
Readability of Hearing-Related Information on the Internet in the German Language

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“Putting the right book into the hands of the right reader”
(Dale & Chall, 1949a)

“Nicht weil es schwer ist, wagen wir es nicht, sondern weil wir es nicht wagen, ist es schwer”
[Not because it’s hard, we do not dare, but because we do not dare, it’s hard]
(Lucius Annaeus Seneca)

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Abstract

Purpose: To describe the readability of hearing-related information on the Internet in the German language and compare the readability between webpage origins (by country), type of organisation (i.e., government, non-profit, and commercial), and with and without Health on the Net Foundation (HONcode) certification.

Method: Hearing-related search terms were identified using native German-speaking informants. The three keywords, *Schwerhörigkeit* [hard of hearing], *Hörtest* [hearing test], and *Hörgerät* [hearing aid], were checked with Google Trends and then entered into five country code top-level domain (ccTLD) versions of the Google search engine (Google.de; Google.at; Google.ch; Google.li; and Google.hu). The first 10 retrieved webpages, that matched the inclusion criteria, were documented for each key word along with their webpage origins, type of organisation, date of last update, and HONcode certification. After removing duplicates, from the total of 150 webpages, 39 webpages remained from four ccTLDs. These webpages were analysed for readability using the *Läsbarhetsindex 1* (LIX 1) [readability index 1], *Läsbarhetsindex 2 - German technical literature* (LIX 2) [readability index 2]; *Quadratwurzelverfahren* (Qu) [square root process], Rate index 1 (RIX 1), and Rate index 2 - German non-fiction (RIX 2); and the Simple Measure of Gobbledygook 1 (SMOG 1) readability formulas (RFs) provided by the Readability Studio software 2012.1 that generated the reading grade levels (RGLs). Descriptive statistics were computed to describe the readability of hearing-related information on the Internet in the German language, and any differences between readability formulas. Univariate and non-parametric ANOVA were used to determine whether there are significant differences in hearing-related information between webpages with, and without, HONcode certification.

Results: The different RFs consistently showed that readability levels for the assessed webpages exceeded the recommended 6th RGL. All webpages analysed in this study had a

mean RGL of 12 which was not significantly different based on location and type of organisation. Seventy-seven percent of the webpages were of commercial origin and 23% non-profit. No government webpages were retrieved by the ccTLDs. The date of last update on 67% of the webpages was not documented. The location of organisation for most webpages was in Germany. Eighty-two percent of the assessed webpages did not have HONcode certification but, most of the webpages that did have HONcode certification were of commercial origin. RGLs did not significantly differ based on HONcode certification.

Conclusion: The readability of hearing-related information on the Internet in the German language is above the 12th grade level, that is, readers need on average 12 years of education to be able to comprehend the information: however, the limitations of the different RFs, and the software used for the analysis, need to be kept in mind when interpreting results because they can artificially influence the RGL results. Due to the increasing number of people who seek health information online, further studies are needed to investigate whether the online health information in the German language informs or misinforms adults with hearing impairment (HI). The clinical implications of poor readability for audiologists and other stakeholders are discussed.

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List of Abbreviations

ASHA	American-Speech-Language-Hearing Association
ccTLD/s	Country Code Top-Level Domain/s
dB HL	Decibels in Hearing Level
ENT/specialist	Ear-, Nose-, and Throat/specialist
HI	Hearing Impairment
HONcode	Health on the Net Foundation
ICF	International Classification of Functioning, Disability and Health
LIX	<i>Läsbarhetsindex</i> -Original formula by Björnsson (1983)
LIX 1	<i>Läsbarhetsindex 1</i> -Formula provided by the Readability Studio 2012.1 software
LIX 2	<i>Läsbarhetsindex 2</i> -German technical literature-Formula provided by the Readability Studio 2012.1 software
NAAL	National Assessment of Adult Literacy survey
OECD	Organisation for Economic Cooperation and Development
Qu	<i>Quadratwurzelverfahren</i> -Formula provided by the Readability Studio 2012.1 software
RF/s	Readability Formula or Readability Formulas
RGL/s	Reading grade level or Reading Grade levels
RIX	Rate index-Original formula by Anderson (1983)
RIX 1	Rate index 1-Formula provided by the Readability Studio 2012.1 software
RIX 2	Rate index 2-German non-fiction-Formula provided by the Readability Studio 2012.1 software
SMOG	Simple Measure of Gobbledygook-Original Formula by Bamberger and Vanacek (1984)
SMOG 1	Simple Measure of Gobbledygook 1-Formula provided by the Readability Studio 2012.1 software
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

Chapter 1: Introduction

1.1 Study Overview

About 328 million adults around the world have disabling hearing impairment (HI) (WHO, 2017). One of the main consequences of HI is that the affected individual has reduced ability to communicate with others. HI has social and emotional impacts which can lead to loneliness, isolation, and frustration (Ciorba, Bianchini, Pelucchi, & Pastore, 2012). In addition, HI has effects on the economy because people with HI may be less productive or may need more educational support due to their difficulty of comprehending others at work (WHO, 2017). Individuals with HI and/or their significant other/s are likely to use the Internet to gather information about their hearing problems and rehabilitation options (Thorén, Öberg, Wänström, Andersson, & Lunner, 2013).

The Internet has become a popular source for finding health information (Morahan-Martin, 2004). Globally, about 4.5% of all Internet searches are for health-related information (Eysenbach & Köhler, 2003). On average, 56.6% of the German-speaking population uses the Internet to search for health-related information with the third highest Internet use amongst seven European countries, after Denmark (71.6%) and Norway (66.8%) (Kummervold et al., 2008). People around the world seek health information online to prepare for a medical appointment for themselves or a person they know, or in less developed countries, searching for health information online may be more affordable than visiting a doctor (McDaid & Park, 2010; Morahan-Martin, 2004).

The results of online health information searches strongly affect how the individuals manage their health or the health of someone they know, or whether they will seek medical attention. Some adults with hearing impairment will seek information on the Internet before they make an intervention decision, for example whether to trial hearing devices (Laplante-Lévesque, Hickson, & Worrall, 2010a), and therefore, the information on the Internet must be

readable and comprehensible. In addition, readers should be able to trust the health information on the Internet. Research, however, shows that hearing health-related information on the Internet in the English language is difficult to read and comprehend due to complex linguistic structures, such as longer sentences and the use of jargon (Atcherson, DeLaune, Zraick, Kelly-Campbell, & Minaya, 2014; Laplante-Lévesque et al., 2010a).

A typical English-speaking American's average reading ability is between 7th and 8th grade level which is equivalent to 7 to 8 years of education (Kutner, Greenburg, Jin, & Paulsen, 2006). Studies show that hearing-related Internet information in the English language is generally written above the recommended 6th grade level (Laplante-Lévesque & Thorén, 2015). If the health information exceeds the 5th or 6th Reading Grade levels (RGLs), the material is hard to read and it remains inaccessible to individuals who have low health literacy (Doak, Doak, & Root, 1996; McInnes & Haglund, 2011). Health literacy is the ability of a person to comprehend health materials, and is a strong predictor of health outcomes (Ritchie, Tornari, Patel, & Lakhani, 2016). Previous research on websites of university and nonuniversity [*sic*] Ear-, Nose-, and Throat (ENT) hospitals in Germany suggests that audiology-related online information in the German language is only readable for individuals with more than 12 years of education.

The following literature review elaborates on HI, the Internet as a source of information, health literacy, readability, and readability formulas (RFs), before reviewing the existing literature on the link between health literacy and readability of hearing health-related information on the Internet. Last, the study rationale, aims, and hypotheses are outlined.

At the outset, it is necessary to define, and to distinguish between, the *World Wide Web* and the *Internet*. According to the English Oxford Living Dictionaries (2017b), the World Wide Web is “an information system on the Internet which allows documents to be connected to other documents by hypertext links, enabling the user to search for information by moving

from one document to another”. In contrast, the Internet is “a global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols” (English Oxford Living Dictionaries, 2017a). These terms are often (incorrectly) used interchangeably. In the current study, it was *the World Wide Web* that was studied (that is, the network of webpages) not the technical architecture (which would have been an examination of the *Internet*). Because of this, the term *World Wide Web* would have been the correct one to have used for the current study, but because the *Internet* is the word that has been most commonly used in earlier research on this topic, and, to avoid any confusion, the word Internet is used throughout this thesis.

1.2 Hearing Impairment

According to the World Health Organization (WHO) (2017), a person who cannot hear as well as a person with normal hearing, which is defined as a hearing threshold of 25 decibels in Hearing Level (dB HL) or better in both ears, has hearing impairment (HI). The degree of HI ranges from *mild* to *profound* loss of hearing that has an impact on the person’s quality of life as well as on their significant other/s (Appolonio, Carabellese, Frattola, & Trabucchi, 1996; Dalton et al., 2003). There are three types of HI. A *conductive HI* occurs when less sound energy is transmitted through the outer and middle ear than for someone without HI, which is often temporary and may be corrected medically or surgically (American Speech-Language-Hearing Association, 2015). A *sensorineural HI* occurs when the damage is to the inner ear (cochlea), or to the nerve pathway from the inner ear to the brain, which is the most common type of permanent HI. Last, *mixed HI* is the combination of a conductive and sensorineural HI, and damage may be in the outer or middle ear, and the inner ear or to the hearing nerve.

1.2.1 Prevalence of hearing impairment.

HI and deafness affect over 5% of the world's population (WHO, 2017). Adult onset HI is the third leading cause of disability with approximately 360 million people with disabling HI worldwide (Organisation, 2008; WHO, 2017). The WHO (2017) defines disabling HI in adults as an HI greater than 40 dB HL in the better hearing ear. About one third of people over the age of 65 have a disabling HI. The term *presbycusis* refers to HI that is associated with the gradual degeneration of the peripheral and central auditory system due to the natural ageing process, which manifests itself as a bilateral, symmetrical, and high-frequency HI, with difficulty understanding speech (Ciorba et al., 2012; Li-Korotky, 2012; Roth, Hanebuth, & Probst, 2011). Ageing and its intrinsic and extrinsic factors that interact with each other determine “the degree and rate at which our hearing ages” (Ciorba et al., 2012, p. 160). Presbycusis is the most common sensory impairment in people 75 years of age and older, and this leads to a permanent sensorineural HI (American Speech-Language-Hearing Association, 2015; Ciorba et al., 2012).

Stevens et al.'s (2013) work synthesised available data on HI from 42 studies in 29 countries between 1973 and 2010 to generate an estimate of global HI. They found that the global prevalence of HI (an average hearing level of 35 dB HL or greater in the better ear) in 2008 was 9.8% for females and 12.2% for males over the age of 15 years. They also found that HI was positively related to age and male sex. Moreover, they reported that the prevalence of HI is markedly higher in low- and middle-income countries than in high-income countries, indicating the need to address HI globally. In high-income countries 18.5 million people over the age of 60 years have an HI, compared with 43.9 million in low- and in middle-income countries (WHO, 2004). Nonetheless, population based studies about HI are particularly rare, especially in Europe, due to the complex logistic hurdles the data collection requires, such as the need for a sound-treated room or a booth (Roth et al., 2011; Stevens et al., 2013).

The WHO also note that there are 44.5 million people in Europe with moderate or greater HI (41 dB or greater thresholds in the better ear measured average at 0.5 kHz, 1 kHz, 2 kHz, and 4 kHz), and about 78.8 million people with a mild HI (26 dB HL to 40 dB HL thresholds in the better ear measured average at 0.5 kHz, 1 kHz, 2 kHz, and 4 kHz) WHO (2004). The epidemiological data about age-related HI (aged 60 years and above) in Europe is not well established, however, mainly due to the heterogeneity of the structure of the data (Roth et al., 2011). For example, studies have utilised different measures of HI and different classifications of the degree of HI. This difference in measures is evident with studies conducted in Germany, which generally use the guidelines determined by the *Studie des Deutschen Grünen Kreuzes* [Study of the German Green Cross] (Heger & Holube, 2010; Von Gablenz & Holube, 2015). For this reason, the results are not comparable with the findings of international studies because those studies mainly use the criteria defined by the WHO.

Roth et al. (2011) conducted a study to estimate the prevalence of age-related HI in Europe. They found that approximately 30% of men and 20% of women in Europe have an HI of 30 dB HL or greater by the age of 70 years, and 55% of men and 45% of women by the time they reach the age of 80 years. Roth et al. (2011) recognised the need for standardised processes when collecting epidemiological data on HI and recommend the use of the WHO classification of HI and audiometric measures to be able to compare findings internationally.

The prevalence of HI is expected to increase in the next decades due to occupational and recreational noise exposure, and the rising Baby Boomer [*sic*] generation (Li-Korotky, 2012). As our societies age, more people live longer into their 60s, 70s, 80s, and beyond, due to factors such as better diet and healthcare (Ciorba et al., 2012). On the contrary, other studies predict a decline in life expectancy due to factors such as obesity, cancer, or dementia (Carnes, Olshansky, & Grahn, 2003; Olshansky et al., 2005). Even so, age-related HI often remains undetected, underestimated, and neglected due to the gradual development of HI which is

related to decreased quality of life (often referred to by the abbreviation QoL) for adults over the age of 50 years (Dalton et al., 2003; Wallhagen & Pettengill, 2008). Hence, it is essential to assess age-related HI as early as possible and improve services for auditory rehabilitation using hearing or assistive listening devices (Dalton et al., 2003).

1.2.2 Hearing impairment and the International Classification of Functioning, Disability and Health Model.

According to the International Classification of Functioning, Disability and Health (ICF) model, disability includes impairments, activity limitations, and participation restrictions (WHO, 2002b). The purpose of the ICF is to create a framework to help to describe how people function, their disabilities, and health. It aims to emphasise the person's level of health rather than their disability. There are two major conceptual models of disability that the ICF is based on. The medical model views disability as a feature of an individual that is caused by a trauma or disease that requires medical care by professionals. The social model views disability as a socially created problem that results from an unaccommodating environment that demands a political response. Neither of these models on its own is adequate to describe a disability because disability is a complex phenomenon. Hence, ICF is the combination of both models, a biopsychosocial model, in which a person's health is viewed from a biological, individual, and social perspective.

The ICF makes it possible to collect important information in a consistent and internationally comparable manner. It takes a holistic approach to account for different factors that could influence the outcome of an assessment about a person's health condition. The ICF model can be used at individual, institutional, and societal levels,

such as for policy development, economic analysis, and research. Figure 1 shows the diagram of the ICF model (WHO,2002a, p. 9).

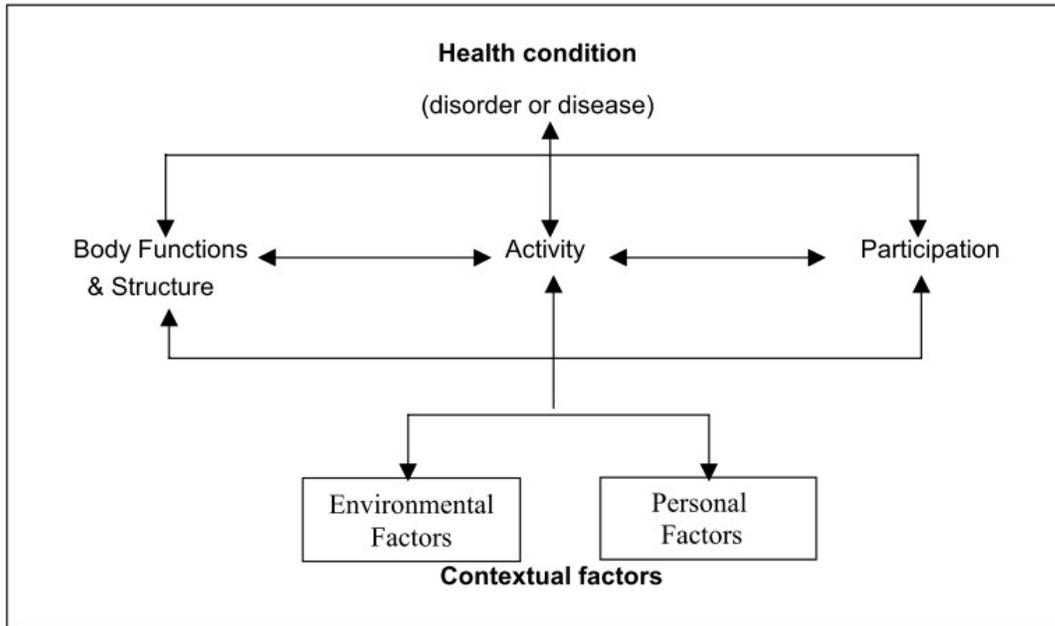


Figure 1. The diagram of the ICF model demonstrating the model of disability.

The Figure 1 shows the interactions between the health conditions and contextual factors (WHO, 2002b). A person’s state of health cannot be judged by considering only one part of this model because disability has many components. At the top of Figure 1 is the health condition, disease, or injury someone might have, such as damaged inner hair cells in the cochlea (body functions and structure) which becomes an HI. The ICF model also assesses the activities a person normally does, such as playing bridge, or cricket, and the involvement in social activities (participation) by being a member of clubs or going to church. An impairment of any kind will lead to activity limitations, for instance no longer playing bridge or cricket, and participation restrictions, such as no longer going to church because the person cannot understand what is being said because of the HI. The bottom part of the diagram indicates that a person’s health is also influenced by

environmental factors, for instance, low economic status, personal factors (e.g., low literacy skills), which can be either a barrier or facilitate the person's behaviour regarding a health condition. The underlying principles of the ICF model are:

1. Universality, in which the classification of disability and functioning is applicable to every one universally;
2. Parity and aetiological neutrality, in which the focus lies on functioning and not on disability that allows for comparison of all health conditions using a common metric, and makes us aware that no inference about participation in everyday life based on diagnosis alone can be made;
3. Neutrality that infers that the definitions are worded in neutral language;
4. Environmental influences, which play a role in people's functioning (WHO, 2002b).

For these reasons, the impact of HI cannot be estimated by audiometric assessment alone because other personal and environmental factors also determine a person's activity limitations and participation restrictions (Wiley, Cruickshanks, Nondahl, & Tweed, 2000).

1.2.3 The impact of hearing impairment.

Although HI is not likely to be the direct cause of the reduction of physical functioning, it has an impact on physical health and has been associated with poorer physical functioning, and self-sufficiency when performing activities of daily living, such as walking across the room, or showering (Appolonio et al., 1996; Chen, Genther, Betz, & Lin, 2014; Dalton et al., 2003; Kamil et al., 2016; Lin & Ferrucci, 2012). There is a significant relationship between HI and cardiovascular disease for older adults, especially for women (Gates, Cobb, D'Agostino, & Wolf, 1993). Individuals with a

moderate or greater HI are likely to have a 63% higher risk of frailty which is characterised by physiologic weakness that increases vulnerability to stressors, such as difficulty getting up from a sitting or reclining position (Fried et al., 2001). People with HI are more likely to have a balance problem which may make them a higher risk for falls and hospitalisation (Fried et al., 2001; Lin & Ferrucci, 2012).

One of the more obvious functional impacts of HI is communication difficulties and this limits the person's activities and participation in social interactions (WHO, 2002b). Laplante-Lévesque, Hickson, and Worrall (2010b) note that HI leads to:

- Reduced speech perception, especially in adverse environments such as in reverberating and noisy rooms, and with accented speech;
- Reduced ability to understand what is being said on the television and radio;
- Reduced ability to localise sounds, for example footsteps and cars; and
- Reduced ability to detect environmental signals such as the ringing of the telephone and alarms.

In addition, adults between the ages of 64 to 76 years require more listening effort (attention and cognitive resources) to understand speech in a noisy environment and this leads to increased fatigue (Gosselin & Gagne, 2011; Li-Korotky, 2012). As a result, communication difficulties due to HI have several negative consequences for the person and the person's environment (Kochkin & Rogin, 2000; Shield, 2006).

HI also has psychosocial, economic, and cognitive impacts. Incomplete communication due to HI leads to withdrawal from social interactions, including loneliness, social isolation, stigmatisation, depression, frustration, anger, and anxiety, just to name a few (Mohr et al., 2000; Ruben, 2000; Shield, 2006). These adverse effects are also evident with a mild HI (Newman, Hug, Jacobson, & Sandridge, 1997). Moreover, people with HI are more likely to be unemployed than people with no HI, with

a consequent loss of earnings and reduced productivity that places strains on the economy, and thus, HI has a negative effect on society (Ruben, 2000; Shield, 2006). People with HI tend to have difficulties in relationships with their spouses, family, and friends due to the increased distress caused by communication difficulties (Kochkin & Rogin, 2000; Scarinci, Worrall, & Hickson, 2008). Last, greater withdrawal and isolation results in reduced sensory input that may influence cognition which may be associated with neurodegenerative dementias, such as Alzheimer's disease (Kochkin & Rogin, 2000; Lin, Metter, et al., 2011). However, the causal relationship between dementia and HI is unclear (Lin, Metter, et al., 2011).

In short, regardless of the severity of HI, HI reduces a person's general wellbeing and quality of life, thus limits activity and restricts participation, that in turn will have an impact on friends and family, as well as on society (Shield, 2006; WHO, 2002b). Hence, early prevention, detection, identification, and management of HI are essential (Li-Korotky, 2012; Strawbridge, Wallhagen, Shema, & Kaplan, 2000)

1.3 eHealth Information

1.3.1 The definition of eHealth.

The digital age changed the landscape of health information (Jacobs, Amuta, & Jeon, 2017). eHealth research is on the rise and this has the potential to empower citizens to manage their health better (European Commission, 2014; Eysenbach, 2001; Shaw et al., 2017). eHealth, however, is not consistently defined and already in 2005, 51 unique definitions of the term eHealth have been identified (Oh, Rizo, Enkin, & Jadad, 2005; Shaw et al., 2017). The most cited definition is that by Eysenbach (2001) as follows:

e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

In the context of the current study, eHealth refers to the health information that is voluntarily obtained from the Internet by the consumers to manage their own health or the health of someone they know.

1.3.2 The Internet as a source of health information.

The sources of health information for consumers include, amongst others, friends, family members, healthcare professionals, other patients, government agencies, the food and drug industry. This information is found in the form of books or other printed materials, or in the popular media (such as newspapers, television, radio), and on the Internet (Brashers et al., 2000; Eysenbach, Powell, Kuss, & Sa, 2002; Fox, 2011; Kindig, Panzer, & Nielsen-Bohlman, 2004). The significant reduction of computer costs during the 1990s allowed for an increase in their use (OECD, 2000). In the European Union in 1998, 30.8% of people used a personal computer at home, 40.5% at work, and 8.3% had access to the Internet at home and 13.3% at work. By 1999, 40.8 billion host computers were used in the Organisation for Economic Cooperation and Development (OECD) countries, or 94% around the world (OECD, 1999). Today, there are 3.8 billion Internet users globally (We Are Social, 2017).

The Internet is becoming an increasingly popular primary source of health information (Medlock et al., 2015; Tan & Goonawardene, 2017). In 2017, the global Internet user penetration rate was estimated at 49.7%, including regional estimates, such as Africa 28.3%, Asia 45.2%, Latin America/Caribbean 59.6%, Middle East 56.7%, North America 88.1%, and Oceania/Australia 68.1%, which shows a 936% growth between 2000 and 2017 (Internet World Stats, 2017, June). The penetration rate is a measure “of the percentage of the total population of a country or region that uses the Internet” (Internet World Stats, 2017, August). As of March 2017, from the estimated 3.8 billion global Internet users, 73.5% are European users that includes every country in the Western, Central, and Eastern Europe, as well as Russia and Turkey (We Are Social, 2017). Table 1 lists the Internet penetration rate in the European countries where German is spoken as a first language by at least 5% of the population, and/or is an official language of the country (Central Intelligence Agency, n.d.; Ethnologue, 2017; Internet World Stats, 2017, June).

Table 1. Internet Penetration Rate in the Five European Countries.

European countries	Penetration in % population
Austria	83
Germany	89
Hungary	80.5
Liechtenstein	95.2
Switzerland	87.2

In 2014, the main source of online health information in Europe were search engines (such as Google and Yahoo), followed by specific health websites (including blogs and forums), websites from official health organisations (like the Ministry of Health or WHO), and

by online newspapers, magazines, social networks (such as Facebook and Twitter), specific mobile devices (such as tablets and mobile phones), and patient organisation websites (European Commission, 2014). Despite this in 2016, 14% of the European individuals have never used the Internet (Eurostat, 2016).

The European citizens' digital health literacy survey found that 59% of the respondents used the Internet to gather health information in the 28 Member States of the European Union between September 2013 and September 2014 (European Commission, 2014). Eighty-nine percent of the respondents were satisfied with the information gathered on the Internet and 10% reported dissatisfaction (European Commission, 2014). The three most common reasons for dissatisfaction reported by the respondents were that the information found on the Internet was unreliable (50%), commercially oriented encouraging them to buy something (48%), or not detailed enough (46%). Moreover, most people in Portugal (53%) and Cyprus (45%) reported dissatisfaction because the information was hard to understand. The majority of respondents (76% to 87%, depending on the type of information searched for), look for health information for themselves, and about 30% of individuals look on behalf of other family members, spouses, or their children with only 8% to 13% on behalf of a friend or colleague (European Commission, 2014). Nonetheless, the Internet search habits vary significantly between the European countries (Eurostat, 2016).

About half of the European eHealth users search for general health information about nutrition, diet, exercise, and pregnancy (European Commission, 2014). Other consumers look for information on a specific injury, disease, or condition (43%), followed by specific medical treatment or procedures (24%), and a second opinion after visiting a doctor (16%). People primarily search for specific medical conditions, diseases, procedures, or information on conditions that are usually chronic and stigmatising (European Commission, 2014; Laplante-Lévesque, Brännström, Andersson, & Lunner,

2012; McDaid & Park, 2010). Cause HI is described as chronic and stigmatising, it is likely that people frequently search for online information related to hearing (Couper et al., 2010).

1.3.3 Demographic characteristics of online health information searches.

The differentiating factors within countries with regards to access to computers, the Internet, help-seeking behaviour, and online search strategies are socioeconomic status, and demographic characteristics, such as age, gender, and education (Eysenbach & Köhler, 2002; Fox & Jones, 2009, June; Kindig et al., 2004; OECD, 1999). The European Commission (2014) notes that 71% of the individuals who finished their education at age 20 or above may use the Internet every day and are more likely to be dissatisfied with the information due to its commercial nature. People with higher education who finished education at 20 years old or more are also more likely to comprehend health-related information on the Internet and can distinguish high from low-quality information. In contrast, people who left school at age 15 years and below do not tend to use the Internet every day and are more likely to be dissatisfied with the health information because they cannot understand it.

In the United States of America (USA) people with higher socioeconomic status (with incomes of USD75,000 or more) are more likely to use the Internet to search for health information than people with low socioeconomic status (with incomes below USD30,000) who tend to use more traditional media as a source of health information (Jacobs et al., 2017). Individuals with low income are also more likely to report that the online information helped only a little, or not at all (Purcell & Rainie, 2014). In addition, people with more Internet experience are more likely to search health information (Fox, 2006). Thus, low education, socioeconomic status, and Internet skills are a disadvantage when it comes to online health information.

The European Commission (2014) notes that in Europe, men are more likely to use the Internet every day than women (65% vs. 54%). They also reported that European people aged between 15-24 years tend to use the Internet (84%) every day compared to those aged 55 years and above (34%). To the contrary, Kummervold et al. (2008) and Andreassen et al. (2007) found that in seven European countries, women aged between 15 and 29 years are the most active Internet health users. The Bupa Health Pulse 2010 survey, which was conducted in 12 countries: Australia, Brazil, China, France, Germany, India, Italy, Mexico, Russia, Spain, United Kingdom (UK), and the USA, reported that the use of the Internet for searching health information sharply reduces after the age of 35 years (McDaid & Park, 2010). Despite some inconsistencies in these findings, most research seems to agree that users over the age of 30-35 years look less actively for health information online.

1.3.4 Benefits and challenges of accessing health-related online information.

Online health information has economic benefits whereby contact time for healthcare professionals may be freed up from those who have no discerning signs of ill health and re-directed to those who have severe diseases (McDaid & Park, 2010). A study in Sweden showed that individuals with HI had a higher Internet usage compared with the general age-matched population (Thorén et al., 2013). The Internet provides extra benefits for people with HI because the communication is primarily based on visual and not auditory channels, and it also reduces the perceived stigma about their HI due to anonymity (Barak & Sadovsky, 2008). Because of this, the Internet may be an empowering mediator for individuals with HI.

Uncertainty is a central aspect when individuals experience an acute or chronic illness, like HI (Brashers et al., 2000; Couper et al., 2010). Communication is a way of managing uncertainty to double-check the accuracy of information which is why certain people may look

for information about their condition. Information seeking can reduce uncertainty when there is a clear explanation and/or treatment for the condition (Brashers et al., 2000). Although the Internet is a popular source of information because it can be accessed any time and it provides plenty of information, it can increase uncertainty when too many contradictory alternative explanations are offered about a condition (Brashers et al., 2000; Fox, Rainie, & Horrigan, 2006). Most online searchers have difficulties understanding all the online information about their condition, and then feel frustrated, confused, and overwhelmed by the material (Fox, 2006).

Commercial and social marketing of product-, health-, and service information is a multibillion dollar industry. People are consistently exposed to quick, but often contradictory, and inaccurate information, and this has increased markedly since the Internet became an important source of health information (Kindig et al., 2004; Powell, Inglis, Ronnie, & Large, 2011; WHO, 2011). Not all eHealth searchers are knowledgeable enough to differentiate between high and low-quality information (McDaid & Park, 2010). Research shows that there are some issues with the quality, evaluation, credibility, and accuracy of online health information (McDaid & Park, 2010; Rice, 2006).

1.3.5 Reasons for seeking health information online.

The number one reason people look for online health information about specific medical conditions is because they, or someone they know, have a health condition (Fox & Rainie, 2002; Morahan-Martin, 2004). The Pew Internet and American Life Project reported that 61% of respondents found that the Internet helped to improve the way they care for their health (Fox & Rainie, 2002). Individuals seek information online to prepare for medical appointments or surgery, to share information, for example, on blogs, and

seek and provide support. Moreover, in developing countries, such as India, searching for information on the Internet may be a cheaper alternative than face-to-face consultation with a doctor (McDaid & Park, 2010). Online health information is often complex and requires a high reading ability to comprehend the material, and therefore the material remains inaccessible to those with inadequate literacy levels and this may increase health inequalities (Bodie & Dutta, 2008).

1.3.6 Effects of online health information.

The Internet has become a major source of information that may help people understand their condition and improve their self-efficacy (McMullan, 2006). *Self-efficacy* is defined as an individual's confidence in his/her ability to successfully undertake behaviours to achieve specific goals (Bandura, 1977). Online health information has an impact on the person's health decisions and actions, as well as empowering people to talk to their physicians, which leads to a more patient-centred approach (Fox & Jones, 2009, June). Evidence shows that there are more positive than negative experiences: only 3% of Internet users reported that they, or someone they know, have been harmed by medical advice found on the Internet. To the contrary, 42% of people reported an improvement in health following advice from the Internet. Although these data may be now outdated, Diaz et al. in a survey in 2002 reported that 61% of the 512 survey respondents (between 18 to 65 years of age) found the information on the Internet the same as or better than the information from their doctors (Diaz et al., 2002).

A cross-sectional survey of a nationally-representative sample of USA physicians (1050 respondents, 53% response rate) reported that most physicians believed that the health information gathered by the patient from the Internet, and brought in to a

consultation, was *very* (8%; 95% CI, 5%-11%), or *somewhat* (66%; 98% CI, 61%-71%) accurate (Murray et al., 2003). Many Canadian health professionals see the availability of online health information as a positive development (Chen & Siu, 2001). In contrast, in a study of healthcare professionals from the UK, online health information was viewed more commonly as negative than as positive (Hart, Henwood, & Wyatt, 2004). Physicians reported concerns about the accuracy of online information and their patients' ability to interpret the information, leading to inappropriate self-diagnosis, and the challenging of medical authority (D'Auria, 2010; Hart et al., 2004).

1.3.7 Search engines.

The majority (85%) of online health seekers tend to start with a search engine or directory rather than with a health website (e.g., NetDoktor) (Fox & Rainie, 2002; Ybarra & Suman, 2006). Search engines are software programmes for entering a topic on a computer to locate websites with possible relevant information (Ownby, 2006). Most searches for health-related information take place on major search engines such as Google and Yahoo (McDaid & Park, 2010). The Netmarketshare (2017) estimated that, globally, Google owns 79.45% of the search engine marketshare, followed by Bing (7.31%), Baidu (7.06%), and Yahoo (4.91%). Hence, Google is the most widely used general-purpose search engine.

The use of search engines for seeking health-related information is important because search engines rank their results based on algorithms. Search engines are designed to provide the most popular and relevant sites first (Scullard, Peacock, & Davies, 2010). However, Scullard et al. (2010) found that when the search was restricted to the first page of results, 87% of the websites were accurate but 35% of websites did not answer the requested question. Google uses a proprietary search algorithm which is known to be based on search location in which the search results may somewhat differ in different locations (Pusz & Brietzke, 2012).

Search results can also be altered based on previous search habits of the computer user, as recorded by Google. It may be possible that search engines match the sophistication of search terms when generating information and this may affect the readability of the information (Ownby, 2006). On this basis, health seekers may retrieve websites which may be popular but may not provide answers to their enquiry.

1.3.8 Types of organisations controlling online health information.

It is vital to assess the credibility of websites to make an informed health decision (Fox & Rainie, 2002). Most consumers tend to access only websites on the first page of search results and use short phrases (that are often misspelled) (Lissman & Boehnlein, 2001; Morahan-Martin, 2004). The consumers frequently have limited search and evaluation skills, although, they aim for quality information (Morahan-Martin, 2004). People tend to avoid overt commercial websites, despite that the indicators of credibility are ignored, such as checking the “about us” section. According to the Pew Survey, only 15% of the USA respondents reported to “always” check the source of online publication, although this information may be outdated (Fox, 2006). About half of the English language websites that provide health information are commercial, supported by advertisers, and are free for the public to visit; however, they may not be identified as such by the consumer (California HealthCare Foundation, 2001, May; Pendleton, 1999). As a result, people predominantly access health information from commercial organisations (Lissman & Boehnlein, 2001). This predominance is mainly due to the sponsored links in the search results (Kaimal et al., 2008; Walji, Sagaram, Meric-Bernstam, Johnson, & Bernstam, 2005). Sponsored sites are sites that pay a premium to appear prominently in the result list on a search engine, increasing their visibility (Scullard et al., 2010). In addition, often these sites have a conflict of interest by offering products and

services (Brann & Anderson, 2002; Scullard et al., 2010). Hence, it is important to identify the sponsor of a website to establish its credibility (Fox & Rainie, 2002).

Another type of organisation that may control a website is non-profit organisation. The term *non-profit* emphasises that the organisation does not earn money with the website operation, and has restrictions on what the organisation can do with its profit while receiving a variety of tax and subsidy benefits (Weisbrod, 1988). The second most commonly accessed website for health information after commercial websites is Wikipedia (Laurent & Vickers, 2009; Law, Mintzes, & Morgan, 2011). Wikipedia is a non-profit, web-based encyclopaedia, written collaboratively by people around world, with the goal of providing everyone free access to reliable, comprehensible, and up-to-date information (Heilman et al., 2011; Laurent & Vickers, 2009). Because there is no formal editorial review and heterogeneous contributors, it is questionable whether Wikipedia can be used as a reliable and accurate source of health information (Kräenbring et al., 2014). Kräenbring et al.'s (2014) systematic analysis of the English- and German-language versions of Wikipedia found that Wikipedia is an accurate and comprehensive source of drug-related information for undergraduate medical education. Nonetheless, Wikipedia showed poor readability. Readability in Kräenbring et al.'s study was assessed using readability indices (Amstad and Flesch Reading Ease) to assess sentence composition, complexity, and sentence length to predict the difficulty of online texts and the number of years of education that is needed to comprehend them. In contrast, Heilman et al. (2011) and Clauson, Polen, Boulos, and Dzenowagis (2008) reported that Wikipedia has a narrower scope, and less complete drug information than a comparative free online database, the Medscape Drug Reference. On this basis, they concluded that Wikipedia is a useful step in gathering initial health information but it should only be an additional source of drug information.

Another source of online information is government websites that highlight the work and research of government agencies in the health sector (Fox & Rainie, 2002; Scullard et al., 2010). Scullard et al. (2010) reported that the information on government websites were factually accurate (100%) compared to educational websites (85%); for example, websites with university affiliation, company websites (81%), news sites (55%), and websites from interest groups (80%) and individuals (83%). None of the sponsored websites were found to provide completely accurate information. Scullard et al.'s recommendation, therefore, is for consumers to use government websites as the first choice when searching for online health information.

1.3.9 Quality of information.

One key challenge of online health information is quality control (McDaid & Park, 2010). One of the goals of a working group of the WHO (2011) was to determine quality control practices of health information on the Internet. The most common quality control mechanism reported by the WHO (2011) survey of member states was voluntary compliance (55%) in which the website content is controlled by the website owners/content providers. It is easy for anyone to publish information on the Internet, which provides fertile ground for inaccurate information and even scams, and this can make it difficult to distinguish inaccurate from accurate information (Morahan-Martin & Anderson, 2000). Quality usually refers to the content and usability of a website (Gattoni & Sicola, 2005). A high-quality health information website can be defined as one that provides accurate and unbiased information, which can be read and understood easily by its target audience (Dunne et al., 2013). However, online health information is highly variable, which is problematic and in some cases, can even be detrimental to health (Barker, Charlton, & Holstege, 2010; Dunne et al., 2013; Eysenbach et al., 2002).

Studies across languages have shown that it is difficult to access relevant health-related information (Berland et al., 2001; Kunst, Groot, Latthe, Latthe, & Khan, 2002). Websites in the English language tend to be reasonably accurate regarding complete health information in comparison to those in other languages (California HealthCare Foundation, 2001, May), and some studies have shown that many of the non-English language sites are poor quality (Berland et al., 2001; Kunst et al., 2002). Readability becomes a key factor of quality when the general public is intended to be the audience of a website (Dunne et al., 2013). The number of hits a website receives will determine its ranking on Internet search engine results; however, higher ranking does not necessarily mean that the health information is more readable. More than 300 studies indicate that health-related information on the Internet far exceeds the average reading ability of American adults (Kindig et al., 2004). This means that most web-based information is difficult to understand for the average consumer because of the low level of education, therefore, the information remains inaccessible for the reader (McInnes & Haglund, 2011).

Another quality control mechanism of online health information includes official seals of approval (WHO, 2011); although, according to the WHO (2011), only 16% of quality control mechanisms for health information use official approval globally. One of the primary organisations that contributes to quality assessment is the HONcode certification. The Swiss non-profit HON foundation, created in 1995, developed an ethical standard for medical and health websites to assess online health information for clients, professionals, and the general public, called the HONcode (Health On the Net Foundation, 2014). The HON organisation evaluates the compliance of websites with the HONcode which includes principles such as authority, complementarity, confidentiality, attribution, justifiability, transparency, financial disclosure, and advertising. The developer and information providers of a website voluntarily apply for the certification, which involves the annual re-assessment of the website after obtaining the HONcode certification, accompanied by an annual membership fee. HON

certification does not guarantee that the medical information provided on a certified website is accurate, complete, and readable, but it does indicate that a website intends to deliver objective and transparent information to the reader (Health On the Net Foundation, 2014).

Fallis and Frické's (2002) study found that the HON logo was almost four times more common on a more accurate, than a less accurate, website. There is a slight to moderate correlation between judged credibility and accuracy of a website (Kunst et al., 2002). Risoldi Cochrane, Gregory, and Wilson (2012) reported no significant difference in readability of websites with and without HONcode certification between government and commercial websites, and they do not recommend HONcode-certified websites over others. Laplante-Lévesque et al. (2012) found that government websites are more likely to have HONcode certification than websites from commercial and non-profit organisations, although, overall only 14% of the websites had HONcode certification. Readability was not significantly associated with HONcode certification.

1.4 Health Literacy

1.4.1 Health literacy definitions.

Health literacy is a key characteristic of effective health communication (Healthy People 2020, 2017). The American Speech-Language-Hearing Association (ASHA) (2017, July) emphasises the vision of making effective communication a human right that is accessible and achievable for all. Multiple definitions are available for health literacy in the international literature (Berkman, Davis, & McCormack, 2010; Peerson & Saunders, 2009). A widely-used definition of health literacy is “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Ratzan & Parker, 2000, p. vi). Berkman et al. (2010) recently revised this

definition, based on a review of relevant literature, and described health literacy as “the degree to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions” (p. 16). According to Nutbeam (1998), health literacy refers to the cognitive and social skills of an individual which will determine the motivation and the ability of that individual to access, understand, and implement the information in a way that can promote and maintain good health. The skills health literacy encompasses are all necessary to understand and use healthcare information effectively, and include the ability to find and quantify print information, and to speak and listen effectively (Berkman et al., 2011).

Due to the rapid growth of information about health distributed over the Internet, the term eHealth literacy was introduced by Norman and Skinner (2006). eHealth literacy has not received much attention compared to general health literacy yet, but it is becoming more prominent. *eHealth literacy* is defined as “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem” (p. 2). To date, there is no valid measure of eHealth literacy.

Health literacy changes with the development of the use of health information as people gain more experience with numerous health circumstances and choices (Berkman et al., 2010; Zarcadoolas, Pleasant, & Greer, 2005). Berkman et al. (2010) argue that it is inevitable to conceptualise health literacy as dynamic in nature, and it needs to be measured and re-evaluated constantly. The concept of health literacy is complex and cannot be defined using one single definition because the definitions depend on one’s goal, which can be viewed through a variety of lenses. Thus, due to the inconsistencies in the definition of health literacy, the comparison of findings from different countries regarding health literacy is very difficult (Sørensen et al., 2012). For a detailed review of the models and definitions of health literacy, refer to Berkman

et al. (2010), Squiers, Peinado, Berkman, Boudewyns, and McCormack (2012), and Sørensen et al. (2012).

Health information disseminated on the Internet can reach the general public easily, especially low-income, less educated, and minority groups (Cotten & Gupta, 2004). There is great potential for eHealth information, mainly because online companies can profit from its implementation (Bodie & Dutta, 2008). In order to become eHealth literate, individuals need to have and be able to apply six different types of literacies (Bodie & Dutta, 2008):

- Traditional literacy;
- Health literacy;
- Information literacy;
- Scientific literacy;
- Media literacy; and
- Computer literacy.

One problem is that people with low health literacy, computer skills, often on low incomes, or with less education, minority groups, or older populations, may not have the necessary eHealth literacy skills or Internet access to conduct online searches.

1.4.2 Prevalence of limited health literacy.

The prevalence of limited health literacy is more common than anticipated (Kutner et al., 2006; Van den Broucke, 2014). One way of measuring health literacy is through conducting surveys (Kindig et al., 2004). Kirsch conducted a population based survey and found that about half of the adult USA population cannot accurately and consistently integrate information from written materials, such as newspapers, advertisements, or forms (Kirsch, 1993). Health literacy can be assessed using four categories (Kutner et al., 2006):

1. Below basic;
2. Basic;
3. Intermediate; and
4. Proficient.

The 2003 National Assessment of Adult Literacy (NAAL) survey, conducted by Kutner et al. (2006), reported that 53% of adults in the USA had intermediate, 12 % proficient, 22% basic, and 14% below basic health literacy. Although these data may be outdated, there is no more recent information on this and so it stands as a guide. The OECD (2000) reported that health literacy skills on document literacy in the USA were similar to those in New Zealand, Switzerland (German and Italian), and in the UK for individuals aged between 16 and 65 years, between 1994 and 1998. Health literacy in the USA is significantly lower than in Canada, and is also lower than in most of the European countries (such as Germany, Sweden, Finland, and Norway), but significantly higher than, for instance, in Ireland, Hungary, and Slovenia. Again, the data are almost 20 years old so may be outdated.

Pelikan, Rothlin, and Ganahl (2012) conducted a health literacy survey in eight European countries (Austria, Bulgaria, Germany, Greece, Ireland, Netherlands, Poland, and Spain) with respondents aged 15 years and older. They reported that from the four health literacy survey categories (inadequate, problematic, sufficient, and excellent), 12% of the surveyed individuals had inadequate health literacy, and over 35% had problematic health literacy. They also reported that health literacy varied considerably between the countries and between groups within populations for the four categories.

Although the NAAL 2003 has not specifically studied the deaf and hard of hearing populations, health literacy is a major issue for these populations (Lin, Thorpe, Gordon-Salant, & Ferrucci, 2011). More than half of the world's and Europe's adult population, and nearly

two third of the USA adult population, have a disabling HI at age 65 years and above (Lin, Thorpe, et al., 2011; Roth, 2011 #490; WHO, 2012). Therefore, people with the combination of an HI and limited health literacy will have even more difficulties in accessing and understanding health information than people who only have low health literacy (Neuhauser et al., 2013).

1.4.3 Demographic characteristics and health literacy.

Several demographic characteristics are associated with health literacy (Pelikan et al., 2012). Health literacy in the USA is higher amongst women than men (U.S. Department of Health and Human Services (HHS), 2003). Adults (16 years of age or older) whose first language is English before starting school had higher health literacy, measured in English, than those who spoke another language alone or English and other languages (Kutner et al., 2006). Individuals aged 65 years and above had lower mean health literacy levels than younger age groups. The 2003 NAAL survey showed that each level of educational attainment increased the average health literacy. For example, 49% of adults who had never started or finished high school had below basic health literacy compared with the 15% of adults who graduated from high school. Finally, USA adults who lived below the poverty level had lower average health literacy than those living above the poverty threshold. Hence, the most vulnerable groups of people to low health literacy are those aged 65 years or older, minority ethnic groups, and people in lower socioeconomic situations, which suggests that health literacy may play a critical role in reducing health inequality in healthcare (Doyle, Cafferkey, & Fullam, 2012; Ratzan & Parker, 2006; WHO, 2013).

1.4.4 The importance of health literacy.

Health literacy has gained considerable attention in recent years around the world (WHO, 2013). Health literacy is the interaction between the individual and the healthcare system (Doyle et al., 2012). Health literacy is the responsibility of multiple stakeholders, such as the individual, general public, policy-makers, healthcare professionals, and amongst others, the electronic media (WHO, 2013). It first may appear that health literacy is primarily concerned with the comprehension of reading materials, however, health literacy is more than just reading, writing, and numeracy (Doyle et al., 2012).

The main issue with health literacy is the mismatch between the demands of the healthcare system and the skills of the individuals. Most health information, that is expected to be understood, comes from personal communication with healthcare professionals and health information through various forms of media. Today's healthcare requires individuals to make more informed decisions about their health and lifestyle choices than ever before.

Research suggests that optimising health literacy can improve health and wellbeing because health literacy is a resource that helps people to understand and manage their own and their families' health and gives them the sense of control of those aspects of their lives that determine their health (Doyle et al., 2012; WHO, 2013). Health literacy is essential for accessing health information and empowering people to take responsibility for their health (Friedman & Hoffman-Goetz, 2006). Health literacy is a stronger predictor of health outcomes than age, income, employment status, education level, and ethnic group (Berkman et al., 2011; Ritchie et al., 2016; WHO, 2013).

1.4.5 The consequences of limited health literacy.

Individuals with limited health literacy skills tend to have poorer health outcomes compared to individuals with higher health literacy (McInnes & Haglund, 2011; Weiss et al.,

1994). Limited health literacy is associated with lower quality of life, higher mortality (because of the lack of awareness and prevention of illnesses), and the overuse, or misuse, of medications (Davis, Williams, Marin, Parker, & Glass, 2002; Kindig et al., 2004; Merriman, Ades, & Seffrin, 2002; Ratzan & Parker, 2006). People with low health literacy tend to miss appointments with their physicians, have difficulties filling out forms, and may leave with unanswered questions about their health because they are embarrassed to ask their physicians to explain or repeat important information (Safeer & Keenan, 2005). Physicians often believe that their patients have a higher health literacy level than they really do and this may lead to difficulties in following their instructions and taking medications as prescribed (Bass, Pat, Wilson, Griffith, & Barnett, 2002; Kirsch, 1993).

People with low health literacy tend to have a higher rate of hospitalisation and emergency service use and this has been associated with an increase in additional healthcare costs (Parker et al., 1999). For example, health literacy below the USA third grade level cost more than USD8 billion in Canada in 2009, about USD73 billion in the USA (WHO, 2013). No comparative data are available for the European healthcare market yet.

Health literacy is also influenced by culture (Thomson & Hoffman-Goetz, 2007). The cultural meaning of disease may be associated with shame and stigma that is related to low health literacy skills which are a major barrier to improving health literacy because people are less likely to seek health information, admit low health literacy, and ask for help (Davis et al., 2002; Kindig et al., 2004; Thomson & Hoffman-Goetz, 2007). People with limited health literacy are more prone to having poorer health than others (McInnes & Haglund, 2011). It is, therefore, important to make written material as accessible as possible to readers based on their literacy skills (Weiss et al., 1994). In addition to literacy surveys, another way to measure health literacy is to evaluate the readability of written health information and this is described in the next section (Kelly-Campbell, Atcherson, Zimmerman, & Zraick, 2012; Kindig et al.,

2004; Pothier, 2005). In short, overall health outcomes are influenced by the interaction of the various stakeholders because health literacy is the skill that a consumer brings to the situation, while readability is part of what the healthcare system provides; these two elements need to match.

1.5 Readability

1.5.1 Background and definitions.

Researchers have been interested in readability and its assessment worldwide since the 19th century (DuBay, 2004). In the 1920s, educators discovered a way of using vocabulary difficulty and sentence length to predict text difficulty and this sparked interest in readability research and the development of readability formulas (RFs), based on the English language. Although research was conducted and progress made in developing formulas by many, the formulas were not widely used until the 1950s. By the 1980s, more than a thousand studies were published using 200 different RFs testing their validity and reliability. Readability assessments are popular for measuring the comprehension level of written materials in clinical and healthcare settings (Bailin & Grafstein, 2001; Brabham & Villaume, 2002; Friedman & Hoffman-Goetz, 2006; Kelly-Campbell et al., 2012; Laplante-Lévesque et al., 2012; McInnes & Haglund, 2011).

When assessing the readability of written materials, two questions need to be answered: is the text comprehensible, and is the text readable (Kahn & Pannbacker, 2000)? The terms readability and comprehension are often used interchangeably; however, they are two different concepts. The comprehension, or reader understanding of written material, aside from readability, is influenced by many factors, such as psychological, linguistic, cognitive factors, culture, interest, relevance to the reader's life, and previous knowledge on the topic (Kahn &

Pannbacker, 2000; Nădășan, 2016). In contrast, readability is the notion that describes the ease or difficulty with which a written material can be read (Kahn & Pannbacker, 2000; McInnes & Haglund, 2011). Comprehension is assessed by administering formal or informal reading comprehension tests to the reader, while readability is measured by subjecting texts to RFs, that is, readability is evaluated by using mathematical formulas based on sentence and word length (Nădășan, 2016). These two methods are explained in more detail in the next sections.

Readability has been defined in multiple ways based on different aspects of the concept. McLaughlin (1969) defined readability as “the degree to which a given class of people find certain reading matter compelling and, necessarily, comprehensible”. His definition focused on the interaction between the written material and reader characteristics, such as motivation, and prior knowledge (DuBay, 2004). According to Klare (1963), readability is the ease of understanding and comprehension due to writing style. This definition considers the style of writing for readability separate from the issues of content, organisation, and coherence (DuBay, 2004). Dale and Chall (1949b) provided a more comprehensive definition of readability that considers all aspects of readability and their interactions. He defined readability as “the sum total (including the interactions) of all those elements within a given piece of printed material that affect the success that a group of readers have with it. The success is the extent to which they understand it, read it at an optimum speed, and find it interesting” (p. 5). Hence, readability is a complex concept.

As Dale and Chall (1949b) explained, readability is influenced by three main factors:

- The written material, such as its organisation, format, vocabulary, and sentence structure;
- The reader’s characteristics such as reading ability, interest, and the purpose of reading; and

- The measure of readability, such as whether the measure is interest, comprehension, or speed of reading, and what criteria are used.

The current study focuses on measuring readability by means of the sentence structure of the written materials, using RFs where text difficulty is expressed in reading grade levels (RGLs). Readability assessments that use RFs are usually reported in RGLs (DuBay, 2004). The RGLs represent the years of education a person would need to be able to read and comprehend a given written material at a particular reading level.

1.5.2 Assessment of readability.

One accurate and detailed method of determining readability is by a person's comprehension or perception of the written material, is the Cloze test in which the reader is able to fill in the blanks of a text and construct sufficient meaning from the remaining text through semantic, cultural, and pragmatic clues to replace the omitted words which provide closure to the text (Dale, 1999; DuBay, 2004; Klare, 1963). The Cloze test is derived from the Gestalt concept of closure in which people are able to complete incomplete texts by recognising existing parts of a text (Dale, 1999; Taylor, 1953). Appendix A shows an example of a Cloze test. However, the Cloze test is more time-consuming and is inappropriate for individuals with basic literacy skills as they may feel intimidated or uncomfortable by the lengthy assessment (Friedman & Hoffman-Goetz, 2006).

Another method for determining readability of texts is by computing a readability score based on the semantic difficulty of texts, for example, word and sentence length (Dale, 1999; Ley & Florio, 1996). This readability assessment often uses RFs which assure that none of the words in the text are too difficult for the intended audience. Reading is an interactive process (Martinez, 2011). Assessing readability provides the opportunity to develop materials that are effective for their purpose and consumers. Martinez (2011) explained that reading

comprehension has a shallow and a deep level. The shallow level of reading comprehension looks at the number and complexity of syllables, words, and sentences using regression analysis, which are also available in software (for example, Microsoft Word). The reading comprehension software assesses texts by calculating RGLs and based on that RGL, the text can be revised by including, for example, vocabulary or sentence structures that are not so complex, to make the text more comprehensible. The deeper level of reading comprehension assesses “semantic complexity and frequency of words and phrases, as well as cohesion and coherence of text”; however this assessment is outside of the scope of this thesis (p. 24). The current study examined the shallow level of reading comprehension with the use of RFs which will be described in the next section.

RFs are commonly used because they can objectively and quantifiably evaluate text difficulty by assigning a numeric score to inform the user of the specific level of text difficulty (Bailin & Grafstein, 2001). However, before choosing a formula, there are several other considerations a user might think about, such as the usefulness of the formula, for example, for adults or children, and what the formula intends to measure, for example, whether it measures more abstract ideas or style difficulty. These considerations indicate that it is impossible to select one single best formula for the assessment of readability of a given written material because there is no single one formula that can assess all aspects of readability (Dale & Chall, 1949a; Klare, 1963).

1.5.3 Readability Formulas

1.5.3.1 Flesch-Kincaid grade level.

Rudolf Flesch was most responsible for advocating for the need of readability assessments (DuBay, 2004). He developed the Flesch-Kincaid Grade Level which is referred to by a number of names: F-K formula, Flesch-Kincaid formula, or Kincaid formula, and it is

one of the most commonly used RFs in the English language (Burke & Greenberg, 2010; DuBay, 2004; Flesch, 1948). It is suitable for materials at and above USA 4th grade level (Burke & Greenberg, 2010). The F-K formula considers the average number of words per sentence and the average number of syllables per word using three 100-word passages and calculating a RGL for print information (Friedman & Hoffman-Goetz, 2006). The F-K formula can be calculated by computer programs, such as Microsoft Word, which shows an excellent correlation with the manually calculated F-K scores (Ley & Florio, 1996).

The disadvantage of many computer software programs that use the F-K formula is that they use a different mathematical method to calculate RGLs from the manually calculated F-K grade level. The difference lies in the way that the computer program recognises, for example, abbreviations, periods, and numbers with decimals, and so their presence may reduce the RGL and therefore underestimate the difficulty of texts (Friedman & Hoffman-Goetz, 2006). Generally, the F-K formula tends to underestimate text difficulty by approximately two RGLs because the highest grade level it assesses is USA grade 12 (Estrada, Hryniewicz, Higgs, Collins, & Byrd, 2000; Freda, Damus, & Merkatz, 1999; Walsh & Volsko, 2008). For this reason, texts above 12th grade level have estimated RGLs that are lower than they actually are. The underestimation of RGLs may be due to the formula using a 75% comprehension criterion (DuBay, 2004). This criterion means that the F-K formula was constructed to predict the average grade level of an individual who could comprehend 75% of the written material (Flesch, 1948). Hence, readability analysis with the F-K formula may show that a text is easier to comprehend while only 75% of the material was understood by the reader.

1.5.3.2 Simple Measure of Gobbledygook.

The Simple Measure of Gobbledygook (SOMG) is one of the most commonly used RFs in healthcare and education (Estrada et al., 2000; Martinez, 2011). The original SMOG was

developed as a simple way of determining RGLs of written materials based on the total number of polysyllabic words, and is appropriate for upper elementary to adult materials (Friedman & Hoffman-Goetz, 2006; Gottlieb & Rogers, 2004; McLaughlin, 1969). Polysyllabic words are words that have more than one syllable (English Oxford Living Dictionaries, 2017c). The original SMOG generates a RGL from 30 sentences based on words that contain three or more syllables by multiplying word and sentence length (DuBay, 2004; McLaughlin, 1969). SMOG showed a 100% inter-rater reliability when web-based materials on mental health were assessed (King, Winton, & Adkins, 2003). SMOG is also highly ($r > .9$) correlated with other RFs, such as F-K, when assessing health-based literature and health websites (Gottlieb & Rogers, 2004; Meade & Smith, 1991). The SMOG formula is the only formula which has been validated against other formulas that estimates readability based on 100% comprehension where 100% of the presented information needs to be understood by the reader (DuBay, 2004; Friedman & Hoffman-Goetz, 2006; Gottlieb & Rogers, 2004). Due to the readability estimates that are based on 100% comprehension, SMOG frequently generates scores that are one to two RGLs higher than other commonly used formulas (Gottlieb & Rogers, 2004; Meade & Smith, 1991). Although, the F-K formula is most commonly used for the readability assessment of written health information materials and is highly correlated with SMOG, the SMOG formula is recommended for healthcare applications because SMOG is easy to use, the RGL criteria have recently been validated, has consistent results, and a higher level of expected comprehension (Fitzsimmons, Michael, Hulley, & Scott, 2010; Wang, Miller, Schmitt, & Wen, 2013).

1.5.3.3 Läsbarhetsindex.

According to Anderson (1983), the *Läsbarhetsindex* (LIX) is a little-known RF which is quick, reliable, and easy to interpret. LIX was originally developed by the Swedish scholar Carl-Hugo Björnsson (1983) and it is suitable for elementary to adult reading level. Its most

beneficial feature is that it can be used to determine reading difficulty not only of English but also of other languages. Although LIX was extensively trialled, the lack of its popularity may be due to its development in the Swedish language and was only accessible to Swedish scholars, therefore, no readability reviews of the time could discuss it. LIX uses the usual pattern of formulas taking the sentence length in percentage and word length equally into account, without counting syllables. One benefit of LIX is that it is readily interpretable. The assessor can easily determine whether text difficulty is due to the percentage of long words or the percentage of long sentences. Moreover, LIX can be transferred into RGLs using a conversion chart.

LIX was also trialled with texts in other languages than Swedish, such as English, Greek, and German (Anderson, 1981, August). The German texts have been validated against the English LIX RGL by translating the selected passages into English to reduce the variability between the languages. Although, the German LIX scores correlated with the English LIX scores, the mean LIX scores were higher for the German texts than for English. The difference may be due to the longer words in the German language which increases the percentage of long words, thus the LIX scores. Therefore, there is only some degree of confidence that the LIX grade level can be used as a valid and reliable predictor of text difficulty. Nonetheless, LIX is commonly used in the limited number of studies in the readability research of online health information in the German language (Esfahani, Faron, Roth, Grimminger, & Luers, 2015; Luers, Gostian, Roth, & Beutner, 2013; Meyer, Bacher, Roth, Beutner, & Luers, 2014). Luers et al. (2013) found, that LIX generally classifies online health information more easily readable than other formulas, such as F-K, or SMOG. An even quicker estimate of readability was developed from LIX, the Rate Index (RIX) formula and this is outlined in a later section.

1.5.3.4 Other formulas.

Other commonly used RFs in education and in healthcare settings in the English language are the Fog, Flesh Reading Ease, and the Fry RFs. The Fog Index RF, which assesses adult readability, uses the average sentence length and the number of words with more than two syllables for every 100 words (Gunning, 1952, as cited in DuBay, 2004). The Fog formula has a 90% comprehension criterion. The Flesh Reading Ease formula uses the number of words per sentence, and the number of syllables per word in an equation that generates a reading ease score (Flesch, 1948). Based on this formula, a text is easier to read when it contains shorter sentences, thus, less words. The Flesh Reading Ease formula generates a score on a 100-point scale, not an RGL, as the above-mentioned formulas. The higher the score, the easier it is to read the material. Last, the Fry RF calculates the average number of syllables and sentences that is plotted on the Fry's Readability Graph to classify a grade level score (Fry, 1977). Despite the popularity and history of these formulas, they are unsuitable for the readability assessment in the German language because they have been developed only for texts in the English language.

Chapter 2: Methods

2.1 Overview

The current study investigates the readability of online hearing health-related information in the German language. The study's methodology is based on Laplante-Levesque, Brannstrom, Andersson, and Lanner's (2012) study that assessed the quality and readability of Internet information for adults with HI and their significant other/s in the English language.

The main purpose of this study is to describe the readability of hearing-related Internet information in the German language. In this study, hearing loss refers to a gradual loss of hearing. Another purpose of this study is to compare the readability between webpage origins (by country), and type of organisation (i.e. government, non-profit, and commercial). In addition, the proportion of webpages with and without Health on the Net Foundation (HON) certification are assessed by country of origin and by type of organisation.

The current study is part of a larger international readability study which involved a wider research team. The international team had already made decisions about the methodology to be used in the wider project before the segment on which I have focused commenced and therefore those were followed but there were other decisions about the project that I could make, in consultation with my supervisor.

2.2 Participants

No participants were needed for this study because all the information was collected on the Internet; however, 15 native German-speaker informants were recruited to identify and select hearing-related search terms to use in this study. The careful selection of search terms was essential, because it is these that influence which webpages are identified by the search engine, and hence affects the results of the readability analysis (Ownby, 2006). The search

terms were collected from the German-speaking informants through posting a message on Facebook in the German language. This procedure is outlined in a later section.

2.3 Measures

The study dependent variable was the mean readability level expressed in RGLs, using the following formulas (Oleander Software, 2014):

- Simple Measure of Gobbledygook 1 (SMOG 1);
- *Quadratwurzelverfahren* (Qu);
- *Läsbarhetsindex 1* (LIX 1);
- *Läsbarhetsindex 2* - German technical literature (LIX 2);
- Rate index 1 (RIX 1); and
- Rate index 2 - German non-fiction (RIX 2).

The four factors in my study were:

- The country of origin;
- Type of organisation;
- HONcode certification; and
- Readability formulas (RFs).

2.3.1 Readability formulas in the Readability Studio 2012.1 Software.

The RFs in the Readability Studio 2012.1 software have been used in some studies to assess the readability of texts using different RFs, for example, Eloy et al. (2012) and Misra et al. (2013). Hanna, Brennan, Sambrook, and Armfield (2015) examined the software for its validity to measure online information comprehensively relating to wisdom tooth problems. They found that the software is a valid tool for assessing online health information.

According to Wang et al. (2013), there are no uniform guidelines for selecting and using RFs for written health information materials. It is recommended to use two or more RFs and to average the results because this will provide more accurate and valid readability estimates (Burke & Greenberg, 2010; Kahn & Pannbacker, 2000). The above-mentioned formulas have been selected based on their common use in the healthcare literature, see introduction section. The German version of the SMOG, the SMOG 1, was selected based on the 100% comprehension of the original SMOG formula, and the RIX was added because it is recommended to use for material from Western languages other than English (Burke & Greenberg, 2010). The original formulas, such as SMOG, and LIX, have already been described. The current study used the formulas, such as SMOG 1, Qu, LIX 1, LIX 2, RIX 1, and RIX 2 because these formulas were available in the Readability Studio 2012.1 software; however, these RFs are modified versions of the original RFs (Oleander Software, 2014). Each formula assesses readability slightly differently. These formulas are described in the next section.

2.3.2 Simple Measure of Gobbledygook.

As mentioned above, the original validated SMOG formula was developed as a simple way of determining the RGLs of written materials (McLaughlin, 1969). Ten consecutive sentences near the beginning of the written material are selected, 10 in the middle, and another 10 from near the end. For these formulas, sentences are defined as string of words that end with a question mark, exclamation, or a period (McLaughlin, 1969). Every word of the 30 sentences that has three or more syllables is counted (polysyllabic count) (Courtis, 1987). The nearest square root of the number of polysyllabic words is estimated (DuBay, 2004; McLaughlin, 1969). Then, the formula adds 3 to the approximate square root to obtain the SMOG RGL. The formula is shown, thus.

$$SMOG\ RGL = 3 + \sqrt{\text{polysyllable count}} \quad (\text{DuBay, 2004})$$

The SMOG RGL is the reading grade that a person must have to be able to read and comprehend 100% of the written material. A RGL between 13 and 16 indicates the need for tertiary level education. A RGL between 17 and 18 indicates the need for graduate-level training. A higher professional qualification is needed for RGLs 19 and above (Courtis, 1987). The higher the word count in the sentences, the higher the RGL.

The Readability Studio 2012.1 software uses the German version of the original SMOG by Bamberger and Vanacek (1984), that is, the SMOG 1, and is designed for secondary-age readers (Oleander Software, 2014). It is not defined in the software what secondary-age reader refers to, but it is logical to assume that it refers to children aged between 10 to 15 years, who attend secondary schools between the 5th and 10th grade (UNESCO, 2017). The SMOG 1 formula calculates grade level (G) by estimating the square root of the number of complex words (3+ syllables) (C) minus 2 by using the following equation; however, the Readability Studio 2012.1 software does not provide any information about why the formula subtracts 2 from the complex words before estimating its square root:

$$G = \sqrt{C - 2}$$

The SMOG 1 tests 30 sentences just as the conventional SMOG does, but the SMOG 1 randomly selects the sample from the entire document using standardisation instead of the beginning, middle, and end of the document (Oleander Software, 2014). For written material on the Internet, a SMOG 1 score of 7 means that the text can be read easily, although there is

no information about how the software rates the difficulty of texts (Luers et al., 2013; Oleander Software, 2014).

2.3.3 Quadratwurzelverfahren.

The *Quadratwurzelverfahren* (Qu) is a square root method that is an alternative to the SMOG 1 available in the Readability Studio 2012.1 software. The original Qu RF was developed by Bamberger and Vanacek (1984) to express RGLs in percentage. Nonetheless, based on the information in the Readability Studio 2012.1 software, the only difference between the Qu and SMOG 1 RFs is that the Qu uses a 100-word sample and the SMOG 1 uses a 30-word sample to calculate RGLs following the formula below:

$$G = \sqrt{\left(\frac{C * \frac{100}{W}}{S * \frac{100}{W}}\right) * 30 - 2}$$

Where:

G	Grade level
C	Number of complex words (3+ syllables)
S	Number of sentences
W	Number of words

2.3.4 Läsbarhetsindex.

The original *Läsbarhetsindex* (LIX) was developed by the Swedish scholar Carl-Hugo Björnsson (1983). LIX follows the usual pattern of RFs. LIX uses sentence and word features to predict text difficulty (Anderson, 1983). The sentence length is the number of words per sentence. The sentence length of the formula is calculated by averaging the number of words

per sentence similar to other RFs, such as the Flesch, and the Fry RFs, but the word length variable in LIX is measured differently from other formulas. It estimates word length by the percentage of words that have more than six letters instead of counting each syllable, polysyllabic words, or unfamiliar words. The estimation of word length by the percentage of words makes LIX a reliable RF that is quicker and more objective than other formulas, such as the Fry RF (Anderson, 1983). The words and sentences are weighted equally using the following formula (Anderson, 1983; Meyer et al., 2014):

$$\text{LIX RGL} = \text{word length} + \text{sentence length}$$

Where:

Word length	The percentage of long words with 6+ syllables
Sentence length	The average number of words per sentence

Anderson (1981, August, p.1) used the following steps to calculate LIX scores:

1. Count the total number of words
 - a. The total number of words
 - b. The number of long words (more than six syllables)
 - c. The number of sentences
2. Calculate the percentage of long words in the text by dividing (b) by (a) multiplied by 100
 - a. Divide (b) by (c) to compute the sentence length which is the average length of sentences in words
3. Add the values for (1) and (2) and round to the nearest whole number

According to Björnsson (1983), LIX scores are interpreted as follows:

LIX index	Interpretation
20-25	Very easy (books for children)
30-35	Easy text (fictions)
40-45	Average text (factual prose)
50-55	Difficult text (technical literature)
≥ 60	Very difficult text

LIX index scores usually range from 20 (very easy text) to 60 (very difficult text) (Anderson, 1981, August). These LIX index scores can be converted into equivalent RGLs for English materials as follows (Anderson, 1983, p. 494):

LIX index	Grade level
< 10	1 st grade
10-14	2 nd grade
15-19	3 rd grade
20-23	4 th grade
24-27	5 th grade
28-31	6 th grade
32-35	7 th grade
36-39	8 th grade
40-43	9 th grade
44-47	10 th grade
48-51	11 th grade
52-55	12 th grade
56 +	College/university

The formula is equally suitable for assessing readability of English and other language materials (Björnsson, 1983). LIX has been validated using many thousands of books and texts in multiple languages, including German. It is used for elementary to adult level (Anderson, 1983).

The LIX 1 and LIX 2 RFs in the Readability Studio 2012.1 software calculate the readability scores of texts using the sentence length and the number of words per sentence (Oleander Software, 2014). The software counts the number of words (W) and divides them by the number of sentences (S), then it adds the number of long words (X) divided by the number of words (W) multiplied by 100 arriving at the LIX index (I). The software uses the following formula to calculate the scores for both the LIX 1 and LIX 2 readability scores:

$$I = \frac{W}{S} + 100 * \left(\frac{X}{W}\right)$$

Where:

I	LIX index score
W	Number of words
X	Number of long words (7+ characters)
S	Number of sentences

LIX 1 is a useful formula because it can assess the readability of texts of any Western European language (Oleander Software, 2014). The LIX 1 formula in the software differs slightly in the classification of long words from the original LIX, developed by Björnsson (1983), where the software counts words with 7+ syllables instead of 6+ syllables. Moreover, the LIX 1 also differs in the interpretation from the original LIX index by Björnsson (1983), as shown below:

LIX 1 index	Interpretation
0-30	Very easy (books for children)
30-39	Easy text (fictions)
40-49	Average text (factual prose)
50-59	Difficult text (technical literature)
≥ 60	Very difficult text

2.3.5 Läsbarhetsindex 2 - German technical literature.

The *Läsbarhetsindex 2* (LIX 2) is a modified version of LIX 1 which was designed for technical literature (Oleander Software, 2014). Its basic principles are the same as the LIX 1 but LIX 2 uses a different logic to calculate RGLs which ranges from 4th to 15th RGLs. The Readability Studio 2012.1 software does not provide information on how the LIX 1 assigns the RGLs (Oleander Software, 2014). The LIX 2 uses the following formula to calculate the LIX index scores:

$$I = \frac{W}{S} + 100 * \left(\frac{X}{W}\right)$$

Where:

I	LIX index score
W	Number of words
X	Number of long words (7+ characters)

The LIX 2 RF converts the LIX index scores to grade level in the following way (Oleander Software, 2014):

LIX 2 index	Grade level
0-33	4 th grade
34-37	5 th grade
38-40	6 th grade
41-43	7 th grade
44-47	8 th grade
48-50	9 th grade
51-53	10 th grade
54-56	11 th grade
57-59	12 th grade
60-63	13 th grade
64-69	14 th grade
70 +	15 th grade

2.3.6 Rate index.

While establishing the RGLs for LIX, Anderson (1983) discovered that readability estimates can be obtained even quicker than with LIX, using the Rate index (RIX). Instead of counting the number of long words per sentence, his suggestion was to divide the number of long words by the number of sentences to produce the number of long words in a sentence, which he called the “rate of long words” (p. 495). This is calculated using the following equation:

$$RIX = \frac{\textit{number of long words}}{\textit{number of sentences}}$$

Measuring the rate of long words makes it unnecessary to compute the percentage of long words, as it is done with the LIX, and the calculation easier (Anderson, 1983). The concept of rate is similar to the idea of counting how many times a particular linguistic variable occurs over a fixed number of sentences, introduced by McLaughlin (1969). The concept of rate has the benefit that it can be applied over any number of sentences. In addition, there is a strong correlation ($r = .99$) between RIX and LIX therefore the RIX RF is as valid as the LIX RF (Anderson, 1983). RIX can be used to determine the readability of written materials in any Western languages (Burke & Greenberg, 2010).

Nonetheless, the interpretation of RIX differs from LIX (p. 495):

RIX index	Grade level
< 0.2	1 st grade
≥ 0.2	2 nd grade
≥ 0.5	3 rd grade
≥ 0.8	4 th grade
≥ 1.3	5 th grade
≥ 1.8	6 th grade
≥ 2.4	7 th grade
≥ 3.0	8 th grade
≥ 3.7	9 th grade
≥ 4.5	10 th grade
≥ 5.3	11 th grade
≥ 6.2	12 th grade
≥ 7.2	College

2.3.7 Rate Index 1 and 2.

The Readability Studio 2012.1 software offers two versions of the original RIX, the RIX 1 and the RIX 2 (Oleander Software, 2014). The RIX 1 resembles the original RIX developed by Anderson (1983). RIX 1 can be applied to documents of any Western European language (Oleander Software, 2014). The RIX 1 calculates an index score of a document based on sentence count and number of long word, such as words containing seven or more characters, using the following formula:

$$I = \frac{X}{S}$$

Where:

I	RIX 1 index score
X	Number of long words (7+ characters)
S	Number of sentences

The RIX 1 converts the RIX scores to RGLs in the following way (Oleander Software, 2014):

RIX 1 index	Grade level
< 0.2	1 st grade
≥ 0.2	2 nd grade
≥ 0.5	3 rd grade
≥ 0.8	4 th grade
≥ 1.3	5 th grade
≥ 1.8	6 th grade
≥ 2.4	7 th grade
≥ 3.0	8 th grade
≥ 3.7	9 th grade
≥ 4.5	10 th grade
≥ 5.3	11 th grade
≥ 6.2	12 th grade
≥ 7.2	College/university

The RIX 2 is a modified version of the RIX 1 and it is designed for non-fiction materials (Oleander Software, 2014). The RIX 2 uses the following formula:

$$I = \left(\frac{100 * \left(\frac{X}{W} \right)}{S * \left(\frac{100}{W} \right)} \right) * 10$$

Where:

I	RIX 2 index score
W	Number of words
X	Number of long words (7+ characters)
S	Number of sentences

The RIX 2 uses a different logic for assigning RGLs in comparison to the RIX 1. The RIX 2 assigns RGLs from the 1st to the 11th RGL only (Oleander Software, 2014):

RIX 2 index	Grade level
0-13.5	1 st grade
13.51-17	2 nd grade
17.1-20.5	3 rd grade
20.51-24	4 th grade
24.51-27.5	5 th grade
27.51-31	6 th grade
31.1-34.5	7 th grade
34.51-38	8 th grade
38/.1-41.5	9 th grade
41.51-45	10 th grade
45.1 +	11 th grade

There is no previous scientific and validated data available on the modified versions of the RFs available in the Readability Studio 2012.1 software, such as the SMOG 1, Qu, LIX 1, LIX 2, RIX 1, and the RIX 2 RFs; however, these formulas have been selected for the analysis because they seemed adequate for assessing the target content of the webpages.

2.4 Procedure

The countries were identified in which German is spoken as a first language by at least 5% of the population, and/or is an official language of the country. The 5% was a value chosen arbitrarily by the international research team. The research team used information from the Central Intelligence Agency (n.d.) and Ethnologue (2017) to obtain information about the number of native speakers in each location. Only those countries with a Google country code top-level domain (ccTLD) were included in this study. ccTLD defines the name of the domain for a country or geographic area, such as .de (Germany) or .ch (Switzerland) (Householder, Houle, & Dougherty, 2002). The Google search engine was selected for the study because it is the most popular search engine around the world (Netmarketshare, 2017).

The research team identified five Google ccTLDs in the German language. Therefore, the search terms were entered in five country-specific Google search engines: Google Germany (Google.de), Google Austria (Google.at), Google Switzerland (Google.ch), Google Liechtenstein (Google.li), and Google Hungary (Google.hu). The German search terms for the study were identified by 15 native German-speaking informants who were recruited through a Facebook post.

The search terms were entered in Google Trends (www.Google.com/trend) to find out the localities where these terms are used, and also to identify related search terms. The search terms were then entered in all the identified German-speaking Google domains. The first 10 webpages, excluding duplicates, were analysed for the study. Each webpage was coded as: government, non-profit, or commercial, based on the type of organisation that controls the webpage.

In addition, each webpage was coded for country of origin, for example, Germany, and Switzerland. The HON website (www.healthhonnet.org) was searched to determine whether each webpage has HONcode certification. The content of each webpage was analysed by the

Readability Studio 2012.1 software to determine its RGL (Oleander Software, 2014). The mean RGL for each webpage were calculated by the Readability Studio software.

2.4.1 Informant search term selection

The terms a person might use to search for online hearing health-related information in the German language varies from locality to locality and because of this, two methods were used to identify search terms in the German language: native German-speaking informants and Google Trends.

A panel of 15 informants, who are native German speakers, identified search terms that adults and their significant other/s would most likely use when looking for online hearing health-related information. The inclusion criteria for informant selection were that the informants are:

- Native speakers of the German language; and
- Adults over the age 25 years.

Prior knowledge of hearing and hearing healthcare was not a selection criteria for the informants.

A generic message about hearing difficulties was posted on Facebook in the German language which prompted my native German-speaking friends, acquaintances, and their connections to nominate several search terms they would choose to put into Google to gather the information. The following text was posted on Facebook in the German language. See the English translation below and also the original German version in Appendix B:

I would like to ask all my German-speaking friends to participate and help me with my thesis project. I would like to cover as many regions as possible in Germany and of course any other German-speaking countries, if possible. The more variety I have, the

better it will be for my study. The only requirement is that you need to be a native German-speaker!

What is it about?

I would like to investigate what kind of search words people would put in ‘Google Search’ when they have a hearing problem and they would like to know where they can get professional advice, information, and help. What search words would you use to look for such information? Please write all the search words you can think of in the comment section below. In addition, it would be helpful if you could put in brackets the name of the region/country your comment is coming from.”

The informants suggested 19 search terms. These are shown in Figure 2.

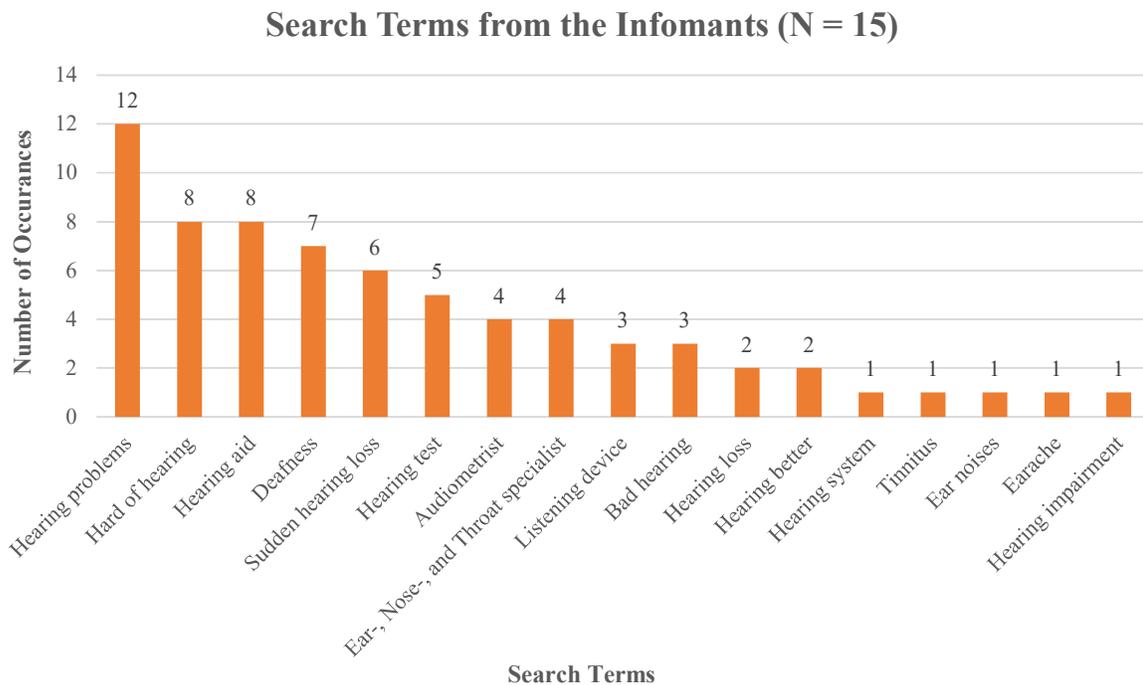


Figure 2. Search terms suggested by the 15 informants.

The German translations of the English words are listed in Table 2 below. The English equivalents of the German words are used in the study for simplicity and better comprehension

Table 2. English Translation of the 19 German Search Words.

English translations	German search terms
Hearing problems	<i>Hörprobleme</i>
Hard of hearing (noun)	<i>Schwerhörigkeit</i>
Hard of hearing (adjective)	<i>Schwerhörig</i>
Deafness	<i>Taubheit</i>
Deaf	<i>Taub</i>
Hearing aid	<i>Hörgerät</i>
Sudden hearing loss	<i>Hörsturz</i>
Hearing test	<i>Hörtest</i>
Listening device (Collective name for describing a variety of different listening devices other than hearing aids, i.e. amplified head phones and telephones, etc.)	<i>Hörhilfe</i>
Bad hearing	<i>Schlecht hören</i>
Audiometrist	<i>Hörgeräteakustiker</i>
Ear-Nose-, and Throat specialist	<i>Ohrenarzt</i>
Hearing loss	<i>Hörverlust</i>
Hearing better	<i>Besser hören</i>
Hearing system	<i>Hörsystem</i>
Tinnitus	<i>Tinnitus</i>
Ear noises	<i>Ohrgeräusche</i>
Earache	<i>Ohrenschmerzen</i>
Hearing impairment / damage	<i>Hörschaden</i>

The key words that were mentioned at least five times by the informants as well as were related to gradual loss of hearing and hearing difficulty were selected for further Google Trends analysis. These terms were: hearing problems, hard of hearing (noun and adjective), deaf (noun and adjective), hearing aid, sudden hearing loss, and hearing test. In contrast, the search words listening device, bad hearing, Audiometrist, ENT specialist, hearing loss, hearing better, hearing system, tinnitus, ear noises, earache, and hearing impairment/damage were mentioned less than five times and therefore they did not meet the inclusion criteria and were excluded.

One limitation of the Facebook post was that it did not specify that the hearing difficulty occurred gradually. As a result, some informants suggested search terms that related to temporary and sudden hearing loss, such as tinnitus, and earache. These terms did not meet the inclusion criteria thus they have been excluded from the study after the Google Trends analysis.

2.4.2 Google Trends search term selection.

One tool that provides information about Internet searches is Google Trends (Nutti et al., 2014). Google Trends is a publicly accessible and free online portal of Google Inc. It analyses one segment of the billions of daily Google searches to provide information on the geospatial and temporal characteristics of user-specified terms. Google Trends has been used in many previous research publications (Laplante-Lévesque et al., 2012; Nutti et al., 2014), and because of this, it was decided to use Google Trends as part of the search term selection for the current study.

The search terms were entered into Google Trends to obtain their search frequency in the past year, accumulated around the world. Search terms that were identified by less than five informants were analysed to see if they could be included in the study based on the frequency of their use suggested by Google Trends. However, in Google Trends, none of these terms

showed frequent use compared to more commonly used terms, such as hearing loss, hearing aid, and hearing test, nor suggested further terms to include. Hence, they were excluded.

Based on Nuti et al.'s (2014) recommendation a checklist was used for the documentation of Google Trends settings to improve the quality and reproducibility of studies using Google Trends. On April 19, 2017, Google Trends was queried and the data for the following combined search terms were downloaded: hearing problems + hearing loss + deafness + hearing aid + hearing test. Google Trends only offers the comparison of five terms, therefore search terms with low occurrences compared to each other were deleted and the remaining search words were added for further comparison (e.g., hard of hearing-adjective, and deaf) until the final search terms were obtained to use in the study. The adjective versions of “hard of hearing” and “deafness” were excluded because they have not been used frequently over time for hearing-related online information, according to Google Trends.

No quotation marks were used for these searches. The following settings were selected for the Google Trends analysis: *worldwide* in the *past five years* within *all categories* using *web search*. The *worldwide* setting was chosen because it generated more meaningful results than selecting each of the countries separately using the German language domains only. The *past five years* setting was selected for establishing the search term trends to capture baseline interest over several years. The setting *all categories* was chosen because it generated more widespread search results compared to a restricted category, for example, *health*. Figure 3 shows the Google Trends settings.

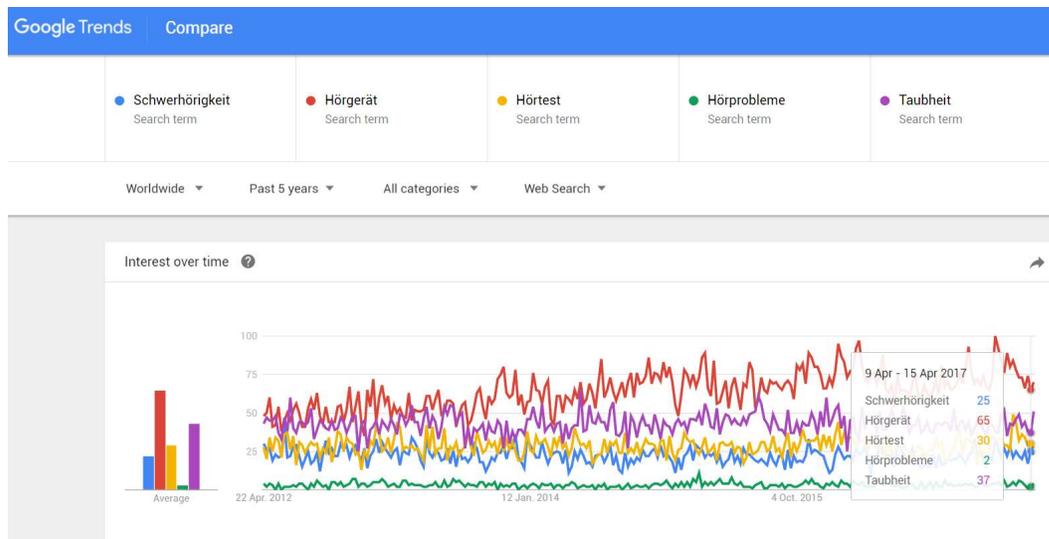


Figure 3. Settings in Google trends used for the further analysis of search terms.

Google Trends identified that the least common key word was “hearing problems” which was only associated with sudden hearing loss, hence this term was excluded. The German equivalent of “deafness” was also excluded because it only retrieved information that was not related to hearing. The remaining three search terms, “hearing aid”, “hearing test”, and “hard of hearing” (noun) retrieved relevant information for adults with hearing impairment. Hence, these three search terms were nominated for the further Google domain analyses.

2.4.3 Internet search.

I am proficient in speaking and reading the German language therefore I performed the Internet searches. The unit of the analysis was webpages instead of websites to increase the sample size of the study. Websites are a series of World Wide Web pages that contain hyperlinks to each other and are made available by an individual, company, government, or organisation (Merriam-Webster., n.d.). Websites can be imagined as a book, and the webpages are the pages of that book.

The first step in the Internet search was to enter the identified ccTLDs into the Google Chrome Internet browser. I started with the German domain because it had the highest language status out of the five domains and therefore I expected to get the most results in this domain (Ethnologue, 2017). The language status here refers to the percentage of people in a country that use the German language. The search continued with Austria, Switzerland, Liechtenstein, and Hungary in this order, based on the frequency of search words used in these countries, according to Google Trends, as well as the country language status. Each search term was entered into a domain one at a time.

The inclusion criteria included that the webpage must be:

- In the German language;
- Contain information relating to hearing or HI;
- Be available to the public; and
- Contain information about the organisation hosting that webpage.

The exclusion criteria were that the webpage must not be:

- An advertisement identified by Google;
- A video;
- A directory listing; and
- Less than 100 words in length.

Advertisements on webpages were defined as any pop-up windows, pictures prompting the purchase or trial of hearing devices and related products, as well as additional links offering further services, and directories.

The next step was to identify the webpages for analysis. The relevant webpages that appeared as the first 10 listings in the search results were analysed. All duplicate webpages

were removed. Furthermore, there were instances where the exact same information was presented on a webpage but under a different domain name (e.g., .de and .ch) where Google did not recognise the webpage as a duplicate. However, after comparing and recognising that information on both webpages was identical, the duplicates were removed.

Next, all relevant content of each webpage was copied and pasted into a Word document. This content included all relevant texts and links without changing its original format. Advertisements in written or pictorial forms were manually removed. After copying the text into a Word document, the document was inspected to see if the copying process was successful and I made edits when errors occurred to restore the original webpage formatting. Pictures and graphs that were part of the copied texts were not removed. However, the Readability Studio 2012.1 software only analyses texts and excludes pictures and graphs automatically. No content from external links was included. When it was not clear whether the content was relevant, I discussed it with my supervisor and we decided whether to include or exclude particular content. This process generated 39 Word documents containing the relevant content of 20 unique webpages. These documents were used for the readability analysis using the Readability Studio 2012.1 software.

For each search, the following information was recorded in an Excel file:

- Uniform Resource Locator (URL) of the webpage, the organisation hosting the webpage;
- Country of origin;
- Type of organisation;
- Whether the webpage has HONcode certification;
- Date of retrieval; and
- Date of last update of information.

2.4.4 The recording process

First, the URL of a webpage was copied and pasted in an Excel data collection sheet after deciding that it fulfilled the inclusion criteria for the selection. Next, the country of origin was identified by researching the location of the organisation hosting the information. This task was accomplished by looking for the physical address of the organisation in the *Über uns* or *Impressum* [About us] sections of the webpages. In some cases, the information about the organisation hosting the webpage was not apparent. In these cases, further Internet research was conducted to gather additional information, along with further consultation with my supervisor.

Organisations that targeted a global audience (e.g., Wikipedia), webpages that provided the information in multiple languages (e.g., <http://www.hear-it.org/de/einen-horverlust-bestimmen>), or webpages that retrieved the exact same information in one or more other ccTLDs, were coded as “multi-region site”. Despite the multiple number of results of the same information, only the first search result was kept for the readability analysis and all other duplicates from other ccTLDs were excluded, but coded as “multi-region site” location of organisation because of this. This code was used to accommodate both international webpages, such as Wikipedia, as well as webpages that can be retrieved only in Europe, or have webpages in the German speaking countries only.

Then, the type of organisation was coded as “government” if it was associated with a governmental agency. The organisation was coded as “non-profit” if the organisation could be verified as being non-profit by further search on their webpages or on the Internet. All other organisations were coded as “commercial”, websites that are supported by advertisers and are free to visit by the public (Pendleton, 1999). The date of retrieval was the date on which the searches were conducted. The date of last update was obtained by looking for a date of last

update that was usually displayed on the top or the bottom of a webpage. Finally, the HON website was searched to verify HONcode certification by copying and pasting each of the hyperlinks into the HON search box.

2.4.5 Readability analysis

To perform the readability analysis, the Readability Studio 2012.1 software was used to assess the 39 webpages from 20 different websites (Oleander Software, 2014). This software was selected for three reasons. First, it determines the age of the youngest reader that can understand a document by generating a readability score in RGL or reading ease score for a given document using multiple RFs. The current study used RFs that generated RGLs only. Second, the software supports numerous file formats such as *.txt, *.doc, *.docx, *.pptx, *.odt, *.htm, *.rtf, *.ps, and *.idl. Third, the software offers 13 different readability tests for documents written in the German language.

Before beginning the readability analysis, the software was set to *right-align* each text. The software did not take images into account for the analyses. The language was set to *German* and the above-listed RFs were selected for analysis. The content of each Word document was copied and pasted into the software excluding navigation menus, legal disclaimers, advertisements, header and footer elements because these are typically ignored by the reader of web content (Martin & Gottron, 2012). The results were saved for further statistical analysis. The above steps were repeated for each of the files.

2.5 Statistical Analysis

The statistical analysis included:

- Descriptive statistics that included the mean, median, standard deviation, minimum, maximum, frequency counts;
- Levene's Test of Equality of Error Variance;
- Mann-Whitney Test;
- Chi Square;
- Chi Square cross-tabulation;
- Non-parametric Spearman correlation;
- Univariate and non-parametric ANOVA;
- One-sample t-test; and
- Post hoc testing.

Chapter 3: Results

3.1 Overview

The main purpose of this study was to describe the readability of hearing-related Internet information in the German language. In addition, this study compared the readability between webpage origins (by country), and type of organisation (i.e. government, non-profit, and commercial). As well as the proportion of websites with and without HONcode certification was assessed by country and type of organisation.

In total, 150 webpages were retrieved: the first 10 webpages that met the inclusion criteria, multiplied by three German keywords (“hard of hearing”, “hearing aid”, and “hearing test”), multiplied by five Google ccTLD (Google Germany, Google Austria, Google Switzerland, Google Liechtenstein, and Google Hungary). Some of these webpages did not meet the inclusion criteria, or were retrieved by more than one ccTLD or keyword. After removing the webpages that did not match the inclusion criteria, and duplicates, only 39 webpages from four ccTLDs remained and underwent a readability analysis. Further domain information is described in the following sections. The date of last update was recorded where possible but this information was more often missing than stated. The date of last update, type of organisation, location of organisation, and HONcode certification of the 39 webpages are summarised in Table 3 and the occurrences of webpages is shown in Figure 4.

Table 3. List of the Remaining 39 Webpages.

URL	Date Last Update	Type of Organisation	Location of Organisation	HON Certification
https://de.wikipedia.org/wiki/Schwerh%C3%B6rigkeit	Mar-17	Non-profit	Multi-region site	No
http://www.hno-aerzte-im-netz.de/krankheiten/schwerhoerigkeit/definition-und-haeufigkeit.html	none	Commercial	Germany	No
http://www.netdokter.de/symptome/schwerhoerigkeit/	Jun-16	Commercial	Germany	Yes
http://www hoeren-heute.de/schwerhoerigkeit/	none	Commercial	Germany	No
http://www.hear-it.org/de/einen-horverlust-bestimmen	none	Non-profit	Multi-region site	No
http://www.onmeda.de/krankheiten/schwerhoerigkeit.html	Jan-16	Commercial	Germany	Yes
http://www.schwerhoerigen-netz.de/MAIN/schwerhoerig.asp?inhalt=broschuere06	none	Non-profit	Germany	No
http://www.apotheken-umschau.de/Schwerhoerigkeit/Schwerhoerigkeit--Ursachen-Kreislauf-Herz-Stoffwechsel-11804_8.html	Mar-17	Commercial	Germany	Yes
https://www.welches-hoergeraet.de/schwerhoerigkeit-365.html	none	Commercial	Germany	No
https://de.wikipedia.org/wiki/H%C3%B6rger%C3%A4t	Apr-17	Non-profit	Multi-region site	No
http://www hoeren-heute.de/hoergeraete-ohne-zuzahlung/	none	Commercial	Germany	No
http://www hoeren-heute.de/hoergeraete-preise/	none	Commercial	Germany	No
http://www.amplifon.com/web/de/hoergeraete-kategorien-kosten#	none	Commercial	Germany	No
https://www.audibene.de/hoertest/	none	Commercial	Multi-region site	No
http://www.netdokter.at/krankheit/schwerhoerigkeit-8141	Feb-17	Commercial	Austria	Yes
http://www.gesund.at/f/schwerhoerigkeit	none	Commercial	Austria	No
http://www.hear-it.org/de/kombinierte-schwerhoerigkeit	none	Non-profit	Multi-region site	No
http://www.oesb-dachverband.at/schwerhoerigkeit/schwerhoerigkeit-erklaeungen/	Nov-08	Non-profit	Austria	No
http://www.oessh.or.at/hoerspuren/tinnitus	none	Non-profit	Austria	No
http://flexikon.doccheck.com/de/Schwerh%C3%B6rigkeit	none	Commercial	Germany	No
http://www.neuroth.at/hoergeraete/ueber-hoergeraete/	none	Commercial	Multi-region site	No
https://www.hansaton.at/de/hoerloesungen/preisklassen/	Apr-16	Commercial	Austria	No
http://www.gesund.at/f/hoergeraete	Dec-16	Commercial	Austria	No
https://www.audibene.de/hoergeraetepreise/	none	Commercial	Multi-region site	No

URL	Date Last Update	Type of Organisation	Location of Organisation	HON Certification
http://www.oessh.or.at/hoerspuren/hoergeraete	2011	Non-profit	Austria	No
https://www.ganzohr.ch/hoertest/online-hoertest/	none	Commercial	Switzerland	No
http://www.netdokter.at/untersuchung/hoertest-8270	Jun-16	Commercial	Austria	Yes
http://www.hear-it.org/de/sensorineuraler-horverlust	none	Non-profit	Multi-region site	No
http://www.apotheken-umschau.de/Schwerhoerigkeit/Schwerhoerigkeit-Therapie-und-Selbsthilfe-11804_10.html	Mar-17	Commercial	Germany	Yes
http://www.apotheken-umschau.de/Schwerhoerigkeit/Schwerhoerigkeit-Ursachen-Stoerungen-im-Innenohr-11804_6.html	Mar-17	Commercial	Germany	Yes
http://www.amplifon.com/web/de/hoergeraete	none	Commercial	Multi-region site	No
https://www.welches-hoergeraet.de/horgerate-im-test-stiftung-warentest-testet-mehrere-hersteller-38.html	none	Commercial	Germany	No
https://www.ganzohr.ch/schwerhoerigkeit/	none	Commercial	Multi-region site	No
http://www.sprechzimmer.ch/sprechzimmer/Krankheitsbilder/Schwerhoerigkeit.php	none	Commercial	Switzerland	No
http://www.amplifon.ch/Rund-ums-Hoeren/ursachen-schwerhoerigkeit/Seiten/default.aspx	none	Commercial	Multi-region site	No
http://www.beobachter.ch/gesundheit/krankheit/krankheit/schwerhoerigkeit/	none	Commercial	Switzerland	No
http://www.amplifon.ch/hoergerate/Seiten/hoergeraete-preise.aspx	none	Commercial	Multi-region site	No
http://www.neuroth.ch/hoergeraete/	none	Commercial	Multi-region site	No
https://www.akustikschweiz.ch/service/online-hoertest/	none	Commercial	Switzerland	No

Note. A “multi-region site” is defined as international webpages, like Wikipedia, webpages that can be retrieved only in Europe, or have webpages in the German speaking countries only.

3.2 Summary of Retrieved Webpages

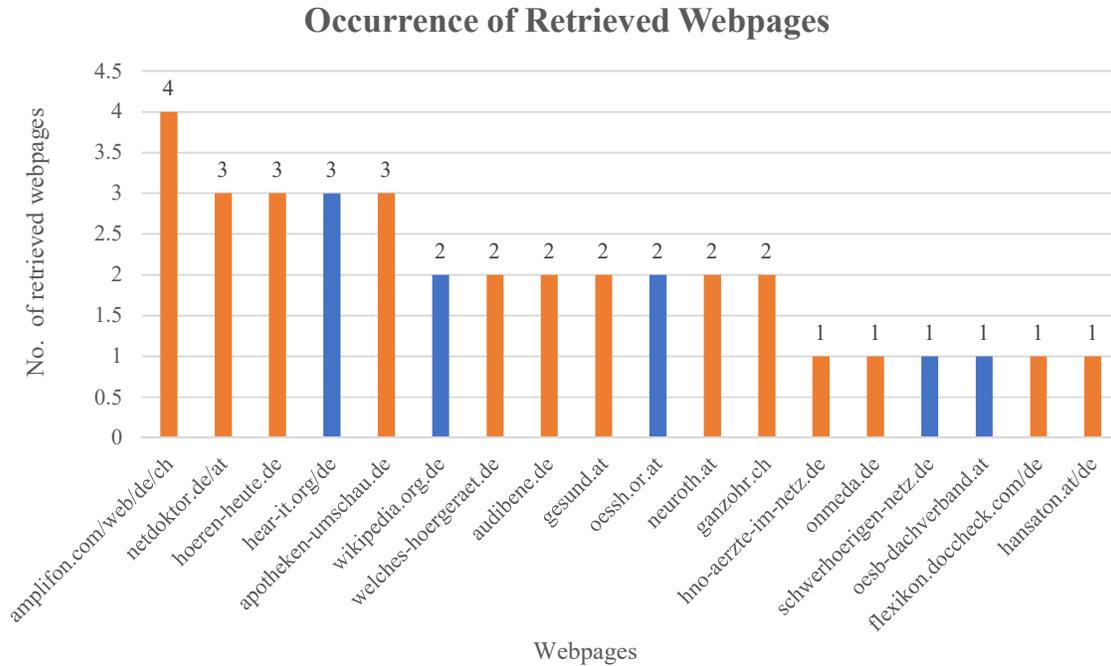


Figure 4. Summary of the occurrence of the 20 retrieved webpages. The orange colour indicates commercial organisation and the blue shows colour shows non-profit organisations

3.3 Descriptive Statistics

3.3.1 Domain information.

The use of the three keywords and the examination of the webpages for the inclusion criteria retrieved information from four Google domains: (1) Google Germany, (2) Google Austria, (3) Google Switzerland, and (4) Google Liechtenstein. No retrieved webpages fitted the inclusion criteria from Google Hungary. Figure 5 provides a pictorial presentation of the data.

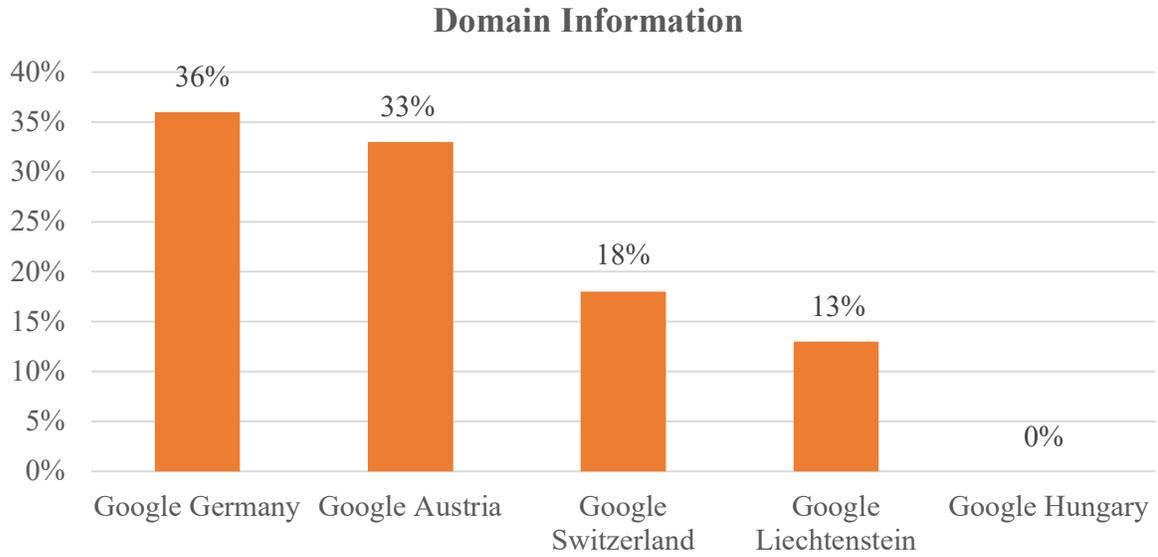


Figure 5. Proportion of retrieved information between the five Google domains.

3.3.2 Date of last update.

On the retrieval date of the 20th of April 2017, the majority of webpages did not list the date of last update, as shown in Figure 6.

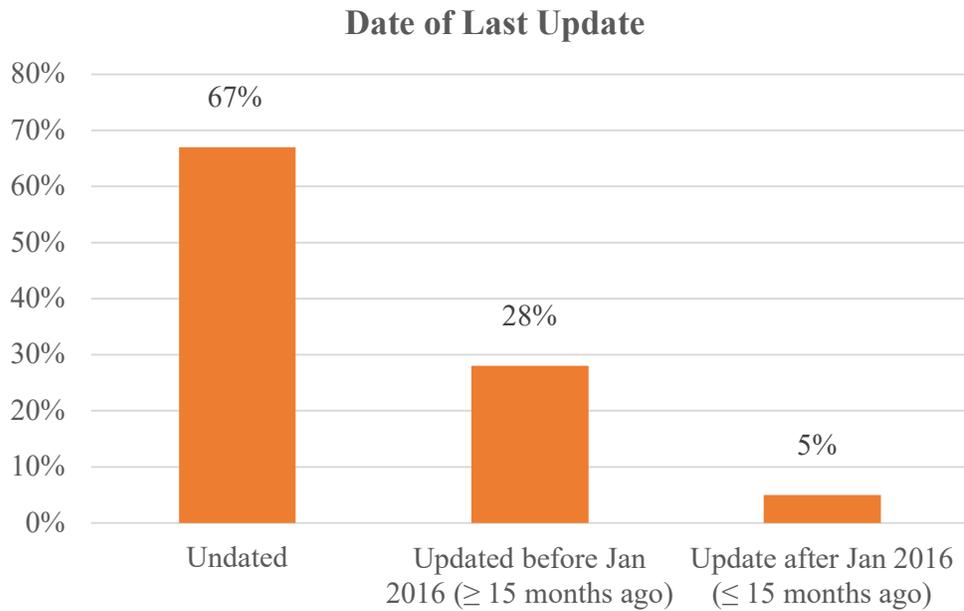


Figure 6. Date of last of the 39 webpages assessed.

Updated webpages were either updated longer than 15 months ago, that is before January 2016, or within the past 15 months, after January 2016.

3.3.3 Type of organisation.

The type of organisation hosting a webpage was recorded for each of the 39 webpages and was put into one of these three categories: (1) government, (2) non-profit, or (3) commercial. Most webpages were of commercial origin, followed by non-profit origin. None of the webpages were hosted by government agencies. Figure 7 provides a pictorial presentation of the data.

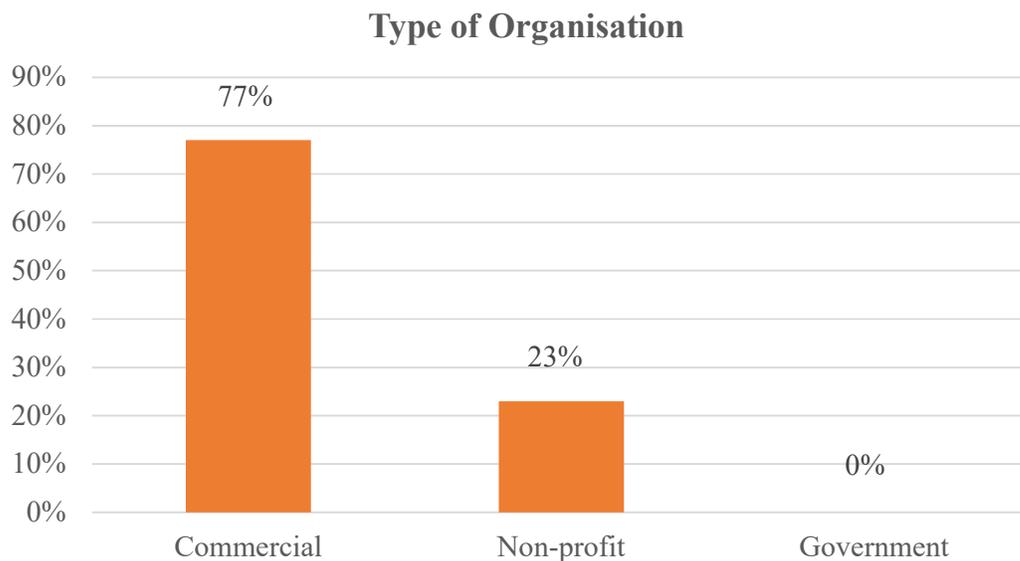


Figure 7. The proportion of the type of organisation for the 39 webpages.

3.3.4 Location of organisation

Most of the organisations that hosted the webpages were located in Germany, followed closely by multi-region site, then Austria, and Switzerland, as shown in Figure 8.

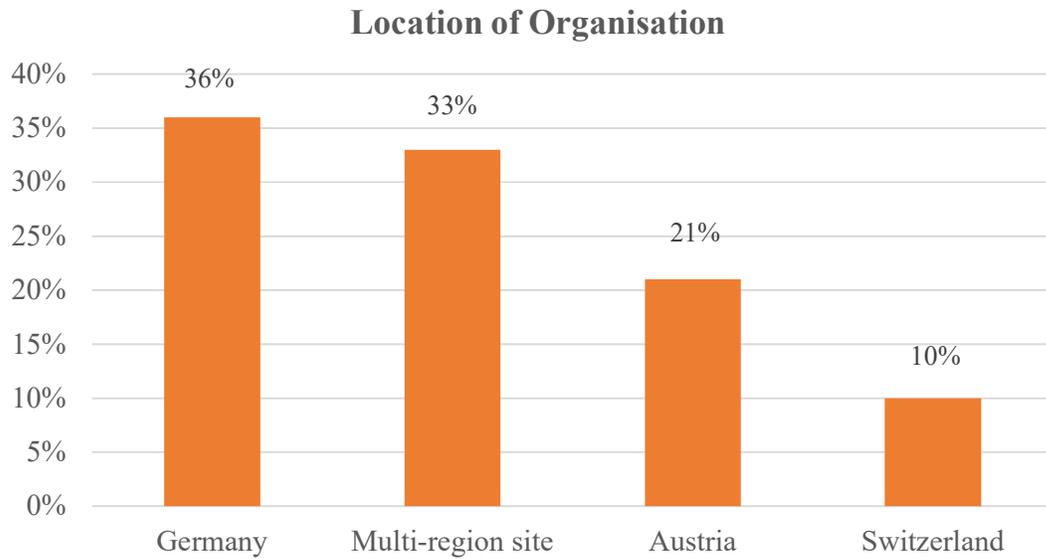


Figure 8. The proportion of the locations of the organisation for the 39 webpages.

3.3.5 HONcode certification.

Most webpages had no HONcode certification, as shown in Figure 9.

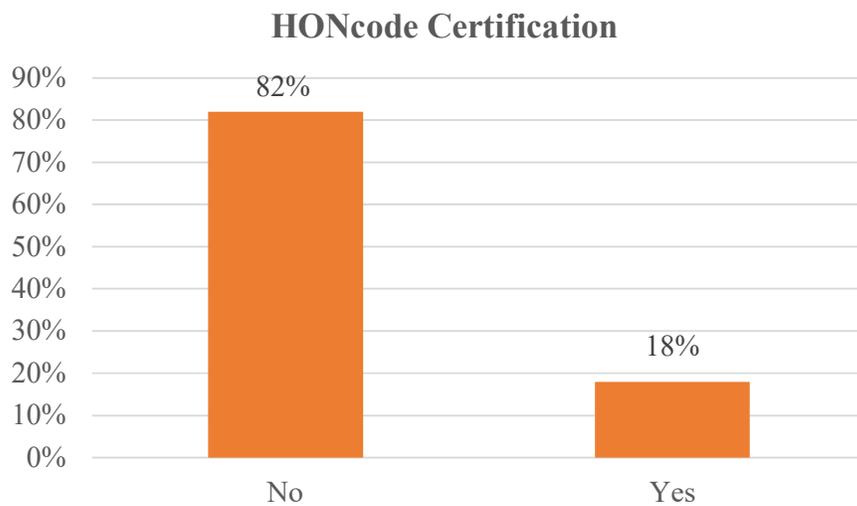


Figure 9. The proportion of HONcode certification amongst the 39 webpages.

3.3.6 Readability.

The readability of the webpages was analysed using the, LIX 1, LIX 2, Qu, SMOG 1, RIX 1, and RIX 2 RFs. The summary of descriptive statistics of readability scores is presented in Table 4.

Table 4. Descriptive Statistics of the Readability Formulas in RGL.

Formula	Minimum	Maximum	Mean	Standard Deviation
LIX 1	9	15	11.15	1.60
LIX 2	11	13	12.69	0.57
Qu	9	18.3	11.99	2.11
SMOG 1	9	18.3	11.99	2.11
RIX 1	10	14	12.20	0.89
RIX 2	8	14	11.15	1.60
Mean RGL	9.3	15.3	12.04	1.37

Note. LIX 1 stands for *Läsbarhetsindex 1*; LIX 2 stands for *Läsbarhetsindex 2* - German technical literature, Qu stands for *Quadratwurzelverfahren*, SMOG 1 stands for Simple Measure of Gobbledygook, RIX 1 stands for Rate index 1, and RIX 2 stands for Rate index 2 - German non-fiction, as presented in in the Readability Studio 2012.1 software.

3.4 Hypotheses Testing

The data were first examined for skewness and kurtosis to see if parametric tests could be used for the analyses. After examining the distribution of scores underlying these measures, the z-scores for skewness coefficients and kurtosis revealed significant departures from normality for data using individual RGL values. They were not significantly different from a normal distribution for mean RGL values and therefore, data analyses using the individual RGL

values required the use of non-parametric tests, while parametric tests could be applied for the data analyses using mean RGL values. The alpha level of .05 was used unless otherwise stated.

3.4.1 Distribution of webpages based on type of organisation.

From the search criteria, it was expected that the proportion of commercial webpages would be significantly higher than the proportion of non-profit and government webpages. The Google search criteria did not retrieve any government webpages in the German language for this study. The remaining two types of organisation, commercial and non-profit, were then compared. A Chi Square test was performed and results showed that the number of commercial webpages was significantly higher, $\chi^2 (1, N = 39) = 11.31, p < .001$, than the number of non-profit webpages. Hence, the null hypothesis that there is an even distribution of websites based on type of organisation was not supported.

3.4.2 Distribution of webpages based on location of organisation.

It was expected that the location of organisation of the webpages, using the search criteria, will be evenly distributed. The results of the Chi Square test showed that the distribution of these webpages based on location of organisation was not significantly uneven, $\chi^2 (3, N = 39) = 6.64, p = .083$, thus the null hypothesis that there is an even distribution of websites based on location was supported.

3.4.3 Distribution of the type of organisation based on location of organisation.

It was expected that there would be an even distribution of the type of organisation across the webpages by location of organisation. The most commercial webpages were found to be in Germany, and the most non-profit webpages were in multi-region sites, compared to

all other locations of organisation, as can be seen in Table 5. The results of a Chi Square test (cross-tabulation) indicated no significant difference in the distribution of type of organisation across the webpages by location of organisation, $\chi^2(1, N = 39) = .118, p = .126$. Even though there are more commercial webpages than non-profit in Germany and multi-region sites than in Austria and Switzerland, they are not significantly unevenly distributed. Thus, the null hypothesis was supported.

Table 5. Frequency of Type of Organisation Based on Location of Organisation.

Location of organisation	Type of organisation		
	Commercial	Non-profit	Total
Germany	13	1	14
Multi-region site	8	5	13
Austria	5	3	8
Switzerland	4	0	4
Total	30	9	39

3.4.4 Distribution of HONcode certification based on location of organisation.

It was anticipated that there would be an even distribution of the proportion of HONcode certification across the webpages by location of organisation. As Table 6 shows, most webpages have no HONcode certification. Germany and Austria had some webpages with HONcode certification, while multi-region sites and Switzerland did not have any webpages with HONcode certification. The results of a Chi Square test indicated that the distribution of HONcode certification is evenly distributed based on location of organisation, $\chi^2(3, N = 339) = .072, p = .067$. Hence, the null hypothesis was supported.

Table 6. Frequency of HONcode Certification Based on Location of Organisation.

HONcode certification	Location of organisation				
	Germany	Multi-region site	Austria	Switzerland	Total
Yes	5	0	2	0	7
No	9	13	6	4	32
Total	14	13	8	4	39

3.4.5 Distribution of HONcode certification based on type of organisation.

It was anticipated that there would be an even distribution of the proportion of HONcode certification across the webpages by type of organisation. As shown in Table 7, some of the commercial webpages had HONcode certification and none of the non-profit organisations had HONcode certification. Using a Chi Square test (cross-tabulation), results showed that the distribution of webpages with HONcode certification was evenly distributed between commercial and non-profit organisations, $\chi^2(1, N = 39) = .110, p = .132$. As a result, the null hypothesis was supported.

Table 7. Frequency of HONcode Certification Based on Type of Organisation.

HONcode certification	Type of Organisation		
	Commercial	Non-profit	Total
Yes	7	0	7
No	23	9	32
Total	30	9	39

3.4.6 Mean reading grade levels of webpage with and without HONcode certification.

The planned univariate ANOVA analysis could not be performed because the assumption of equal sample size between the two groups (RGLs with and without HONcode certification) had been violated, and therefore the non-parametric Mann-Whitney test was completed. It was hypothesised that there would be no significant difference in mean RGL between webpages that had HONcode certification and webpages that did not. The mean rank of RGL for seven webpages with HONcode certification was 24.07, and the mean rank of RGL for the 32 webpages with no HONcode certification was 19.11; $U = 83.500$; $Z = -1.045$, $p = .308$. These results showed no significant difference in mean RGL based on whether a webpage had HONcode certification, which supported the null hypothesis.

3.4.7 Relationship between reading grade levels and the readability formulas.

To investigate whether a positive relationship between RGLs derived from each formula exists, a one-tailed Pearson correlation was planned. However, the RGL values were skewed and kurtotic, violating the normality assumptions, and so a Spearman's rho correlation

was used (results in Table 8). The results showed that there was a significant ($p < .001$) positive relationship between RGLs amongst the six RFs, thus the null hypothesis was not supported.

Table 8. Nonparametric Spearman’s Rho Correlations across Readability Formulas.

Readability formulas	Spearman’s correlations					
	SMOG 1	Qu	LIX 1	LIX 2	RIX 1	RIX 2
SMOG 1	1.0**	1.0	.91**	.63**	.89**	.97**
Qu	1.0	1.0	.91**	.63**	.89**	.97**
LIX 1			1.0	.66**	.85**	.89**
LIX 2				1.0	.66**	.62**
RIX 1					1.0	.90**
RIX 2						1.0

** $p < .001$ (2-tailed).

3.4.8 Recommended reading grade levels versus mean reading grade levels for online health information.

It was expected that webpages found using the study criteria would have a mean RGL greater than 6. Results of a one-sample t-test indicated a significantly higher ($t(38) = 27.58, p = .05$) mean RGL ($M = 12.04, SD = 1.37$) above the average RGL of 6. Thus, the null hypothesis was not supported.

3.4.9 Mean reading grade levels and location of organisation.

It was predicted that there would be a significant difference in mean RGL between webpages based on location of the organisation. The Levene’s Test of Equality of Error

Variances showed no significant variance between the different locations of organisation, $F(6,32) = 1.30, p = .284$, hence, the assumption of homogeneity of variance is met. The results of a univariate ANOVA (one-way ANOVA) analysis showed no significant main effect of location of organisation on mean RGL, $F(6, 32) = 2.44, p = .08, \eta_p^2 = .19$. In short, there is no statistically significant difference in RGLs based on location of organisation, thus the null hypothesis was supported.

3.4.10 Mean reading grade levels and type of organisation.

It was predicted that there would be a significant difference in mean RGL between webpages based on the type of the organisation. The results of a univariate ANOVA (one-way ANOVA) analysis showed no significant main effect of type of organisation on mean RGL, $F(1, 32) = .347, p = .569, \eta_p^2 = .01$. Hence, there is no statistically significant difference in RGLs based on type of organisation, which supports the null hypothesis.

3.5 Results Summary

In summary, 39 webpages fulfilled the search criteria in four ccTLDs, which were Google Germany, Google Austria, Google Switzerland, and Google Liechtenstein. Using the search criteria, no government webpages were retrieved in the German language. The webpages retrieved for the study were hosted by either commercial or non-profit organisations.

In the current study, all null hypotheses were supported except for two: that there is no significant relationship between the RGLs from the different RFs (the correlation) and that the mean RGL was not significantly greater than 6 (the one-sample t-test).

Some webpages in Germany and Austria had HONcode certification, but no webpage with multi-region site location and in Switzerland had HONcode certification. Moreover, most

of the webpages based on location had no HONcode certification. Hence, HONcode certification was unevenly distributed across the location of organisation, which did not support the hypothesis. Although the most commercial webpages had no HONcode certification, there were more commercial webpages with HONcode certification than webpages with HINcode certification from non-profit organisations. The distribution of webpages with HONcode certification between commercial and non-profit organisations was not even, which did not support the hypothesis. No significant difference in mean RGL was found between webpages that had HONcode certification and those that did not, which supported the hypothesis. In other words, webpages with and without HONcode certification did not make a difference in RGLs.

A significant positive relationship was found between RGLs generated by the six RFs, which supported the hypothesis. Results confirmed that all webpages analysed in this study had a mean RGL significantly higher than the recommended RGL of 6, supporting the hypothesis. Therefore, based on the mean RGL, individuals would need at least 12 years of education to comprehend the information provided on the webpages. No statistically significant difference was found in RGLs based on location of organisation, which did not support the hypothesis. Last, the mean RGL between webpages based on type of organisation was not significantly different, hence, the hypothesis was not supported.

Chapter 4: Discussion and Conclusions

4.1 Overview

The current study evaluated the readability of 39 hearing-related webpages in the German language using four ccTLDs and three hearing-related keywords. The purpose was to test several hypotheses about the readability and quality of hearing-related online information on webpages written in the German language. Readability was compared between locations of organisation (by country), and type of organisation (non-profit, and commercial). The proportion of webpages with and without HONcode certification was also assessed, based on location and type of organisation.

The results of the readability analysis indicated that hearing-related information on webpages in the German language is difficult to read. All webpages were written above the recommended 6th RGL, which means that the reader requires more than six years of education to comprehend the material. For the webpages assessed in this study, individuals required a minimum of 12 years of education, which was a consistent finding across the six different RFs used in this study. There were no significant differences in RGLs based on the type and location of the organisation. Most of the assessed webpages were of commercial origin rather than non-profit. The search criteria produced no government webpages. The assessed webpages came from all locations of organisation. Commercial and non-profit organisations were not significantly unevenly distributed across the different locations of organisation. Although most webpages had no HONcode certification, those webpages that did have HONcode certification had a German or Austrian origin, and came from commercial rather than non-profit organisations. Last, HONcode certification was not significantly related to the RGLs.

This chapter discusses these findings in relation to the relevant literature. It also outlines the clinical implications, limitations of the study, and future research suggestions.

4.2 Readability

Online hearing health-related information in the German language was difficult to read. In this study, the readability of online hearing health-related information in the German language exceeded the recommended 6th RGL. Several studies examined the readability of online health information on both local and national websites in the English language that related to paediatric patient education materials, Parkinson's disease, glue ear, various causes of diseases, common causes of death, and the emergency preparedness amongst the American deaf and hard of hearing and older adult populations (D'alessandro et al., 2001; Fitzsimmons et al., 2010; McInnes & Haglund, 2011; Neuhauser et al., 2013; Walsh & Volsko, 2008). These studies reported that the mean RGL was at or above the 9th RGL, which is above the recommended 6th RGL, therefore, in line with the current study results.

Similar results were found within audiology. The examination of the readability of four self-report tools, commonly used in audiology (the Hearing Handicap Inventory for the Elderly, Hearing Aid Performance Inventory, Hearing Handicap Inventory for Adults, and Abbreviated Profile of Hearing Aid Benefit); the evaluation of the readability of audiology reports written in English for parents; and the assessment of the readability of audiology- and speech-language pathology-related information provided on the ASHA website, all confirmed a RGL that is well above the recommended 5th to 6th RGL, which again is consistent with the current study results (Atcherson et al., 2014; Donald & Kelly-Campbell, 2016; Kelly-Campbell et al., 2012).

The current study found that, on average, people need 12 years of education to read and comprehend the information online related to hearing, written in the German language. The mean RGL of all the assessed webpages was 12.04 which is significantly higher than the recommended 6th RGL assessed on English materials (Doak et al., 1996; Safeer & Keenan, 2005; Wang et al., 2013; Weiss & Coyne, 1997). These results are consistent with Laplante-Lévesque, Brännström, Andersson and Lunner's (2012) findings in which USA individuals

who have HI and their significant other/s needed 11 to 12 years of education to read and comprehend online information. A 2015 systematic review conducted by Laplante-Lévesque and Thorén (2015) reported that 9 to 14 years of education is needed for people to understand the material related to HI.

The current study is also consistent with the limited research that has been done on the readability of online information in the German language. Similar to the ENT-related topics on German university and nonuniversity [*sic*] hospital websites (Luers et al., 2013; Meyer et al., 2014), the current study found that hearing-related online information written in the German language is comprehensible by individuals with university education only, that is 12 years of education or more. However, this inference is based on the two studies that have been conducted in Germany but not in the other German-speaking countries that were included in this study. Hence, the generalisation of these two study results is limited to Germany.

The results of the readability research on webpages written in the German and English languages cannot be directly compared because it is unknown yet whether the average RGL of all the German-speaking countries used in this study is also at 7th or 8th grade level. It is possible that the RGLs in the German-speaking countries differs from that of the English-speaking countries. At present there appears to be no readily available published data on the average RGLs in the German-speaking countries that have been used in this study.

The current findings are also consistent with the international literature on the readability of health information written in English (Caposecco et al., 2014; Safeer & Keenan, 2005). These studies also found that health information provided by physicians and clinicians, and printed hearing aid user guides are not written optimally for older adults and thus they may serve as a barrier to understanding health information to make better health choices. The information given to clients is frequently written above the 9th RGL that is too high for older adults because it is above the average USA adult 7th or 8th RGL, thus most USA adults are not

able to comprehend these online materials (Caposecco et al., 2014; Kutner et al., 2006). Additional impairment to hearing, such as cognitive and/or vision impairment makes it even more difficult to comprehend health information, increasing difficulty in accessing health care, and follow instructions from physicians (Safeer & Keenan, 2005).

Fifteen percent of all adults in the OECD countries, including Germany and Switzerland, have only very basic literacy skills that makes it difficult to keep up with the rising demands of the information age (OECD, 2000). Research in Europe suggests that there is a positive relationship between health literacy and education in Germany and Austria (Doyle et al., 2012). Hence, if the average RGLs of these German-speaking countries is also at or below the 7th grade, it can be predicted that most people with low education will have low health literacy, and as a consequence, they will not be able to comprehend the online materials written in higher than the recommended 6th RGL. As a result, the information provided on all of these assessed webpages in the German language would be of limited value to people with low health literacy (Atcherson et al., 2014; Donald & Kelly-Campbell, 2016; Kelly-Campbell et al., 2012).

In short, all the above-mentioned studies evaluating readability in the English and German languages consistently showed a higher RGL than the recommended 6th RGL for printed as well as online materials which makes them unsuitable for audiences with low health literacy. Despite the lack of research on the average RGL of the German-speaking countries, there is evidence to believe that information provided on the Internet is likely to be difficult to read and comprehend for the general public in both languages.

4.2.1 Reading grade levels and readability formulas.

Another finding of this study was the positive relationship between RGLs and RFs. This means that no matter which one of the six RFs was used, results consistently indicated

that individuals require an average of 12 years of education to be able to comprehend the material presented on the webpages.

As the nonparametric Spearman's Rho correlations showed (Table 4), the SMOG 1 and the Qu RFs always (100%) yielded the same results for each analysed text. The SMOG 1 uses a different algorithm for different languages when counting numbers based on how they sound out which is consistent with how the original SMOG treats numbers for the calculations (McLaughlin, 1969; Oleander Software, 2014). The only significant difference between the SMOG 1 and Qu is that the SMOG 1 uses a 30-sentence sample while the Qu uses a 100-word sample, otherwise they produce the results in the same way (Oleander Software, 2014). It can, therefore, be concluded that taking a slightly longer sample from the same text while using the same calculation procedure for the analysis, did not make any significant difference in the SMOG 1 and the Qu RGLs scores. This result is consistent with Fitzsimmons's (2010) findings in which webpage length in English did not affect the readability scores, hence, webpages with low word counts had similar reading difficulty to longer webpages. In contrast, Wang et al. (2013) found a 3 to 6 RGL difference using the SMOG RF to assess the readability levels applied to non-random and random word samples of varied sizes (100 words, 150 words, 3 sets of 100 word samples, 3 sets of 10 consecutive sentences, and the entire document) respectively, analysed by the Micro Power and Light Company Software. These findings were inconsistent with the current study.

In addition, there was a stronger relationship between the LIX 1 and SMOG 1/Qu ($\rho = .91$) than between LIX 1 and LIX 2 ($\rho = .66$). A stronger correlation would have been expected between LIX 1 and LIX 2 because the LIX 2 is a modification of LIX 1. The LIX 1 and the LIX 2 RFs showed the greatest variation in RGL scores compared to each other and they had the weakest correlation amongst the RFs. The current study found that, on average, the LIX 2 (adapted to the German language) generated a higher mean RGL than the LIX 1. The difference

in the RGL scores between the two RFs is supposed to be explained by the different logic used for assigning the grade-level scores (Oleander Software, 2014). The Readability Studio 2012.1 software did not disclose how the software assigns the RGL scores for the LIX 1 index (Oleander Software, 2014). Theoretically, the LIX 1 uses the same calculation procedure as the original LIX. If the RGL conversion chart developed by Anderson (1983), for the original LIX were followed, as displayed in section 2.3.4, the LIX 1 RF should generate a higher RGL than the LIX 2 for the same LIX index because the original LIX (and, therefore, LIX 1 that is based on the original LIX) assigns a higher RGL to the same LIX index score than the LIX 2. For example, if a text has a LIX index score of 30, the original LIX would classify it as 6th RGL while LIX 2 in the software would assign a 4th grade level score. Therefore, the LIX 1 RF in the software must calculate the LIX index and/or RGL scores differently from the original LIX because the mean RGL calculated by the LIX 2 RF was higher compared to the mean RGLs using the LIX 1. According to Anderson (1983, p. 492), “the use of publisher’s grade levels as a criterion is suspect unless we know how publishers assign them and how accurate they are”. As a result, it cannot be said that the LIX 1 is equivalent to the original LIX.

In short, the SMOG 1 and Qu RFs produced the same results. Although, the LIX 1 was referenced as the original versions of the LIX RF in the software, this statement could not be confirmed by the current study. Hence, the multiple RFs integrated in the software use different algorithms for the calculations that produce varying results compared to the original RFs, and this can even lead to the misrepresentation of the RGLs if not used and interpreted appropriately (Wang et al., 2013).

4.2.2 Omitted plus (“+”) signs in the Software.

In the Readability Studio 2012.1 software, four out of the six RFs provided a + sign to signal that the RGL is higher than the RFs could assess. After the RGL was generated by the

software, the + sign was omitted for the data analysis in SPSS. The LIX 1 and RIX 1 RFs added the + signs after the 13th grade level was reached. RIX 2 indicated it after the 14th grade level, and LIX 2 after the 15th grade level. However, the SMOG 1 and Qu RFs displayed the actual RGL with the highest RGL score of 18.3. This observation may suggest that the actual RGL scores, when using the LIX 1, LIX 2, RIX 1, and RIX 2, are higher than indicated by the software. It follows that these four formulas underestimated the actual RGL of the hearing-related webpages in the German language. Thus, these webpages may be even more difficult to comprehend than currently reported.

Wang et al. (2013) pointed out that for general literacy, readers only need to understand the gist of a story: however, in healthcare settings, superficial understanding can lead to misunderstanding of recommended treatments and to safety hazard resulting in suboptimal care. For instance, it is crucial for a patient to understand how to take prescribed medications. As a result, Wang et al. argue that RGL estimates from RFs with 100% comprehension levels should not be averaged with RGLs from RFs that have comprehension levels below 100% because the RGLs of the same text is interpreted differently. For instance, a RGL of 12 using the SMOG 1 with 100% comprehension means that the reader needs to understand the complete text at 12th RGL, while a RGL of 12 using other RFs with less than 100% comprehension means that the reader has to have a 12th RGL but it is not necessary for the reader to comprehend everything in the text. Although the current results showed an average RGL of 12 for all RFs, only the results of the SMOG 1 assessed the presented online information based on 100% comprehension (Wang et al., 2013). Thus, caution may need to be exercised when interpreting and comparing the RGLs of the RFs used in the study because they are based on different premises that may not be directly comparable. In addition, it is important to note that there is no published scientific data available on the SMOG 1 and the Qu RFs regarding their suitability and comprehension criteria.

Martin and Gottron (2012) held a contrary stance and argued that web documents are consumed differently from the classic printed materials. Consumers scan and select the information relevant to them instead of reading the material entirely, while ignoring other information, such as headings and advertisements. Because of this, it might be debatable whether a RF with 100% comprehension is more suitable than those with less than 100% comprehension for the assessment of online information.

4.2.3 Bullet points and formatting.

The analysed documents consistently contained bullet points or listings with hyphens, dashes, or numbers, in their original formatted presentation. Most RFs assume that the texts are written in prose style ending with a full stop, exclamation, or question mark (Redish, 2000). The lack of these signs may lead to an erroneous increase of the number of long sentences by joining two lines into one sentence while incorrectly inflating the RGLs (Oleander Software, 2014). Although research shows that listing and spacing in texts help with locating and comprehending information, differences in RGLs can also be exacerbated when different software settings for the connection of the lines are used (Wang et al., 2013). Hence, document formatting is an important factor when interpreting the results of RFs.

Wang et al. (2013) compared the readability of formatted (original format) and unformatted documents whereby bulleted lists, headings, titles, figures, and tables were removed from the documents. They found that the readability of unformatted documents retrieved from the Internet was 4 to 6 RGLs higher than the formatted (original) documents, analysed by the Micro Power and Light Company Software. Therefore, in the current study, the readability of online information related to hearing in the German language could be lower than it currently is, if unformatted texts were used.

Bullet points are a good example of how RGLs could be artificially inflated (Wang et al., 2013). When a listing in a text includes many one- or two-word bullets, the software will determine whether each bullet is counted as a sentence, as part of a sentence, and/or if they should be included in the word count for the RGL calculation. The Readability Studio 2012.1 software uses line chaining to overcome the artificial increase of RGLs due to bulleting (Oleander Software, 2014). *Chaining* is a deduction method in which the software recognises the full stops, question and exclamation marks to join the lines of text together as one sentence. With list items, headers and footers, the program did only chain lines if all of the following three criteria were met:

- A line is not terminated by a full stop (.), question mark (?), exclamation mark (!), and a colon (:);
- There are no blank lines following the line; and
- When the next line of the text is not tabbed over or bulleted.

If these criteria were not fulfilled, the analysed line was seen as an incomplete sentence which was set to be excluded from the analysis, if it contained less than 15 words. Thus, the exclusion of the incomplete sentences may have also influenced the current results due to potential formatting errors of the original texts.

The webpage flexikon.doccheck.com/de stood out of all the webpages with the highest mean readability score of 18.3, and was primarily made up of bullet points which was recognised by the software using the conditions of the line chaining. Based on this rule, the software recognised the bullet points which did not increased the RGLs. However, one reason for the highest readability score might be that this webpage used mainly one- or two-word bulleted keywords that were mostly jargon, such as *Otitis media*, *Morbus Menière* [Ménière's disease], and *Otoskopie* [Otoscopy], in which the searcher could click on the keyword to be directed to another webpage for more information. Research in the English language showed

that hearing health-related information on the Internet is difficult to read and understand due to jargon use reducing the readability of the text (Atcherson et al., 2014; Laplante-Lévesque et al., 2012; Sakai, 2013; Thomson & Hoffman-Goetz, 2007). In contrast, when Berland et al. (2001) analysed the same online texts with and without medical terminology, they found that the readability score reduced only by 0.3 RGL using the F-K formula. It is also important to remember that RFs do not account for non-text elements, for instance figures and pictures, despite that they help readers to comprehend difficult materials (Risoldi Cochrane et al., 2012).

4.3 Type and Location of Organisation

Most webpages retrieved from the German ccTLD examined in this study were hosted by commercial organisations (77%) rather than non-profit organisations (23%). The current study criteria did not retrieve any webpages controlled by the government (0%). Moreover, there was no significant difference in reading difficulty between the webpages based on the type and location of organisation.

When Laplante-Lévesque et al. (2012) examined information on websites in the English language for adults with HI and their significant other/s, they similarly found that the majority of websites (64%) were of commercial origin, followed by non-profit origin (21%), and government origin (15%). The study did not report any results about the readability of websites based on the type and location of organisation. In contrast, Fitzsimmons et al. (2010) analysed 100 webpages containing information about Parkinson's disease based on the types of organisation (commercial or non-profit) using three classifications for the country of origin (USA, UK, or other country). They found that the majority of the webpages (55%) had non-profit interests and only a minority of webpages had commercial origin (45%). In contrast to the current results, using the SMOG 1 RF, they found that commercial websites were significantly easier to read than non-profit websites ($p < 0.035$) and proposed that this is

because commercial organisations aim to target the widest possible commercial audience by reducing the obstacle of readability on their websites as much as possible. However, in line with the current results, the readability of websites with Parkinson's disease information were similarly poor, showing a RGL above the 14th grade, regardless of the location of organisation ($p = .25$). Potter (2015) conducted a study in New Zealand and he also found no significant difference in reading difficulty based on the location of organisation. Hsu (2017) had a different result and he reported that commercial webpages were easier to read than government and non-profit webpages. He also found that most webpages were commercial followed by non-profit and government webpages.

Lissman and Boehnlein's (2001) study found that almost two-third of the websites were commercially funded while one-third of the websites was non-profit. Hence, commercial websites appeared more frequently than non-profit websites amongst the first 20 search results. The placement of websites on the first page of search results by a search engine significantly increases the probability that a website will be visited. All other websites outside the listings of the major search engines exist "in a virtually inaccessible vacuum of cyberspace" (p. 1049). It follows, that because consumers tend to access websites mainly on the first page of search results, they are likely to encounter commercial websites more than all other types (Morahan-Martin, 2004).

One reason for the prevalence of commercial information in the Google search results may be the dominance of sponsored links (Walji et al., 2005). Walji et al. (2005) found that 39% of the results on the first page came from sponsored links. In order for a website to be listed and ranked high by a search engine, a website owner must pay for placement, and/or use certain keywords on the website, commonly used by searchers (Lissman & Boehnlein, 2001). Search engines rank websites based on the number of links they have to other websites and the number of times they were visited which, amongst other things, may artificially be increased

by the website owner by repeatedly clicking on their own websites. However, the artificial increase of higher placement may not provide consumers the desired information. Moreover, most websites containing health information are not created by medical professionals, thus the authors may not place as much emphasis on evidence based information as health professionals would, leading to reduced information quality and accuracy (Kaimal et al., 2008; Scullard et al., 2010).

In the current study, the assessed webpages came from all locations of organisations (multi-region site, Germany, Austria, and Switzerland). No one location was found that provided statistically significantly more results than other locations. Webpages with a multi-region site origin could be switched between, for example, German, Swiss, and Austrian domain names. An observation was made that during most of these switches, the only thing that changed was the ccTLD, such as .de, .ch, and .at, etc., while the text remained the same. It can be speculated that this may be due to similar hearing health system provided in these German-speaking countries in which the primary hearing care is provided by the public health insurance for no cost to the customer if an ENT specialist prescribed hearing devices for an individual (OESS, 2015; SGB-FSS Schweizerischer Gehoerlosenbund, 2017; Verbraucherzentrale, 2017, July). The information related to hearing healthcare on these websites can be used across different countries because they do not tend to mention country-specific details on the webpages, such as funding schemes and prices. Their explanation simply focuses on general hearing information which can be used across multiple countries because the science of hearing-related issues is well-grounded.

In the current study, the commercial and non-profit organisations were not significantly unevenly distributed across the different locations of organisations. For all locations of organisation, the majority of webpages were of commercial origin. Switzerland only retrieved commercial webpages, but there were only four webpages retrieved from Switzerland all

together. Nonetheless, the overall distribution of the webpages based on type of organisation was not significantly different.

Most information was retrieved from Google Germany and many of the webpages retrieved from other ccTLD were duplicates of these webpages that reduced the results to only four ccTLD to work with. When the keywords were put in the German ccTLD, it only retrieved information with the German ccTLD (.de). In contrast, the majority of the retrieved information at all other locations came from their own ccTLD, such as .ch, and .at, but it was a common occurrence to see some links with German ccTLD (.de) within the first 10 retrieved webpages on all other ccTLD, except from the Liechtenstein ccTLD (.li). All links retrieved from Google Liechtenstein used information from the German ccTLD (.de). One reason for this might be that Liechtenstein is a small country and they may have similar healthcare system and regulations compared to Germany. Hence, they can use the exact same information provided on the German webpages.

4.4 Wikipedia

According to the MSL Group (2012), a German public relations network, 74% of German consumers use the Internet to search for health-related information, followed by information gathered from the television (63%) and printed media (56%). They found that 55% of consumers use the non-profit website, Wikipedia, and 51% use websites from commercial health insurance providers to gather health information. Research from Stroll (2013, August), representing Mindline Media, a full-service market research institute in Germany, reported similar results in which 58% of consumers in Germany use Wikipedia as the first source of health information followed by other health websites (41%), such as netdoctor.de, and gesundheit.de, and insurance providers (37%) at the third place. McInnes and Haglund (2011) found that Wikipedia pages occurred most frequently in the search results when searching for

information on various causes of disease on the Internet (26%, $n = 92$) and were one of the hardest websites to read ($p < .001$). Law et al. (2011) reported that 80% of web searches for generic drug names came from Wikipedia. Ritchie et al. (2016) examined the readability of information on the Internet using the term *glue ear*. They reported that Wikipedia websites had the lowest readability scores. It is important to note that the information provided by Stroll (2013, August) and MSL Group (2012) may show a conflict of interest because they are commercial organisations. Moreover, their surveys were conducted only in Germany, therefore, the results cannot be generalised to the population of all German-speaking countries used in this study.

In the current study, the hearing-related keywords retrieved only two Wikipedia webpages out of the 39 webpages which may be due to the chosen keywords in this study. Often, the searched health conditions have multiple names (McInnes & Haglund, 2011). The simpler and more common a keyword is, the more likely it may be to retrieve information from Wikipedia because Wikipedia is written collaboratively by people around the world, with the goal of providing up-to-date health information for the general public (Heilman et al., 2011; Laurent & Vickers, 2009; Law et al., 2011; McInnes & Haglund, 2011). Moreover, after the flexikon.doccheck.com/de webpage, as described above, the two retrieved Wikipedia webpages had the highest RGL of all the 39 webpages. Hence, in line with Ritchie et al.'s (2016) study, Wikipedia webpages in the German language also had one of the highest readability scores.

The most frequently retrieved webpages were the commercial amplifon.com and amplifon.ch with four retrieved webpages, followed by netdokter.de and .at, [hoeren-heute.de](http:// hoeren-heute.de), hear-it.org/de, and apotheken-umschau.de with three retrieved webpages each. Figure 4 provides a review of all retrieved webpages. Hence, the current results were inconsistent with the frequent retrieval of Wikipedia webpages found in other research studies on English

websites; however, most of the retrieved webpages were of commercial origin which, again, is consistent with the literature in English.

4.5 HONcode Certification

Most webpages in the current study did not have HONcode certification. Those webpages that had HONcode certification originated from Germany and Austria, which did not support the hypotheses of even distribution. No significant difference between the location of organisation and HONcode certification could be found, most likely, due to the relatively small number of webpages with HONcode certification. These findings are consistent with Laplante-Levesque et al.'s (2012) study. Although they did not report the relationship between the HONcode certification and location of organisation, they found that 14% of the websites, containing information in the English language for adults with HI and their significant other/s, had HONcode certification. The current study similarly found that only 18% of the examined webpages had HONcode certification. In contrast, Risoldi Cochrane et al. (2012) examined online health information on 107 websites in the English language, from which 66% had HONcode certification. Last, Hsu (2017) examined the online hearing health information in the Chinese language and found that none of the websites had HONcode certification.

All of the retrieved webpages with HONcode certification were of commercial origin. None of the non-profit webpages had HONcode certification. Laplante-Lévesque et al. (2012) reported that commercial and non-profit websites were less likely to have HONcode certification when compared to government websites. However, the current study did not retrieve government webpages, therefore, the HONcode certification of the commercial and non-profit webpages could not be compared to government webpages. Risoldi Cochrane et al. (2012) compared USA government-funded and commercially-funded websites only, and reported that commercial websites are more difficult to read and comprehend than government-

funded websites ($p = .002$). Although Hsu's (2017) search terms retrieved mainly commercial websites, followed by non-profit, and government websites, none of the websites had HONcode certification.

Similar to Hsu's (2017) findings, in the current study, when a simple search was performed on the HON website, it showed a limited number of webpages with HONcode certification in the German language. However, it was observed that most of the webpages with HONcode certification, also had one or two more quality seals in addition to the HONcode certification. According to the *Institut für Qualität und Transparenz von Gesundheitsinformationen* (IQTG) [Institute for quality and transparency in health information] (2017, March), the most well-known consumer safety groups and quality seals in the German-speaking countries are HONcode certification, *afgis* [action forum health information system], *Stiftung Gesundheit* [health foundation], *Medisuch* [Medisearch], and *Webadressbuch* [web directory], of which the last two can be used free of charge. As it was mentioned in the introduction, the HONcode certification is used internationally while the *afgis*, *Stiftung Gesundheit*, and *Webadressbuch* is utilised only in Germany, and the *Medisuch* in all German-speaking countries (IQTG, 2017, March). The *Medisuch* and *Webadressbuch* certifications did not appear in the current study results. The webpages in the current study, that had a quality seal, originated from either Germany or Austria, but not Switzerland or Liechtenstein.

HONcode certification was not significantly related to the RGL score of the webpages in the current study. The small number of retrieved webpages with the HONcode certification had a RGL above the 10th grade in the current study. This finding means that webpages with and without HONcode certification had higher readability scores than the recommended 6th RGL and they are difficult to read for individuals with less than six years of education. Laplante-Lévesque et al.'s (2012) and Risoldi Cochrane et al.'s (2012) results similarly showed

no significant difference in the readability of websites with and without HONcode certification. Risoldi Cochrane et al. (2012) concluded that HONcode certification does not predict the readability of a webpage.

The HONcode aims to unify and standardise the reliability of health information on the Internet and guide the development of website content while establishing a set of rules to help users to assess the source of information and understand its purpose (Gagliardi & Jadad, 2002; Health On the Net Foundation, 2014; Morahan-Martin, 2004). There is no readily available clear definition of what quality encompasses. Multiple approaches have been used to evaluate the quality of information on the Internet (D'Auria, 2010). Most papers refer to the quality of information by examining the accuracy and reliability of online information to see whether the information informs or misinforms the reader (Bernstam, Shelton, Walji, & Meric-Bernstam, 2005). See for example Risoldi Cochrane et al. (2012), Barker et al. (2010), and Bernstam et al. (2005). Other papers encourage the reader to examine the credibility, authority, design, disclosure, and ease of use of the site to be able to make an informed decision about the website (D'Auria, 2010; Fox, 2006).

Neither the HONcode certification, nor the above-mentioned quality seals rate the quality and accuracy of the provided information (Health On the Net Foundation, 2014; IQTG, 2017, March; Morahan-Martin, 2004; Risoldi Cochrane et al., 2012). They do not guarantee that the information is complete and readable. Risoldi Cochrane et al. (2012) argued that readability is not a component of the HONcode certification but the HONcode certification may incorrectly be interpreted as the overall quality and reliability of a website (Brann & Anderson, 2002). It is still unclear whether information seekers are aware of the meaning of the HONcode certification and similar quality seals (Morahan-Martin, 2004). Because the HONcode certification does not require the improvement of readability on webpages, it might be one reason why there was no difference in RGLs between HONcode certified and non-

certified webpages in the current study. Thus, the current results suggest that webpages with and without HONcode certification are equivalently high in terms of readability scores, and it is not recommended to choose HONcode certified over non-certified webpages when looking for readable health information in the German language.

4.6 Clinical Implications

Atcherson, Zraick, and Hadden (2013) reported that audiologists have limited awareness of the average health literacy levels, the low readability of the clinic forms, and the consequences of low health literacy. However, audiologists may encounter clients, who have been informed by the Internet about hearing devices or generally about hearing problems before and after they see an audiologist (McMullan, 2006). The clinicians should be more aware of the poor quality and readability of online health information and expect that clients with an average education below the 6th grade may not be able to comprehend the information presented on the Internet (Nădășan, 2016). Low-income adults over the age of 60 years with no cognitive or visual impairments were shown to have a reading skill at 5th grade level and difficulty understanding written information from clinicians (Weiss, Reed, & Kligman, 1995). Moreover, it may be anticipated that people with low health literacy and HI may have even more difficulties understanding the health materials (Neuhauser et al., 2013). To overcome the mismatch between the demands of the healthcare system and the skills of the individuals, audiologists should be able to recommend websites to clients which have good quality and are easier to read and comprehend (Diaz et al., 2002; Morahan-Martin, 2004).

Research shows that the acknowledgement of the information and the client's effort to seek information results in greater client satisfaction (Bylund et al., 2007). Clinicians should also ensure that the client understands the information provided in the clinic, whatever time that takes (Weiss et al., 1994). Often, information from healthcare professionals given to clients

is too difficult for most clients to comprehend (Safeer & Keenan, 2005). Hence giving clients handouts does not mean they can comprehend the information. It is recommended to keep educational materials short, simple, and clear, presented with pictures (Mayeaux et al., 1996).

In contrast, it is also important that government organisations, and healthcare providers invest more in providing high-quality information to consumers in all communication materials (Nădăşan, 2016; WHO, 2013). Government agencies also need to make sure that all people have a solid health literacy foundation. Last, stakeholders involved in the functioning of the Internet should find ways to provide free access to online health information for the general public without compromising the quality and readability of information (Nădăşan, 2016).

4.7 Limitations and Future Research

Although the search strategy of the current study was planned carefully, people with HI and their significant other/s may search for health information on the Internet in the German language differently, maybe in a less systematic way than it was done in the current study. Although German-speaking informants were asked to identify keywords, these individuals were under the age of 60 years. It is possible that people with HI over the age of 60 years use different keywords for the Google searches. The use of simple rather than more sophisticated search terms may generate different results (Berland et al., 2001). As is usually the case, the searches in the current study were influenced by the personal Google search history of the author's laptop. This issue may be overcome by using a private browsing mode or a clean install in the future. Nonetheless, future studies may want to recruit informants who have an HI and are over the age of 60 years. In addition, these studies may want to use real participants from each German-speaking country, so they can perform the searches in their own ccTLD and select webpages based on their perception, not only based on systematic exclusion and

inclusion criteria, to represent a more realistic search environment and check against their real reading level.

Moreover, consumers tend to only access the first page of search results and use short phrases that are often misspelled. When real participants are used, this aspect of the participant characteristic could also be taken into account, in order to get a better sense of which webpages appear in the searches (Lissman & Boehnlein, 2001; Morahan-Martin, 2004). It cannot be said that the Google search results from the current study is the same as the search results would be from an average Internet user in Europe. Therefore, no conclusions can be drawn here about what people actually encounter when searching for these keywords, and about how well they can interpret the retrieved information (Berland et al., 2001).

The current study only objectively assessed the readability of online hearing health-related information as part of the quality assessment of the webpages in four ccTLDs in the German language. Future studies may consider to use the Cloze test to get real participant responses, which may be compared to the objective RGLs generated by the software in the German language context. However, we need to remember that the Cloze test should not be conducted with individuals with basic literacy skills as they may feel uncomfortable by the lengthy assessment (Friedman & Hoffman-Goetz, 2006). This subjective assessment of readability on the webpages would take some of the reader's characteristics into account (Bailin & Grafstein, 2001). Moreover, a content analysis, using DISCERN, may also give us further information about the accuracy and comprehensiveness of information on these webpages (Pusz & Brietzke, 2012). Hence, audiologists may be able to recommend good quality websites to their clients, based on both objective and subjective readability assessments.

The SMOG RF is recommended as the preferred measure of readability when assessing consumer-oriented online health materials because it provides the most accurate results due to its 100% comprehension rate (Fitzsimmons et al., 2010). It seems that the same can be said

when assessing online health information in the German language. Researchers should select the SMOG 1/Qu over other RFs for the assessment of online health information on webpages written in the German language. However, further research needs to be done to find out how the RFs in the Readability Studio software 2012.1 differ from the original RFs. In addition, further clarification by the software developers is needed about how some of the RFs in the Readability Studio software 2012.1 generate readability scores and assign RGLs. In addition, further research is needed to investigate how older individuals in the German-speaking countries search for and select health information on websites. Whether consumers in these countries also scan and select the information on webpages that are relevant to them instead of reading everything (Martin & Gottron, 2012), and if so, what are the reasons for not staying on a particular website. Older people may not select the same keywords or links as younger individuals (Risoldi Cochrane et al., 2012).

There are no clear guidelines regarding document formatting when calculating RGLs (Wang et al., 2013). In the current study, the copied and pasted texts in to the Word documents from the webpages retained the original format. However, if there were multiple blank lines or other formatting errors that were interpreted as longer sentences by the readability software, it may have artificially increased the RGLs (Redish, 2000). As a result, future research should make sure that a universal formatting rule is applied to all documents before the software analysis because there may be a difference in RGLs when formatted versus unformatted texts are analysed (Wang et al., 2013).

4.8 Conclusions

There is a generation of people that uses the Internet as the primary source of information, and therefore, it is essential to understand how people retrieve and evaluate online health information (Morahan-Martin & Anderson, 2000). In audiology, it is unknown whether

information on the Internet informs or misinforms adults with HI (Laplante-Lévesque et al., 2012). The current study contributes to the literature on the readability of hearing-related online health information in the German language. The results showed, consistent with other readability research in the English language, that webpages in the German language related to hearing health information are inaccessible and incomprehensible to people with six years of education or less because the readability of these materials exceed the recommended 6th grade level.

Audiologists need to expect to deal with clients who have poor health literacy and consume online health information that is difficult to comprehend and then deal with the consequences of poor health literacy on the outcome of hearing healthcare. However, the work that audiologists do with clients will only really be successful if clients can access and comprehend accurate information in a format that is easily understood and matched to their reading ability. Clients who understand their hearing healthcare well will make more informed decisions. This will empower clients, leading to greater client satisfaction. A successful outcome for hearing healthcare can be achieved by a genuine commitment and collaboration of audiologists, governments, and website developers to ensure that hearing healthcare information is accessible and comprehensible for everyone.

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Appendix A

Example of a Cloze test excerpt from Dale (1999, paragraph 2):

“_____ paper describes a pilot _____ that investigates the use _____ the cloze procedure to _____ test questions in algorithm _____. The cloze procedure is _____ prose-based technique used _____ measure the readability of _____ and students' reading comprehension.

Could you fill in the missing words exactly? The number of words replaced exactly can be used to measure an individual student's reading comprehension and to measure the readability of the prose selection itself.”

Appendix B

Informant text in the German language posted on Facebook:

“Hiermit moechte ich euch alle (meine deutschprechende Freunde) um Hilfe bitten.

Ich wuerede gerne so viele Bundeslaneder wie moeglich in Deutschland decken, und natuerlich auch andere deutschsprachigen Laender involvieren. Je mehr Vielfalt, umso besser fuer meine Studie. Die einzige Voraussetzung ist dass Deutsch eure Muttersprache ist!

Um was geht es?

Ich moechte herausfinden, was fuer Woerter man fuer eine Google-suche benutzen wuerde wenn man Probleme mit dem Hoeren hat und herausfinden moechte wo man Informationen und Hilfe bekommt. Was fuer Suchbegriffe wuerden Sie / wuerdest du verwenden?

Bitte schreibe alle Suchbegriffe unten ins Kommentarfeld die dir einfallen. Zusaetzlich, waere es gut wenn du in Klammern auch bemerken koenntest aus welchem Bundesland oder Land deine Antwort kommt.”

Informant text translation in the English language that was posted on Facebook:

“I would like to ask all my German-speaking fiends to participate and help me with my thesis project. I would like to cover as many regions as possible in Germany and of course any other German-speaking countries, if possible. The more variety I have, the better it will be for my study. The only requirement is that you need to be a native German-speaker!

What is it about?

I would like to investigate what kind of search words people would put in ‘Google Search’ when they have a hearing problem and they would like to know where they can get professional advice, information, and help. What search words would you use to look for such information?

Please write all the search words you can think of in the comment section below. In addition, it would be helpful if you could put in brackets the name of the region / country your comment is coming from.”