the assessment of troubleshooting with the user guides. This was considered important because the ability to troubleshoot when things go wrong is likely to lead to successful HA outcomes. Thus, the aims of this study were: 1) To determine if a hearing aid user guide modified using best practice guidelines for health literacy results in superior ability to find and understand hearing aid troubleshooting information, compared to the user guide in the original form; 2) To examine older adults’ preferences for user guides.

6.3 Materials and methods

6.3.1 Participants
The participants were the same as those reported in the companion study (Caposecco et al., submitted); these were 89 adults aged 55 years or over. Three participants were under 60 years of age and hence, not older adults. However, they were included to allow for a greater range of ages in order to better determine the effect of age on HA management ability with a user guide (reported in the companion study). All participants resided in the community and were comfortable speaking and reading English; none had experience with HA use or management. Participants who had a severe cognitive impairment (defined as a score ≤3 on the six-item cognitive screener (Callahan et al., 2002)) or an uncorrected visual impairment (defined as visual acuity of less than 20/100) were excluded from the study. Hearing impairment was neither an inclusion or exclusion factor. Participants were recruited through the Communication Research Registry (www.crregistry.org.au), retirement villages, and word-of-mouth.
Table 6-1 presents detailed demographic information about the participants. The mean number of years of education for participants was 13, indicating that many went onto higher education after completing high school. The majority (90%) had adequate health literacy, measured using the Short Test of Functional Health Literacy in Adults (S-TOFHLA) (Baker et al., 1999). Although all participants passed the six-item cognitive screener, approximately one third (36%) failed the Montreal Cognitive Assessment (MoCA). The six-item cognitive screener was used to rule out severe cognitive impairment, as per the exclusion criteria, whilst the MoCA is sensitive to mild cognitive impairment. Half (51%) of the participants presented with a hearing impairment, defined as a four frequency (500Hz, 1kHz, 2kHz, and 4kHz) average hearing loss of ≥25dB in the better ear.

6.3.2 Assessment measures

User guides and hearing aid
The Oticon Acto behind-the-ear (BTE) HA with an open dome was used in the study. It was selected because this user guide received the median score on The Suitability Assessment of Materials (SAM) (Doak et al., 1996) in an analysis of the content, design, and readability of a sample of 36 HA user guides (Caposecco et al., 2014). This user guide was therefore considered to be representative of a ‘typical’ HA user guide. A second user guide for the same HA was developed for the study to represent a ‘best practice’ HA user guide. From here-on-in, the user guides will be termed the original guide and the modified guide. The design process for the modified user guide involved typing all text from the original guide into a word document; removing information on functions not available on the device; formatting the content based on best practice guidelines for health literacy; enlarging graphics and including a short text instruction with each; and adding a HA details page at the front. The HA details page provided brief information on the aid such as the model, battery size, and sound programs. Approximately 80% of the graphics were taken directly from the original user guide because they met best practice guidelines; they were simple, black and white line drawings. Both user guides had a troubleshooting section and a quick guide, which contained information on the main HA functions. The SAM score for the original guide was 50% (adequate) as compared to 90% (superior) for the modified guide and the reading grade level was 10 for the original guide and 4 for the modified guide. Three pages taken from the modified user guide are shown in Appendix B.
Table 6-1. Demographic information for participants (N = 89).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>61 (69%)</td>
</tr>
<tr>
<td>Male</td>
<td>28 (31%)</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>72</td>
</tr>
<tr>
<td>Range</td>
<td>55-95</td>
</tr>
<tr>
<td>Education level (years)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>13</td>
</tr>
<tr>
<td>Range</td>
<td>6-16</td>
</tr>
<tr>
<td>Health literacy (S-TOFHLA)</td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>80 (90%)</td>
</tr>
<tr>
<td>Inadequate or marginal</td>
<td>9 (10%)</td>
</tr>
<tr>
<td>Cognition (MoCA)</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>57 (64%)</td>
</tr>
<tr>
<td>Abnormal</td>
<td>32 (36%)</td>
</tr>
<tr>
<td>Finger dexterity (GPT) (time: seconds)</td>
<td></td>
</tr>
<tr>
<td>Dominant hand (median)</td>
<td>90</td>
</tr>
<tr>
<td>Non-dominant hand (median)</td>
<td>122</td>
</tr>
<tr>
<td>Hearing (4FAHL in better ear)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>25</td>
</tr>
<tr>
<td>Range</td>
<td>8-58</td>
</tr>
</tbody>
</table>

*Note. S-TOFHLA = Short Test of Functional Health Literacy for Adults; MoCA = Montreal Cognitive Assessment; GPT = Grooved Pegboard Test; 4FAHL = four frequency average hearing level*
**Hearing Aid Troubleshooting Test (HATT)**

The HATT was designed for this study and assesses the ability of adults to find and comprehend information relating to troubleshooting in a HA user guide. Each participant was allowed 2 minutes to look through their user guide before starting the test. The score sheet is shown in Appendix D and examples of questions include: a) What size battery does this HA use?; and b) What do you do if the HA starts to whistle when it is in your ear? The information needed to answer the questions correctly was available in both user guides. For each item the participant was first required to find the correct section in the user guide. If they were unable to find it within 1 minute, the examiner opened the user guide to the correct section. The participant was then required to answer the question based on the information contained in the user guide, and their response was recorded as being either correct or incorrect. One prompt, ‘can you tell me more?’ was permitted for each item.

**User Guide Attitude Survey**

The format of the user guide survey and types of questions were based on a questionnaire by Davis et al. (1998) in a study that compared two polio vaccine pamphlets. The first two questions are open-ended and required the participants to explain what they liked and did not like about their assigned user guide. The remaining seven questions are shown in Table 6-5, five of which utilise a Likert response scale (e.g., “very easy to understand” to “difficult to understand”); the scales differed for each item. Participants were not aware there was an alternate user guide (modified or original) until the second last question, at which point they were shown the other user guide, and asked for their preference. All nine questions were asked verbally; however, to ensure questions were understood, each participant was also provided with a laminated copy of the questions, printed in a large font size. The participants were required to provide a verbal response to each question.

**The Short Test of Functional Health Literacy in Adults**

The Short Test of Functional Health Literacy in Adults (S-TOFHLA) (Baker et al., 1999) is a 36 item timed reading comprehension test that consists of two prose passages containing materials that an adult might encounter in a healthcare setting. One or two words are missing from each sentence, and the respondent is required to select the correct word from four choices provided. The maximum score is 36, with a score of ≥23 indicating adequate health literacy, a score between 17 and 22 indicating marginal health literacy, and a score of ≤16
indicating inadequate health literacy. A version of the S-TOFHLA that has been slightly modified to reflect Australian language and culture (Buchbinder et al., 2006) was used in this study.

**Montreal Cognitive Assessment**

The Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) is a short cognitive screening test designed to detect mild cognitive impairment. It assesses executive function, visuospatial function, memory, attention, language, abstraction, and orientation. The maximum score is 30 and a score of ≥26 is indicative of normal cognitive function and a score of <26 is indicative of cognitive impairment.

**Grooved Pegboard Test**

Finger dexterity was assessed using the grooved pegboard test (GPT) (Lafayette Instruments Model 32025). Participants were required to insert 25 pegs into a five-by-five metal grid that consisted of 25 holes with little grooves. Each peg had to be rotated to match the hole before it could be inserted properly. Participants completed the test with the dominant hand first, followed by the non-dominant hand. The score for this test was the time taken for the participant to complete the task with each hand with a longer time being indicative of poorer finger dexterity.

**Demographic questionnaire**

The demographic questionnaire elicited information about each participant’s age, sex, level of formal education, socio-economic status, self-reported health status, and attitude to HAs.

**Pure-tone screening audiogram**

Air-conduction thresholds were obtained for both ears at 0.5, 1, 2, and 4kHz and a four-frequency average hearing loss (4FAHL) was calculated for each ear.

**6.3.3 Procedure**

The study tasks were completed in a single appointment, in a quiet room, at either the University of Queensland or at the participant’s home. The type of user guide was randomly assigned to each participant based on his/her participant number which was allocated when they provided consent to take part in the study. Participants were numbered consecutively; those allocated an odd number received the modified guide and those allocated an even
number received the original guide. Two weeks before their appointment, each participant was sent the demographic questionnaire to complete. At the test appointment, the Hearing Aid Management Test and the HATT were administered, followed by the user guide attitude survey. The Hearing Aid Management Test results were analysed and reported in a separate study (Caposecco et al., submitted) and thus will not be described in this paper. After a 10 minute break, the remaining tests were conducted and the total testing time was approximately 90 minutes.

6.3.4 Data analysis
Data were analysed using Stata software (version 13.9, 2013). Statistical analyses were conducted to assess differences in 10 baseline characteristics (e.g., age, health literacy, and finger dexterity), between the group of participants assigned the original user guide and the group of participants assigned the modified user guide. The statistical tests included the independent-samples $t$-test, Chi-squared test, Mann-Whitney test, and the Fisher’s exact test. The choice of test was based on the type (categorical versus continuous) and distribution of the data. The main outcome, being the number of participants in each group able to find the correct page in the user guide and answer the question correctly for each item, was analysed using a series of Chi-squared tests or Fisher’s exact tests. The Fisher’s exact test was selected when the assumption requirements of the Chi-squared test were not met (e.g., expected cell frequency <5 in one or more cells).

6.4 Results
Forty-seven participants were assigned the modified guide and 42 were assigned the original guide. The difference in number resulted because more participants who were initially assigned the original guide, withdrew or were excluded from the study. There were no significant differences ($p>0.05$) between the two groups on key demographic indicators or on test results for health literacy (S-TOFHLA), cognition (MoCA), finger dexterity (GPT), or hearing level.

6.4.1 Hearing Aid Troubleshooting Test
Two aspects of utilising a user guide to obtain troubleshooting information were examined: a) the ability to find the correct section in the user guide, and b) the ability to answer the
troubleshooting question correctly (comprehension). See Table 6-2 and 6-3 for a summary of the results.

Compared to participants assigned the original guide, significantly more participants assigned the modified guide were able to locate the correct section on three of the six items: battery size ($p = 0.046$), three ways to avoid moisture and heat ($p < 0.0001$), and two daily tasks to take care of the HA ($p < 0.0001$) (see Table 6-2). Significantly more participants assigned the original guide were able to locate the correct section for one item: action to take if HA whistles in ear.

Across the two groups, between 53% and 96% of participants were able to find the correct section in the user guide for each of the items. Over 90% of participants were able to find the correct page for items 1 and 2: battery size and ability to tell the left HA from the right HA, respectively. In contrast only half (53%) of the participants could find the correct page for item 3: action to take if HA whistles in ear. The answer was located in the troubleshooting guide near the back of both user guides.

Across the two groups, between 45% and 92% of participants were able to answer the troubleshooting questions accurately, after finding the correct page. In fact, for each item, at least 80% of participants who found the correct section in their assigned user guide provided an accurate answer to the question. Compared to participants assigned the original guide, significantly more participants assigned the modified guide were able to locate the correct section and provide accurate information on all items with the exception of item 3 (action to take if HA whistles in ear) (see Table 6-3). For example, 94% of participants assigned the modified guide were able to correctly name two tasks one should do on a daily basis to care for the HA, compared to 45% of participants assigned the original guide ($p < 0.0001$).
Table 6-2. Number of participants who were able to find the correct page in their user guide for each item on the Hearing Aid Troubleshooting Test

<table>
<thead>
<tr>
<th>Test item</th>
<th>Modified (n = 47)</th>
<th>Original (n = 42)</th>
<th>p</th>
<th>Total sample (n = 89)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What size battery does this HA use?</td>
<td>47 (100%)</td>
<td>38 (90%)</td>
<td>0.046*</td>
<td>85 (96%)</td>
</tr>
<tr>
<td>How do you tell which is the left HA and which is the right HA?</td>
<td>46 (98%)</td>
<td>38 (90%)</td>
<td>0.184</td>
<td>84 (94%)</td>
</tr>
<tr>
<td>What do you do if the HA starts to whistle when it is in your ear?</td>
<td>20 (43%)</td>
<td>27 (64%)</td>
<td>0.040*</td>
<td>47 (53%)</td>
</tr>
<tr>
<td>What do you do if the HA is intermittent?</td>
<td>44 (94%)</td>
<td>35 (83%)</td>
<td>0.125</td>
<td>79 (89%)</td>
</tr>
<tr>
<td>Heat and moisture can cause a HA to break down. Name 3 things you can do to avoid heat and moisture?</td>
<td>44 (94%)</td>
<td>10 (24%)</td>
<td>&lt;0.0001*</td>
<td>54 (61%)</td>
</tr>
<tr>
<td>Name 2 tasks you should do on a daily basis to take care of the HA.</td>
<td>45 (96%)</td>
<td>19 (45%)</td>
<td>&lt;0.0001*</td>
<td>64 (72%)</td>
</tr>
</tbody>
</table>

*Note. HA = hearing aid.

*p<.05
Table 6-3. Number of participants who were able to find the correct page and answer the question accurately for each item on the Hearing Aid Troubleshooting Test

<table>
<thead>
<tr>
<th>Test item</th>
<th>Modified $(n = 47)$</th>
<th>Original $(n = 42)$</th>
<th>$p$</th>
<th>Total sample $(n = 89)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>What size battery does this HA use?</td>
<td>46 (98%)</td>
<td>36 (86%)</td>
<td>0.049*</td>
<td>82 (92%)</td>
</tr>
<tr>
<td>How do you tell which is the left HA and which is the right HA?</td>
<td>43 (91%)</td>
<td>28 (67%)</td>
<td>0.004*</td>
<td>71 (80%)</td>
</tr>
<tr>
<td>What do you do if the HA starts to whistle when it is in your ear?</td>
<td>20 (43%)</td>
<td>20 (48%)</td>
<td>0.632</td>
<td>40 (45%)</td>
</tr>
<tr>
<td>What do you do if the HA is intermittent?</td>
<td>40 (85%)</td>
<td>24 (57%)</td>
<td>0.003*</td>
<td>64 (72%)</td>
</tr>
<tr>
<td>Heat and moisture can cause a HA to break down. Name 3 things you can do to avoid heat and moisture?</td>
<td>44 (94%)</td>
<td>10 (24%)</td>
<td>&lt;0.0001*</td>
<td>54 (61%)</td>
</tr>
<tr>
<td>Name 2 tasks you should do on a daily basis to take care of the HA.</td>
<td>44 (94%)</td>
<td>19 (45%)</td>
<td>&lt;0.0001*</td>
<td>63 (71%)</td>
</tr>
</tbody>
</table>

*Note. HA = hearing aid.

*p < .05
6.4.2 The User Guide Attitude Survey

Table 6-4 provides a summary of the main aspects participants liked and disliked about their assigned user guide. Participants assigned the original guide made a total of 64 comments about aspects they liked and participants assigned the modified guide made a total of 156 positive comments. The most liked elements of both user guides (20% of comments from both groups) were the diagrams. Overall, participants felt that the diagrams were clear and detailed in both the original and the modified guides.

Participants assigned the original guide made a total of 109 comments about aspects they disliked and participants assigned the modified guide made 26 negative comments. The main aspect disliked in both user guides was the contents page, accounting for approximately one quarter of all comments. Participants assigned the original guide commented that the contents page was poorly worded, difficult to use, and unclear and participants assigned the modified guide felt that the layout of the contents page could be improved. Five participants suggested that the troubleshooting section be moved from the bottom of the list of contents to the top of the list, so that it would be more visible to the user. Overall, six participants (14%) assigned the original guide reported there were no aspects of the guide that they disliked, compared to 25 participants (53%) assigned the modified guide.

Table 6-5 provides a summary of the answers provided to the closed-ended questions in the survey. Overall, participants assigned the modified guide responded more favourably than those assigned the original guide. For example, approximately 70% of participants assigned the modified guide thought the instructions were ‘very easy to understand’ compared to 14% of participants assigned the original guide. In addition, approximately 20% of participants assigned the original guide felt the print size was ‘too small’, whilst all participants assigned the modified guide felt that the print size was ‘just right’. Across both groups, when shown three user guides of different sizes, 64% of participants preferred A5 size to both A4 size and the size of the original user guide (14.5cm x 9.8cm).
At the end of the survey, participants were shown both the original and the modified guide and asked which one they preferred and why. The majority (83%) preferred the modified guide and 237 responses were made by participants as to why they made this decision. Twenty one percent of the comments related to the size and clarity of the diagrams; the participants liked the fact that the diagrams were large and clear, and that they were able to see the detail. Other reasons cited by participants were ease of use (18%), large print size (11%), and size of the user guide (10%). A total of 34 comments were made by participants who preferred the original guide and the majority (88%) related to size. Participants with a preference for this guide liked the fact that it was small, compact, portable, and easy to store.
Table 6-4. Main aspects participants liked and disliked about their assigned user guide$^a$

<table>
<thead>
<tr>
<th>User Guide</th>
<th>Main aspects liked$^b$</th>
<th>Main aspects disliked$^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topic</td>
<td>Aspect</td>
</tr>
<tr>
<td><strong>Modified</strong></td>
<td>Diagrams</td>
<td>Clear/ detailed diagrams</td>
</tr>
<tr>
<td></td>
<td>Size, layout, and typography</td>
<td>Good print size</td>
</tr>
<tr>
<td></td>
<td>Size, layout, and typography</td>
<td>Clear layout</td>
</tr>
<tr>
<td><strong>Original</strong></td>
<td>Diagrams</td>
<td>Clear/ detailed diagrams</td>
</tr>
<tr>
<td></td>
<td>Clarity</td>
<td>Easy to understand</td>
</tr>
<tr>
<td></td>
<td>Contents page</td>
<td>Well set out and easy to use</td>
</tr>
</tbody>
</table>

*Note.* $^a$Information elicited on the User Guide Attitude Survey, $^b$156 responses for the modified guide and 64 responses for the original guide, $^c$26 responses for the modified guide and 109 responses for the original guide.
Table 6-5. Responses from the User Guide Attitude Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Original (n=42)</th>
<th>Modified (n=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Did you think the pictures/illustrations were:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Very good</td>
<td>15 (36%)</td>
<td>36 (77%)</td>
</tr>
<tr>
<td>b. Good</td>
<td>22 (52%)</td>
<td>11 (23%)</td>
</tr>
<tr>
<td>c. Poor</td>
<td>4 (10%)</td>
<td>0</td>
</tr>
<tr>
<td>d. Very poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>e. Don’t know</td>
<td>1 ( 2%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Did you think the print size was:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Too large</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>b. Too small</td>
<td>8 (19%)</td>
<td>0</td>
</tr>
<tr>
<td>c. Just right</td>
<td>34 (81%)</td>
<td>47 (100%)</td>
</tr>
<tr>
<td>d. Don’t know</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>If you needed a HA do you think this guide would make you feel:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. More comfortable</td>
<td>34 (81%)</td>
<td>45 (96%)</td>
</tr>
<tr>
<td>b. Less comfortable</td>
<td>4 (10%)</td>
<td>0</td>
</tr>
<tr>
<td>c. No different</td>
<td>3 ( 7%)</td>
<td>0</td>
</tr>
<tr>
<td>d. Don’t know</td>
<td>1 ( 2%)</td>
<td>2 ( 4%)</td>
</tr>
<tr>
<td><strong>In your opinion were the instructions:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Very easy to understand</td>
<td>6 (14%)</td>
<td>32 (68%)</td>
</tr>
<tr>
<td>b. Easy to understand</td>
<td>26 (62%)</td>
<td>12 (26%)</td>
</tr>
<tr>
<td>c. Quite easy to understand</td>
<td>5 (12%)</td>
<td>3 ( 6%)</td>
</tr>
<tr>
<td>d. Difficult to understand</td>
<td>5 (12%)</td>
<td></td>
</tr>
</tbody>
</table>
Table 6-5. Responses from the User Guide Attitude Survey (continued)

<table>
<thead>
<tr>
<th>Question</th>
<th>Assigned User Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Original (n=42)</td>
</tr>
<tr>
<td><strong>In your opinion did the instruction book give you:</strong></td>
<td></td>
</tr>
<tr>
<td>a. Too little information</td>
<td>5 (12%)</td>
</tr>
<tr>
<td>b. The right amount of information</td>
<td>33 (79%)</td>
</tr>
<tr>
<td>c. Too much information</td>
<td>4 (10%)</td>
</tr>
<tr>
<td><strong>What size user guide do you prefer?</strong></td>
<td></td>
</tr>
<tr>
<td>a. A4</td>
<td>9 (21%)</td>
</tr>
<tr>
<td>b. A5</td>
<td>27 (64%)</td>
</tr>
<tr>
<td>c. Original (15cm x 10cm)</td>
<td>6 (14%)</td>
</tr>
<tr>
<td><strong>Which user guide do you prefer?</strong></td>
<td></td>
</tr>
<tr>
<td>a. Original</td>
<td>10 (24%)</td>
</tr>
<tr>
<td>b. Modified</td>
<td>32 (76%)</td>
</tr>
</tbody>
</table>
6.5 Discussion

This study examined if the type of user guide (modified versus original) was associated with older adults’ ability to access and understand HA troubleshooting information in a HA user guide. The findings provide strong evidence that older adults are more likely to find and comprehend troubleshooting information in a user guide designed based on best practice guidelines. Participants assigned the modified guide were significantly more likely to locate the correct section in the user guide on three of the six items and were significantly more likely to provide accurate information on all but one of the items.

Only two previous studies have compared best practice versus standard written health-care information for older adults, and consistent with this research both found that materials incorporating aspects of best practice design (e.g., large font size, low reading grade level) were associated with superior comprehension ability. Freed et al. (2013) compared the effects of two health information pamphlets on recognition memory, a key aspect of comprehension. Both documents (original versus modified) provided information on screening for colorectal cancer; the modified document had a lower reading grade level, contained more practical information, and employed more tables and less text. Comprehension was found to be significantly higher for those assigned the modified document after adjustment for age, education level, and health literacy. Morrow et al. (2005) compared original versus modified written instructions, both designed to improve medication knowledge in older adults with chronic health failure. The modified instructions used a larger font size, contained less information, included more graphics, had a lower reading grade level, and presented information in a more logical order. They found that the modified instructions were better recalled and understood more quickly than the original instructions. The findings from these studies combined with our own highlight the benefits of developing health-care material based on best practice design principles.

The only other published research designed to examine the ability of adults to use a HA user guide for troubleshooting was conducted by Brooke et al. (2012) and found that between 65% and 90% (mean = 81%) of participants were able to find the correct section in their assigned user guide (without difficulty or ≥2 prompts) and provide an accurate answer. In the current study between 43% and 98% (mean = 84%) of participants assigned the modified guide provided an accurate answer to each of the troubleshooting questions compared to between
24% and 86% (mean = 55%) of those assigned the original user guide. Although it appears that the participants in the Brooke et al. study obtained similar results to those allocated the modified user guide in this study, it is difficult to draw comparisons because the questions were different in the Brooke et al. study, the sample was younger (mean age 56 years, range = 46–72 years), almost all participants reported using documents regularly in their work, and more prompting was provided. However, taking the two studies together, it would appear that older adults have more difficulty than younger adults using a user guide.

The task of locating the correct section in the user guide was a sizable hurdle for many participants in this study. However, consistent with the Brooke et al. study, the majority of those who could find the correct page went on to answer the question accurately. This finding highlights the potential benefits one might see with improved design of the contents page. Similar across both studies, some troubleshooting questions proved easier for participants to answer than others. In this study, the questions that the majority of participants answered accurately related to battery size, and how to distinguish the left HA from the right HA. The question that proved to be the most difficult required the participant to express what they would do if the HA started to whistle in their ear; less than half answered this accurately. This is of concern because feedback is a reasonably common occurrence and is a major source of dissatisfaction with HAs (Kochkin, 2000, Kochkin, 2005, Dillon, 2001).

The second aim of the study was to determine older adults’ preferences for HA user guides. The main aspect that participants liked in both the modified guide and the original guide were the diagrams. The diagrams were simple black and white line drawings and were the same in the two guides, with the exception that they were larger in the modified guide. This supports the findings of a literature review on graphics in healthcare materials conducted by Houts et al. (2006) that recommended the use of simple line drawings, accompanied by short text captions. In addition, Houts et al. suggested the use of prompts within each diagram (e.g., labels or arrows) to help explain the intended meaning; this approach was used extensively in both user guides in our study.

The second aspect participants liked most about the modified guide was the font size of 20 point as compared to 9 point in the original guide. When asked specifically about the print size, 100% of the participants assigned the modified guide thought the size was ‘just right’,
compared to 81% assigned the original guide, and the remaining 19% assigned the original guide felt that the print size was ‘too small’. These findings support the use of a 12 point font size or larger, for healthcare material as per best practice guidelines (Doak et al., 1996, Centers for Disease Control and Prevention, 2009).

The main aspect that participants disliked in both user guides was the contents page. Thirty percent of the participants assigned the original guide felt that the contents page was inadequate, unclear, and/or difficult to use; and one quarter of those assigned the modified guide felt that the layout could be improved. The emphasis placed on the contents page in this survey may stem from the fact that many participants had difficulty using it and this was highlighted by the finding that over a third of the participants were unable to locate the correct section in the user guide on three of the items in the HATT. This suggests that in the design phase, particular focus should be placed on ensuring the contents page is clear and easy-to-use. As per best practice guidelines, it is recommended to use a large font, black text on a white background, and subheadings to group sections (e.g., using the HA, cleaning and maintenance, troubleshooting etc) (Doak et al., 1996, Centers for Disease Control and Prevention, 2009); these guidelines were adhered to in the development of the modified guide. Feedback from the participants also suggests that the troubleshooting section should be placed in a more prominent position on the contents page, so that it can easily be seen by the user. The troubleshooting section was listed at the end of the contents page in both the original guide and the modified guide.

Overall, 80% of participants preferred the modified guide and the key reasons reported for this decision were ease of use; large print size; and large, clear diagrams. This is the first study to compare a best practice HA user guide with a typical HA user guide, however findings are similar to a study from another area of healthcare. Davis et al. (1998) compared comprehension and preferences for two polio vaccine information pamphlets: the original pamphlet and a pamphlet modified based on best practice guidelines. Although both were written at 6th grade reading level, the modified pamphlet had 50% less text, larger print, incorporated colours, used a question-answer format instead of narrative text, and was printed on thicker paper. Approximately three quarters (76%) of the 610 parents in the study preferred the modified pamphlet with the main reasons for their decision including the colourful printing, illustrations, reading ease, question-answer format, and thick paper.
6.5.1 Limitations and future directions

A limitation of the present study is that 90% of participants presented with adequate health literacy and hence the findings cannot be generalised to adults with poor health literacy. Second, the participants only had to demonstrate knowledge of troubleshooting and did not have to perform the actual tasks. Third, it is acknowledged that clients being fitted with HAs receive verbal instruction on device troubleshooting from their hearing care professional at the time of fitting. In this study no verbal instruction was provided, hence the participants were faced with a more difficult task compared to individuals in a typical clinical setting and it is not known how this would have impacted on the observed differences between the user guides. Nevertheless, we maintain that the differences are relevant for two reasons. First, Kessels (2003) reports that between 40 and 80% of information communicated in a healthcare appointment is immediately forgotten. Second, HAs are often managed by other people, such as family members or staff at a residential care facility, who may not attend appointments and thus be reliant on the user guide.

In future research, participants could be asked to perform troubleshooting on HAs that have actual faults, such as a blocked dome. Future research could also investigate the assumption that improving clients’ abilities to perform HA troubleshooting will result in better HA outcomes.

6.5.2 Clinical implications

There are two major clinical implications stemming from the findings of this study. First, HA user guides and other instruction materials should be designed and developed based on best practice guidelines. It is suggested that particular attention be paid to diagrams, font size, and the contents page, which should be clear and easy-to-use with the troubleshooting section highlighted. Second, the hearing care professional should go through the user guide with the client and his or her significant others, if present, and highlight the troubleshooting information. This is suggested because the participants who were able to locate the correct section in the user guide were able to answer the question accurately most of the time. Working through a troubleshooting scenario (e.g., a whistling HA), using the user guide, may also help clients understand how to approach a problem that requires troubleshooting, when it occurs. In turn, this may counteract the frustration associated with a device that is not working properly and, ultimately, contribute to better HA outcomes and satisfaction.
6.6 Conclusions

This research shows that older adults are better able to find and understand HA troubleshooting information in a user guide designed based on best practice guidelines for health literacy as compared to a typical user guide. Participants assigned the modified guide were significantly more likely to provide accurate answers to five of the six troubleshooting questions on the Hearing Aid Troubleshooting Test, compared to those assigned the original user guide. In addition, the majority of older adults preferred the modified HA user guide. Hence, it is recommended that HA user guides and other printed materials in audiology clinics are developed according to health literacy principles.
6.7 References


Chapter 7: Summary, Clinical Implications, Limitations, and Future Directions

7.1 Summary of the research

The aims of this research were to:

1. Analyse the content, design, and readability of printed HA user guides to determine their suitability for older adults.
2. Review the literature on best practice guidelines for written healthcare materials and to apply this information to the development of written instructions for a self-fitting hearing aid.
3. Investigate if a HA user guide modified using best practice guidelines for health literacy results in superior ability to perform HA management tasks, compared to the user guide in the original form.
4. Investigate if the type of HA user guide (modified versus original) is associated with the ability of older adults to find and understand HA troubleshooting information and to examine older adults’ preferences for user guides.

Chapter 2 presented a review of the literature on three topic areas central to the thesis: the older adult, health literacy, and HA management. The research indicated that many older adults have difficulty with HA management tasks, such as changing the volume and cleaning the device (e.g., Desjardins & Doherty, 2009). It was suggested that one way to address this is the provision of well-designed printed HA instruction materials which can be read and understood by older adults. The many factors one must consider when developing such materials to meet the needs of this population were highlighted. For example, a significant proportion of older adults have age-related deterioration in cognition and vision which can affect their ability to read and comprehend printed healthcare material, and at least one third have low health literacy (e.g., Watson, 2009; Kutner, Greenberg, Jin, & Paulsen, 2006).

The literature review revealed a number of gaps in the research relating to older adults, HA user guides, and HA management. Although two studies had examined the reading grade level of HA user guides, no research had been conducted on their content and design. In addition, there was no research on how to design a HA user guide according to best practice guidelines for health literacy. Finally, no-one had investigated if a user guide designed using
best practice guidelines improves HA management and troubleshooting, compared to a typical user guide.

Chapter 3 described a study in which a sample of 36 HA user guides were assessed to determine their suitability for older adults. The majority of user guides scored poorly for scope, vocabulary, layout and typography, and reading level. There was frequent use of uncommon words, technical words, and jargon in lieu of common words. In addition, aspects of the layout and typography did not adhere to best practice guidelines, including small font size, small diagrams, inadequate white space, and low contrast between the text and the paper. The mean reading grade level for the user guides was 10 which is considered too high for healthcare materials. Taken together, the results showed that HA user guides are not optimal for older adults and therefore may be a barrier to successful HA management.

Having found that the majority of user guides were not suitable for older adults, Chapter 4 described a study that sought to determine if it was realistic and feasible to design HA instruction materials, based on best practice guidelines for health literacy. The aim was to review the literature on best practice guidelines and to apply the information to the design of written instructions for a HA. A wealth of information was found on best practice guidelines, covering the areas of content, language, layout/typography, organization, and graphics (e.g., Centers for Disease Control and Prevention, 2009). The research also indicated that all readers, regardless of their literacy level, prefer easy-to-read healthcare materials, and that comprehension is significantly higher than for less easy-to-read materials (e.g., Paul, Redman, & Sanson-Fisher, 1997). Best practice guidelines were then applied to the design and development of a set of written instructions for a self-fitting hearing aid. The information was presented in small practical steps and the readability grade level was 3.5 (between third and fourth grade). The content consisted of simple line drawings accompanied by text captions; the text was 16-point black font, printed on A4-size white matte paper. The instructions were assessed using the Suitability Assessment of Materials (SAM) and qualified as superior material.

The next step was to determine if a best-practice user guide is beneficial for the end user and findings were reported in Chapters 5 and 6. The participants in this research included 89 older adults (a mean age of 72 years) and no experience of HAs. Participants were randomly assigned either the original user guide or the modified user guide. The modified user guide
had a lower reading grade level, larger text size and graphics, and considerably less jargon and technical information. The original guide attained a rating of adequate on the SAM, and the modified guide attained a rating of superior.

HA management was assessed using the Hearing Aid Management (HAM) Test, designed for this study. The results of the regression analysis showed that participants assigned the modified guide demonstrated superior ability to perform HA management tasks, after adjusting for eight potential co-variates (e.g., age, sex, cognitive function). In addition, participants assigned the modified guide required significantly less prompts to perform complex tasks correctly and were significantly more likely to perform four of the tasks correctly, without the need for any prompts. The median time taken to perform three of the tasks was also significantly shorter for those assigned the modified guide. Other variables associated with performance on the test were health literacy, finger dexterity, and age.

The fore-mentioned research also included the assessment of troubleshooting with the user guides and administration of a questionnaire, designed to elicit information on participants’ preferences for HA user guides. These findings, which address the final two aims of the thesis, were reported in a paper described in Chapter 6. Troubleshooting ability, an important component of HA management, was assessed using the Hearing Aid Troubleshooting Test (HATT), designed for this study. The HATT assesses the ability of adults to find and comprehend information relating to troubleshooting in a HA user guide (e.g., action needed if HA is intermittent). Significantly more participants assigned the modified guide were able to locate the correct section and provide accurate information on five of the six items. When shown both user guides, over three quarters of all participants (80%) preferred the modified guide and the main reasons reported for this decision were ease of use; large font size; and large, clear diagrams.

In summary, the research reported here indicates that HA instruction materials designed based on best practice guidelines for health literacy result in superior HA management ability. In addition, when given the choice, the majority of older people preferred HA user guides designed based on best practice guidelines.
7.2 Clinical implications

This body of research has a number of important clinical implications for hearing care professionals and HA manufacturers. First, it provides clear evidence that older adults are better able to perform HA management tasks and understand troubleshooting information using healthcare instructions designed according to best practice guidelines for health literacy. Hence, it is recommended that all hearing healthcare professionals and organizations design their materials based on these guidelines. Examples of materials beyond HA user guides are appointment letters, outcome measures, newsletters, and HA purchase documents. Information brochures on topics such as rehabilitation options, communication strategies, and assistive listening devices would also benefit from being designed using health literacy principles. Particular attention should be paid to the diagrams, font size, and overall ease of use, as these aspects were deemed important by the majority of participants in this research.

Second, the findings from this research indicate that it is important for hearing care professionals to be aware of the association between health literacy and performance on HA management tasks, particularly as approximately one third of older adults have low health literacy. However, it is not considered necessary to perform health literacy testing in the clinic. Rather, resources should be directed toward ensuring all written materials meet best practice guidelines as suggested above and hence are suitable for all clients.

Third, age and finger dexterity were also found to be associated with the ability to perform HA management tasks with a user guide. Therefore, slightly longer appointments or an extra appointment could routinely be provided to older adults and/or adults who have poor finger dexterity. This would allow more time to describe and demonstrate HA management and to explain what is in the user guide and how to use it at home. Particular attention should be paid to teaching the client how to insert the aid, clean the aid, and use it with the phone, as these tasks proved to be the most difficult for participants in our research. This client group might also benefit from other materials, such as video clips showing how to perform HA management tasks. It is also recommended that significant others are involved so they can learn the tasks alongside the client and provide assistance at home when necessary. In order to determine if a client has poor finger dexterity, a standard question, such as “do you have any problems with finger movement?” could be used. Alternatively, the hearing care
professional could ask the client to change a battery on a dummy HA at the initial appointment to provide an indication of how they will handle HA management tasks.

Fourth, the hearing care professional should be cognizant that the content and design of many user guides is not optimal for older adults. If they have to use a standard user guide, it would be worthwhile highlighting important sections in the guide in order to assist the client. One of the main issues with many user guides is that the text and diagrams are too small. To address this, it is suggested that pages containing key information are enlarged for the client.

Lastly, regardless of the quality of the user guide, it is suggested that the hearing care professional go through the booklet with the client. This is considered important because a substantial number of participants in this research experienced difficulty finding and understanding troubleshooting information in a user guide indicating this is a difficult task for many older adults. It would be beneficial to draw the client’s attention to the main sections of the user guide, and to show them how and when to use it, with emphasis placed on the contents page. Working through a troubleshooting scenario (e.g., a whistling HA), using the user guide, may also help the client understand how to approach a problem, that requires troubleshooting when it occurs.

7.3 Research limitations

It is acknowledged that the research presented in this thesis has a number of limitations. A limitation of the first study, described in Chapter 3, relates to the use of the SAM; this assessment has a subjective element in that there is latitude allowed in interpretation of criteria. However, this is the case for all assessments of this type and an attempt was made to minimise this by having two research audiologists evaluate each user guide. The two researchers developed a standardised procedure to allow consistent interpretation of each item on the SAM. They assessed all the user guides independently and then came together to discuss their ratings. Any discrepancies in ratings were discussed and 100% concordance in the ratings was achieved.

The final two studies described in Chapters 5 and 6, had limitations relating to the characteristics and size of the participant group. In particular, only 10% of participants presented with low health literacy based on results for the S-TOFHLA. The findings may
have been different if a larger proportion of the sample had low health literacy, as such adults are likely to experience more difficulty understanding written information. Hence, the studies may have been strengthened with the addition of more participants, particularly from lower socio-economic areas, where the prevalence of low health literacy is typically higher. In addition, the studies only included printed HA instruction materials; thus the results cannot be generalised to instruction materials available on web platforms or delivered through smart technology, such as telephone apps.

7.4 Future directions

It is encouraging to see that many HA manufacturers and audiology clinics are endeavouring to produce materials that meet best practice guidelines for health literacy. As such, future research studies could design and evaluate clinic materials beyond HA user guides in order to guide developers. In addition, it would be interesting to examine the useability of HA instruction materials available on web platforms or delivered through smart technology. There are a number of potential benefits of electronic instruction material, such as personalised content for the user (e.g., only showing features and functions available on the user’s HA), inclusion of videos, and portability. It would also be interesting to compare performance on the HAM Test for electronic based HA instructions and printed HA instructions.

7.5 Conclusions

Across the globe, there is a growing number of older adults with hearing impairment, many of whom will be fitted with HAs. As hearing care professionals it is imperative that we develop ways to assist older adults in gaining maximum benefit from their HAs which ultimately involves enabling them to effectively manage and troubleshoot their devices. The HA user guide is an important vehicle for the transfer of information on management and troubleshooting so it is important that the instructions in it can be easily understood and applied by the reader.

This body of research clearly shows that older adults are better able to perform HA management tasks and to find and comprehend troubleshooting information using a HA user guide designed according to best practice guidelines, as compared to a standard user guide. Based on this evidence it is hoped that all HA manufacturers start to produce HA user guides
that integrate aspects of best practice with particular attention paid to graphics, font size, and ease-of-use. It is deemed equally important that audiology clinics adhere to best practice principles when designing materials for their clients, such as information brochures and outcome measures. Ultimately, it is up to audiologists to advocate for change because “clear communication practices and the removal of literacy related barriers will improve care for all patients” (US National Institute for Health, 2010).
7.6 References


Appendix A – Ethics approval: University of Queensland Behavioural and Social Sciences Ethical Review Committee

THE UNIVERSITY OF QUEENSLAND
Institutional Approval Form For Experiments On Humans Including Behavioural Research

<table>
<thead>
<tr>
<th>Chief Investigator:</th>
<th>Prof Louise Hickson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Title:</td>
<td>Improving Clinical Pathways For Hearing Rehabilitation</td>
</tr>
<tr>
<td>Supervisor:</td>
<td>None</td>
</tr>
<tr>
<td>Co-Investigator(s)</td>
<td>Dr Sharon Cameron, Dr Harvey Dillon, Dr Nerina Scarnici, Helen Glyde, Els Wairavens, Paul Bunn, Caitlin Barr, Andrea Caposecco, Dr Carly Meyer, Dr Heidi Ham</td>
</tr>
<tr>
<td>Department(s):</td>
<td>School of Health and Rehabilitation Sciences</td>
</tr>
<tr>
<td>Project Number:</td>
<td>2011000857</td>
</tr>
<tr>
<td>Granting Agency/Degree:</td>
<td>The Hearing Cooperative Research Centre</td>
</tr>
<tr>
<td>Duration:</td>
<td>31st December 2021</td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>

Name of responsible Committee:-
Behavioural & Social Sciences Ethical Review Committee
This project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research and complies with the regulations governing experimentation on humans.

Name of Ethics Committee representative:-
Associate Professor John McLean
Chairperson
Behavioural & Social Sciences Ethical Review Committee

Date 19/2011 Signature JMC

197
# The University of Queensland

## Institutional Human Research Ethics Approval

<table>
<thead>
<tr>
<th>Project Title:</th>
<th>Improving Clinical Pathways For Hearing Rehabilitation - 12/08/2014 - AMENDMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chief Investigator:</td>
<td>Prof Louise Hickson</td>
</tr>
<tr>
<td>Supervisor:</td>
<td>Prof Louise Hickson, Dr Stefan Launer</td>
</tr>
<tr>
<td>Co-Investigator(s):</td>
<td>Dr Sharon Cameron, Dr Harvey Dillon, Dr Nerina Scarinol, Helen Glyde, Elis Weiravens, Caitlin Grenness, Andrea Caposecco, Dr Carly Meyer, Dr Adrian Fuente, Dr Katie Ekberg, Karen Pedley, Barbra Timmer, Dr Stefan Launer</td>
</tr>
<tr>
<td>School(s):</td>
<td>School of Health and Rehabilitation Sciences</td>
</tr>
<tr>
<td>Approval Number:</td>
<td>2011000857</td>
</tr>
<tr>
<td>Granting Agency/Degree:</td>
<td>The Hearing Cooperative Research Centre; Phonak AG, Stafsha, Switzerland</td>
</tr>
<tr>
<td>Duration:</td>
<td>31st December 2021</td>
</tr>
</tbody>
</table>

**Comments/Conditions:**

---

**Note:** If this approval is for amendments to an already approved protocol for which a UQ Clinical Trials Protection/Insurance Form was originally submitted, then the researcher must directly notify the UQ Insurance Office of any changes to that Form and Participant Information Sheets & Consent Forms as a result of the amendments before action.

**Name of responsible Committee:**

**Behavioural & Social Sciences Ethical Review Committee**

This project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research and complies with the regulations governing experimentation on humans.

**Name of Ethics Committee representative:**

Associate Professor John McLean  
Chairperson  
Behavioural & Social Sciences Ethical Review Committee

---

**Signature** [Signature]  
**Date** 19/10/2014
Appendix B – Three Pages from the Modified User Guide

Contents

Quick Guide ................................................................. 1

Your hearing aid

Your hearing aid details ............................................. 3
Diagram of your hearing aid ....................................... 4
Left & Right aid markings ......................................... 5

Using the hearing aid

Turning On & Off ......................................................... 6
Batteries .................................................................... 7
Putting on the hearing aid ......................................... 9
Removing the hearing aid ......................................... 11
Volume control ......................................................... 12
Changing sound programs ....................................... 13
Telephone use ........................................................... 15

Cleaning and Maintenance

Daily care tasks .......................................................... 17
Cleaning the tube ....................................................... 19
Replacing the tube ...................................................... 21
Cleaning the dome ..................................................... 22
Replacing the dome .................................................... 23
Avoiding moisture & heat ......................................... 25
Warnings ................................................................... 27
Repair & Warranty ..................................................... 29

Trouble shooting guide ............................................. 30
Quick Guide

1. Changing batteries

1. Find battery door.
2. Open battery door — pull up on ridge.
3. Put battery in battery door. Make sure + side faces up.

2. On / Off

ON
OFF
Volume control

1. Find the volume control. It is the push-button on the hearing aid.

2. **To increase the volume:** Press the upper part of the button for 1 second. Each time you press it the volume will increase. Do not hold it down. You will hear a beep, each time you press the button.

3. **To decrease the volume:** Press the lower part of the button for 1 second. Each time you press it the volume will decrease. Do not hold it down.
**Appendix C - Scoresheet for the Hearing Aid Management (HAM) Test**

<table>
<thead>
<tr>
<th>Item</th>
<th>Part A</th>
<th>Part B - Prompts</th>
<th>Time from start to finish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Move to Part B (Prompts) after 2 minutes has elapsed, participant scores 1 or 0, or gives up</td>
<td>Move to next step in hierarchy after 2 minutes has elapsed, participant scores 1 or 0, or gives up.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Item</td>
<td>Used contents page</td>
<td>Nil</td>
</tr>
<tr>
<td>Start each command with &quot;Please show me how you would...&quot;</td>
<td></td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
<td>2 = correct 1 = errors or incomplete 0 = could not perform</td>
</tr>
<tr>
<td>1 Change the HA battery</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
<tr>
<td>2 Turn the HA on and off</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
<tr>
<td>3 Put the HA in your ear</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
<tr>
<td>4 Hold the phone with the HA</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
<tr>
<td>5 Turn up the volume of HA</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
<tr>
<td>6 Switch the HA to program 2 – noise sound program</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
<tr>
<td>7 Clean wax from tube and put the HA back together so it is ready to use</td>
<td></td>
<td>2 1 0</td>
<td>2 1 0</td>
</tr>
</tbody>
</table>
## Appendix D – Scoresheet for the Hearing Aid Troubleshooting Test (HATT)

<table>
<thead>
<tr>
<th>Question</th>
<th>Correct page found in user guide within 1 min (√)</th>
<th>Time taken to start responding to question (after correct page found)</th>
<th>Participant’s Response/s (Please tick the responses provided)</th>
<th>Prompt for additional response (√)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 What size battery does this HA use?</td>
<td></td>
<td></td>
<td>Size 13</td>
<td></td>
</tr>
<tr>
<td>2 How do you tell which is the left HA and which is the right HA?</td>
<td></td>
<td></td>
<td>Colour marking inside battery door Left hearing aid (HA) indicated by a blue mark Right HA indicated by a red mark</td>
<td></td>
</tr>
<tr>
<td>3 What do you do if the HA starts to whistle when it is in your ear?</td>
<td></td>
<td></td>
<td>Remove aid and put it on again (reinsert aid) See a Doctor to check for wax in ear canal</td>
<td></td>
</tr>
<tr>
<td>4 What do you do if the HA is intermittent (switches on &amp; off)?</td>
<td></td>
<td></td>
<td>Change battery Clean dome / ear mould Wipe battery and HA with a dry cloth</td>
<td></td>
</tr>
<tr>
<td>5 Moisture &amp; heat can cause a HA to break down. Name 3 things you can do to avoid moisture &amp; heat?</td>
<td></td>
<td></td>
<td>Do not leave in extreme heat (e.g., parked car in sun) Do not wear in heavy rain, steam baths, or showers Do not dry HA in microwave or other oven Take HA off when you apply cosmetics, hairspray, suntan lotion etc Keep aid in a dri-aid kit (anti-humidity kit) Wipe the aid and batteries if there is moisture on them If you use lotion, wipe hands dry before putting on HA</td>
<td></td>
</tr>
<tr>
<td>6 Name 2 tasks you should do on a daily basis to take care of your HA?</td>
<td></td>
<td></td>
<td>Ensure no wax in ear mould / dome opening Open the battery door to allow air to circulate Check there is no wax in the tube Keep HA in a dri-aid kit (anti-humidity kit)</td>
<td></td>
</tr>
</tbody>
</table>