EVALUATION AND REVISION OF HEARING AID USER GUIDES AVAILABLE IN NEW ZEALAND/AOTEAROA

Bethney Marie Russell

A thesis submitted in partial fulfilment of the requirements for the

Degree of Master of Audiology

in the Department of Communication Disorders

at the University of Canterbury

2015

Acknowledgements

My most earnest and sincere thanks go to my supervisor Rebecca Kelly-Campbell. Words truly cannot express my gratitude to you and all that you have done for this project and myself. Thank you for your practical help, editing skills and patience. I could not have completed this thesis without you.

Thank you also to all who participated in this project. Your willingness to offer your opinions and time have made this research possible.

To all fellow Canterbury audiology students from my graduating class, I say a massive thank you. You are all fantastically helpful and friendly individuals and have made these past two years an enjoyable experience. A special thank you must be said to Louise Margaret Allan and Caitlin Kengmana; perfect study partners and beloved friends.

Finally, I would like to thank my family for their love and support through all my endeavours. You have made me who I am today and none of this would have been possible without each of you.

Abstract

Hearing impairment and the issues associated with it is prominent issue in today's society, especially when considering the aging nature of New Zealand/Aotearoa's population. Hearing impairment affects a diverse range of people of varying ages, ethnicities, socioeconomic status, levels of education, and degrees of literacy skills. in many cases of hearing impairment, hearing aids are suitable tools to help improve an individuals hearing, and thus their quality of life. It is important that individuals suffering from hearing impairment are provided with all the information they need to order to get the best outcomes.

Poor health literacy skills can also affect a wide range of people, with research showing the majority of New Zealanders have poor health literacy. This is a concerning fact, given that poor health literacy skills can lead to poor health outcomes. It is therefore of great importance that any written materials provided to individuals, such as a hearing aid user guide, have a suitable readability for the majority of the New Zealand/Aotearoa population to understand.

The aim of this study was to evaluate the readability and suitability of 24 hearing aid user guides available in New Zealand/Aotearoa. It also aimed to improve the readability and suitability of the lowest scoring user guide, by implementing learner verification and revision.

Results confirmed that all 24 of the hearing aid user guides assessed had readability levels above the level recommended across previous literature. The suitability of the user guides, assessed using the SAM tool, showed that 87% of the guides were "adequate", while the remaining guides were deemed "not suitable".

The hearing aid user guide was revised using best practise guidelines and incorporating feedback from 10 participants. After revision, the user guide readability was improved and it was received much more positively by the participants. It is hoped the results of this study will encourage revision to more hearing aid user guides available in New Zealand/Aotearoa, in order to make them easier for the hearing impaired population to read and understand.

Table of Contents

ACKNOWLEDGMENTS……………………………..ii

ABSTRACT……………………………...iii

TABLE OF CONTENTS……………………………...v

LIST OF ABBREVIATIONS……………………………......................................ix

LIST OF FIGURES……………………………..x

CHAPTER ONE: INTRODUCTION……………………………........................1

1.1 Overview……………………………...1

1.2 Process of Hearing……………………………..2
1.2.1 Overview……………………………..2
1.2.2 Outer Ear……………………………..2
1.2.3 Middle Ear……………………………..4
1.2.4 Inner Ear……………………………..6

1.3 Hearing Impairment……………………………...7
1.3.1 Overview……………………………..7
1.3.2 Prevalence of Hearing Impairment……………………………..................10
1.3.3 Incidence of Hearing Impairment……………………………....................12
1.3.4 Impact of Hearing Impairment……………………………........................13

1.4 Hearing Aids……………………………...16
1.4.1 Overview……………………………..16
1.4.2 Hearing Aid Benefits……………………………......................................18

1.5 Health Literacy and Readability…………………………….......................21
1.5.1 Health Literacy Overview……………………………..............................21
1.5.2 Readability Overview…………………………….....................................23
1.5.3 Measuring Readability……………………………....................................24
1.5.4 Readability and Audiology……………………………..............................26

1.6 Suitability of Written Health Care Materials……………………………....28
1.6.1 Suitability Assessment of Material……………………………..................28
1.6.2 Learner Verification and Revision……………………………..................36

1.7 Study Rationale……………………………..38

1.8 Aims and Hypotheses……………………………...39

CHAPTER TWO: METHODS………………………………...............................42

2.1 Overview………………………………..42

2.2 Stage One………………………………...42
2.2.1 Materials……………………………...42
2.2.2 Procedure……………………………..44
2.2.3 Statistical Analysis……………………………..45

2.3 Stage Two………………………………...46
2.3.1 Materials……………………………...46
2.3.2 Procedure……………………………..46
2.3.3 Statistical Analysis……………………………..47

2.4 Stage Three………………………………..48
2.4.1 Revised Guide……………………………..48
2.4.2 Participants……………………………..49
2.4.3 Materials……………………………...50
2.4.4 Procedure……………………………..51
2.4.4.1 Interview One……………………………...51
2.4.4.2 Interview Two……………………………...52
2.4.5 Data Treatment……………………………..53

CHAPTER THREE: RESULTS………………………………...............................54

3.1 Overview………………………………..54

3.2 Readability………………………………..55
3.2.1 Comparison by Hearing Aid Style…………………………………..................55
3.2.1.1 Button Section……………………………..56
3.2.1.2 Cleaning Section……………………………..56
3.2.1.3 Safety Section……………………………...57
3.2.2 Comparison by Level of Technology…………………………………..............57
3.2.2.1 Button Section……………………………..58
3.2.2.2 Cleaning Section……………………………..58
3.2.2.3 Safety Section……………………………...59
3.2.3 Comparison by Hearing Aid Section…………………………………..............59
3.2.3.1 Mean Readability……………………………...60
3.2.3.2 Flesch-Kincaid……………………………..60
3.2.3.3 Flesch Reading Ease……………………………..61
3.2.3.4 Simple Measure of Gobbledygook……………………………….......61
3.2.3.5 Gunning FOG……………………………...62

3.2.4 Comparison by Hearing Aid Manufacturer……………………………….....62
3.2.5 Readability Results Summary……………………………........................63

3.3 Suitability……………………………...63
3.3.1 Overview……………………………...64
3.3.2 Comparison by Hearing Aid Style…………………………….................64
3.3.3 Comparison by Level of Technology…………………………….............65
3.3.4 Comparison by Hearing Aid Manufacturer……………………………....65
3.3.5 Suitability Results Summary…………………………….........................66

3.4 Learner Verification and Revision……………………………......................66
3.4.1 Overview……………………………...66
3.4.2 Participants……………………………...67
3.4.3 Original Cleaning and Care Section…………………………….............67
3.4.4 Original Telephone Section…………………………….............................68
3.4.5 Original Volume Control Section…………………………….....................68
3.4.6 Readability of Original Guide vs. Revised Guide………………………..69
3.4.7 Participant Feedback on Revised Guide………………………….........70
3.4.8 Learner Verification and Revision Summary………………………………71

CHAPTER FOUR: DISCUSSION……………………………...........................72

4.1 Overview……………………………...72

4.2 Aim One: Readability……………………………...72
4.2.1 Hypotheses……………………………...72
4.2.2 Comparison to Literature…………………………….................................74

4.3 Aim Two: Suitability……………………………...77
4.3.1 Hypotheses……………………………...77
4.3.2 Comparison to Literature…………………………….................................78

4.4 Aim Three: Learner Verification…………………………….........................79
4.4.1 Hypotheses……………………………...79
4.4.2 Comparison to Literature…………………………….................................80

4.5 Clinical Implications……………………………...81

4.6 Limitations and Suggestions for Future Research……………………………84

4.7 Conclusion……………………………...85

REFERENCE LIST……………………………...87

APPENDIX A: *STUDY PARTICIPANTS*…………………………………………93

APPENDIX B: ***ETHICS APPROVAL*****……………………………………...……94**

APPENDIX C: ***INFORMATION FOR PARTICIPANTS*****…………………………95**

APPENDIX D: ***PARTICIPANT CONSENT FORM*****………………………………97**

APPENDIX E: ***DEMOGRAPHIC QUESTIONNAIRE*****…………………………...99**

APPENDIX F: ***INTERVIEW QUESTIONS*****…………………………………...…100**

APPENDIX G: ***STRATEGIES FOR IMPROVING WRITTEN HEALTH CARE MATERIALS*****……………………………………………………………….102**

APPENDIX H: ***REVISED SECTIONS OF USER GUIDE*****……………………...103**

List of Abbreviations

ASHA	American Speech-Language-Hearing Association
BTE	Behind-The-Ear
CCVJ	Concept, Category, Value, Judgement
CIC	Completely-In-The-Canal
F-K	Flesch-Kincaid Grade Level
FOG	Gunning Fog Index Readability Formula
FRE	Flesch Reading Ease
HA	Hearing Aid
HI	Hearing Impairment
ITE	In-The-Ear
LLE	Logic, Language, Experience
RGL	Reading Grade Level
RIC	Receiver-In-The-Ear
SAM	Suitability Assessment of Materials
SMOG	Simple Measure of Gobbledygook

List of Figures

Figure 1. Classifications of Hearing Impairment Severity…………………………9

Figure 2. SAM evaluation criteria of Content (adapted from Doak et al. (1996))…29

Figure 3. SAM evaluation criteria of Literacy Demand (adapted from Doak et al. (1996))………………………...30

Figure 4. SAM evaluation criteria of Graphics (adapted from Doak et al. (1996))..31

Figure 5. SAM evaluation criteria for Layout and Typography (adapted from Doak et al. (1996))………………………...33

Figure 6. SAM evaluation criteria for Learning Stimulation and Motivation (adapted from Doak et al. (1996))………………………...34

Figure 7. SAM evaluation criteria for Cultural Appropriateness (adapted from Doak et al. (1996))………………………...35

Figure 8. Key Elements for Learner Verification and Revision (adapted from Doak et al. (1996))………………………...37

Figure 9. Largest six hearing aid "brands" as of 2011 (adapted from DiGiovanni, 2011))………………………...42

Figure 10. Means and Standard Deviations (SD) for the 3 hearing aid sections for the hearing aid styles…………………………..55

Figure 11. Means and Standard Deviations (SD) for the 3 hearing aid sections for the levels of technology…………………………..57

Figure 12. Means and Standard Deviations (SD) for the 3 hearing aid sections for the

levels of technology……………………………..59

Figure 13. Means and Standard Deviations (SD) for the 6 hearing aid manufacturers on the mean readability for all user guide sections……………………………….....62

Figure 14. Means, Standard Deviations (SD), Maximum and Minimum suitability scores for ITE and RIC HA user guides……………………………......................64

Figure 15. Means, Standard Deviations (SD), Maximum and Minimum suitability scores for low level and high level technology HA user guides……………………65

Figure 16. Means, Standard Deviations (SD), Maximum and Minimum suitability scores for the six different HA manufacturers……………………………..............66

Figure 17: Flesch-Kincaid readability scores of each section of the original and revised user guides……………………………..69

Figure 18: Contextual factors of the original and revised user guides………………70

Chapter One: Introduction

1.1 Overview

With an estimated 360 million sufferers of hearing impairment (HI) worldwide (World Health Organization, 2012), HI and the issues associated with it should be considered a prominent issue in today's society. HI affects a diverse range of people of varying ages, ethnicities, socioeconomic status, levels of education, and degrees of literacy skills (Erdman & Demorest, 1998; World Health Organization, 2014a).

Health literacy is an important concept for all health professions, including audiology. It is within the patient's code of rights (Health & Disability Commissioner, 2009) that they be fully informed about products and services so they can make an informed medical choice and give informed consent. If patients have poor health literacy skills, they may be unable to do so when given written health material (DeWalt, Berkman, Sheridan, Lohr & Pignone, 2004; World Health Organization, 2014b). Accordingly, the New Zealand Audiological Society code of ethics states that clinicians shall fully inform the persons they serve of the nature and possible effects of services rendered and products dispensed (New Zealand Audiological Society, 2014). It is therefore of great importance that any written materials provided to patients, such as hearing aid (HA) user guides, have a suitable readability for the majority of HI sufferers to comprehend the information and instructions given (Nutbeam, 2000).

In Stage One of this study, the readability of 24 HA user guides from six different HA manufacturers were analysed and discussed. These user guides were sampled from low and high level HA technology and from two HA styles (in-the-ear and receiver-in-the-canal). Stage Two of the study involved assessing the suitability of the HA user guides using the Suitability Assessment of Materials procedure. The third and final stage involved learner verification and revision of the HA user guide with the lowest combined readability and suitability score.

This chapter provides information on the process of hearing and the impact HI can have. The concept of readability and the possible ways to measure it are described and previous research is discussed. Measuring the suitability and readability of HA user guides using the Suitability Assessment of Materials (SAM) procedure is explored and the use of learner verification and revision is explained. Finally, the rationale, aims and hypotheses of the study are set out.

1.2 The Process of Hearing

1.2.1 Overview

In order to have an understanding of HI and how it can impact an individual's life, one must first have an understanding of the anatomy and function of the ear and the different types of HI that can occur. Therefore the anatomy and physiology of the ear are briefly discussed alongside information on how damage to, or abnormalities within, these structures can cause a HI.

The ear can be thought of as four main structures. These are the outer ear; the middle ear; the inner ear; and the auditory neural system.

1.2.2 Outer Ear

The outer ear is made up of the pinna, or auricle, and the external auditory canal (Katz, 2002). Together these structures combine to help collect sound and direct it towards the middle ear. The outer ear is also instrumental to the localisation of a sound source. It provides information to the auditory neural system about inter-aural time and inter-aural level differences in order to detect where a sound is coming from. When this information is combined, the distance and direction of the sound source can be determined (Geisler, 1998; Shaw, 1974). Inter-aural time differences occur when sound takes longer to reach the outer ear furthest away from the sound source. Inter-aural level differences are related to the intensity of the sound source and these amplitude differences help to determine the location of a sound. The further a sound wave has to travel to the outer ear, the weaker its intensity becomes (Geisler, 1998). However, this is only strictly true for sound waves of frequencies above 500Hz. The lower a frequency is, the longer the size of the sound wave. Longer sound waves diffuse around the head, creating what is known as a head shadow. A head shadow is when the amplitude is reduced not because the sound source is far away, but because the sound wave has been obscured by the head (Geisler, 1998).

The pinna is the visible part of the human ear and it consists of both skin and cartilage. (Geisler, 1998).

The external auditory canal is made up of both cartilage and bone covered with skin. In the cartilaginous portion resides hair, to help stop foreign objects entering too far into the canal. The lateral two thirds of the canal also have glands crucial in the production of cerumen (Chai & Chai, 1980; Geisler, 1998). Cerumen, colloquially known as ear wax, is produced via secretions from the sebaceous and sweat glands (Chai & Chai, 1980). Cerumen can vary in colour and consistency, depending on genetic factors, such as ethnicity (Chai & Chai, 1980; Yoshiura et al., 2006). Like the hairs of the canal, cerumen assists in stopping foreign objects reaching the tympanic membrane and contributes to the migration of dead skin cells out of the external auditory canal (Chai & Chai, 1980).

There are different ways that a problem or abnormality with the outer ear can affect an individual's hearing ability. For example, an absence or deformity of the pinna can result in HI, especially if the entrance to the external auditory canal is obscured. This results in what is known as a conductive HI. (Katz, 2002). Another cause of a conductive HI can be a build-up of excess cerumen in the canal. The loss in hearing due to this is often accompanied by otalgia, aural fullness and possibly tinnitus (Geisler, 1998).

1.2.3 Middle Ear

The middle ear is embedded in the temporal bone of the skull. The middle ear system's main components are the tympanic membrane, the Eustachian tube, and the three ossicles (Katz, 2002). The tympanic membrane is what separates the outer ear from the middle ear. One would expect a healthy tympanic membrane to be thin, translucent and a pearly-grey colour (Katz, 2002). The ossicular chain is made up of three ossicles; the malleus, the incus and the stapes. The purpose of this system is to transfer the mechanical vibrations from the tympanic membrane, via air conduction, to the fluid-filled inner ear. The ossicular chain concentrates this energy directly onto the oval window, and it’s these vibrations that trigger the movement of the inner ear fluid (Geisler, 1998). The middle ear system acts as an amplifier and ensures over 90% of the sound energy is conveyed to the inner ear (Killion & Dallos, 1979). Finally, the Eustachian tube acts as the middle ear’s drainage system, as well as a pressure equaliser. The tube opens up in order to relieve middle ear pressure and drain any build-up of fluid (Geisler, 1998).

There are many different pathologies that can affect the middle ear, thus affecting an individual's hearing. For example, if the tympanic membrane is unhealthy in any way, be it scarring, swelling or a perforation, its ability to vibrate and trigger the vibration of the ossicular chain is comprimised. Damage to the tympanic membrane can result in a conductive HI, temporary or permanent (Geisler, 1998; Katz, 2002). Another cause of a conductive HI is damage to the ossicular. If the delicate chain is disrupted, sound cannot be amplified and transferred to the inner ear as it should. Possible issues affecting the ossicles include otosclerosis, cholesteatoma and head trauma (Katz, 2002). Also, if the Eustachian tube is dysfunctional, this can also result in a conductive HI. If the Eustachian tube is unable to open, negative pressure builds up in the middle ear cavity, which results in the tympanic membrane retracting. This gives rise to what most describe as a “blocked” feeling in the ears, otherwise known as aural fullness or pressure, and sound waves are not transmitted as effectively as possible (Geisler, 1998). A closed Eustachian tube also means any fluid that might arise due to an ear infection is unable to drain away. This results in another form of conductive HI, the most common of which is otitis media with effusion.

1.2.4 Inner Ear

The inner ear is also located in the temporal bone. It consists of the cochlea and vestibular system. The cochlea plays a vital role in hearing, whilst the vestibular system contributes to an individual’s sense of balance. The cochlea is an extremely intricate and complicated organ and therefore its inner workings are only briefly described here, as it is not the chief objective of this paper. As the vestibular system is not as directly related to hearing, it shall not be described in this paper.

The cochlea is commonly described as resembling a snail shell consisting of two and a half turns. The primary objective of the cochlea is to convert mechanical energy from the middle ear into electrical energy, whilst providing information about the intensity and frequency of the sound (Geisler, 1998).

The basilar membrane and Reissner’s membrane divide the cochlea lengthwise, creating three chambers: the scala vestibuli, the scala media, and the scala tympani (Geisler, 1998; Parnes, Sun & Freeman, 1999). Sitting on the basilar membrane is what is known as the organ of Corti. This is where the auditory hair cells are located, crucial for the conversion of mechanical energy to an electrical signal. Displacement of the hair cells sends an electrical signal to the brain via afferent fibers connecting the hair cells to the auditory nerve (cranial nerve VIII) (Geisler, 1998).

Damage to the inner ear system can result in a permanent sensorineural HI. Damage may be due to disease, such as Ménière’s; trauma, such as noise exposure; or it may simply be a result of presbycusis (age related HI). However the delicate hair cells are affected, once impaired the damage is irreversible. The location of the lesion determines which frequency region one may find impaired. For example, Ménière's disease usually results in an initial low frequency loss, which levels out at a flat loss as the disease progresses (Schuknecht, 1963).

1.3 Hearing Impairment

1.3.1 Overview

The ability to detect and understand the sounds around us has a direct impact on how we relate and respond to our environment. When one suffers from HI, they have an impaired sensitivity to the frequency and intensity of sound waves (Bagai, Thavendiranathan, & Detsky, 2006).

HI can be classified by its type, severity and configuration. These defining features are determined via the use of audiological assessment. While audiology test batteries may differ between countries and clinics, pure-tone audiometry is a standard procedure used and is considered the 'gold standard' (Katz, 2002). Pure-tone audiometry is used to determine an individual's threshold of hearing, using decibel hearing level, or dB HL (Katz, 2002). The threshold is considered to be the intensity at which a given frequency is heard at least two out of three times on an ascending run (American Speech-Language-Hearing Association, 2005). The ascending and descending pattern of dB HL used in pure-tone audiometry is known as the Hughson-Westlake technique (1944), modified by Carhart & Jerger (1959).

The type of HI refers to its classification as conductive, sensorineural or mixed. Lesions can vary not only in their location, but severity, aetiology and duration as well (Gelfand, 2009). As previously mentioned, conductive HI occurs when damage or a lesion affects the outer or middle ear. When something is impacting how sound waves travel through to the cochlea in the inner ear, it is considered a conductive HI. Conductive HI is often reversible and the damage can sometimes be reversed using surgical treatment.

Sensorineural HI is generally a more permanent form of HI and is brought on by a lesion to the inner ear, the auditory nerve or the central auditory pathway. The most common causes include noise-induced HI and presbycusis (Rabinowitz, 2000). Presbycusis has the highest incidence rate. It typically follows the pattern of a high frequency loss in the initial stages, with lower frequencies being affected over time. (Schuknecht, 1974).

When both a conductive and a sensorineural HI are present in an individual, this is known as a mixed hearing HI. One could conceivably have both presbycusis and a build-up of cerumen.

Severity of a HI can be inferred from the information gathered by a pure-tone audiological assessment. As mentioned, thresholds are obtained using a modified Hughson-Westlake procedure. Thresholds are found at octave frequencies, commonly ranging from 250 Hz to 8 kHz (Katz, 2002). Severity of a HI can be determined by looking at the thresholds obtained from all frequencies tested.

There are multiple classification systems in use to define the severity of a HI. Figure 1 outlines two of the more common systems in use, devised by Goodman (1965) and Jerger & Jerger (1980).

Figure 1. Classifications of Hearing Impairment Severity

Degree of Impairment (dB HL)	Goodman (1965)	Jerger & Jerger (1980)
Normal	< 26	< 21
Mild	26 - 40	21 - 40
Moderate	41 - 55	41 - 60
Moderately-severe	56 - 70	
Severe	71 - 90	61 - 80
Profound	> 90	> 80

Finally, the configuration of the HI is determined by the shape of the audiogram obtained from pure-tone audiometry. Common terms used to described the audiogram shape include sloping, steeply sloping, rising, flat, cookie-bite or notched (Carhart, 1945).

Typically the type, severity and configuration of a HI are combined into one diagnostic statement once audiologic assessment is complete. For example, one might suffer from a mild sloping to moderately-severe sensorineural impairment, or a moderate flat conductive impairment.

Not being able to hear environmental sounds such as traffic noises or alarms can be rife with negative consequences for one's safety (World Health Organization, 2014a). Also, missing or mishearing the sounds of speech has an impact on one's interactions. Relationships can be negatively affected, as a HI sufferer may be less willing and able to engage with their communication partners (Arlinger, 2003; Mathers, Smith & Concha, 2000). The embarrassment and isolation that can come from having a HI can have a negative psychological impact (World Health Organization, 2014a) and affect the sufferer's quality of life significantly (Chia et. al., 2007; Hickson et al., 2008).

1.3.2 Prevalence of Hearing Impairment

As previously stated, the World Health Organization (2012) claims there are 360 million individuals around the world who suffer to some degree from a HI. This is a worldwide prevalence of 5.3%. A third of these HIs can be attributed to adults over the age of 65. HI is the third most common chronic health problem in American adults aged 65 and over (Chisolm et al., 2007).

The prevalence of HI is higher amongst men than women (Agrawal, Platz & Niparko, 2008; Greville, 2005; World Health Organization, 2012). The World Health Organization (2012) states that 183 million males report to experience HI, compared to 145 million females.

At the time of publication of this work, the latest New Zealand/Aotearoa statistics on HI prevalence could be found in the 2013 New Zealand Disability Survey. This survey relied on members of the public self-reporting their impairments. HI was the highest self-reported sensory impairment, with 380,000 individuals reporting to be affected by it. This is a New Zealand/Aotearoa wide prevalence of 9%. The survey found that 34% of males and 23% of females over the age of 65 reported a HI (Statistics New Zealand, 2013). The New Zealand National Foundation for the Deaf claims an even higher prevalence of approximately 17%. It is reported there are over 700,000 New Zealanders that are "deaf or hard of hearing" ("National Foundation for the Deaf," n.d.).

It is well documented that the prevalence of HI increases as the population's age increases (Agrawal et al., 2008; Cruickshanks, Wiley & Tweed, 1998; Greville, 2005).

In New Zealand/Aotearoa the prevalence of HI in adults 65 years of age or older is 3.5 times higher than it is in adults under the age of 65 (Greville, 2005).

In an American study using objective measures, HI was shown to steadily rise as the sample population aged. HI was estimated to have a prevalence of 8.5% in those aged 20 – 29, 17% in the 30 – 39 age group, 34% for those aged 40 – 49, 53% for 50 – 59 year olds and 77% for those aged 60 – 69 (Agrawal et al., 2008).

It is important to note that the estimation of prevalence of HI can be dependent on many factors. For example, whether data was gathered using objective or subjective measures of HI can have a significant influence on the results. Objective measures include audiological testing, such as pure-tone audiometry. Subjective measures are techniques such as self-reporting. Objective measures result in a higher prevalence of HI. Self-reporting seems less reliable, as individuals can be reluctant to acknowledge their impairment. Duijvestin et al., (2003) found that 34% of a random sample population (aged 55 and over) were found to have HI when objective measures were used. But of that 34%, less than half had acknowledged this impairment and sought medical advice from their General Practitioner.

Another factor that affects prevalence of HI estimates is the definition different publications give to HI. Some may include unilateral HIs, some may not. Others may include mild impairments in their estimates while others do not. Of course, even the very definition of a ‘mild’ impairment can vary throughout the literature, depending on which classification system is used. An estimate using Goodman’s system would result in a lower prevalence than an estimate using Jerger & Jerger’s system. This is due to the fact that Goodman considers any loss less than 26 dB HL to be normal, whereas Jerger & Jerger only consider a loss less than 21 dB HL normal (Goodman, 1985; Jerger & Jerger, 1980). Please refer to Figure 1 for a detailed look at each classification system.

1.3.3 Incidence of Hearing Impairment

Life expectancy has improved dramatically over the past century, with a significant mortality decline trending for younger, as well as older ages. As of 2013, global life expectancy has increased to an estimated 71.5 years. This is a prolongment of 6.2 years when compared to the global life expectancy of 65.3 in 1990 (Naghavi et al., 2015).

Given the aging nature of the world’s population, incidence of HI is forecast to increase. A study by Kochkin (2009) concluded that the hearing impaired population grew by 8.8% in America from 2004 to 2008, while the number of American households only increased 4.5%.

Of course, age is not the only factor to impact an individual’s hearing ability. Noise-induced HI is the second largest cause of sensorineural HI (Rabinowitz, 2000), and despite stricter regulations in workplaces, it also appears to be on the rise. Accident Compensation Corporation (ACC) data in New Zealand/Aotearoa shows that the number of claims due to noise-induced HI continues to rise annually. From July 2005 to June 2006, 5580 claims were made. This is significantly more than the 2823 claims made from July 1995 to June 1996 (Thorne et al., 2008).

Overall it is predicted that one in four New Zealanders will suffer from some degree of HI by 2050, up from the current (at time of publication) estimate of one in six New Zealanders (National Foundation for the Deaf," n.d.).

With HI on the rise, both nationally and internationally, it is important for health care professionals to understand the impact HI can have on an individual and their family or whanau.

1.3.4 Impact of Hearing Impairment

The impact a HI can have varies from individual to individual. Not only can the person with HI suffer, but their friends, co-workers and family or whanau can all be affected in some way. There are a variety of negative consequences associated with HI.

Jennings & Shaw (2008) found that HI can contribute to difficulties in a work environment. It was summarised that adults in the workplace with HI are generally unaware of the services available to them to help maintain an ideal level of work performance and productivity. Two out of the three adults followed in this case study experienced further losses due to their HI, losing their identity as a worker, and even the eventual loss of employment (Jennings & Shaw, 2008). This seems consistent with World Health Organisation (2014a) reports that there is a higher unemployment rate amongst adults with HI compared to non-hearing impaired adults.

HI has been associated with an overall reduction in an individual's perceived quality of life (Chia, et al., 2007; Hickson et al., 2008). Quality of life is defined by the World Health Organization (1993) as "the individual's perception of his/her position in life in the context of the culture and value systems in which he/she lives and in relation to his/her goals, expectations, standards, and concerns" (World Health Organization, 1993, p.p 153).

HI can reduce an individual's perceived quality of life by placing restrictions on their everyday life. One may not feel able to participate in all the activities one used to due to their impairment, causing social isolation and possible emotional distress (Dalton et al., 2003; Mulrow et al., 1990; Stumer, Hickson & Worrall, 1996). An increased difficulty detecting and understanding speech can negatively impact communication. This can be a burden both on the hearing impaired and their communication partner (Arlinger, 2003; Mathers, et al., 2000).

It is worthy of note that the impact a HI may have cannot be predicted from audiological data alone (Erdman & Demorest, 1998). That is to say, someone with a mild impairment may greatly feel their quality of life has decreased. Perhaps they now struggle to hear in noisy restaurants and can no longer participate in meetings. Alternatively, a moderate HI sufferer who rarely leaves their home may not acknowledge as many negative consequences. The impact of HI on an individual's quality of life is entirely subjective to the individual's experience. There is no objective test to measure this, only self-report can provide information about what the individual is feeling (Swan & Gatehouse, 1990). Components of the individual's life may impact how they experience their impairment. These include, but are not limited to, age, gender, education, socioeconomic status, race, locus of control and past experiences (Erdman & Demorest, 1998; World Health Organization, 2014a).

Because HI can result in many negative consequences, effective intervention is of great importance. Intervention can come in different forms, such as through the use of HAs, cochlear implants or counselling. This body of work focuses on participants' understanding of HA user guides, therefore only intervention via the use of HAs is explored in more detail here.

1.4 Hearing Aids

1.4.1 Overview

Dillon (2012) describes HAs as "a collection of functional building blocks." (Dillon, 2012, p.p 20). Different components combine together to amplify the sound received at the user's ear. Which frequencies need amplification and how much amplification (gain) is needed is determined by audiological testing of the HA user. Programming of the HAs is done via company specific computer programs by a trained clinician.

The first essential component is the microphone. This serves to convert the acoustic sound wave to electrical energy. Modern microphones are capable of providing excellent sound quality with minimal internal electrical noise interference. Some higher technology level HAs have directional microphones. These have two entry ports for sound, and focus more on sound arriving from directly in front of them, rather than sound coming from other directions (Dillon, 2012).

The next main component is the HA amplifier. The purpose of this component is precisely as the name suggests; it amplifies the incoming sound. Most modern HAs use what are known as compression amplifiers. Compression amplifiers avoid distorting the sound through excessive amplification. They achieve this by decreasing their gain as the volume of the incoming signal increases. This ensures sound signals are both audible and at a comfortable level for the user (Dillon, 2012).

Filters are a common (although not essential) component of HAs. Filters change the amplitude of low, mid and high frequency sounds. They can be used to break up the signal into these different frequency ranges so each range can be amplified separately, tailored to the specific individual's needs (Dillon, 2012).

The final HA component described here is the receiver. The receiver is the part of a HA that is usually placed in the ear (with the exception of receiver-in-the-ear style HAs), much like a "miniature headphone" (Dillon, 2012, p.p 20). The job of the receiver is to convert the electrical signals coming from the other components back into acoustic energy (Dillon, 2012). This amplified and modified sound signal is then sent down the external auditory canal towards the inner ear for the HA user to process.

HAs are battery powered devices. HA users need to be counselled on how to change their HA batteries and how often. Rechargeable batteries are also available for some models of HAs.

HAs may also come with many other features, such as feedback suppression, Bluetooth connection and data logging to name a few. Separate remote controls or built in buttons and switches on the device may also be included. This allows the user to exercise control over the volume of the devices or switch between different listening programs for different listening environments. Generally speaking, the more features built into a HA, the more expensive they become to purchase. HAs can range from low technology levels to high levels of technology.

There are also different styles of HAs, such as completely-in-the-canal (CIC), in-the-ear (ITE), behind-the-ear (BTE) and receiver-in-the-ear (RIC) models. The two styles whose user guides are investigated in this study are ITEs and RICs.

ITEs are small moulds that sit in the pinna or outer portion of the user's ear canal. All components of the HA are housed in the one mould. They are custom fit for each individual user and are thought to be relatively discreet (Dillon, 2012). ITEs can be suitable for impairments ranging from mild to moderately-severe. ITEs are less suitable for individuals with good low frequency hearing. Having the ITE aid blocking the ear completely can interfere with low frequency sound entering naturally (Dillon, 2012), resulting in a occluded feeling for the patient.

RICs consist of two parts, one that sits behind the user's ear and another that sits inside the ear canal. The part behind the ear houses all electrical components other than the receiver. A small wire inside a tube connects this outer shell to the receiver, which sits inside the ear. Having the receiver removed from the main bulk of the HA allows the outer shell to be smaller and more discreet. RICs also help to provide powerful amplification without completely blocking the users ear canal. This prevents the user feeling like their ear is blocked or occluded (Dillon, 2012). RICs are suitable for individuals with HIs ranging from mild to severe (Dillon, 2012).

All HAs are given out with written instructions, otherwise known as a HA user guide. These user guides contain information on how to use and care for the aid. This crucial information may not always be explained in full detail by an audiologist to the HA user, due to factors such as time constraints (Caposecco, Hickson & Meyer, 2014). Therefore it is of the upmost importance that HA user guides be as clear and concise as possible. If a HA user is unable to gain the knowledge they need to successfully use their aids, it is possible they will not receive the optimal benefit from having said aids.

1.4.2 Hearing Aid Benefits

A comprehensive systematic review conducted in 2007 found that the use of HAs by adults with some form of sensorineural HI did indeed improve their health-related quality of life. HAs were found to reduce the negative social, psychological and emotional effects of sensorineural HI (Chisolm et al., 2007). Therefore, not only do HAs achieve their primary purpose (amplifying sounds to make them audible for the user), they also provide other benefits to the HA user.

Dillon (2012) lists five outcome measures that HA use seeks to achieve. According to Dillon (2012), these benefits of rehabilitation can be summarised as: 1) decreased activity limitation; 2) decreased participation restriction; 3) decreased listening effort; 4) decreased emotional consequences; and 5) quality of life improvement (Dillon, 2012, p.p 404).

Activity limitation can be simply described as when an individual cannot do an activity they once could. The way the impairment in their body structure or function combines with environmental and personal factors can impact the activities an individual can carry out, relative to what they may consider “normal”. For example, maybe one with a HI can no longer understand conversation on the telephone, finding speech less clear than they used to.

Participation restriction can be thought of as a consequence of activity limitation arising from the impairment suffered when combined with an individuals specific environmental and personal factors. For example, since one can no longer understand on the telephone, one stops using the telephone altogether, thus missing out on an aspect of social interaction.

Participation restrictions, when acknowledged by the hearing impaired, can influence their likelihood to adopt HAs (Swan & Gatehouse, 1990). The greater they perceive their restrictions to be, the more likely they are to want intervention in the form of HAs (Fischer et al., 2011; Gopinath et al., 2011; Swan & Gatehouse, 1990).

Bagai et al. (2006) reported that individuals with HI and no HAs had decreased social activity compared to individuals with HI who used HAs. Kochkin (2011) reported that 50% of survey respondents/patients felt that HAs improved their ability to contribute to groups, thus improving their social lives. Therefore one can conclude that the use of HAs is related to decreases in activity limitation and decreases in participation restriction.

Decreasing listening effort is another goal of hearing use according to Dillon (2012), aiming to decrease the struggle hearing impaired individuals can experience while attempting to listen to and understand conversation. When using HAs, seven out of 10 individuals reported their ability to communicate effectively increased (Kochkin, 2011).

The use of HAs has also been shown to decrease the emotional consequence of HI (Dillon, 2012). It has been shown that the use of HAs for the hearing impaired is associated with a reduction in depression, anxiety and paranoia (Acar, Yurekli, Babademez, Karabulut, & Karasen, 2011; Bagai et al., 2006; Mulrow et al., 1990). An improved emotional state is not only beneficial for the HA user, but for their friends and family or whanau as well. Those living with suffers of HI may in turn suffer from what is known as third-party disability. Third-party disability is any impairments, activity limitations or participation restrictions a family member may experience as a result of their loved ones impairment, such as HI (Scarinci, Worrall & Hickson, 2009; Scarinci, Worrall & Hickson, 2012). Kochkin (2011) reported that 50% of participants believed wearing HAs had improved their relationships in their home environments.

Obviously, in order for a hearing impaired individual to obtain all the possible benefits from HAs, they would need to actually use the HAs they obtain. One needs to have a basic understanding of how to care for and operate their HAs so they can take full advantage of them. HA user guides are an integral tool for educating HA users about their new devices. However, HA user guides are not always appropriate for the hearing impaired population.

1.5 Health Literacy & Readability

1.5.1 Health Literacy Overview

The term health literacy refers to a patient's ability to obtain, process and comprehend information relevant to their health needs in order to make informed health decisions (Atcherson et al., 2014). If an individual has adequate health literacy they should be able to apply these skills when reading health related materials. Such materials include (but are not limited to) appointment cards, prescriptions, warning labels and user guides (Nutbeam, 2000). It therefore follows that poor health literacy can result in poor health outcomes, as effected patients may not be fully aware of and involved in the health process (DeWalt, Berkman, Sheridan, Lohr & Pignone, 2004; World Health Organization, 2014b). It has been shown that inadequate functional health literacy is an obstacle when trying to educate patients about their chronic diseases, such as sensorineural HI (Nutbeam, 2000; Williams, Baker, Parker & Nurss,
This is a problem of significant clinical importance, especially when taking into account that 56% of New Zealanders have poor health literacy skills (Workbase, 2014).

There is also a high rate of poor health literacy in America, where over 89 million individuals have low health literacy skills (American Medical Association, 2014). This translates to around 28% of the American population.

Such high rates of poor health literacy in a nation not only affect those with limited skills, but can impact society as a whole. Nutbeam (2000) claims that such a high number of individuals with low health literacy skills can present a significant financial burden to the health care industry. This can be due to inappropriate use of medicine and/or medical supplies.

Many of individuals struggling with poor health literacy will feel too embarrassed to discuss this issue with their medical professionals, and unfortunately can struggle in silence.

In a study by Parikh, Parker, Nurss & Williams (1996), out of all the participants with low literacy skills, only 67.4% admitted to them. Of the group that admitted having difficulty with literacy, almost 40% acknowledged feeling shame because of this. From this same group, 19% of claimed to have never told anyone about their difficulty with literacy before, including their health care providers. This seems to strongly indicate that literacy struggles are associated with shame and embarrassment.

If a patient is unwilling to inform their health care professional, be it an audiologist or General Practitioner, about their low health literacy skills, it becomes of crucial importance that written materials are as manageable as possible for them.

Also, time constraints common in a clinical setting may result in a health care professional being unable to go into adequate detail on every aspect covered in a session, again making any take-home materials vitally important. Any written materials provided to patients, such as HA user guides, ideally should have a suitable readability for the majority of HI sufferers to comprehend the information and instructions given.

1.5.2 Readability Overview

Two components contributing to health literacy are the readability and comprehensibility of written materials.

Readability can be thought of as the difference between texts that makes one easier to read than another (DuBay, 2004). There are many different factors that contribute to the readability of a text. DuBay (2004) mentions some suggestions on how to improve readability, such as using short, simple words and avoiding jargon and complex sentence structure.

It is widely agreed upon that in order to keep written materials at a level at which the majority of the population can access it, readability should be at approximately a 5^{th} (US) reading grade level (RGL) (Atcherson et al, 2014; Kelly-Campbell, Atcherson, Zimmerma & Zraick, 2012; Laplante-Levesque, Brannstrom, Andersson & Lunmer, 2012; Weiss & Coyne, 1997). A RGL can be interpreted as the average number of years of education required to effectively read the given text. For example, a RGL of 10 would equate to the reader needing approximately 10 years of formal education to effectively read the material. However, it is important to note that an individual’s education level may not necessarily always reflect their RGL (DuBay, 2004). It is of course possible for a reader to perform better or worse than their level of education may suggest.

Readability of a text is not the only element that can affect an individual's comprehension of said text. Reader variables such as prior experience, age and motivation can also play an important role (DuBay, 2004). Parikh et al. (1996) found that participants with low literacy skills were more likely to be male, older than 60 years of age, and with less education than a high school level. Kutner, Greenberg, Jin & Paulsen (2006) found that older participants, participants with less years of education, and participants with a lower income level all had lower levels of comprehension.

1.5.3 Measuring Readability

There are many different formulas that can be used to analyse the readability of text. The following section describes some of the formulas frequently in use throughout the literature. Each formula measures slightly different elements of readability (sentence length, polysyllabic words, jargon etc.). Many then provide a RGL estimate for the material (with the exception of the Flesch Reading Ease score). Seeing as each formula calculates readability differently, it naturally follows that each formula produces a slightly different end result.

The Flesch Reading Ease score (FRE) calculates a reading ease score ranging from 0 to 100. The lower the FRE score, the more difficult a text is to read (Flesch, 1948). Therefore a piece of text scoring 83 would be considered easier to read and comprehend than a piece of text scoring 30. The FRE works by examining the number of words, number of syllables and number of sentences in a given piece of text (Flesch, 1948).

The Flesch-Kincaid Grade Level formula (F-K) is one of the most commonly used readability formulas (Si & Callan, 2001; Wang, Miller, Schmitt & Wen, 2013). Wang et al. (2013) found 57.42% of the analysed health care materials they investigated had used the F-K to analyse readability. The F-K is derived from the FRE, converting a FRE score into a RGL.

Another readability formula is the Simple Measure of Gobbledygook (SMOG). According to Wang et al. (2013), the SMOG performed most consistently when calculating the readability of health care materials. The SMOG works by examining the number of words containing three or more syllables, otherwise known as polysyllabic words (McLaughlin, 1969). The SMOG has been found to often give higher readability values than other readability formulas (Si & Callan, 2001). This is due to the fact that the SMOG calculates the RGL based on the thought that the reader needed to comprehend 100% of what they are reading. All other formulas discussed in this paper calculate the RGL based on the underlying assumption that the reader only needs to comprehend 75% of the text in order to understand it overall (Wang et al., 2013).

The final readability formula to be discussed here is the Gunning Fog Index Readability Formula (FOG). The FOG calculates readability by looking at the average sentence length and the percentage of monosyllables (Si & Callan, 2001). Along with the SMOG and F-K it is one of the most commonly used readability formulas (Si &

Callan, 2001).

The F-K, FRE, FOG and SMOG are all used in this study to calculate the readability of the 24 HA user guides being analysed.

1.5.4 Readability and Audiology

There are few studies in the literature that have investigated the concept of readability of written materials specifically related to audiology. More bodies of work are needed to further investigate the concept of readability specific to the field of audiology.

Atcherson et al. (2014) looked at online audiological material on the American Speech-Language-Hearing Association (ASHA) website. 85.4% of 225 consumer articles on the ASHA website were discovered to exceed the recommend 5^{th} RGL. This conclusion was reached using four different readability formulas (FRE, F-K, FOG and FORCAST). It can therefore be theorised that many individuals seeking audiological guidance and information may misinterpret said information on the ASHA website. As previously discussed, this places individuals at risk of poor health outcomes (DeWalt et al., 2004; World Health Organization, 2014b).

Laplante-Levesque et al. (2012) also looked at online audiological material, using the FRE, F-K and SMOG to analyse the readability of 66 English-language websites relevant to HI. They concluded that, on average, readers of these websites would need at least 11 to 12 years of education to fully read and comprehend the material. This far exceeds a 5^{th} RGL.

Kelly-Campbell et al. (2012) investigated the readability of four audiologic self-report assessment tools using the FRE, FOG and FORCAST. All three formulas found all four assessment tools exceeded the recommended 5^{th} RGL.

Nair & Cienkowski (2010) investigated not only the RGL of written material given to audiology patients, but also of the verbal information audiologists were using during the appointments. They used the F-K to determine the RGL of HA user guides and the grade level equivalent of the recorded and transcribed sessions with the patients. It was found that both methods of information transfer were not at a suitable RGL. Nair & Cienkowski (2010) concluded that in an audiology context, patients had lower health literacy than functional literacy, meaning they may have had difficulty understanding at least some of the information provided to them, whether it was verbally passed on or in a written format.

Kelly (1996) investigated the readability of the informational and instructional brochures provided with HAs. It was found that of the 109 documents analysed, 58% required a college-age RGL. Obviously, this is significantly higher than the recommended 5^{th} RGL. This conclusion was reached by using three different readability measures (FOG, F-K and Fry). Kelly (1996) was conducted almost two decades ago; therefore it is difficult to speculate if the data gathered then is still relevant to the HA informational brochures and instruction manuals being produced today.

Finally, a study by Caposecco et al. (2014) looked into the content, design and readability of hearing aid user guides. Readability was assessed using the FRE, Fry, F-K and Fog formulas and it was found that the mean RGL for all 36 HA user guides assessed was 9.6, clearly higher than the recommended 5th grade level. The SAM was used to assess the content and design of the materials to determine their suitability for use with older adults and 69% of the user guides rated 'not suitable'. Therefore Caposecco et al. (2014) was able to conclude that the content, design and readability of HA user guides was unsuitable for older adults. This may negatively impact HA outcomes for that population.

1.6 Suitability of Written Health Care Materials

1.6.1 Suitability Assessment of Materials

An instrument used to assess the suitability of health care material is the Suitability Assessment of Materials (SAM). The SAM has been validated by 172 health care professionals across a multitude of cultures. The SAM provides a systematic and time efficient way to assess the suitability of patient education material, including HA user guides. The SAM analyses both the content and the design of written material. It works by providing an overall percentage score to indicate superior, adequate or non-adequate suitability. Experienced professionals score each of the 22 factors from six main areas as Superior (two points), Adequate (one point) or Not Suitable (zero points). Once the SAM is complete, the overall score is tallied up and a percentage score is derived by comparing the achieved score to the highest possible score. Once in percentage form, a score of 70 -100% indicates superior material, 40-69% indicates adequate material and 0-39% indicates the material is not suitable (Doak, Doak & Root, 1996).

The following figures 2-7 outline the SAM evaluation criteria for each of the six main areas and their respective factors being scored. All content has been adapted from Doak et al. (1996).

Figure 2: SAM evaluation criteria of Content (adapted from Doak et al. (1996)).

CONTENT	
Purpose	*Superior:* Purpose is explicitly stated in title, or cover illustration, or introduction.
	Adequate: Purpose is not explicit. It is implied, or multiple purposes are stated.
	Not suitable: No purpose is stated in the title, cover illustration, or introduction.
Content Topics	*Superior:* Thrust of the material is application of knowledge/skills aimed at desirable reader behaviour rather than nonbehaviour facts.
	Adequate: At least 40% of content topics focus on desirable behaviours or actions
	Not suitable: Nearly all topics are focused on nonbehaviour facts.
Scope	*Superior:* Scope is limited to essential information directly related to the purpose. Experiences shows it can be learned in time allowed.
	Adequate: Scope is expanded beyond the purpose; no more than 40% is nonessential information. Key points can be learned in time allowed.
	Not suitable: Scope is far out of proportion to the purpose and time allowed.
Summary and Review	*Superior:* A summary is included and retells the key messages in different words and examples.
	Adequate: Some key ideas are reviewed.

	Not suitable: No summary or review is included.

Figure 3: SAM evaluation criteria of Literacy Demand (adapted from Doak et al. (1996)).

LITERACY DEMAND	
Reading Grade Level (Fry Formula)	*Superior:* 5^{th} RGL or lower (five years of schooling level).
	Adequate: 6^{th}, 7^{th} or 8^{th} RGL (six to eight years of schooling level).
	Not suitable: 9^{th} RGL and above (nine years or more of schooling level).
Writing Style	*Superior:* Both factors: (1) Mostly conversational style and active voice. (2) Simple sentences are used extensively; few sentences contain embedded information.
	Adequate: (1) About 50% of the text uses conversational style and active voice. (2) Less than half the sentences have embedded information.
	Not suitable: (1) Passive voice throughout. (2) Over half the sentences have extensive embedded information.
Vocabulary	*Superior:* All three factors: (1) Common words are used nearly all of the time. (2) Technical, concept, category, value, judgement (CCVJ) words are explained by examples. (3) Imagery words are used as appropriate for content.
	Adequate: (1) Common words are frequently used. (2) Technical and CCVJ words are sometimes explained by examples. (3) Some jargon or math symbols are included.

	Not suitable: Two or more factors: (1) Uncommon words are frequently used in lieu of common words. (2) No examples are given for technical and CCVJ words. (3) Extensive jargon.
In Sentence Construction, the Context is Given Before New Information	*Superior:* Consistently provides context before presenting new information.
	Adequate: Provides context before new information about 50% of the time.
	Not suitable: Context is provided last or no context is provided.
Learning Enhancement By Advance Organisers (Road Signs)	*Superior:* Nearly all topics are preceded by an advance organiser (a statement that tells what is coming next).
	Adequate: About 50% of the topics are preceded by advance organisers.
	Not suitable: Few or no advance organisers are used.

Figure 4: SAM evaluation criteria of Graphics (adapted from Doak et al. (1996)).

GRAPHICS (ILLUSTRATIONS, LISTS, TABLES, CHARTS, GRAPHS)	
Cover Graphic	*Superior:* The cover graphic is (1) friendly, (2) attracts attention and (3) clearly portrays the purpose of the material to the intended audience.
	Adequate: The cover graphic has one or two of the superior criteria.
	Not suitable: The cover graphic has none of the superior criteria.
Type of Illustrations	*Superior:* Both factors: (1) Simple, adult-appropriate, line drawings/sketches are used. (2) Illustrations are likely to be familiar to the viewers.

	Adequate: One of the superior factors is missing.
	Not suitable: None of the superior factors are present.
Relevance of Illustrations	*Superior:* Illustrations present key messages visually so the reader/viewer can grasp the key ideas from the illustrations alone. No distractions.
	Adequate: (1) Illustrations include some distractions. (2) Insufficient use of illustrations.
	Not suitable: One factor: (1) Confusing or technical illustrations (nonbehaviour related). (2) No illustrations or an overload of illustrations.
Graphics: Lists, Tables, Graphs, Charts, Geometric Forms	*Superior:* Step-by-step directions, with an example, are provided that will build comprehension and self-efficacy.
	Adequate: “How-to” directions are too brief for reader to understand and use the graphic without additional counselling.
	Not suitable: Graphics are presented without explanation.
Captions Are Used to “Announce”/Explain Graphics	*Superior:* Explanatory captions with all or nearly all illustrations and graphics.
	Adequate: Brief captions used for some illustrations and graphics.
	Not suitable: Captions are not used.

Figure 5: SAM evaluation criteria for Layout and Typography (adapted from Doak et al. (1996)).

LAYOUT AND TYPOGRAPHY	
Layout	*Superior:* At least five of the following eight factors are present: (1) Illustrations are one the same page adjacent to the related text. (2) Layout and sequence of information are consistent, making it easy for the patient to predict the flow of information. (3) Visual cuing devices (shading, boxes, arrows) are used to direct attention to specific points or key content. (4) Adequate white space is used to reduce appearance of clutter. (5) Use of colour supports and is not distracting to the message. Viewers need not learn colour codes to understand the message. (6) Line length is 30-50 characters and spaces. (7) There is high contrast between type and paper. (8) Paper had nonglossy or low-gloss surface.
	Adequate: At least three of the superior factors are present.
	Not suitable: (1) Two (or less) of the superior factors are present. (2) Looks uninviting or discouragingly hard to read.
Typography	*Superior:* The following four factors are present: (1) Text type is in uppercase and lowercase serif (best) or sans-serif. (2) Type size is at least 12 point. (3) Typographic cues (bold, size, colour) emphasize key points. (4) No ALL CAPS for long headers or running text.
	Adequate: Two of the superior factors are present.
	Not suitable: One or none of the superior factors are present. Or, six or more type styles and sizes are used on a page.

Subheadings or “Chunking”	*Superior:* (1) Lists are grouped under descriptive subheadings or “chunks”. (2) No more than five items are presented without a subheading.
	Adequate: No more than seven items are presented without a subheading.
	Not suitable: More than seven items are presented without a subheading.

Figure 6: SAM evaluation criteria for Learning Stimulation and Motivation (adapted from Doak et al. (1996)).

LEARNING STIMULATION AND MOTIVATION	
Interaction Included in Text And/Or Graphic	*Superior:* Problems or questions presented for reader responses.
	Adequate: Question-and-answer format used to discuss problems and solutions (passive interaction).
	Not suitable: No interactive learning stimulation provided.
Desired Behaviour Patterns Are Modelled, Shown In Specific Terms	*Superior:* Instruction models specific behaviour or skills.
	Adequate: Information is a mix of technical and common language that the reader may not easily interpret in terms of daily living.
	Not suitable: Information is presented in nonspecific or category terms.
Motivation	*Superior:* Complex topics are subdivided into small parts so that readers may experience small successes in understanding or problem solving, leading to self-efficacy.

	Adequate: Some topics are subdivided to improve the readers' self-efficacy.
	Not suitable: No partitioning is provided to create opportunities for small successes.

Figure 7: SAM evaluation criteria for Cultural Appropriateness (adapted from Doak et al. (1996)).

CULTURAL APPROPRIATENESS	
Cultural Match: Logic, Language, Experience (LLE)	*Superior:* Central concepts/ideas of the material appear to be culturally similar to the LLE of the target culture.
	Adequate: Significant match in LLE for 50% of the central concepts.
	Not suitable: Clearly a cultural mismatch in LLE.
Cultural Image and Examples	*Superior:* Images and examples present the culture in positive ways.
	Adequate: Neutral presentation of cultural images.
	Not suitable: Negative image such as exaggerated or caricatured cultural characteristics, actions, or examples.

The SAM has previously been used in studies analysing written health care materials (Caposecco et al. 2014; Weintraub, Maliski, Fink, Choe & Litwin, 2004).

As previously mentioned, Caposecco et al. (2014) used the SAM to analyse the content and design of 36 HA user guides to assess their suitability for an older audience. It was concluded that the HA user guides were not suitable for older adults. The SAM found major fault with inclusion of too much information per guide, use of uncommon vocabulary, small graphic and text size, and a RGL of 9.6. This all contributes to a hard to read and comprehend written material. As Caposecco et al. (2014) pointed out; this raises the issue of the older population not being fully aware of how to get the optimal use out of their HAs.

1.6.2 Learner Verification and Revision

Learner verification and revision is a process used to verify the suitability of health care written materials with the intended audience. It can be argued that the opinion of the target population on the suitability of written material is the most important. Any major issues with the materials content or design can then be revised to become more appropriate, and once again put through learner verification. This process can be repeated as many times as necessary until both the intended audience and the material reviser are satisfied the text is suitable (Doak et al., 1996).

Learner verification usually takes place through an interview, be it one on one or in a focus group. The key elements to be verified can be seen in Figure 8. Text-specific questions can be devised from these key elements in order to probe the intended audience.

Figure 8: Key Elements for Learner Verification and Revision (adapted from Doak et al. (1996)).

KEY ELEMENTS FOR LEARNER VERIFICATION AND REVISION	
Attraction	*For example:* Is it attractive to the audience? Are the visuals appealing? Do the colours fit the tone and mood of the subject?
Comprehension	*For example:* Can the audience understand it? Can they repeat the message back in their own words? Can the information be interpreted in more than one way?
Self-Efficacy	*For example:* Do the audience feel that they can carry out the message? Do they feel confident they have enough information? If not, what additional information is needed?
Cultural Acceptability	*For example:* Is it culturally suitable? Is the message in any way offensive? Is the message perceived as true?
Persuasion	*For example:* Does it make sense to carry out the message? Does the audience feel they should follow the messages advice? What could be added to make the message more persuasive?

No matter what questions are ultimately asked, it is always essential the interview makes the interviewees feel their opinions are respected and valued. The more comfortable the interviewees feel, the more likely they are to give their honest views on the written material (Doak et al., 1996).

Learner verification and revision has been shown to make written health care materials more suitable for their intended recipients. Davies et al. (1996) revised a polio informational pamphlet after feedback from 522 parents of paediatric patients. The revised pamphlet had a lower RGL, and participants had a lower reading time and higher comprehension level when reading it.

1.7 Study Rationale

As previously stated, HI is a global issue, affecting a wide variety of people from multiple demographics. In New Zealand/Aotearoa, 380,000 people report experiencing a HI (Statistics New Zealand, 2013). As this body of work has outlined, HI can have a vast impact on an individual, negatively affecting their perceived quality of life (Chia et al., 2007; Hickson et al., 2008).

HAs have been proven to help alleviate the negative side effects of HI, when used properly by the HA user (Dillon, 2012). With HAs come HA user guides. These user guides instruct the HA user on how to care for and operate their aids. But if these user guides are not appropriate for their intended audience then many individuals may not get optimal benefit from their HAs, due to a lack of understanding. This is a problem of significant clinical importance in New Zealand/Aotearoa when one takes into account that 56% of New Zealanders have poor health literacy skills (Workbase, 2014).

A study by Kelly (1996) investigated the readability of informational and instructional

HA brochures, finding none of the 109 documents analysed to be at the recommended 5^{th} RGL. Being an American study conducted almost two decades ago, it is impossible to speculate how relevant these findings would be today in New Zealand/Aotearoa society.

Another, more recent study looked at the suitability of HA user guides using the SAM (Caposecco et al., 2014). It was concluded that the HA user guides were not suitable for older adults. This study was conducted in Australia and may not be able to be generalised to New Zealand/Aotearoa society.

Therefore, this current study aims to investigate both the readability and suitability of HA user guides currently in circulation in New Zealand/Aotearoa. It also aims to use learner verification and revision on the lowest scoring HA user guide in order to improve portions of it. It is hoped the findings of this study can provide data clinically significant to the population of New Zealand/Aotearoa.

1.8 Aims and Hypotheses

This study has three aims.

The first aim of this study is to examine the readability of 24 HA user guides accessible in New Zealand/Aotearoa. These user guides will be spilt into four groups; (1) low level technology ITE, (2) high level technology ITE, (3) low level technology RIC and (4) high level technology RIC.

The following hypothesis will be tested:

- There will be a significant difference in the RGL between the low and high technology HA guides.
- There will be a significant difference in RGL between the ITE and RIC style HA guides.
- There will be a significant difference in RGL between the buttons, cleaning and safety sections of the user guides.
- There will be a significant difference in RGL between HA manufacturers user guides.

The second aim of this study is to examine the suitability of the same 24 HA user guides, using the SAM procedure.

The following hypothesis will be tested:

- There will be a significant difference in the SAM ratings between the low and high technology HA guides.
- There will be a significant difference in the SAM ratings between the ITE and RIC style HA guides.
- There will be a significant difference in the SAM ratings between HA manufacturers user guides.

The third and final aim of this study is to improve the suitability of the HA user guide that receives the lowest combined readability scores and SAM score. This will be achieved via learner verification and revision.

The following hypothesis will be tested:

- For the HA guide undergoing revision, the revised HA guide will have lower a RGL than the original (unrevised) HA guide.
- The opinions of the participants will suggest the revised user guide is easier to comprehend than the original (unrevised) guide.

Chapter Two: Methods

2.1 Overview

The current study investigated the readability and suitability of hearing aid user guides. The study consisted of multiple readability calculations and a suitability measure carried out on 24 user guides from six different hearing aid manufacturers. Participants were required for learner verification and revision, to assess the suitability of the user guide that received the worst combined readability score and suitability score, thus enabling appropriate revision to take place. Once the selected material had been revised participants were once again asked to discuss the suitability of the user guide.

2.2 Stage One

The first stage of the study involved calculating the readability of 24 hearing aid user guides.

2.2.1 Materials

Hearing aid user guides were accessed from six different hearing aid manufacturer websites. According to DiGiovanni, (2011), the six largest "brands" of hearing aids are as follows in Figure 9.

Figure 9: Largest six hearing aid "brands" as of 2011 (adapted from DiGiovanni, 2011)).

Manufacturer	Brand
Siemens	Siemens
William Demant	Oticon
Sonova	Phonak
ReSound	ReSound
Starkey	Starkey
Widex	Widex

This information from 2011 appears to be the most up-to-date research regarding hearing aid manufacturer market share, therefore the hearing aid user guides were obtained from the websites of these six brands.

From each website, four user guides were taken, giving a total of 24 hearing aid guides for review. The four different categories for the materials were: (1) low level technology ITE; (2) high level technology ITE; (3) low level technology RIC; (4) high level technology RIC.

There is currently no industry standard to define the technology level of HAs. Caposecco et al. (2014) used price points in order to distinguish between technology levels, defining a low-end HA as costing USD $1400 to $3000 a pair and a mid-end HA costing $4700 to $7300 a pair (Caposecco et al., 2014). After consulting several practicing audiologists in New Zealand/Aotearoa, it appeared that there is great variation in price-points across different HA brands and audiology practices. Therefore distinguishing technology level using price-points was considered impractical in the New Zealand/Aotearoa market and it was decided to use HA features to categorise high and low level technologies. Specifically, the features available from each manufacturer were examined and HAs that included all/most of the features on offer were assigned to the high level technology group. HAs that included few features were assigned to the low level technology group. All decisions regarding technology levels were a consensus reached by the authors of this study.

From each user guide selected, a 100 word sample was taken from three different sections. These sections were on the use of buttons and switches on the aids (Buttons), how to clean and care for the aids (Cleaning) and relevant safety information (Safety). The selection of these sections was based on 2 factors: (1) the section needed to have at least 100 words so that the readability analysis could be performed and (2) to the extent possible, the goal was to evaluate sections that were not previously evaluated by Caposecco et al. (2014). In that study, the battery, on/off, and care sections were evaluated. By selecting different sections for analysis, the current study aimed to add to the information provided by Caposecco et al. (2014).

2.2.2 Procedure

Four different established readability measures were undertaken on the each of the three sections taken from every user guide. Each readability test measured a slightly different element of readability, together acquiring a more complete overview of the materials readability. The readability measures used were:

- F-K
- FRE

- FOG
- SMOG

The F-K, FRE and FOG were selected for this study based on their widespread use throughout the literature. In using the same readability formulas, this allowed for direct comparison between results from this study and those from Caposecco et al. (2014). The SMOG was selected because, as previously discussed, it is the only formula that calculates readability based on 100% comprehension. For more detailed information about each of these readability formulas, refer to section 1.5.3.

The readability calculations were run using the Readability Studio 2012 software.

2.2.3 Statistical Analysis

The readability of the HA user guides were compared across sections, HA styles, technology levels and manufacturers. Statistical information was obtained using the Statistical Package for the Social Sciences (SPSS version 19) software.

Within each section (buttons, cleaning and safety) a multivariate analysis of variance (MANOVA) was performed on the data set to determine if there were significant differences in the readability of each section based on HA style or level of technology. Repeated Measures analysis of variance (RM-ANOVA) were performed to determine if there were significant differences between the three sections of the user guides themselves. Mauchly's test of sphericity was used in order to assume or not assume sphericity of this data.

Finally, a univariate analysis of variance (ANOVA) was performed to determine if there were differences in the mean readability level of the user guides based on HA manufacturer.

2.3 Stage Two

The second stage of the study involved evaluating the suitability of the hearing aid user guides for use with hearing impaired adults.

2.3.1 Materials

All 24 hearing aid user guides were subjected to an assessment of suitability. This was done using the Suitability Assessment of Materials (SAM). For a description of the SAM, refer to section 1.6.1.

2.3.2 Procedure

Suitability was assessed using the SAM procedure. The SAM is specifically designed to objectively and efficiently assess the suitability of health-related material for adults. The SAM is used to rate health material on multiple factors in six different areas. For a detailed description on scoring each factor, refer to Figures 2-7 (pages 29, 30, 31, 33, 34, 35.)

For the current study, the SAM was conducted by two PhD-level audiologists. One of the SAM raters has 10 years of clinical and academic experience; the other has 14 years of clinical and academic experience. Each rater has previous experience using the SAM to evaluate hearing health patient education material. The raters first read the background material about the SAM. They practiced scoring non-study material and discussed their ratings with each other. Then they independently rated non-study materials, discussing any discrepancies in scores. Finally, they independently rated the study material. Of the items on the SAM tool, readability was removed as it had already been adequately measured using other tools. It was thought more important for the SAM to reflect the other factors relating to suitability. The cultural appropriateness items were also removed as they were not applicable. This resulted in the highest possible SAM score being 38.

The two experienced professionals scored each remaining factor of the SAM as Superior (Two points), Adequate (One point) or Not Suitable (Zero points) for all of the 24 hearing aid user guides. Once the SAM was complete, a percentage score was calculated for each user guide from the raw score. A score of 70 -100% indicates superior material, 40-69% indicates adequate material and 0-39% indicates the material is not suitable for use with hearing impaired adults.

2.3.3 Statistical Analysis

The inter-rater reliability between the two raters was assessed using Cronbach's Alpha and the intra-class correlation coefficient (ICC) in SPSS software.

Cronbach's Alpha can be used to measure how reliably a group of values is measuring a single thing. The score can range from zero to one; the higher the value, the better likelihood a single thing is being measured. The alpha for the SAM scores was 0.989, indicating both raters were reliably measuring the SAM score.

The ICC is also scored from zero to one. Values greater than 0.75 indicate excellent agreement between raters beyond chance (Fleiss, 1981). The ICC for the SAM scores was 0.978, indicating excellent agreement between the two raters.

With reliability established, the average SAM rating was used to compare the HA user guides by HA style and technology level. A non-parametric test, such as the Mann-Whitney U, was used to compare the suitability scores as the distribution of the data didn't meet the assumption of normal distribution.

A Kruskal-Wallis test was used to compare suitability scores based on hearing aid manufacturers.

2.4 Stage Three

The third and final stage of this study involved attempting to improve the suitability of the HA user guide that received the lowest combined readability scores and SAM score.

2.4.1 Revised Guide

It was deemed too time consuming and impractical for the participants to read all 24 hearing aid user guides obtained from the six different manufacturers. Therefore, the user guide that obtained the worst combined readability score and SAM score was selected for the learner verification procedure. This user guide belonged to category (1) low level technology, ITE.

In order to determine which user guide that was, firstly an average RGL was calculated for each HA user guide by (1) averaging the results of the F-K, FOG, and SMOG for each section and (2) averaging the sections for each HA user guide. Next, the HA user guides were ranked based on the average RGL so that HA user guide with the lowest (best) RGL received a rank of 1 and the guide with the highest (worst) RGL

received a rank of 24. There were no instances of tied ranks. Then an average SAM rating was calculated for each HA user guide by averaging the SAM rating of the 2 raters. The HA user guides were then ranked based on SAM rating so that the user guide with the highest (best) SAM rating received a rank of 1 and the user guide with the lowest (worst) SAM rating received the highest ranking value. There were 4 instances of tied ranks. In these cases, the tied user guides received the same ranking value. The ranking values were then summed to achieve a combined ranking. The HA user guide with the highest (worst) combined ranking value was selected to undergo learner verification and revision.

2.4.2 Participants

Participants were recruited from within Christchurch, New Zealand. Three recruiting strategies were used: (1) participants from a database who met the selection criteria were contacted and invited, (2) advertisements were placed around Christchurch in supermarkets and public libraries, and (3) word of mouth.

All participants underwent a hearing assessment, with two participants found to have normal hearing on average, seven participants found to have a mild hearing loss on average, and one participant found to have a moderate to moderately-severe hearing loss on average, using the Goodman (1965) classification system.

The inclusion criteria for the participants are as follows:

1. Must be over the age of 18
2. Must have some form of hearing impairment (no restrictions on degree

or type)

3. Must have no prior experience with HAs
4. Must be a capable of reading and conversing in English

This study focused on the suitability of hearing aid user guides for use with hearing impaired adults. The first two criterions ensured the participants were indeed hearing impaired adults. The third criterion ensured that all information given to the participants for analysis was unfamiliar to them, helping to eliminate a learner effect. The final criterion was necessary for the participants to be able to evaluate the written information presented to them and effectively communicate their opinions. For a detailed description of each participant, along with their audiometric results, please refer to Appendix A.

The University of Canterbury‘s Institutional Ethics Review Committee approved all procedures involving participants (Appendix B). Prior to participating, all participants were informed of the purpose and procedure of the study (Appendix C) and informed consent was obtained from each participant (Appendix D). Participants were compensated for their participation with a $10 voucher, for either a petrol station or supermarket.

2.4.3 Materials

Participants were required to fill in a demographic questionnaire, which can be seen in Appendix E.

The HA user guide chosen for this part of the study belonged to category (1) low level technology, ITE.

2.4.4 Procedure

All participants took part in the study individually at the University of Canterbury Communication Disorders Department. Participation took part in two interviews. These interviewed were conducted independently by two researchers. Prior to each interview, participants were sent the material to be discussed in advance. They were asked to read it over and become familiar with it before their interviews took place.

2.4.4.1 Interview One

All ten participants took part in Interview One. At this point in time, participants were asked to fill in a demographic questionnaire about themselves (Appendix E). If their hearing had not been assessed in the past year, they also underwent a standard hearing screening. This involved the researcher obtaining puretone air and bone conduction thresholds bilaterally from 250 – 8000 Hz.

Participants were then asked to discuss the user guide that was to be revised. This discussion was recorded using a voice recorder and transcribed for further analysis. Each interview with all the participants followed the same script and the same questions were put to all participants. A copy of the questions asked can be seen in Appendix F. These questions were adapted from the description of learner verification and revision in Doak, et. al (1996). They were devised to probe information on the user guides attraction, comprehension, self-efficacy and cultural acceptability. (Refer to Figure 8, page 37, for more details).

2.4.4.2 Interview Two

Once the user guide was discussed in Interview One, revisions were made to the guide according to the participant's suggestions. Based off of consistent feedback from the majority of participants, revisions were made in the following areas: a) cleaning and care of the hearing aids; b) using the telephone with the hearing aids; c) how to control the volume of the hearing aids.

The goal of these revisions was to make the HA user guide more simple for the participants to read and understand. The revisions made focused on the language and content of the HA user guide in the three sections outlined above. Sentence length was reduced, as was the number of polysyllabic words. Where possible jargon was avoided and so were passive sentences. These changes to the language and content worked to reduce the RGL of the chosen sections. An overview of the recommended strategies to improve the readability and suitability of written health materials that were implemented can be seen in Appendix G.

The revised sections of the user guide can be seen in Appendix H**.**

Eight participants took part in Interview Two. Both of the two participants that were unable to take part in the second interview cited scheduling difficulties as the reason for this (one was going overseas and the other was "too busy").

The revised user guide was sent to the eight remaining participants for them to read over. Participants were brought back in for a final interview to discuss the revised user guide. This interview followed the same format of the original interview, with participants being asked the same relevant questions. Once again, this interview was recorded and transcribed.

2.4.5 Data Treatment

The data collected in this stage of the study was the opinions of the participants. All interviews were transcribed within 48 hours of taking place. For each of the interview questions, the participant transcriptions were summarised independently by the researcher conducting the interview. Commonalities across the participant responses were also summarised in order to find common themes to suggest which areas needed revision.

Responses from the ten participants in interview one were directly compared to responses from the eight participants in interview two in order to ascertain if improvement in the HA user guide was perceived by the participants.

Chapter Three: Results

3.1 Overview

This chapter presents the results of the study.

To begin with, the results of the readability assessments of the 24 user guides are presented, comparing across sections, HA styles, technology levels and manufacturers. This data serves to answer the following four hypotheses; 1) there will be a significant difference in RGL between the high and low level technology user guides, 2) there will be a significant difference in RGL between the ITE and RIC style HAs, 3) there will be a significant difference in RGL between the buttons, cleaning and safety sections of the user guides, and 4) there will be a significant difference in RGL between HA manufacturers.

Next, the suitability results of the user guides are presented in order to answer the following hypotheses; 1) there will be a significant difference in suitability between the high and low level technology user guides, 2) there will be a significant difference in suitability between the ITE and RIC style HAs, and 3) there will be a significant difference in suitability between HA manufacturers.

Finally, revision was made to the HA user guide with the lowest combined readability and SAM score after participants read and gave feedback on the cleaning and care, using the telephone and volume control sections of the guide. It was hypothesised that; 1) the RGL of the revised user guide sections would be lower than the RGL of the original sections and, 2) the opinions of the participants will suggest the revised user guide sections are easier to comprehend than the original sections.

3.2 Readability

The readability of the user guides was relatively high. The mean readability (average of F-K, SMOG, and FOG) for all the user guides (with all sections) ranged from 7.77 to 13.38, with a mean of 10.68 (SD = 1.47). This is well above the RGL of 5 (Atcherson et al, 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997).

There were no significant differences in readability levels based on HA style or level of technology. There were significant differences based on HA manufacturer and HA section.

3.2.1 Comparison by Hearing Aid Style

The mean readability of the ITE user guides ranged from 7.77 to 12.79, with a mean of 10.51 (SD = 1.57). The mean readability of the RIC user guides ranged from 9.19 to 13.38, with a mean of 10.86 (SD = 1.41). The means and standard deviations for each section are shown in Figure 10.

Figure 10. Means and Standard Deviations (SD) for the 3 HA sections for the HA styles.

	ITE			**RIC**		
	Buttons	*Clean*	*Safety*	*Buttons*	*Clean*	*Safety*
F-K	7.72 (1.81)	8.17 (1.57)	11.79 (3.86)	8.18 (1.31)	8.73 (1.23)	11.44 (4.06)
FRE	63.50 (5.83)	61.75 (9.54)	42.17 (19.36)	61.33 (8.53)	58.83 (7.33)	44.33 (20.07)

SMOG	9.25 (1.03)	10.72 (1.47)	13.18 (3.03)	10.09 (1.27)	11.52 (.77)	13.63 (3.16)
evelFOG	8.50 (1.32)	10.33 (1.01)	14.18 (3.55)	9.09 (1.77)	11.21 (.78)	13.87 (3.60)
Mean	*9.12* *(1.36)*	*10.48* *(.87)*	*12.98* *(3.56)*	*8.49* *(1.06)*	*9.75* *(1.62)*	*13.28* *(3.42)*

Note. Mean = average of the F-K, SMOG, and FOG readability levels. ITE = in-the-ear, RIC = receiver-in-the-canal, F-K = Flesch-Kincaid Reading Grade Level, FRE = Flesch Reading Ease score, SMOG = Simple Measure of Gobbledygook Reading Grade Level, FOG = Gunning FOG Reading Grade Level.

3.2.1.1 Button Section

A multivariate analysis of variance (MANOVA) was performed to determine if there were significant differences in the readability of the button section based on HA style. The MANOVA revealed that readability in the button section did not differ significantly, Wilks Λ = .833, F (4,19) = .455. p = .455. Box's M = 8.427, p = .749 indicating the equality of variance assumption had not been violated. The following multivariate effect size was calculated for the set of variables: $\eta^2 = 0.167$.

3.2.1.2 Cleaning Section

A multivariate analysis of variance (MANOVA) was performed to determine if there were differences in the readability of the cleaning section based on HA style. The MANOVA revealed that readability in the cleaning section did not differ significantly, Wilks Λ = .779, F (4,19) = 1.35. p = .298. Box's M = 24.09, p = .087 indicating the equality of variance assumption had not been violated. The following multivariate effect size was calculated for the set of variables: $\eta^2 = 0.221$.

3.2.1.3 Safety Section

A multivariate analysis of variance (MANOVA) was performed to determine if there were differences in the readability of the cleaning section based on HA style. The MANOVA revealed that readability in the safety section did not differ significantly, Wilks Λ = .989, F (4,19) = .052. p = .995. Box's M = 3.56, p = .985 indicating the equality of variance assumption had not been violated,. The following multivariate effect size was calculated for the set of variables: $\eta^2 = 0.011$.

3.2.2 Comparison by Level of Technology

The mean readability of the low technology user guides ranged from 7.77 to 13.38, with a mean of 10.57 (SD = 1.67). The mean readability of the high technology user guides ranged from 9.32 to 13.01, with a mean of 10.79 (SD = 1.31). The means and standard deviations for each section are shown in Figure 11.

Figure 11. Means and Standard Deviations (SD) for the 3 HA sections for the levels of technology.

	Low			**High**		
	Buttons	*Clean*	*Safety*	*Buttons*	*Clean*	*Safety*
F-K	7.75 (1.25)	8.39 (1.62)	11.56 (3.91)	8.25 (1.23)	8.51 (1.23)	11.67 (4.02)
FRE	62.33	60.08	43.67	62.50	60.50	42.83

	(8.98)	(9.93)	(20.01)	(5.35)	(7.12)	(19.50)
SMOG	9.53 (1.23)	11.13 (1.50)	13.93 (3.11)	9.82 (1.22)	11.11 (.93)	13.93 (3.10)
FOG	8.63 (1.52)	10.79 (1.73)	12.17 (3.65)	8.96 (1.64)	10.79 (1.73)	14.27 (3.65)
Mean	*9.08* *(1.35)*	*10.54* *(.74)*	*12.02* *(3.00)*	*8.53* *(1.11)*	*9.68* *(1.66)*	*14.24* *(3.56)*

Note. Mean = average of the F-K, SMOG, and FOG readability levels. F-K = Flesch-Kincaid Reading Grade Level, FRE = Flesch Reading Ease score, SMOG = Simple Measure of Gobbledygook Reading Grade Level, FOG = Gunning FOG Reading Grade Level.

3.2.2.1 Button Section

A multivariate analysis of variance (MANOVA) was performed to determine if there were differences in the readability of the button section based on level of technology. The MANOVA revealed that readability in the button section did not differ significantly, Wilks Λ = .970, F (4,19) = .209. p = .889. Box's M = 2.14, p = .935 indicating the equality of variance assumption had not been violated,. The following multivariate effect size was calculated for the set of variables: η^2 = 0.030.

3.2.2.2 Cleaning Section

A multivariate analysis of variance (MANOVA) was performed to determine if there were differences in the readability of the cleaning section based on level of technology. The MANOVA revealed that readability in the cleaning section did not differ significantly, Wilks Λ = .947, F (4,19) = 265. p = .298. Box's M = 8.76, p = .724 indicating the equality of variance assumption had not been violated,. The following multivariate effect size was calculated for the set of variables: η^2 = 0.053.

3.2.2.3 Safety Section

A multivariate analysis of variance (MANOVA) was performed to determine if there were differences in the readability of the cleaning section based on level of technology. The MANOVA revealed that readability in the safety section did not differ significantly, Wilks Λ = .911, F (4,19) = .465. p = .760. Box's M = 5.19, p = .940 indicating the equality of variance assumption had not been violated,. The following multivariate effect size was calculated for the set of variables: η^2 = 0.089.

3.2.3 Comparison by Hearing Aid Section

Descriptive statistics for the mean readability (average of F-K, SMOG, and FOG) and the individual readability measures for each HA section are shown in Figure 12. Repeated Measures analysis of variance (RM-ANOVA) were performed to determine if there were significant differences between the three sections of the user guides. The RM-ANOVA showed significant differences for the mean readability as well as each of the readability measures. Overall, the Safety section was found to have the highest average RGL, while the Buttons section was found to have the lowest.

Figure 12. Means and Standard Deviations (SD) for the 3 HA sections for the levels

of technology.

	Buttons	**Clean**	**Safety**
F-K	7.95 (1.24)	8.45 (1.41)	11.62 (3.88)
FRE	62.42 (7.23)	60.29 (8.45)	43.25 (19.32)
SMOG	9.67 (1.21)	11.12 (1.22)	13.75 (3.03)
FOG	8.80 (1.56)	10.77 (1.49)	14.03 (3.50)
Mean	*8.81 (1.24)*	*10.11 (1.33)*	*13.13 (3.42*

Note. Mean = average of the F-K, SMOG, and FOG readability levels. F-K = Flesch-Kincaid Reading Grade Level, FRE = Flesch Reading Ease score, SMOG = Simple Measure of Gobbledygook Reading Grade Level, FOG = Gunning FOG Reading Grade Level.

3.2.3.1 Mean Readability

Mauchly's test of sphericity was significant (W = .505, p = .001), so sphericity was not assumed and the Greenhouse-Geisser correction was applied. The R-M ANOVA was significant: $F(1.38, 30.76) = 27.90$, $p < .001$, $\eta^2 = 0.548$. Bonferroni post hoc tests revealed that all the sections were significantly different ($p < .001$): the safety section was significantly higher than the button and cleaning sections, and the cleaning section was significantly higher than the button section.

3.2.3.2 Flesch-Kincaid

Mauchly's test of sphericity was not significant (W = .907, p = .343), so sphericity was assumed. The R-M ANOVA was significant: $F(1, 23) = 512.53$, $p < .001$, $\eta^2 = 0.957$. Bonferroni post hoc tests revealed that the safety section was significantly higher than the button and cleaning sections ($p < .001$) but there were no significant differences between the button and cleaning sections ($p = .24$) based on the F-K reading measure.

3.2.3.3 Flesch Reading Ease

Mauchly's test of sphericity was significant ($W = .447$, $p < .001$), so sphericity was not assumed and the Greenhouse-Geisser correction was applied. The R-M ANOVA was significant: $F(1.28, 29.63) = 21.13$, $p < .001$, $\eta^2 = 0.479$. Bonferroni post hoc tests revealed that the reading ease of the safety section was significantly lower (more difficult) than the button and cleaning sections ($p < .001$) but there were no significant differences between the button and cleaning sections ($p = .23$) based on the FRE reading measure.

3.2.3.4 Simple Measure of Gobbledygook

Mauchly's test of sphericity was significant ($W = .576$, $p = .002$), so sphericity was not assumed and the Greenhouse-Geisser correction was applied. The R-M ANOVA was significant: $F(1.40, 32.29) = 29.75$, $p < .001$, $\eta^2 = 0.564$. Bonferroni post hoc tests revealed that all the sections were significantly different ($p < .001$): the safety section was significantly higher than the button and cleaning sections, and the cleaning section was significantly higher than the button section, based on the SMOG reading measure.

3.2.3.5 Gunning FOG

Mauchly's test of sphericity was significant (W = .678, p = .014), so sphericity was not assumed and the Greenhouse-Geisser correction was applied. The R-M ANOVA was significant: $F(1.51, 34.80) = 35.38$, $p < .001$, $\eta^2 = 0.606$. Bonferroni post hoc tests revealed that all the sections were significantly different ($p < .001$): the safety section was significantly higher than the button and cleaning sections, and the cleaning section was significantly higher than the button section, based on the Gunning FOG reading measure.

3.2.4 Comparison by Hearing Aid Manufacturer

Descriptive statistics for the mean readability (average of F-K, SMOG, and FOG) levels for the 6 different HA manufacturers (with all sections) are shown in Figure 13. A Univariate analysis of variance (ANOVA) was performed to determine if there were differences in the mean readability level of the user guides based on HA manufacturer. The Levene's test indicated equal variances (p = .061). The univariate $F(5,18) = 15.637$, $p < .001$, $\eta^2 = 0.813$, indicating the mean readability levels differed significantly by HA manufacturer. The significant univariate ANOVA was followed by Bonferroni post hoc testing. HA manufacturer 3 had the highest mean readability and was significantly higher than all other manufactures except manufacturer 6. HA manufacturer 2 had the lowest mean readability but was only significantly lower than manufacturer 3.

Figure 13. Means and Standard Deviations (SD) for the 6 HA manufacturers on the

mean readability for all user guide sections.

Manufacturer	1	2	3	4	5	6
Mean	9.98	9.48	12.17	9.60	10.80	10.68
SD	.43	.33	.60	1.45	.46	1.47

3.2.5 Readability Results Summary

It was hypothesised that there would be a significant difference in RGL between the high and low level technology user guides. However, this hypothesis was not supported, as there were no significant differences in any readability measure based on level of technology. It was hypothesised that there would be a significant difference in RGL between the ITE and RIC styles. This hypothesis was also not supported, as there were no significant differences in any readability measure based on style of HA.

The last two readability hypotheses were supported by the data. There was a significant difference between the sections of the user guides. The safety section had the poorest readability levels by all readability measures. The button section had the best readability level by the mean readability and the FOG readability measure. There were also significant differences in readability based on HA manufacturer. The mean readability level for the user guide from Manufacturer 3 was significantly higher than the mean readability of the other 5 manufacturers. The mean readability levels for all 6 manufacturers exceeded the recommended levels.

3.3 Suitability

3.3.1 Overview

Overall, the suitability of the HA user guides was deemed to be adequate. Out of the 24 user guides, 21 scored within the “adequate range”, with the remaining three being scored as “not suitable”. All three “not suitable” user guides were for low level technology HAs, with two being RIC style, and one ITE style.

The mean suitability (derived from the percentage score attributed to each guide) for all the user guides ranged from 28.95% to 65.79%, with a mean of 46.60% (SD = 8.34). This mean falls within the percentage range for adequate material of 40-69%. There were no significant differences in suitability scores based on HA style, level of technology or different manufacturers.

3.3.2 Comparison by Hearing Aid Style

A non-parametric test, such as the Mann-Whitney U, is used throughout this section comparing suitability scores as the distribution of the data didn’t meet the assumption of normal distribution. It is significantly skewed and kurtotic. A Mann-Whitney U test revealed no significant differences in suitability scores between ITE user guides and RIC user guides (U = 62.5, p = .598). The means, standard deviations and maximum and minimum suitability scores for the different HA styles are shown in Figure 14.

Figure 14. Means, Standard Deviations (SD), Maximum and Minimum suitability scores for ITE and RIC HA user guides.

	ITE	**RIC**
Mean	46.49	46.71
SD	7.3	9.6
Maximum	55.27	65.79

Minimum	28.95	34.21

3.3.3 Comparison by Level of Technology

A Mann-Whitney U test revealed no significant differences in suitability scores between low and high level of technology user guides ($U = 69.0$, $p = .876$). The means, standard deviations and maximum and minimum suitability scores for the different HA technology levels are shown in Figure 15.

Figure 15. Means, Standard Deviations (SD), Maximum and Minimum suitability scores for low level and high level technology HA user guides.

	Low	**High**
Mean	46.49	46.71
SD	9.14	7.87
Maximum	63.16	65.79
Minimum	28.95	34.21

3.3.4 Comparison by Hearing Aid Manufacturer

A Kruskal-Wallis test revealed no significant differences in suitability scores based on hearing aid manufacturer ($\chi2 = 4.06$, $p = .541$). The means, standard deviations and maximum and minimum suitability scores for the different HA manufacturers are shown in Figure 16.

Figure 16. Means, Standard Deviations (SD), Maximum and Minimum suitability scores for the six different HA manufacturers.

Manufacturer	1	2	3	4	5	6

Mean	43.42	44.73	44.74	44.73	51.31	50.66
SD	8.18	14.09	3.72	5.68	11.06	4.49
Maximum	34.21	28.95	42.11	36.84	39.47	44.74
Minimum	52.63	63.16	50.00	50.00	65.79	55.27

3.3.5 Suitability Results Summary

It was hypothesised that there would be a significant difference in suitability between the high and low level technology user guides. However, this hypothesis was not supported, as there were no significant differences in SAM suitability percentage scores based on level of technology of the user guides. It was hypothesised there would be a significant difference in suitability between ITE and RIC style HAs. Again, this hypothesis was not supported, as there were no significant differences in suitability scores based on style of HA. Finally it was hypothesised that there would be a significant difference in suitability between manufactures and this hypothesis was also not supported, as there was no significant difference in suitability scores across the different HA manufacturers.

3.4 Learner Verification and Revision

3.4.1 Overview

The HA user guide with the worst combined RGL and SAM score was selected for this process (See Methods for detailed description of selection process). The HA user guide used belonged to the category of ITE style, low level technology. Based off of consistent feedback from the majority of participants, revisions were made to the user guide in the following areas: a) cleaning and care of the HAs; b) using the telephone with the HAs; c) how to control the volume of the HAs. These revisions were made based off of participant feedback and using suggestions taken from the literature (outlined in Appendix F).

3.4.2 Participants

Ten participants were involved in the learner verification section of the study, six females and four males. They ranged in age from 49 to 74 years of age (mean = 62.6). All participants identified as New Zealand European. The amount of years of education they had ranged from 13 years to 19 years (mean = 15.7). Three of the 10 participants had a family member who wore HAs (a mother, father and husband.) For a detailed description of each participant, along with their audiometric results, please refer to Appendix A.

3.4.3 Original Cleaning and Care Section

Cleaning and care of the HAs was chosen for revision as many participants expressed confusion over how certain aspects of cleaning worked. Common complaints from participants were that cleaning instructions were unclear and confusing. When asked if there were any instructions they might have difficulty following, participant one said, “Yeah the bit about cleaning the aid”. Participant four responded with, “The cleaning part was a bit confusing. Not sure exactly how to do that.” Again, when asked if they felt they had enough information to clean the HAs, participant seven noted, “It tells you to clean it but doesn’t tell you exactly what to do”. Participant 10 pointed out a particularly long sentence in the cleaning section (> 22 words) and said, “I had to read this a few times to get the jist of it”. Finally, when asked if there was anything not included in the guide that should have been, cleaning and care was again a common complaint amongst participants. Participant five said they wanted, “More detailed instructions on things like cleaning… It says my hearing care professional can tell me about it. But I would want the information in my instruction manual.”, and participant nine noted, “Just the cleaning stuff again… I think it needs to tell you more about that.”.

3.4.4 Original Telephone Section

Using the telephone with HAs was another section of the original guide that caused confusion amongst most participants. A very common complaint was that the jargon ‘telecoil’ was often used but never explained. Participant nine said, “...it doesn’t really explain what telecoil is. I didn’t know what that was. It uses that term, so it should explain it. I still don’t really know what that is.” When participants were asked how the answer the telephone with this HA, participant one said, “Some have a special phone thing in them. So I think you have to push a button.” Participant four answered, “Use the tele-thing. Maybe you have to push a button too.” Confusion around using the phone with the HA was a common theme.

3.4.5 Original Volume Control Section

The final section chosen for revision based off of consistent participant feedback was the section on volume control of the HAs. Again, the use of jargon was a common complaint about this section. Participant two said, “They did use words like multi –

something. I wasn't sure what that meant". Participant ten made a similar point; "It kept talking about a multi-function button. Not too sure what they mean by that. Is that the volume?" When asked if participants felt they had enough information to control the volume of the hearing aid, many weren't confident. Participant seven said, "I got the impression that some models I could turn up and some I could turn down. You turn the wee dial to turn it up, not sure which direction, that would be trial and error", implying they were confused about exactly which button would work for the volume. Participant nine said, "I guess you'd get the hang of it…but it seems a bit confusing really."

3.4.6 Readability of Original Guide vs. Revised Guide

Figure 17 compares the F-K readability scores of the original guide as compared to the revised guide across all three sections. In every section measured, the RGL drops after revision to the section took place. Revision involved using shorter sentence length, less polysyllabic words, avoiding technical jargon and avoiding passive voice. Figure 18 compares some of these contextual factors from the original and revised user guide.

Figure 17: Flesch-Kincaid readability scores of each section of the original and revised user guides.

	Original F-K score	Revised F-K score	Difference between scores
Care of HAs	5.9	4.2	1.7
Telephone	6.3	5.8	0.5
Volume	7.2	5.5	1.7

Figure 18: Contextual factors of the original and revised user guides.

	Original user guide	Revised user guide
Sentences classified as "hard" (> 22 words)	54.00%	6.80%
Words > 2 syllables	12.40%	8.30%
Words > 5 characters	30.20%	25.00%
Passive voice sentences	29.00%	7.00%

3.4.7 Participant Feedback on Revised Guide

The revised user guide (which can be seen in Appendix H), received much more favourable feedback from the eight participants who read both versions of the guide. Participant nine said, “It’s all far more simple isn’t it? Just makes things more obvious for people”. Participant ten said, “It’s more clear… it only seems to cover the important parts”.

When asked again if they would feel comfortable cleaning the HA, majority of participants thought they would, although participant four pointed out, “The cleaning section could use some pictures.”

When asked if they thought they would be able to use the telephone with the HA, again most participants felt they had enough information to do so. As participant nine pointed out, “I think it’s pretty easy (using the phone). This makes it sound like you just use the phone like normal really”.

Finally, participants also seemed more confident using the volume control of the HA after reading the revised user guide. Participant ten even pointed out the reduction in jargon, stating, “No mention of the multi-button thingy any more I see. Good, it’s clearer when it’s all called the same thing.”

3.4.8 Learner Verification and Revision Summary

As hypothesised, the RGL of each section of the selected user guide dropped after revision was made in these areas. The sections chosen for revision ((a) cleaning and care of the HAs; b) using the telephone with the HAs; c) how to control the volume of the HAs) were all selected based off of participants feedback. Subjective feedback from the participants improved after revision to the aforementioned sections was made. Common feedback post revision was that the sections were now, “better”, “easier to follow”, “much more simple” and “making sense”.

Chapter Four: Discussion

4.1 Overview

The aim of this study was to investigate both the readability and suitability of HA user guides currently in circulation in New Zealand/Aotearoa. It also aimed to use learner verification and revision on the lowest scoring HA user guide in order to improve portions of it. This chapter discusses the results of these investigations, put forth in Chapter Three, comparing these results to those found in previous literature. The clinical implications of the findings of this study are outlined, and their relevance to the population of New Zealand/Aotearoa discussed. The limitations of the study itself are also discussed. Finally, directions of possible future research are suggested.

4.2 Aim One: Readability

4.2.1 Hypotheses

The first hypothesis of the study was that there would be a significant difference in RGL between the high and low level technology user guides. This hypothesis was not supported, as there were no significant differences in any readability measure (F-K, SMOG and FOG) based on level of technology. The mean readability of the low technology user guides was 10.57, while the mean readability of the high technology user guides was slightly, but not significantly, higher at 10.79. Both high and low level technologies mean RGL is clearly higher than the recommend level of five (Atcherson et al, 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997).

The hypothesis that there would be a significant difference in RGL between the ITE and RIC style HAs was also not supported, as there were no significant differences in any readability measure based on style of HA. The mean readability of the ITE user guides was 10.51, while the mean readability of the RIC user guides was a slightly higher, but not significantly higher, 10.86. Both ITE and RIC user guides had clearly had a mean RGL higher than five (the recommended level; (Atcherson et al, 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997)).

The last following two hypotheses were supported by the data. The hypothesis that there would be a significant difference in RGL between the button, cleaning and safety sections of the user guides was supported. The button section had the lowest mean readability of 8.81. Next was the cleaning section, with a mean readability of 10.11. Finally, the safety section had the highest mean readability of 13.13. All three sections failed to meet the recommended RGL of five (Atcherson et al, 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997).

Finally, the hypothesis that there would be significant differences in readability based on HA manufacturer was also supported. HA manufacturer 3 had the highest mean readability of 12.17 (significantly higher than all other manufactures except manufacturer 6). HA manufacturer 2 had the lowest mean readability of 9.48 (only significantly lower than manufacturer 3). With a mean of 9.48 being the lowest readability across manufacturers, it logically follows that the mean readability levels for all six manufacturers exceeded the recommended level of five (Atcherson et al, 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997).

4.2.2 Comparison to Literature

The mean readability (average of F-K, SMOG and FOG) of the user guides in this current study, across all technologies, styles, sections and manufacturers, ranged from 7.77 to 13.38, with a mean of 10.68. This shows that all of the 24 user guides assessed (100%) had a mean readability higher than the RGL of five (Atcherson et al, 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997).

In comparison, when Atcherson et al. (2014) looked at online audiological material on the American Speech-Language-Hearing Association (ASHA) website, 85.4% of the 225 consumer articles assessed exceeded the recommend RGL of five. (Using FRE, F-K, FOG and FORCAST readability measures). It therefore naturally follows that 14.6% of the online articles assessed were within recommended levels. Although still a much lower percent than is desirable, it is at least a step in the right direction towards more written audiological material being not only accessible but comprehendible for the HI population. Having said that, it is important to emphasise that the Atcherson et al. (2014) study looked only at data gathered from one website (the ASHA website).

Laplante-Levesque et al. (2012) looked at the readability of material taken from 66 different English-language websites relevant to HI, using the FRE, F-K and SMOG . It was concluded that one would need an average of at least 11 to 12 years of education to fully read and comprehend the material, far exceeding a 5th RGL. The

data from Laplante-Levesque et al. (2012) would suggest that online audiological material unfortunately appears to be, on average, above recommended RGLs and therefore difficult for a large portion of the HI population to fully understand.
As mentioned, the material selected for analysis in this study was sourced online. One can assume that these materials are intended for use by the hearing impaired population without them necessarily having the support of a clinician. This makes their unsuitable readability levels all the more alarming, as some individuals may not have anyone with experience with HI to turn to for help and clarification. With the HA user guides used in the current study, this is not necessarily presumed to be the case. Although accessed online for the purposes of this study, the HA user guides chosen for analysis are typical of materials given out by clinicians to HI individuals upon purchasing HAs.

Another similar study to mention is the Kelly (1996) investigation into the readability of informational and instructional brochures provided with HAs. Kelly (1996) concluded (based on the FOG, F-K and Fry) that 58% of the 109 documents assessed required a college-age RGL, 20% were at a high school level and 16% were at a junior high school level. Only 6% of the documents assessed were classified as being at a grade school level. Although conducted almost two decades ago, this data appears to unfortunately still be largely relevant to HA informational brochures and instruction manuals today, as evidenced by the current study. It is not explicitly mentioned if being at a grade school level implies the material falls within the recommended RGL of five or lower. Assuming that this is the case, that would make the results from Kelly (1996) marginally more promising than those from the current s study (where none of the assessed materials were at recommended RGLs). A possible explanation for this slight difference in findings between Kelly (1996) and the current study is that, although both studies used multiple readability formulas in the attempt to obtain an accurate estimate of readability, each study did not use the exact same readability measures. This could account for Kelly (1996) finding a small percentage of material being at a lower RGL level.

A major difference between Kelly (1996) and the current study is that Kelly (1996) looked exclusively at the readability of HA user guides. The current study also included a suitability measure (the SAM) to further scrutinise the HA user guides in question.

Kelly (1996) included helpful suggestions for improving readability for written materials which were incorporated into the revision of a HA user guide in this current study. These suggestions are outlined in Appendix G.

Finally, the Caposecco et al. (2014) study investigating the content, design and readability of hearing aid user guides used the FRE, Fry, F-K and FOG to measure readability. The mean RGL for all 36 HA user guides assessed was 9.6. This result is higher than the recommended RGL of five, but lower than the mean RGL of 10.68 found in the 24 HA user guides of this study. Again, this difference in results between studies could be due to the different materials assessed, or to the different readability measures used to assess them.

Caposecco et al. (2014) also compared readability between BTE and ITC style HA user guides and between low-priced and mid-priced HA user guides. As with the current study comparing different HA style user guides and different technology level user guides, no significant difference was found in readability levels.

A difference between the Caposecco et al. (2014) study and the current study is the sections of the HA user guides that were chosen for analysis. Caposecco et al. (2014) looked at the readability of the information pertaining to a) batteries; b) turning the HA off/on; and c) care and maintenance. As previously outlined, the sections of the HA user guides subjected to readability analysis in the current study were a) buttons; b) cleaning; and c) safety. The difference in sections used does somewhat limit the accuracy of making direct comparisons between the two studies.

4.3 Aim Two: Suitability

4.3.1 Hypotheses

The hypothesis that there would be a significant difference in suitability between the high and low level technology user guides was not supported by the data. There were no significant differences in SAM suitability percentage scores based on level of technology of the user guides. The mean suitability score for low level technology user guides was 46.49%, for high level technology user guides it was 46.71%. Both these scores are considered adequate according to Doak et al. (1996).

The hypothesis that there would be a significant difference in suitability between ITE and RIC style HA user guides was also not supported, as there were no significant differences in suitability scores based on style of HA. The mean suitability score for ITE HA user guides was 46.49%, for RIC HA user guides it was 46.71%. Once again, Doak et al. (1996) deems these score adequate.

Finally, the hypothesis that there would be a significant difference in suitability between manufactures was also not supported. No significant difference in suitability scores across the different HA manufacturers user guides was found. All six manufacturers managed an average suitability score in the adequate range, falling between 43.42% and 51.31% (Doak et al. (1996) defines an adequate score to be 40-69%).

4.3.2 Comparison to Literature

As previously mentioned, a suitability score of 70 -100% indicates superior material, 40-69% indicates adequate material and 0-39% indicates the material is not suitable (Doak et al., 1996). It is important to note that none of the 24 HA user guides assessed in this study achieved a suitability score in the superior range. The same can be said for the 36 HA user guides assessed by Caposecco et al. (2014). However, while Caposecco et al. (2014) found 69% of their user guides not suitable and only 31% adequate, the current study found 87% of the user guides were adequate, with only 12.5% deemed not suitable. These results are more promising, hopefully suggesting that HA user guides available in New Zealand/Aotearoa are more often than not suitable for use with the HI population. Caposecco et al. (2014) concluded that the 36 HA user guides assessed were overall unsuitable for use with older Australian adults. The current study could not conclude the same when considering the suitability of the 24 HA user guides assessed for use within the New Zealand/Aotearoa population.

Given the close time frame between these two studies and the fact that both sets of HA user guides were sampled from many of the same manufacturers, there is a feasible possibility that both studies were analysing very similar, if not the same, HA user guides. This speculation then begs the question of why there were differences in the SAM scores of the two studies. It is quiet possibly down to methodological differences. For example, both studies mention having eliminated the Cultural Appropriateness section of the SAM as it was deemed irrelevant to the material. However, this study also eliminated the RGL section of the SAM, as this was already being thoroughly assessed via other means and it was thought more important for the SAM to reflect other aspects of suitability. Caposecco et al. (2014) makes no mention of also eliminating this section, thus possibly accounting for the differences in SAM scores.

4.4 Aim Three: Learner Verification

4.4.1 Hypotheses

It was hypothesised that the RGL of the revised user guide sections (care, telephone, volume) would be lower than the RGL of the original sections. This hypothesis was supported when using the F-K to compare readability results. The sections from the original user guide had a combined F-K average of 6.5, while the revised user guide sections had a combined F-K average of 5.2.

It was also hypothesised that the opinions of the participants would suggest the revised user guide sections were easier to comprehend than the original sections. This was shown to be true by analysing the responses given during the interviews before and after revision of the material took place. Participants felt better able to understand and follow the information provided in the revised material, compared to the original guide. Comments such as “It’s definitely more simple” (P10) and “It’s not as complicated, that’s for sure!” (P9) were commonly made by participants after reading both versions of the user guide.

4.4.2 Comparison to Literature

Previous literature has shown revision of health related documents can be an effective way of making them for suitable for use with the intended population. It is a practical way to reduce the RGL of a document, with the aim of producing information that falls at or below the widely acknowledged recommended RGL of five. Revision of the chosen HA user guide in this study did indeed lower the RGL. This was also the case for the Davis et al., (1996) study. Revision of a polio information pamphlet significantly lowered the pamphlets RGL level (to grade four). The revised polio pamphlet not only had a lowered RGL level, but was also easier for the participants to comprehend and had a lower reading time.

No matter what their level of education, be it 13 years or 19 years, all participants in this study preferred the revised version of the HA user guide. Davis et al. (1996) also found this to be the case, outlining that no matter their socioeconomic status, level of education or reading ability, all participants prefer documents that are more simple to read and thus easier to comprehend. Revision of health materials can lead to a better understanding of said materials, making the target population more likely to follow recommendations with less confusion (Davies et al., 1996).

4.5 Clinical Implications

This study is the first to investigate both the readability and suitability of HA user guides currently in circulation in New Zealand/Aotearoa, as well as use learner verification and revision in order to improve portions of a user guide. Although previous studies have looked one or more similar aspects, none have combined all the above information such as this study has done and made it relevant to the New Zealand/Aotearoa population.

As previously discussed, it is reported there are over 700,000 New Zealanders that are "deaf or hard of hearing" ("National Foundation for the Deaf," n.d.). Currently, HI is estimated to affect one in six New Zealanders. This number in expected to rise to one in four New Zealanders by 2050 (National Foundation for the Deaf," n.d.). With HI being such a prominent issue in today's society, and indeed an issue for future generations, it is important that New Zealander's have an understanding of how best to deal with this issue, in order to limit its negative consequences.

The use of HAs has been found to reduce the negative consequences brought on by HI (Acar et al., 2011; Bagai et al., 2006; Chisolm et al., 2007; Dillon, 2012; Kochkin, 2011; Mulrow et al., 1990). But in order to obtain maximum benefits from HA use, one must have a solid understanding of how to use said HAs. Such information can be found in HA user guides, such as the 24 assessed in this study. These user guides, and many others for that matter, can be easily accessed online by anyone familiar with searching for information on the internet. User guides like those assessed can also be given out by health professionals when supplying HI individuals with HAs.

The fact that every user guide assessed in this study had a mean readability score above the RGL of five should be of serious concern. When one considers that 56% of New Zealanders have poor health literacy skills (Workbase, 2014), the unsuitable readability of the HA user guides becomes not only an area of significant clinical importance, but also an ethical concern.
Every citizen of New Zealander/Aotearoa has the right to be fully informed about products and services so they can make an informed medical choice and give informed consent (Health & Disability Commissioner, 2009). To relate this specifically to audiology, the New Zealand Audiological Society code of ethics states that clinicians shall fully inform the persons they serve of the nature and possible effects of services rendered and products dispensed (New Zealand Audiological Society, 2014). A clinician may assume they are meeting this guideline by providing a relevant user guide, but the 56% of New Zealanders with poor health literacy skills (Workbase, 2014) may not be as informed as the rest of the population when reading this information pertaining to HAs. When considering that the majority of New Zealand/Aotearoa is predicted to have poor health literacy, it is very disappointing to see that none of the 24 HA user guides assessed met the RGL of five.

Potential misinterpretation of the written material provided could lead to inappropriate use of an HA. This is not only detrimental to the HI individual trying to get the best out of their HA, but can be detrimental to New Zealand/Aotearoa society as a whole. Nutbeam (2000) found that inappropriate use of medical devices can be a financial burden on the nation’s health care industry. It is therefore within New Zealand/Aotearoa societies best interests to provide written health care material, such as HA user guides, that is able to be read and understood by the majority of the population.

Although this study found that HA user guides currently available in New Zealand/Aotearoa may not be meeting recommended RGLs, it has shown that it is possible to amend said material to be more suitable for the HI population. It is hoped that the findings of this study will encourage the producers of HA user guides to consider working towards lowering the RGLs of their written materials, in order to optimise HI individuals understanding on the use and care of their HAs. This can be achieved through revision of written materials, using the suggestions outlined in Appendix G.

It is also hoped that the results of this study will make health professionals more aware that written material they provide to their patients may not always be suitable. This places extra importance on verbal information passed on to patients. As mentioned when discussing the current study in relation to the study by Laplante-Levesque et al. (2012), it is assumed that the HA user guides examined in this study would most likely reach HI individuals via clinicians directly, rather than being accessed online. HI individuals rely solely of their health literacy skills when accessing relevant materials online, such as the materials assessed by Laplante-Levesque et al. (2012). But when the materials are passed on to HI individuals by a clinician, it can be assumed that the clinician will also pass along verbal information.

Nair & Cienkowski (2010) recorded and transcribed the verbal information that audiologists were using during appointments. It was found that the transcribed verbal information was also not at a suitable RGL and did not match the RGL of the clients. If written material given is not suitable for individuals with poor health literacy, as evidenced by the current study, then clinicians need to strive to make sure they are presenting verbal information in an easy to follow manner. In order for HI individuals to have the best chance of fully comprehending important information pertaining to their HAs, both written and verbal information needs to be conveyed at an appropriate and understandable level. The general principals in Appendix G for improving written health care materials could be applied to verbal transfer of information also.

4.6 Limitations and Suggestions for Future Research

It is important to note that the number of participants in the current study was rather small. Initially, 10 participants took part in the learner verification process, completing the first interview. However, due to attrition, this number dropped to eight participants for the second round of interviews. Although this number was still sufficient to meet “saturation”, it does somewhat limit our ability to make generalisations from the results. For future research looking at learner verification and revision, ideally one would not wish to have such large attrition. This could perhaps be avoided by conducting the two interviews closer together in time.

Furthermore, the small sample size of participants made it difficult to obtain the opinions of an ethnically diverse range of participants. All participants in this study identified themselves as New Zealand European. Therefore the views of ethnic and cultural minorities may not be accurately represented in this study. Given New

Zealand/Aotearoa's diverse range of ethnicities and cultural backgrounds, it may be of interest to conduct a similar study ensuring a wider range of ethnicities and cultures are included. With a more diverse sample of the population represented by a group of participants, one can assume a more diverse range of opinions and ideas will also be represented. As they stand, the opinions of the participants from the current study alone cannot be generalised to the New Zealand/Aotearoa population as a whole, as they do not represent the society as a whole.

4.7 Conclusion

In conclusion, this study aimed to investigate the readability and suitability of 24 HA user guides available in New Zealand/Aotearoa.

The results obtained from this study would suggest that the readability of HA user guides in New Zealand/Aotearoa is above the recommended RGL of five. This could result in the majority of the HI population of New Zealand/Aotearoa not fully comprehending the information and instructions laid out in these user guides. This can ultimately lead to misuse of the relevant HA, resulting in poor health outcomes for the individual.

In measures of suitability other than readability, using the SAM, the majority of the HA user guides were found to be adequate. This is result is better than what was been found in previous literature, and is an encouraging step in the right direction for HA user guides.

It was found that by applying careful revision to the HA user guide with the lowest combined readability and SAM score, readability was able to be improved. Participants also reacted more positively to the revised HA user guide, finding it easier to understand and the instructions clearer.

This result is clinically significant for the HI population of New Zealand/Aotearoa. Revising available HA user guides would make them easier to comprehend for the majority of the New Zealand/Aotearoa population with poor health literacy skills. If able to better understand the written instructions given on the use of their HA, it is hoped an individual will be better able to use and take care of said HA. This is hypothesised to result in improved health outcomes for the individual.

As the results of this study show, through simple revision of HA user guides, these materials can be made more suitable for use with the New Zealand/Aotearoa HI population. It is hoped these results inspire change in future HA related literature. All individuals have the right to be fully informed in all aspects of their health, regardless of their health literacy skills, and changes need to be made to accommodate the majority of the New Zealand/Aotearoa population.

Reference List

Acar, B., Yurekli, M. F., Babademez, M. A., Karabulut, H., & Karasen, R. M. (2011). Effects of hearing aids on cognitive functions and depressive signs in elderly people. *Archives of Gerontology and Geriatrics*, *52*(3), 250–2. doi:10.1016/j.archger.2010.04.013

Agrawal, Y., Platz, E. A., & Niparko, J. K. (2008). Prevalence of hearing loss and differences by demographic characteristics among US adults. *Archives of Internal Medicine*, *168*(14), 1522–1530.

American Medical Association. (2014*). Health Literacy*. Retrieved from: http://www.ama-assn.org/ama/pub/about-ama/ama-foundation/our-programs/public-health/health-literacy-program.page

American Speech-Language-Hearing Association. (2005). *Guidelines for manual pure-tone threshold audiometry.*

Arlinger, S. (2003). Negative consequences of uncorrected hearing loss - a review. *International Journal of Audiology*, *42*(2), 17–20.

Atcherson, S. R., DeLaune, A. E., Hadden, K., Zraick, R. I., Kelly-Campbell, R. J., & Minaya, C. P. (2014). A Computer-Based Readability Analysis of Consumer Materials on the American Speech-Language-Hearing Association Website. *Contemporary Issues in Communication Science and Disorders*, *41*, 12-23.

Bagai, A., Thavendiranathan, P., & Detsky, A. S. (2006). Does this patient have hearing impairment? *Journal of the American Medical Association, 295*(4), 416–428.

Caposecco, A., Hickson, L., & Meyer, C. (2014). Hearing aid user guides: Suitability for older adults. *International Journal of Audiology, 53*, S43-S51.

Carhart, R. (1945). An improved method of classifying audiograms. *Laryngoscope*, *5*, 1–15.

Carhart, R., & Jerger, J. (1959). Preferred method for clinical determination of pure-tone thresholds. *Journal of Speech and Hearing Research*, *24*, 330–345.

Chai, T.-J., & Chai, T. C. (1980). Bactericidal activity of cerumen. *Antimicrobial Agents and Chemotherapy*, *18*(4), 638-641.

Chia, E., Wang, J. J., Rochtchina, E., Cumming, R. R., Newall, P., & Mitchell, P. (2007). Hearing impairment and health-related quality of life: the Blue Mountains Hearing Study. *Ear and Hearing*, *28*(2), 187–95. doi:10.1097/AUD.0b013e31803126b6

Chisolm, T. H., Johnson, C. E., Danhauer, J. L., Portz, L. J. P., Abrams, H. B., Lesner, S., . . . Newman, C. W. (2007). A systematic review of health-related quality of life and hearing aids: final report of the American Academy of Audiology Task Force On the Health- Related Quality of Life Benefits of Amplification in Adults. *Journal of the American Academy of Audiology*, *18*(2), 151–83. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/17402301

Cruickshanks, K. J., Wiley, T. L., & Tweed, T. (1998). Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin. The Epidemiology of Hearing Loss Study. *American Journal of Epidemiology, 148*, 879–886.

Dalton, D. S., Cruickshanks, K. J., Klein, B. E., Klein, R., Wiley, T. L., & Nondahl, D. M. (2003). The impact of hearing loss on quality of life in older adults. *The Gerontologist*, *43*(5), 661–668.

Davis, T. C., Bocchini, J. A., Fredrickson, D., Arnold, C., Mayeaux, E. J., Murphy, P. W., … Paterson, M. (1996). Parent comprehension of polio vaccine information pamphlets. *Paediatrics*, *97*(6), 804–810. Retrieved from http://pediatrics.aappublications.org/content/97/6/804.short

DeWalt, D. A., Berkman, N. D., Sheridan, S., Lohr, K. N., & Pignone, M. P. (2004). Literacy and health outcomes. *Journal of General Internal Medicine, 19*(12), 1228-1239.

DiGiovanni, J. (2011). *Hearing Aid Handbook.* Delmar Cengage Learning: Clifton Park, NY

Dillon, H. (2012). *Hearing Aids* (Second ed.). Sydney: Boomerang Press.

Doak, C. C., Doak, L. G., & Root, J. H. (1996). *Teaching patients with low literacy skills.* Philadelphia: J. B. Lippincott Company.

DuBay, W. H. (2004). *The Principals of Readability*. Impact Information: Cost Mesa, California.

Duijvestin, J., Anteunis, L. J. C., Hoek, C., van den Brink, R., Chenault, M. N., & Manni, J. (2003). Help-seeking behaviour of hearing impaired persons aged. *Acta Oto-Laryngological*, *123*(7), 846–850.

Erdman, S. A., & Demorest, M. E. (1998). Adjustment to hearing impairment I: Description of a heterogeneous clinical population. *Journal of Speech, Language, and Hearing Research*, *41*, 107–122.

Fischer, M., Cruickshanks, K. J., Wiley, T. L., Klein, B. E., Klein, R., & Tweed, T. (2011). Determinants of hearing aid acquisition in older adults. *American Journal of Public Health*, *101*(8), 1449–1455.

Fleiss, J, L. (1981). The measurement of interrater agreement. *Statistical methods for rates and proportions. 2,* 212-236.

Flesch, R. (1948). A new readability yardstick. *Journal of applied psychology, 32*(3), 221-233.

Fry, E. (1968). A Readability Formula That Saves Time. *Journal of Reading, 11*(7), 513-516.

Geisler, C. D. (1998). *From Sound To Synapse- Physiology of The Mammalian Ear*. New York: Oxford University Press, Inc.

Gelfand, S. (2009). *Essentials of Audiology* (3rd ed.). New York: Thieme.

Goodman, A. C. (1965). Reference zero levels for pure-tone audiometers. *Asha, 7*, 262-263.

Gopinath, B., Schneider, J., Hartley, D., Teber, E., McMahon, C., Leeder, S., & Mitchel, P. (2011). Incidence and predictors of hearing aid use and ownership among older adults with hearing loss. *Annals of Epidemiology*, *21*(7), 497–506. doi:10.1016/j.annepidem.2011.03.005

Greville, K. A. (2005). *Hearing impaired and deaf people in New Zealand; an update on population numbers and characteristics.* Auckland.

Health & Disability Commissioner. (2009). The Code of Rights. Retrieved from: http://www.hdc.org.nz/the-act--code/the-code-of-rights

Hickson, L., Allen, J., Beswick, R., Fulton, M., Wolf, D., Worrall, L., & Scarinci, N. (2008). Relationships between hearing disability, quality of life and wellbeing in older community-based Australians. *Australian and New Zealand Journal of Audiology, 30*(2), 99–112. doi:10.1375/audi.30.2.99

Hughson, W., & Westlake, H. (1944). Mannual for program outline for rehabilitation of aural causalities both military and civilian. *Transactions American Academy of Ophthalmology and Otolaryngology*, *48*, 1–15.

Jennings, M. B., & Shaw, L. (2008). Impact of hearing loss in the workplace: raising questions about partnerships with professionals. *Work*, *30*(3), 289–295.

Jerger, J., & Jerger, S. (1980). Measurement of hearing in adults. In M. Paperella & D. Shumrick (Eds.), *Otolaryngology* (2nd ed.). Philadelphia: W.B. Saunders.

Katz, J. (2002). *Handbook of Clinical Audiology* (Fifth ed.). Baltimore: Lippincott Williams & Wilkins.

Kelly, L. J. (1996). The Readability of Hearing Aid Brochures. *Journal of the Academy of Rehabilitative Audiology, 29*, 41-47.

Kelly-Campbell, R. J., Atcherson, S. R., Zimmerma, K. R., & Zraick, R. I. (2012). Readability of Audiologic Self-Report Assessment Tools. *Journal of the Academy of Rehabilitative Audiology, 45*, 63-73.

Killion, M. C., & Dallos, P. (1979). Impedance matching by the combined effects of the outer and middle ear. *Journal of the Acoustical Society of America, 66*, 599-602.

Kochkin, S. (2009). MarkeTrak VIII: 25-Year Trends in the Hearing Health Market. *The Hearing Review, 16(11),* 12-31.

Kochkin, S. (2011). MarkeTrak VIII: Patients report improved quality of life with hearing aid usage. *The Hearing Journal, 64*(6), 25–32.

Kutner, M., Greenberg, E., Jin, Y., & Paulsen, C. (2006). *The Health Literacy of America's Adults: Results from the 2003 National Assessment of Adult Literacy (NCES 2006-483).* Washington, DC: National Center for Education Statistics, U.S. Department of Education.

Laplante-Levesque, A., Brannstrom, K. J., Andersson, G., & Lunmer, T. (2012). Quality and readability of English-language internet information for adults with hearing impairment and their significant others. *International Journal of Audiology, 51,* 618-628.

Mathers, C., Smith, A., & Concha, M. (2000). *Global burden of hearing loss in the year 2000.* Retrieved from: http://www.who.int/healthinfo/statistics/bod_hearingloss.pdf

McLaughlin, G. H. (1969). A new readability formula. *Journal of reading, 12*(8), 639- 646.

Mulrow, C. D., Aguilar, C., Endicott, J. E., Tuley, M. R., Velez, R., Charlip, W. S., . . . DeNino, L. A. (1990). Quality-of-life changes and hearing impairment. A randomized trial. *Annals of Internal Medicine*, *113*, 188–194.

Naghavi, M., Wang, H., Lozano, R., Davis, A., Liang, X., Zhou, M., ... Murray, C. J. (2015). Global, regional, and national age–sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *385*(9963), 117-171.

Nair, E. L., & Cienkowski, K. M. (2010). The impact of health literacy on patient understanding of counseling and education materials. *International Journal of Audiology, 49*(2), 71-75.

National Foundation for the Deaf. (n.d.). Retrieved from www.nfd.org.nz

New Zealand Audiological Society (2014). Code of Ethics. Retrieved from http://www.audiology.org.nz/Userfiles/file/Code%20of%20Ethics%2011%20December%202014%20(1).pdf

Nutbeam, D. (2000). Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International, 15*(3), 259-267. doi:10.1093/heapro/15.3.259

Parikh, N. S., Parker, R. M., Nurss, J. R., Baker, J. R., & Williams, M. V. (1996). Shame and health literacy: the unspoken connection. *Patient Education and Counselling*, *27*(1), 33-39. doi:10.1016/0738-3991(95)00787-3

Parnes, L. S., Sun, A.-H., & Freeman, D. J. (1999). Corticosteroid pharmacokinetics in the inner ear fluids: An animal study followed by clinical application. *The Laryngoscope*, *109*, 1-17.

PLAIN. (2011). Federal Plain Language Guidelines. Retrieved from http://www.plainlanguage.gov/howto/guidelines/FederalPLGuidelines/index.cfm

Rabinowitz, P. M. (2000). Noise-induced hearing loss. *American family physician, 61*(9), 2759-2761.

Scarinci, N., Worrall, L., & Hickson, L. (2009). The ICF and third-party disability: Its application to spouses of older people with hearing impairment.*Disability & Rehabilitation*, *31*(25), 2088-2100.

Scarinci, N., Worrall, L., & Hickson, L. (2012). Factors associated with third-party disability in spouses of older people with hearing impairment. *Ear and hearing*, *33*(6), 698-708.

Schuknecht, H. F. (1963), Symposium: Meniere's disease. Meniere's disease: A correlation of symptomatology and pathology. *The Laryngoscope*, 73: 651–665.

Schuknecht, H. F. (1974). *Pathology of the Ear*. Cambridge, MA: Harvard University Press.

Shaw, E. A. G. (1974). Transformation of sound pressure level from the free field to the eardrum in the horizontal plane. *Journal of the Acoustical Society of America, 56*(6), 1848-1861.

Si, L., & Callan, J. (2001). A statistical model for scientific readability. In *Proceedings of the tenth international conference on Information and knowledge management* (pp. 574-576). ACM.

Statistics New Zealand – Tatauranga Aotearoa. (2013). *Disability survey: 2013.* Retrieved from: http://www.stats.govt.nz/browse_for_stats/health/disabilities/DisabilitySurvey_HOTP_2013.aspx

Stumer, J., Hickson, L., & Worrall, L. (1996). Hearing impairment, disability and handicap in elderly people living in residential care and in the community. *Disability and Rehabilitation*, *18*(2), 76–82.

Swan, I., & Gatehouse, S. (1990). Factors influencing consultation for management of hearing disability. *British Journal of Audiology*, *24*, 155–160.

Thorne, P. R., Ameratunga, S. N., Stewart, J., Reid, N., Williams, W., Purdy, S. C., . . . Wallaart, J. (2008). Epidemiology of noise-induced hearing loss in New Zealand. *Journal of the New Zealand Medical Association, 121*(1280), 33-44.

Wang, L., Miller, M. J., Schmitt, M. R., & Wen, F. K. (2013). Assessing readability formula differences with written health information materials: Application, results and recommendations. *Research in Social and Administrative Pharmacy, 9*(5), 503-516. doi:10.1016/j.sapharm.2012.05.009

Weintraub, D., Maliski, S. L., Fink, A., Choe, S., & Litwin, M. S. (2004). Suitability of prostate cancer education materials: Applying a standardized assessment tool to currently available materials. *Patient Education Counselling*, 55, 275-280.

Weiss, B.D., & Coyne, C. (1997). Communicating with patients who cannot read. *The New England Journal of Medicine, 337,* 272-274.

Williams, M. V., Baker, D. W., Parker, R. M. and Nurss, J. R. () Relationship of functional health literacy to patient's knowledge of their chronic disease: a study of patients with hypertension and diabetes.,,–172.

Workbase. (2014). *Definitions of Health Literacy*. Retrieved from: http://www.healthliteracy.org.nz/about-health-literacy/definitions-of-health-literacy/

World Health Organization. (1993). Study protocol for the World Health Organization project to develop a quality of life assessment instrument WHOQOL. *Quality of Life Research*, *2*, 153–159.

World Health Organization (2012). *WHO global estimates on prevalence of hearing loss*. Retrieved from: http://www.who.int/pbd/deafness/WHO_GE_HL.pdf

World Health Organization. (2014a). *Deafness and hearing.* Retrieved from http://www.who.int/mediacentre/factsheets/fs300/en/

World Health Organization. (2014b*). Health Promotion. Track 2: Health Literacy and Health Behaviour*. Retrieved from: http://www.who.int/healthpromotion/conferences/7gchp/track2/en/

Yoshiura, K., Kinoshita, A., Ishida, T., Ninokata, A., Ishikawa, T., Kaname, T., . . . Niikawa, N. (2006). A SNP in the ADCC11 gene is the determinant of human earwax type. *Nature Genetics, 38*, 324-330.

Appendix A: Study Participants

Participant Number	Age	Gender	Years of Education	Degree	Ethnicity	Family Member with HAs	Left Pure Tone Average (dB HL)	Right Pure Tone Average (dB HL)	Goodman (1965) Classification of Hearing
1	68	Female	13	= HS/NCEA 3	New Zealand European	No	38	40	Mild
2	72	Male	17	= Diploma	New Zealand European	No	40	30	Mild
3	62	Male	16	= BA/BS/GDip/GCert	New Zealand European	No	33	33	Mild
4	53	Female	15	= Certificate	New Zealand European	No	15	18	Normal
5	73	Male	17	= PGDip/PGCert/Hons	New Zealand European	Mother	33	32	Mild
6	74	Female	19	= Diploma	New Zealand European	No	65	48	Moderately-severe/Moderate
7	49	Male	16	= Diploma	New Zealand European	Father	28	28	Mild
8	72	Female	14	= Certificate	New Zealand European	Husband	37	38	Mild
9	49	Female	17	= PGDip/PGCert/Hons	New Zealand European	No	20	25	Normal
10	54	Female	13	= HS/NCEA 3	New Zealand European	No	38	38	Mild

Appendix B: Ethics Approval

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2014/120

25 September 2014

Bethney Russell
Department of Communication Disorders
UNIVERSITY OF CANTERBURY

Dear Bethney

The Human Ethics Committee advises that your research proposal "Evaluation and revision of hearing aid user guides" has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 23 September 2014.

Best wishes for your project.

Yours sincerely

Lindsey MacDonald
Chair
University of Canterbury Human Ethics Committee

Appendix C: Information for Participants

University of Canterbury
Department of Communication Disorders
Private Bag 4800
Christchurch 8140
New Zealand

Project Title: Evaluation and Revision of Hearing Aid User Guides

The purpose of this project is to evaluate and revise a hearing aid user guide for adults with hearing impairment. It is hoped that the findings of this study will help adults with hearing impairment better use their hearing aids.

Your involvement in this project would be to complete a questionnaire about yourself (your age, gender, ethnicity, level of education, experience with hearing aids). You'll also be asked to read a hearing aid user guide. Then, you'll be asked to come to the University of Canterbury to have a hearing test and to participate in a group interview to talk about your options of the hearing aid user guide. The user guide will be revised based on your opinions. You will then be asked to read the revised user guide and return to the University of Canterbury for a second interview about the revised guide. Your total time commitment for this study should take about 3.5 hours, and will require at least 2 sessions at the University of Canterbury. You will receive a $10 petrol voucher to help cover the travel expenses.

You have the right to withdraw from the project at any time. You have the right to withdraw the information you have provided until the interview has been transcribed. After that point, withdrawal of your information would not be possible. Your involvement or withdrawal from this project will not affect how you are treated within the field of audiology or at the University of Canterbury.

As a result of reading the user guide and participating in the interview, there is a possibility that you may become frustrated or distressed. A list of available support services is provided at the end of this document. Any cost incurred in seeking assistance from those services is not provided by the University of Canterbury.

The group interviews will be audio recorded, but you can be assured that your identity will be protected. The interview will be transcribed by me and only my supervisor and I will have access to the recording. The audio recording will be stored on a password protected computer housed in a locked and alarmed room on the University of Canterbury campus. You may receive a copy of the interview by ticking the box on the consent form.

The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation. To ensure confidentiality, your name will not be used on your information sheet or during the interview. In both situations you will be given a participant number and referred to only by this. In addition, the consent form will be kept in a locked cabinet in a locked room on the University of Canterbury campus in Christchurch, New Zealand. The audio recording of the interview and any other electronic data will be kept on password-protected computers that are stored in a locked room on the University of Canterbury campus in Christchurch, New Zealand.

This project is being carried out by Bethney Russell, a Master of Audiology student at the University of Canterbury. The project is being supervised by Dr. Rebecca Kelly-Campbell. Dr. Kelly-Campbell will be happy to answer any questions you have about participation in this project and can be reached on 03 364 2987 extension 8327 or via email at Rebecca.kelly@canterbury.ac.nz.

The project and been reviewed and approved by the University of Canterbury Human Ethics Committee. The Human Ethics Committee can be contacted at University of Canterbury, Okeover House, Christchurch and on 03-364-2987

Available support services:

Hearing related support services:

New Zealand Audiological Society
0800 625 166
http://www.audiology.org.nz/

Ministry of Health
http://www.health.govt.nz/your-health/conditions-and-treatments/disabilities/hearing-loss

Life Unlimited
0800 008 011
http://www.life.nzl.org/

Other support services:

LifeLine
09 5222999 (within Auckland)
0800 543 345 (outside Auckland)
http://www.lifeline.org.nz/

New Zealand Association of Counsellors
http://nzac.org.nz/nzac_counsellor_search.cfm
07 834 0220 (National Office)

Appendix D: Participant Consent Form

University of Canterbury
Department of Communication Disorders
Private Bag 4800
Christchurch 8140
New Zealand

Project Title: Evaluation and Revision of Hearing Aid User Guides

I have been given a full explanation of this project and have had the opportunity to ask questions.

I understand what is required of me if I agree to take part in the research.

I understand that participation is voluntary and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information I have provided.

I understand that any information or opinions I provide will be kept confidential to the researcher and the researcher's supervisor and that any published or reported results will not identify the participants. I understand that a thesis is a public document and will be available through the UC Library.

I understand that all data collected for the study will be kept in locked and secure facilities and in password protected electronic forms will be destroyed after five years.

I understand the risks associated with taking part and how they will be managed.

I understand that I am able to receive a report of the findings of the study by contacting ticking the box below.

I understand that I can contact Rebecca Kelly-Campbell (rebecca.kelly@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Please tick the box if you would like to:

☐ receive a copy of the transcribed interviews.

☐ receive a copy of the summary of findings.

Email or postal address:

____

By signing below, I agree to participate in this research project.

Signature: ____________________________ Date: __________

Appendix E: Demographic Questionnaire

University of Canterbury
Department of Communication Disorders
Private Bag 4800
Christchurch 8140
New Zealand

ID: ___________

Thank you for choosing to take part in our study.

To start, we need to ask you a few questions about yourself. If you do not know an answer, or feel uncomfortable answering, please skip the question and move on to the next one.

What is your age? ____________________

What is your current gender? __________________

How many years did you go to school? ___________________

What is the highest degree you finished? ___________________

What ethnicity/culture do you identify with? _________________

Have you ever owned hearing aids? (Circle one) Yes No

Do any of your family members own hearing aids? (Circle one)

Yes No

If yes, please describe your relationship to this person (e.g. husband/wife, mother, son)

____

Appendix F: Interview Questions

Topic 1: Attraction

In this first part of the interview, I want to get your opinion about how well the guide attracts your attention. If you can, please use your guide to give me some specific examples.

1. Do you feel, in general, that the guide was able to *attract your attention*?

2. Did you find the *visuals* in the guide interesting?

3. Did you think the *tone* of the guide was engaging?

4. Did the colours used in the guide fit the tone and mood of the purpose of the guide?

Topic 2: Comprehension

In this next part of the interview, I want to get your opinion about how well the guide helped in your understanding of the content. Again, if you can give me some specific examples, that will be very helpful.

1. Were there any *words* used in the guide that you thought were difficult to understand?

2. Were there any *instructions* you had difficulty following?

3. Did you find the *pictures* helpful?

4. Were there any *pictures* you thought were not helpful or confusing?

5. Were there things that you *would have liked* a picture of that were not given?

6. What size *battery* does this hearing aid take?

7. How do you turn the hearing aid *on*? How do you turn it *off*?

8. How can you tell the *right from the left* hearing aid?

9. How can you "*mute*" the hearing aid?

10. How do you answer the *telephone* with this hearing aid?

Topic 3: Self-efficacy

In this next part, I'd like to get your opinion about how well the guide helped you feel you could use the hearing aid.

1. After reading the guide, how confident do you feel that you could use the hearing aid in general?

2. Do you feel you have enough information to: (if not, what other information is needed)

a. change the batteries?

b. insert the hearing aids and remove them?

c. use the buttons in the hearing aid?

d. change the dome?

e. use the volume control?

f. use the phone?

g. clean the aid?

h. replace the wax protector?

i. keep it safe?

Topic 4: Cultural appropriateness

In this last part of the interview, I'd like to get your opinion about the cultural appropriateness of the user guide.

1. Is there anything about the guide that you feel could cause offense?

2. Is there anything in the guide that you feel is not true or genuine?

3. Were there any parts of the guide you felt were annoying?

4. Is there anything not included in the guide you felt should have been?

Wrap-up

Is there anything else you'd like to say about the user guide that I haven't asked you?

Thank you for your time and opinions.

Appendix G: Strategies for Improving Written Health Care Materials

- Keep readability of the material at or below a RGL of five (Atcherson et al, 2014; Caposecco et al., 2014; Kelly-Campbell et al, 2012; Laplante-Levesque et al, 2012; Weiss & Coyne, 1997).
- Avoid using jargon or technical terms (Caposecco et al., 2014; Kelly, 1996).
- If using technical terms is unavoidable, make sure they are defined and explained (PLAIN, 2011).
- Use terms and phrases consistently (PLAIN, 2011).
- Avoid polysyllabic words and keep words short (1-2 syllables) (Kelly, 1996).
- Use short sentences (8-10 words) (Capopsecco et al., 2014; Kelly, 1996).
- Use short paragraphs (<4-5 lines) (Kelly, 1996; PLAIN, 2011) .
- Use personal pronouns (Caposecco et al., 2014; Kelly, 1996).
- Use an active (not passive) voice (Kelly, 1996).
- Use headings and subheadings (PLAIN, 2011).
- Use numbers or bullet points to provide order to the document (Kelly, 1996; PLAIN, 2011).

Appendix H: Revised Sections of User Guide

Cleaning/Care Section

Instrument Care

- Try to keep your HA clean at all times. Heat, moisture, dust and dirt can damage your HA.
- Clean your HA daily over a soft cloth. This will stop damage from a fall to a hard surface.
- Use the cleaning brush to brush around the outside of your HA. Brush away any visible wax.
- Use the soft cloth to wipe down your HA.
- Never use water, solvents, cleaning fluids or oil to clean your HA.
- Do not put the cleaning tools inside the HA.

Your audiologist can provide more information on cleaning your HA if needed.

Helpful Hints

- Do not take your HA apart.
- When not wearing your HA, open the battery door to get rid of any moisture.
- When not wearing your HA, take the batteries out.
- When not wearing your HA, place it in the storage container.
- Store your HA:

– In a dry, safe place
– Away from direct sunlight or heat
– Where you can easily find them
– Safely out of reach of pets and children

Service and Repair

If your HA is not working as it should, do NOT try to fix it yourself. You could cause further damage and violate your warranty or insurance. Contact your audiologist for help when your HA is not working.

Telephone Section

Telephone Use

Your HA can help you listen on the phone. Ask your audiologist about the best way for you to use the phone. There are two main options.

1. Automatic Telephone
If you own a HA compatible phone, this option will trigger the phone response by itself. To use, hold the phone as you normally would and the HA will select the phone

setting on its own. You might need to move the phone slightly to find the best reception. Once the phone is removed from your ear, the HA will go back to the normal listening mode.
Note: Ask your audiologist if your HA does not switch to the phone setting automatically.

2. Telecoil and Manual Switching
A manual telecoil lets you switch to phone mode when you need to. You can go into the telecoil setting by pushing the Multifunction button. Once finished on the phone, push the Multifunction button again to go back to your normal listening setting.

General Telephone Use

- Some HAs work best by holding the phone close to, but not fully covering your ear. In some cases, you may hear whistling (feedback). If whistling occurs, tilt the phone at different angles until the whistling stops.
- The HA in the non-phone ear (ear opposite the phone) may also switch to a phone setting to reduce background sounds. Talk to your audiologist for more specific instructions on using the phone with your hearing aid.

Volume Control Section

Volume Control

Automatic
The volume of your HAs can be set at one level by your audiologist. You will not be able to change the volume of your HAs. If sounds are too loud or too soft, please let your audiologist know and they can change the volume for you.

Multifunction Button
If wanted, the Multifunction Button can be used to control the volume of your HAs. One press and release of the button will change the volume one step. Keep pressing the button until you reach the volume you want.