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Targeted Re-Instruction for Hearing Aid Use and Care Skills

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Abstract

Purpose: Approximately 30% of hearing aid owners do not wear their hearing aids. One of the main reasons reported for hearing aid non-use is that hearing aid owners cannot successfully use and/or care for their hearing aids (Lupsakko, Kautiainen, & Sulkava 2005; Popelka et al. 1998; Vuorialho, Karinen, & Sorri 2006). The primary purpose of the present study was to evaluate the benefit of identifying specific hearing aid use and care skills that a hearing aid user cannot perform or has difficulty performing and providing re-instruction on those specific skills. This is operationally defined in the present study as targeted re-instruction. A second purpose was to determine if adding targeted re-instruction to a hearing aid fitting would result in greater hearing aid satisfaction and more hours of daily hearing aid use. Last, factors that may influence an individual's learning and remembering of hearing aid use and care skills were also assessed.
Method: Twenty-six participants (13 experimental; 13 control) were included in this randomized control trial. All participants were new hearing aid users who had never worn or tried hearing aids before. Participants were fit with ReSound Linx 3D 962 RIC-style hearing aids for a four-week trial period and provided a standard hearing aid orientation. Participants assigned to the experimental group were also administered the Practical Hearing Aid Skills Test – Revised (PHAST-R; Desjardins & Doherty 2009; Doherty & Desjardins 2012) and provided targeted re-instruction. Hearing aid use and care skills were measured using the Hearing Aid Skills and Knowledge (HASK; Saunders et al. 2018) test immediately following the hearing aid fitting and then again at four weeks post-hearing aid fitting. The relationship between hearing aid use and care skills and measures of hearing handicap, hearing aid-related attitudes, and working memory were assessed. In addition, hearing aid satisfaction was measured at two and four weeks post-hearing aid fitting. Data logging was used to determine average daily hours of hearing aid use.

Results: Participants in the experimental group maintained their hearing aid use and care skills over the four week hearing aid trial, but participants in the control group showed a significant decline in their hearing aid use and care skills over the same time period. None of the factors assessed in the present study were significantly correlated to learning and remembering of hearing aid use and care skills. Also, no significant difference in average daily hours of hearing aid use was observed between the two groups of participants. Level of satisfaction was significantly different between the two groups at two weeks post-hearing aid fitting, but not at the end of the four week trial period. Last, it took an average of 9 minutes and 15 seconds (SD = 3 minutes and 13 seconds) to administer the PHAST-R app and provide targeted re-instruction.

Conclusions: Targeted re-instruction prevented a decline in hearing aid use and care skills after four weeks of hearing aid use. Participants who did not receive targeted re-instruction showed a decline in their hearing aid use and care skills after only four weeks of hearing aid use. This indicates that targeted re-instruction can help new hearing aid users maintain their hearing aid use and care skills over time. It took an average of less than 10 minutes to administer the PHAST-R app and provide targeted re-instruction.

TARGETED RE-INSTRUCTION FOR HEARING AID USE AND CARE SKILLS

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Introduction

Hearing Loss, Aging, and Memory

Prevalence and Effects of Hearing Loss.

More than 16% of American adults have some degree of hearing loss (Agrawal, Platz, & Niparko 2008; Zelaya, Lucas, & Hoffman 2015). The prevalence of hearing loss increases with age, and according to data reported by the American Speech-Language-Hearing Association (ASHA), 29% of adults aged 50-59 years; 49% of adults age 60-69; and 63.1% of adults older than age 70 have at least a mild degree of hearing loss in the frequencies important for speech (ASHA n.d.). As the population ages, the number of Americans with hearing loss is expected to grow substantially in the next 15 years. The proportion of U.S. adults over the age of 65 is expected to increase from less than 15% to more than 20% by the year 2030. Therefore, the number of people with hearing loss who are potentially eligible for hearing aids is expected to more than double from a current estimate of about 23 million people to 48.3 million people (Bainbridge & Wallhagen 2014). Hearing aids are the recommended intervention for most adults with age-related hearing loss, and hearing aids reduce the effects of hearing loss, which are numerous and far-reaching (Amieva, Ouvrard, Giulioli, Meillon, Rullier, & Dartigues 2015; Bisgaard & Ruf 2017; Chisolm et al. 2007; Ciorba, Bianchini, Pelucchi, & Pastore 2012; Ferguson, Kitterick, Chong, Edmondson-Jones, Barker, & Hoare 2017).

Many of the effects of untreated hearing loss can be interpreted through the World Health Organization's (WHO) International Classification of Functioning, Disability, and Health (ICF) framework. In the ICF framework, disability is an umbrella term that encompasses impairments, activity limitations, and participation restrictions (WHO 2002). An impairment is a problem with body function or structure (i.e. damaged hair cells which result in a hearing loss). An activity limitation is a challenge that a person may have executing an activity as a result of an impairment (i.e. difficulty following a conversation in the presence of background noise due to a hearing loss). Participation restriction refers to the difficulty a person may encounter engaging in life situations because of an activity limitation (i.e. avoiding social gatherings because of an inability to participate in group conversations).

Activity limitations reported by Arlinger (2003) include a loss of or reduction in the ability to detect sounds, difficulty recognizing speech, problems localizing sound, trouble understanding reverberant speech, difficulty understanding speech in background noise, and increased listening effort and fatigue. Other effects described in Arlinger's (2003) review include withdrawing from social situations, social isolation, declining invitations to parties and group gatherings, and limiting visits to theaters, churches, lectures, etc. These effects of hearing loss could all be classified as participation restrictions. Arlinger (2003) reported that even a slight degree of hearing loss can cause problems with speech understanding in noise and have a negative emotional effect on individuals with hearing impairment.

Ciorba et al. (2012) conducted a systematic review of literature relating to the effects of age-related hearing loss on quality of life in older adults. Similar to Arlinger (2003), Ciorba et al (2012) identified emotional effects of hearing loss, including loneliness, isolation, dependence, frustration, depression, anxiety, anger, embarrassment, frustration, and guilt, as well as social effects such as withdrawing from social situations and blaming others for communication problems and breakdowns. Hearing loss can also result in problems in personal relationships and increased dissatisfaction with family life (Arlinger 2003; Ciorba et al. 2012). In addition to the social and emotional effects of untreated hearing loss, the reviews by both Arlinger (2003) and Ciorba et al. (2012) detailed the relationship between untreated hearing loss and cognition and risk for dementia.

Arlinger (2003) noted that a significant correlation between hearing loss and reduced cognitive function was a common finding of many studies included in his review. Similarly, Ciorba et al. (2012) described confusion, difficulty focusing, and distracting thoughts as part of the cognitive effects of hearing loss. Lin has conducted multiple studies which have more clearly elucidated the relationship between hearing loss and cognitive function (Lin 2011; Lin et al. 2011a; Lin et al. 2011b; Lin 2012). For example, Lin et al. (2011a) examined the link between hearing loss and cognitive function in adults enrolled in a prospective study on the effects of aging, the Baltimore Longitudinal Study of Aging (BLSA). Specifically, they investigated the association between hearing loss and scores on cognitive tests that measured mental status, memory, and executive function. Lin et al. (2011a) found that greater degrees of hearing loss were associated with lower scores on tests of memory and executive function.

In another study Lin (2011) analyzed data from the National Health and Nutritional Examination Survey to examine the association between hearing loss and cognition in a sample representative of older adults in the United States. Performance on the Digit Symbol Substitution Test (DSST), a nonverbal measure of processing speed and executive function, was used as a measure of cognitive function. Lin (2011) found that hearing loss was associated with poorer performance on the DSST. Specifically, Lin (2011) concluded that the reduction in cognitive performance associated with a hearing loss of only 25 dB was equivalent to the reduction in cognitive performance associated with aging seven years.

There is also an association between hearing loss and being at a greater risk for dementia. Lin et al. (2011b) explored the association between hearing loss and incident dementia in a cohort of subjects included enrolled in the BLSA. The investigators controlled for sex, age, education, diabetes, smoking, and hypertension and found that hearing loss was significantly associated with dementia (Lin et al. 2011b). It has also been found that compared to individuals with normal hearing, individuals with mild, moderate, and severe hearing loss are two, three, and five times, respectively, more at risk for developing dementia (Lin 2012). Multiple theories have been proposed to explain the relationship between hearing loss and reduced cognitive function (Committee on Hearing Bioacoustics and Biomechanics 1988; Humes, Busey, Craig, & Kewley-Port 2013; Lin et al. 2013; Lindenberger & Baltes 1994; Pichora-Fuller 2003; Schneider & Pichora-Fuller 2000; Wayne & Johnsrude 2015), however little research has been dedicated to exploring how reduced cognitive function may affect a person's ability to use hearing aids effectively.

Aging and Memory.

For adults with age-related hearing loss, cognitive function may be affected not only by the hearing loss itself, but also by the aging process. Working memory is one such area that has been shown to be affected by age, and also to be important for speech understanding (Akeroyd 2008; Aydelott, Leech, & Crinion 2010; Park et al. 1996; Pichora-Fuller, Mick, & Reed 2015; Pichora-Fuller, Schneider, & Daneman 1995; Salthouse 1994; Schneider, Daneman, & Pichora-Fuller 2002). Working memory can be defined as a capacity-limited system where information is temporarily stored as it is processed and manipulated for more permanent storage in long-term memory (Yumba 2017). The concept of working memory evolved from the concept of short-term memory, which Baddeley (2010) defines as, "the temporary storage of small amounts of information over brief periods of time."

Working memory capacity is most commonly assessed using working memory span tests (Conway, Kane, Bunting, Hambrick, Wilhelm, & Engle 2005), including the Counting Span test (Case, Kurland, & Goldberg 1982), the Operation Span test (Turner & Engle 1989), and Reading Span test (Daneman & Carpenter 1980). The Reading Span test (Daneman & Carpenter 1980) was the first task developed to measure both the storage and processing aspects of working memory (Conway et al. 2005). The Reading Span test requires test subjects to read sentences and judge their veracity, and Daneman and Carter argued that this reading component was a necessary component of a working memory span task if a goal of that task was to be able to predict reading ability. Turner and Engle later developed the Operation Span test (Turner & Engle 1989), which requires test subjects to solve mathematical equations, to test their belief that working memory capacity is independent of the actual processing component of the span task. They demonstrated that reading ability could be predicted from a working memory span test even if the processing component was not a reading task (Turner & Engle 1989). The Counting Span test involves a counting task as the processing component (Case et al. 1982), and therefore, due to the relative simplicity of this task, has been most commonly used when assessing working memory in children (Conway et al. 2005). These working memory span tests have been shown to have good reliability and validity in numerous studies, and research has also demonstrated the importance of the processing components of these tests compared to short term memory tests which include no processing task (Conway et al. 2005). Working memory span tests are better predictors of general intellectual ability than short term memory tests which do not include a processing component (Conway et al. 2005).

Working memory plays a role in speech comprehension in that listeners must hold earlier parts of the spoken message in their working memory in order to relate them to later parts of the message (Cohen 1987). Working memory and speech processing have both been shown to decline with age. For example, Park et al. (1996) administered a battery of cognitive tests to 301 participants between 20 and 90 years of age in order to examine cognitive factors thought to influence long-term memory function. They found that working memory and processing speed best explained age-related variations in memory function and concluded that processing speed and working memory are central to understanding age-related changes in cognition (Park et al. 1996).

In order to compensate for these age-related changes in working memory function, older adults may rely more heavily on contextual cues (Aydelott et al. 2010; Desjardins 2011). These cues can provide additional information which can aid in speech understanding. Aydelott et al. (2010) described the results of their pilot study of 21 adults between the ages of 18 years old and 40 years old and 11 adults older than 50 years of age. Participants were asked to identify one-syllable target words which were always the last word in a sentence. Sentences were either neutral (i.e. “The next item is …”), congruent (i.e. “There are seven days in a WEEK”), or incongruent (i.e. “She hung the painting on the BEAR”), and half of the sentences were presented in quiet while the other half were presented in the presence of competing speech. The results of their study showed that when identifying speech in quiet, older adults depended more on contextual information than younger adults. Similarly, Desjardins (2011) reported that older adults showed greater differences in performance scores on a speech identification task in high context conditions versus low context conditions compared to younger adults, suggesting that older adults benefited more from contextual clues regardless of their hearing status. However, relying on context cues when an older adult is being fit with hearing aids for the first time may not be as helpful because the terminology used by the audiologist may be new or unfamiliar to them.

Working memory is important for learning and remembering new information. For example, high working memory capacity is associated with better performance on memory tasks (Hambrick & Engle 2002). Hambrick and Engle (2002) asked younger and older adults to listen to simulated radio broadcasts of baseball games and answer questions about the games. They reported that high working memory capacity was associated with better memory performance in both older and younger adults. They also reported that older age was associated with poorer memory performance, and that prior knowledge of the topic did not mitigate this effect (i.e. older adults had poorer recall of the baseball games even if they had extensive knowledge about baseball; Hambrick & Engle 2002). These findings can be applied to the learning and remembering of hearing aid use and care information. For example, Hambrick and Engle's (2002) findings suggest that hearing aid users who are older and have limited working memory capacity may struggle to remember important hearing aid use and care information, even if they have prior knowledge of that information.

Desjardins, Alicea, and Doherty (2018) reported that when working memory was measured using the Digit Span Test, a subtest of the Wechsler Adult Intelligence Scale (Wechsler 1997), participants' working memory scores were significantly related to their ability to use and care for their hearing aids such that participants with poorer working memory scored lower on a measure of their ability to use and care for their hearing aids, regardless of whether they were new or experienced hearing aid users. Desjardins et al. (2018) used the Digit Span Test because it was easy and quick to administer in a clinical setting. However, the Digit Span Test requires participants to listen to speech stimuli, which could be difficult for some people with hearing loss. Therefore, a working memory measure such as the Reading Span test, which does not use an auditory stimulus, may provide a more reliable measure of working memory in adults with hearing loss.

Hearing Aid Use in Adults

Benefits of Hearing Aids.

It is important to consider the influence of working memory function on adults' ability to use hearing aids because hearing aids are the recommended intervention for most adults with sensorineural hearing loss. The benefits and effectiveness of hearing aids are well-established.

Hearing aids have been shown to improve communication, reduce the psychosocial consequences of hearing loss, and mitigate some of the effects of hearing loss on cognitive function (i.e. hearing aids reduce activity limitations; Amieva et al. 2015; Bisgaard & Ruf 2017; Chisolm et al. 2007; Ciorba et al. 2012; Ferguson et al. 2017). Ferguson et al. (2017) recently published a review of the evidence supporting hearing aid use by adults with mild to moderate hearing loss. They reviewed evidence from five randomized controlled trials on hearing aid use and drew three primary conclusions. First, they concluded that hearing aids have a positive effect on adults' ability to participate in everyday situations (i.e. hearing aids are effective in reducing participation restrictions). Second, they concluded that hearing aids have a positive impact on adults' general quality of life (i.e. physical, social, emotional, and psychological well-being). And third, hearing aids have a significant positive effect on adults' ability to listen to other people (Ferguson et al. 2017).

Chisolm et al. (2007) also conducted a systematic review on the benefits of hearing aids, specifically examining the effects of hearing aid use on health-related quality of life in adults. Their review consisted of 16 studies that were randomized controlled trials, quasi-experimental controlled trials with non-randomized, parallel group, or crossover designs, or well-designed non-experimental studies. The investigators noted that outcomes for hearing aid interventions measured with generic tools were less robust than those measured with tools specific to hearing loss (Chisolm et al. 2007). Like Ferguson et al. (2017), Chisolm et al. (2007) concluded that hearing aid use improves quality of life for adults with sensorineural hearing loss by mitigating the social, emotional, and psychological effects of hearing loss. Desjardins and Doherty (2017) also reported positive social, emotional, and psychological effects of hearing aid use. They fit 24 adults with mild to moderate bilateral sensorineural hearing loss with hearing aids for a six week period and found that using hearing aids for six weeks significantly reduced participants' hearing handicap and resulted in positive effects on participants' attitudes towards wearing hearing aids (Desjardins & Doherty 2017).

Bisgaard and Ruf (2017) analyzed data from the 2009 and 2015 EuroTrak surveys to determine the prevalence of hearing loss, trends in hearing aid adoptions, and benefits of hearing aid use. They found that the EuroTrak survey data revealed that people with hearing loss who do not wear hearing aids experience more symptoms of depression than people with hearing loss who do use hearing aids (Bisgaard and Ruf 2017). They also reported that hearing aids may reduce forgetfulness, which they found to be related to hearing loss, as well as listening effort and fatigue (Bisgaard and Ruf 2017) .

Amieva et al. (2015) also found that hearing aid use has positive effects on cognitive function. They conducted a prospective population-based study of 3,670 individuals who were followed for 25 years. Participants self-reported as having "no hearing loss," "moderate hearing loss," or "major hearing loss" (Amieva et al. 2015). At baseline, individuals with hearing loss (of all degrees) performed poorer on the Mini-Mental State Examination (MMSE), a measure of global cognitive performance, compared to the control group (with no hearing loss). Over the course of the 25-year study, individuals with hearing loss who did not use hearing aids showed a greater decline in cognitive abilities compared to individuals with normal hearing and individuals with hearing loss who used hearing aids. Additionally, participants who used hearing aids showed no differences in cognitive decline when compared to participants without hearing loss. Therefore, the investigators concluded that hearing aid use abates cognitive decline (Amieva et al. 2015). In summary, hearing aids have significant and important benefits on the cognitive function of those who wear them.

Reasons for Non-Use.

Despite the benefits of hearing aids, there is a high prevalence of hearing aid non-use. Only 30% of adults over the age of 70 who could benefit from hearing aids own them (NIDCD 2014), and rates of non-use among hearing aid owners are also high (Lupsakko, Kautiainen, & Sulkava 2005; Popelka et al. 1998; Vuorialho et al. 2006). In a population-based cohort study of 1629 adults ages 48 to 92 conducted in Beaver Dam, Wisconsin, Popelka et al. (1998) found that nearly one in three adults fit with hearing aids no longer used them. Lupsakko et al. (2005) conducted a population-based survey of 601 adults over the age of 75 and found that nearly one quarter of hearing aid owners reported non-use. Vuorialho et al. (2006) reported that only 6 months after being fitted with a hearing aid, 9% of those fitted reported that they never used their hearing aids and nearly 30% reported that they only occasionally used their hearing aids.

McCormack & Fortnum (2013) conducted a literature review on hearing aid non-use and found that the reasons hearing aid owners do not use their hearing aids could be grouped into the following general categories: issues with hearing aid use, care, and maintenance; concerns about hearing aid value/speech clarity; poor fit or discomfort; attitude; device, situational, financial, or psychosocial factors; interactions with healthcare professionals; concerns about appearance; ear problems or infections; and pressure from family to get hearing aids.

Difficulty with use, care, and maintenance of hearing aids was one of the most common reasons for hearing aid non-use identified by McCormack & Fortnum (2013). Care and maintenance was reported as a reason for hearing aid non-use in eight of the ten studies included in McCormack & Fortnum's (2013) scoping study. Care and maintenance was reported as the most common reason for hearing aid non-use in Öberg et al.'s (2012) survey of 346 older adults. Lupsakko et al. (2005) found that the second most common reason for hearing aid non-use was because the hearing aids were "too difficult to use." Over 20% of hearing aid non-users reported not using their hearing aids for this reason (Lupsakko et al. 2005). Gianopoulos, Stephens, &

Davis (2002) followed up with adults who had been fit with hearing aids 8 to 16 years earlier. They found that 59% of non-users cited hearing aid handling difficulties as being among their reasons for non-use.

Difficulty with using, caring for, and maintaining hearing aids is a major reason for non-use among adults who own hearing aids. These difficulties are even more prevalent in nursing home populations. Cohen-Mansfield & Taylor (2004) conducted structured interviews with nursing home resident-caregiver pairs. They found that nearly 50% of nursing home residents found their hearing aids to be too hard to put in or inconvenient to use (Cohen-Mansfield & Taylor 2004). Additionally, 65% of nursing home residents were identified as needing support with changing hearing aid batteries and/or putting hearing aids on and taking them off (Cohen-Mansfield & Taylor 2004).

Other commonly reported reasons for non-use, such as dissatisfaction with the volume of their hearing aids or how the hearing aids perform in background noise, may also be manifestations of difficulty with hearing aid use. For example, data from the MarkeTrak V survey showed that difficulty with volume control was among the top 10 reasons for hearing aid non-use (Kochkin 2000). Additionally, dissatisfaction with hearing aid performance in background noise was the second most common reason for hearing aid non-use (Kochkin 2000). It is possible that hearing aid non-users who are dissatisfied with how their hearing aids work in background noise actually do not know how to use their hearing aids in background noise (e.g. do not know how to turn on the directional microphones and/or switch into a noise program). Although automatic switching into the noise program is available in many modern hearing aids, this feature may not be activated for all users and/or the hearing aids may not always appropriately identify that they are in a noisy listening situation and switch accordingly. Similarly, non-users who report that their hearing aids are too loud (or not loud enough) may not realize that they may have access to volume control and/or may not know how to use the volume control.

There is a clear pattern of difficulty with hearing aid use, care, and maintenance as a major contributor to non-use. Several studies have suggested that this common reason for hearing aid non-use could be addressed with re-instruction and informational counseling (Ferguson, Brandreth, Brassington, Leighton, & Wharrad 2016; Gianopoulos et al. 2002; McCormack & Fortnum 2013; Vuorialho et al. 2006). Informational counseling is providing patients and their caregivers and/or families with information about their hearing loss and/or hearing aids, including information about use, care, and realistic expectations for hearing aid use (ASHA 2008). McCormack & Fortnum (2013) summarized that hearing aid non-users rejected their aids for "reasons amenable to better training in use of the aid." Similarly, Vuorialho et al. (2006) found that follow-up informational counseling on hearing aid use conducted 6 months post-hearing aid fitting resulted in a significant decrease in the number of non-users at 12 months post-fitting. There was, however, no control group in Vuorialho et al.'s (2006) study, so it is unclear as to whether the reduction in the number of non-users at 12 months post-fitting was a result of the counseling itself, or rather a result of the follow-up appointments and increased contact with the audiologist.

Hearing Aid Handling Skills

Hearing Aid Orientation & Counseling.

Informational counseling is typically provided to hearing aid users during a hearing aid orientation. Clinical audiology practice guidelines developed by both the American Academy of Audiology (AAA; Valente et al. 2006) and the American Speech-Language-Hearing Association (ASHA n.d.) dictate that all hearing aid users should receive a hearing aid orientation when new hearing aids are dispensed. The purpose of a hearing aid orientation is to teach hearing aid users the information they need to maximize their benefit from the hearing aids (AAA 2015). Audiologists typically give the patient practical information about the use and care of hearing aids, as well as counseling on realistic expectations and/or listening strategies (ASHA n.d.). Common hearing aid orientation topics include: hearing aid landmarks; insertion and removal of the hearing aid; device features (i.e. programs/program button, volume control, directional microphone settings, etc.); cleaning of the hearing aid and dome/earmold; battery management and safety; storage of the hearing aids; managing feedback; telephone use; moisture control; repair procedures; and warranty information (AAA 2015; ASHA n.d; Reese & Hnath-Chisolm 2005).

All of this information is typically covered during hearing aid orientations within the Veterans Affairs (VA) health system (Reese & Hnath-Chisolm 2005). The VA health system is the largest single purchaser of hearing aids in the United States, dispensing about 20% of all hearing aids sold in the U.S. (Staab 2015; Strom 2017). This means that at least one-fifth of hearing aid users in the U.S. receive a hearing aid orientation consisting of this information when they are fitted with hearing aids.

The benefits of spending the time to provide patients with a hearing aid orientation have been well-documented. Valente et al. (2006) cite evidence that patients provided with this information during a hearing aid orientation are less likely to return their hearing aids, and they report higher levels of hearing aid satisfaction (Kochkin 1999, 2002; Northern & Beyer 1999). Kemker & Holmes (2004) performed a study with 45 participants recruited from a VA hospital who were all new hearing aid users. In this study, one-third of the participants received a hearing aid orientation (consisting of information about their hearing loss and care and maintenance of their hearing aids) prior to being fit with hearing aids, one-third of the participants received the same hearing aid orientation after being fit with hearing aids, and one-third of the participants received no hearing aid orientation at all. Adults younger than age 66 who received a hearing aid orientation prior or post-fitting were significantly more satisfied with their hearing aids than adults in the control group who did not receive a hearing aid orientation (Kemker & Holmes 2004). Additionally, patients who received a hearing aid orientation and were identified as having greater degrees of initial disability (as measured by the Glasgow Hearing Aid Benefit Profile) were significantly more satisfied than those who received no hearing aid orientation (Kemker & Holmes 2004).

Recently, Humes et al. (2017) also reported on the benefits of hearing aid orientations. Humes et al. (2017) used a measure called the Practical Hearing Aid Skills Test - Revised (PHAST-R; Desjardins & Doherty 2009; Doherty & Desjardins 2012) to assess hearing aid use and care skills in their randomized double-blind placebo-controlled clinical trial which compared an "over-the-counter" (OTC) hearing aid fitting approach (i.e. participants were provided with a user manual but did not receive a hearing aid orientation) to an audiology best-practices fitting approach (i.e. participants were provided with a 45-60 minute hearing aid orientation). They compared PHAST-R scores among three groups: a group fit with hearing aids using the OTC or "consumer-decides" approach (CD group), a group fit with hearing aids using the audiology best-practices approach (AB group), and a group fit with placebo hearing aids (i.e. hearing aids that did not amplify sound; P group; Humes et al. 2017). The PHAST-R was administered to all participants six weeks after being fit with hearing aids. Humes et al. (2017) reported that participants who did not receive a hearing aid orientation (i.e. the CD group) had lower scores on the PHAST-R than participants who did receive a hearing aid orientation (i.e. the AB and P groups). In summary, hearing aid orientations result in better hearing aid outcomes, including better hearing aid use and care skills and higher levels of hearing aid satisfaction.

Hearing aid orientations have several challenges, though. For example, Nair & Cienkowski (2010) recorded and transcribed 12 randomly selected hearing aid orientation sessions and then analyzed the dialogue between the patients and clinicians. They used the Flesch-Kincaid reading level formula, which provided an approximation of a patient's health literacy, as well as a measure of the level of the language used by the audiologist during the orientation. They found that in nearly all cases, audiologists presented hearing aid orientation information at a Flesch-Kincaid level that was more advanced than that of the patient (Nair & Cienkowski 2010). This means that most patients probably did not understand at least some of the information that was presented during the hearing aid orientation. In addition, large amounts of new and unfamiliar information are disseminated in a typical hearing aid orientation session (Reese & Hnath-Chisolm 2005). Although the hearing aid orientation may be a significant portion of the total time spent with a patient during a hearing aid fitting appointment, it also may not be enough time for patients to fully comprehend and remember the information they are given. The sheer amount of new information presented during a hearing aid orientation may overwhelm patients, and patients are not likely to recall all of the new information taught during the hearing aid orientation (Margolis 2004).

Patient recall of hearing aid-related information.

Margolis (2004) reviewed research both outside of and within the field of audiology and concluded that new hearing aid users may have difficulty remembering all of the information presented during a hearing aid orientation. Kessels (2003) found that 40-80% of medical information provided to patients is immediately forgotten. Furthermore, half of the information that patients do recall is remembered incorrectly (Kessels 2003; Margolis 2004). Patient recall of medical information is inversely related to the amount of information presented such that presenting greater amounts of information yields lesser amounts of remembered information

(Kessels 2003). Margolis (2004) reported that although patients remember only a small amount of the information taught to them at a hearing aid fitting, that information is recalled correctly for at least a few weeks.

Reese & Hnath-Chisolm (2005) assessed the amount of hearing aid use and care information that is remembered immediately following and one month after a hearing aid orientation using a multiple-choice method. On average, less than 80% of information was remembered (Reese & Hnath-Chisolm 2005). This study is not necessarily representative of the difficulty that patients may experience remembering hearing aid use and care information in real life situations because the multiple-choice assessment method they used could provide cues and only requires recognition of information versus free recall of information. Ferguson et al. (2016) reported that El-Molla et al. (2012) used a free recall method to assess recall of hearing aid-related information and they found that half of the information was forgotten within 6 weeks. Patient recall of hearing aid use and care information is affected primarily by patient factors, clinician factors, and presentation factors (Margolis 2004).

Patient factors.

An example of a patient factor that may affect recall of information is familiarity with hearing loss. Patients who are already familiar with hearing loss because they have a friend or family member with hearing loss, have been to see an audiologist in the past, and/or have professional experience with hearing loss are more likely to have better recall of audiology-related information (Margolis 2004; Reese & Hnath-Chisolm 2005). It has been hypothesized that age, another patient factor, may be related to patient recall of audiology-related information, but Reese & Hnath-Chisolm (2005) did not find age to be a predictor of patient recall of hearing aid orientation information in their study of 100 veterans age 56 to 88 (M = 71.4, SD = 7.1).

Other patient factors include a patient's level of hearing handicap due to their hearing loss and a patient's attitude towards hearing loss and hearing aids. It is not yet known whether a patient's level of hearing handicap and/or hearing aid-related attitudes are related to their recall of hearing aid use and care information, but it has been shown that these factors are significantly related to a person's motivation to take action for their hearing problems (Alicea & Doherty 2017). For example, adults who experience greater levels of emotional distress and inadequacy and report greater social restrictions due to their hearing loss are more motivated do something about their hearing problems. Similarly, adults who have more positive and favorable hearing aid-related attitudes (e.g. adults who do not minimize their hearing loss) are also more motivated to take action to address their hearing problems (Alicea & Doherty 2017). Therefore, it is reasonable to hypothesize that adults who are more motivated to take action for their hearing problems might also be more committed to learning and remembering the information needed to use their hearing aids effectively. If this were the case, then hearing handicap level and/or hearing aid-related attitudes may also be related to patient recall of hearing aid use and care information.

Clinician factors.

Clinician factors such as the clinician's demeanor, the clinician's communication techniques, and the level at which clinicians present hearing aid orientation information also have an impact on patient recall of audiology-related information (Margolis 2004). Additionally, clinicians should be cognizant of presenting hearing aid orientation information at a speed at which patients can understand and absorb the information. There is an enormous amount of information to be presented during a hearing aid orientation, and clinicians commonly report that they have an inadequate amount of time to follow best practices (Palmer 2009). There may be ways to more efficiently instruct and counsel patients on hearing aid use and care during the initial hearing aid orientation, and this may save time in the long run. For example, poorly maintained hearing aids are the most common reason that patients return for repair appointments (Block 2001), but if a patient has a clear understanding of how to care for and maintain their hearing aids then they will be less likely to need hearing aid repairs.

Presentation factors.

As previously stated, the more information presented, the lower the proportion of information recalled (Margolis 2004; Kessels 2003). Additionally, information presented first benefits from the primacy effect, meaning that it is remembered better than information presented later on in a hearing aid orientation (Margolis 2004). Mode of presentation (i.e. oral versus written presentation of information) of hearing aid use and care information is an important consideration, as well. Considering mode of presentation is especially important when working with patients with hearing loss as a patient's inability to hear all of the information presented during a hearing aid orientation could contribute to decreased recall of the information (Reese & Hnath-Chisolm 2005).

However, relying entirely on written materials such as hearing aid user manuals is also not ideal for practical reasons and because it has been shown that most hearing aid user manuals are written at a level that is too complex for the average hearing aid user to fully understand (Nair & Cienkowski 2010). Caposecco, Hickson, Meyer, and Khan (2015) showed that hearing aid user guides provided by the manufacturer were inferior to a hearing aid user guide modified to have a lower reading grade level, a larger font size, more graphic images, and less technical information. These modifications reflect best practice guidelines for health literacy (Caposecco et al. 2015). Participants who were provided with the modified user guide were significantly better able to perform hearing aid use and care tasks including inserting the hearing aid, using the hearing aid with the telephone, adjusting the hearing aid program settings, and cleaning the hearing aid (Caposecco et al. 2015). In Caposecco et al. (2015), hearing aid use and care skills were measured using the Hearing Aid Management (HAM) test, a tool developed for the study based on the PHAST-R (Desjardins & Doherty 2009; Doherty & Desjardins 2012). The HAM test requires hearing aid users to perform seven hearing aid use and care tasks taken from the PHAST-R.

Measuring Hearing Aid Use & Care Skills.

The HAM test and the PHAST-R are two of the various tools that have been developed to measure hearing aid use and care skills. Bennett, Taljaard, Brennan-Jones, Tegg-Quinn, and Eikelboom (2015) conducted a systematic review of surveys that evaluate hearing aid use and care skills. This systematic review included surveys specifically designed for measuring hearing aid use and care skills, as well as surveys that were designed to measure other outcomes, such as hearing aid satisfaction, but included at least one item that assessed some aspect of hearing aid handling (Bennett et al. 2015). Bennett et al. (2015) identified 12 surveys as having at least one item that assessed hearing aid use and care skills. These surveys were: the PHAST-R (Desjardins & Doherty 2009; Doherty & Desjardins 2012); the MarkeTrak survey (Kochkin 1990); the Hearing Aid Users Questionnaire (HAUQ; Dillon et al. 1999); the Hearing Instrument Operation Checklist (HIOC; Kemker 1999); the Satisfaction with Amplification in Daily Life (SADL; Cox & Alexander 1999); the Effectiveness of Auditory Rehabilitation (EAR; Yueh et al. 2005); the Dynamic Assessment of Hearing Aids (DAHA; Cienkowski et al. 2006), the insertion/removal question (Pothier & Bredenkamp 2006); the Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids (MARS-HA; West & Smith 2007); the Audiological Rehabilitation - Clinical Global Impression (AR-CGI; Öberg, Wänström, Hjertman, Lunner, & Andersson 2009); the Device Oriented Subjective Outcome (DOSO; Cox, Alexander, & Xu 2014); and the Style Preference Survey (SPS; Smith et al. 2013).

Bennett et al. (2015) reported that their systematic review revealed 15 aspects of hearing aid handling that were assessed by at least one survey. However, no single survey evaluated all aspects of hearing aid handling (Bennett et al. 2015). Additionally, Bennett et al. (2015) reported that there was considerable variability in the reporting and quality of the evaluation of the psychometric properties of the surveys. However, Bennett et al. (2015) concluded that the PHAST-R was the most thorough of the clinician-administered surveys, and the PHAST-R also received the highest quality rating for reporting of psychometric properties.

The PHAST-R is a clinician-administered survey that requires hearing aid users to perform eight hearing aid use and care skills which are basic, but critical to the proper functioning of a hearing aid (Doherty & Desjardins, 2012). These skills include (1) inserting the hearing aid, (2) removing the hearing aid, (3) opening the battery door, (4) changing the hearing aid battery, (5) cleaning the hearing aid, (6) changing the volume, (7) using the hearing aid with the telephone, and (8) using the noise program or directional microphones. The PHAST-R has been shown to have excellent content validity, interrater reliability, feasibility, and interpretability (Bennett et al. 2015; Desjardins & Doherty 2009). Prior to the present study, the PHAST-R was administered via paper and pencil and a computer version was available for scoring. A mobile app version of the PHAST-R was developed for use in the present study.

Recently, Saunders et al. (2018) published a tool called the Hearing Aid Skills and Knowledge (HASK) test. The HASK was developed by adapting a combination of the PHAST-R and a quiz used by the Reese and Smith (2006) called the Hearing Aid Probed Recall Inventory (HAPRI). The HASK assesses both a patient's ability to use and care for their hearing aids and a patient's knowledge of how to use and care for their hearing aids. The skills assessed by the HASK test include the same eight skills tested by the PHAST-R, plus troubleshooting for feedback and troubleshooting for a non-working hearing aid. The HASK also assesses a hearing aid user's knowledge of hearing aid use and care, which is useful for users who may be unable to manage their own hearing aids due to poor manual dexterity or vision, but need to be able to describe to a family member or caregiver what must be done to manage the hearing aids.

Re-Instruction for Hearing Aid Use & Care Skills.

Some tools for measuring hearing aid use and care skills can be used not only as an assessment tool, but also as a treatment tool. For example, instructions for the PHAST-R dictate that patients should be re-instructed on any tasks that they cannot perform or have difficulty performing. Currently, most audiologists do not rely on tools like the PHAST-R to help them identify which hearing aid use or care skills a patient needs re-instruction on. Instead, an audiologist may simply ask a patient if they feel comfortable using their hearing aids and/or if they have any questions about using or caring for their hearing aids (Desjardins & Doherty 2009). However, Desjardins and Doherty (2009) found that although 96% of experienced hearing aid users reported that they knew how to use their hearing aids well, only 48% of users were able to correctly demonstrate these use and care skills. This suggests that relying on hearing aid users to report which hearing aid use and care skills they cannot perform or need re-instruction on may not be the most effective method of identifying and correcting deficiencies in hearing aid use and care skills.

Instead, it may be more effective to use a measure like the PHAST-R to identify hearing aid use and care skills that a patient cannot perform or has difficulty performing, and then focus re-instruction specifically on these skills. This method of re-instructing patients specifically on tasks that they have demonstrated they cannot perform or have difficulty performing is operationally defined in this study as "targeted re-instruction." Targeted re-instruction may result in better outcomes because it may be more effective at identifying hearing aid use and care skills that need re-instruction, and may therefore reduce the amount of information presented to the patient during re-instruction.

For example, if an audiologist asks a patient if they have any questions about the use and care of their hearing aids and the patient states that he or she cannot remember how to change the battery, the audiologist will likely re-instruct the patient on *all* information related to changing a hearing aid battery. This could include selecting the appropriate battery size, opening the battery door, removing the old battery from the battery compartment, removing the sticker from the new battery, and inserting the new battery. However, if an audiologist uses the PHAST-R to identify which skills related to changing the hearing aid battery a patient needs re-instruction on, it may be discovered that the patient is able to select the appropriate battery size, open the battery door, remove the old battery from the battery compartment, and remove the sticker from the new battery, but cannot insert the new battery properly. In this scenario, targeted re-instruction will reduce the amount of information provided to the patient by allowing the audiologist to identify specifically which skills are in need of re-instruction. As reported by Kessels (2003) and Margolis (2004), reducing the amount of information provided to a patient increases the likelihood that the patient will remember a greater proportion of that information.

In addition to improving hearing aid use and care skills, targeted re-instruction may also result in more hours of hearing aid use. Solheim, Gay, and Hickson (2017) followed up with hearing aid users six months after they were fit with new hearing. They used data logging built into the hearing aid software to objectively measure how often hearing aid users wore their hearing aids. They found that hearing aid users who experienced more issues with their new hearing aids used their hearing aids for fewer hours (Solheim et al. 2017). Additionally, they found that issues with hearing aid handling (i.e. hearing aid use and care) were the most commonly reported issues in their study (Solheim et al. 2017). Therefore, because of this association between issues with hearing aid use (including issues with hearing aid use and care) and hours of hearing aid use, it is reasonable to hypothesize that targeted re-instruction has the potential to increase hours of hearing aid use in new hearing aid users.

Hours of hearing aid use and hearing aid satisfaction are related to one another. Knudsen, Öberg, Nielsen, Naylor, & Kramer (2010) conducted a literature review of studies that looked at factors influencing hearing help seeking, hearing aid uptake, hearing aid use, and hearing aid satisfaction. They found that hearing aid use and satisfaction were most closely related (Knudsen et al. 2010). Knudsen et al. (2010) identified four studies (Hickson, Timm, & Worrall 1999; Jerram & Purdy 2001; Öberg, Andersson, Wänström, & Tunner 2008; Uriarte et al. 2005) that have shown a positive association between hearing aid use and satisfaction. Considering this relationship, targeted re-instruction may also result in greater levels of hearing aid satisfaction. Additionally, targeted re-instruction may result in greater levels of hearing aid satisfaction because hearing aid users who are better able to use and care for their hearing aids and/or feel more comfortable and confident using their hearing aids may likewise feel more satisfied with their hearing aids.

Summary and Significance

Hearing aids have been shown to reduce the psychosocial effects of hearing loss, improve communication, and diminish some of the effects of hearing loss on cognitive function (Amieva et al. 2015; Bisgaard & Ruf 2017; Chisolm et al. 2007; Ciorba et al. 2012; Ferguson et al. 2017). Despite the benefits of hearing aids, the prevalence of hearing non-use is high. One reason many hearing aid owners do not wear their hearing aids is because they have difficulty using or caring for them (McCormack & Fortnum 2013). It has been suggested that hearing aid use and care problems could be addressed with informational counseling and re-instruction (Ferguson et al. 2016; Gianopoulos et al. 2002; McCormack & Fortnum 2013; Vuorialho et al. 2006). Currently, re-instruction on hearing aid use and care occurs only if users report having difficulty with a specific task. Thus, audiologists rely on the hearing aid user to identify the specific use and care skills that they cannot perform or have difficulty performing. This is not an effective strategy given that even experienced hearing aid users have been shown to not be able to reliably identify the use and care skills they cannot perform or have difficulty performing (Desjardins & Doherty 2009).

The PHAST-R (Desjardins & Doherty 2009; Doherty & Desjardins 2012) is an objective measure that can be used to clinically identify the hearing aid use and care skills that a hearing aid user cannot perform or has difficulty performing. In the present study, the PHAST-R was used to identify the hearing aid use and care skills hearing aid users could not perform or had difficulty performing. Those participants were provided targeted re-instruction on these skills. It was hypothesized that targeted re-instruction would be more effective than only relying on hearing aid users to self-report the hearing aid use and care skills they think they need more information or re-instruction on.

Specific Objectives

The purpose of the present study was to address the following objectives:

<u>Objective 1:</u> Determine if adding targeted re-instruction to a hearing aid orientation can improve hearing aid outcomes.

Hypothesis 1. Participants who receive targeted re-instruction will demonstrate greater improvements in their hearing aid use and care skills over time compared to participants who do not receive targeted re-instruction.

Hypothesis 2. Participants who receive targeted re-instruction will use their hearing aids for more hours, as indicated by data logging, than participants who do not receive targeted re-instruction.

Hypothesis 3. Participants who receive targeted re-instruction will be more satisfied with their hearing aids than participants who do not receive targeted re-instruction.

Objective 2: Assess factors that may influence learning and remembering hearing aid use and care skills.

Hypothesis 4. Participants with better memory function will demonstrate better hearing aid use and care skills compared to participants with poorer memory function.

Hypothesis 5. Participants with greater degrees of hearing handicap and/or better attitudes towards hearing aids will demonstrate better hearing aid use and care skills compared to participants with lesser degrees of hearing handicap and/or poorer hearing aid-related attitudes.

Objective 3: To assess the amount of time that a targeted re-instruction protocol adds to a hearing aid orientation.

Experimental Design and Methods

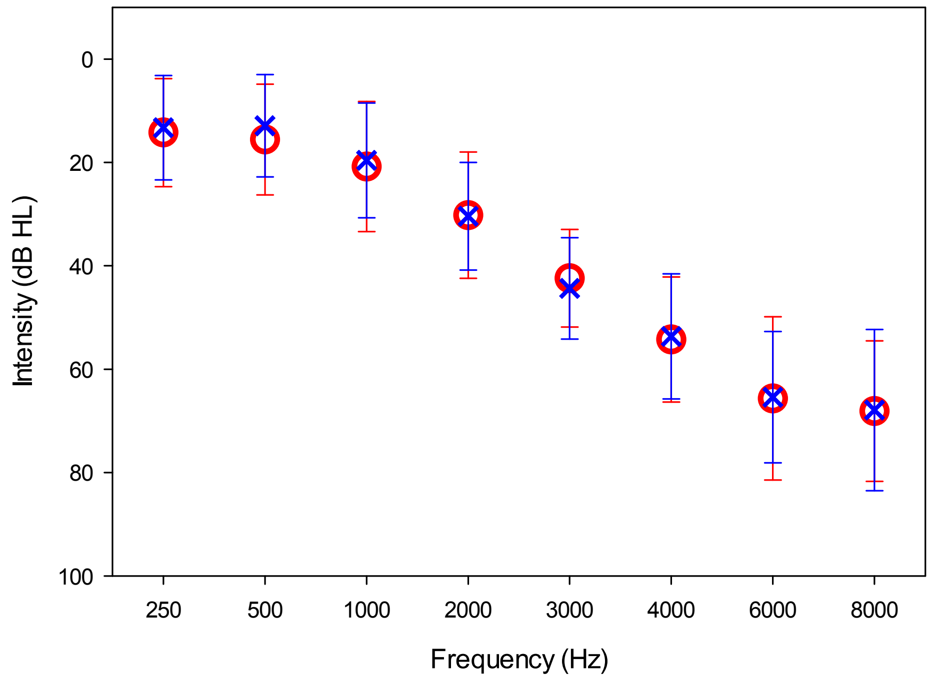
Participants

A statistical power analysis was performed for sample size estimation, based on data from Desjardins & Doherty (2017) and Saunders et al. (2018). The effect size in this study was 0.5 and considered to be medium using Cohen's (1988) criteria. With an $\alpha = .05$ and power = 0.90, the projected sample size needed with this effect size was approximately N = 24. However, the proposed sample size was 27 to allow for expected attrition. Forty individuals were screened to yield the 27 participants who met the study criteria. One participant withdrew from the study following the first test session. Therefore, 26 participants were included in this randomized control study. Thirteen participants were assigned to the experimental group (received targeted re-instruction) and 13 participants were assigned to the control group (did not receive the targeted re-instruction).

Permission for research and recruitment was obtained from the Institutional Review Board (IRB) at Syracuse University. All participants provided informed consent, and were paid for their participation. Participants were recruited through IRB-approved flyers posted at Syracuse University and in local community gathering spaces, such as libraries, churches, and community centers. Participants were also recruited through an IRB-approved recruitment email sent to persons who have voluntarily elected to be added to the Syracuse University Hearing Science Lab's prospective participant database, and through an IBR-approved notice in the Syracuse University newsletter, which is sent daily to the general university population.

All eligible participants were between the ages of 60 and 85 years old. Adults older than 85 years of age were not eligible to participate because research has shown that these "oldest older adults" experience a unique set of challenges that could affect their ability to use and care for hearing aids effectively (Dubno 2015; Pichora-Fuller 2015; Weinstein 2015). The mean age of the participants assigned to the experimental group was 71 years old (SD = 5.3) and the mean age of the participants assigned to the control group was also 71 years old (SD = 6.9). All participants had a sensorineural hearing loss in the mild to severe degree range, and had never tried or worn hearing aids before. Mild to severe hearing loss was defined as at least two out of three hearing thresholds that were > 26 dB HL at 2000 Hz, > 30 dB HL at 3000 Hz, or >35 dB HL at 4000 Hz with no thresholds between 250 Hz and 4000 Hz exceeding 89 dB HL. Average hearing thresholds for the right and left ears of all participants are shown in Figure 1.

Figure 1. Mean pure tone thresholds (in dB HL) averaged across the right and left ears for all 26 participants.



Additionally, all participants had hearing loss that could be appropriately fit with a ReSound receiver-in-the-canal (RIC) hearing aid coupled to a low, medium, or high power receiver. All participants had normal cognitive and finger dexterity function as determined by the Short Portable Mental Status Questionnaire (SPMSQ; Pfeiffer 1975) and 9-Hole Peg Test (Grice et al. 2003), respectively, normal or corrected normal vision (i.e. 20/40 acuity) according to the Snellen eye chart, and were native English speakers. Demographic information for both groups of participants is displayed in Table 1.

Table 1. Demographic information for participants assigned to the experimental and control groups.

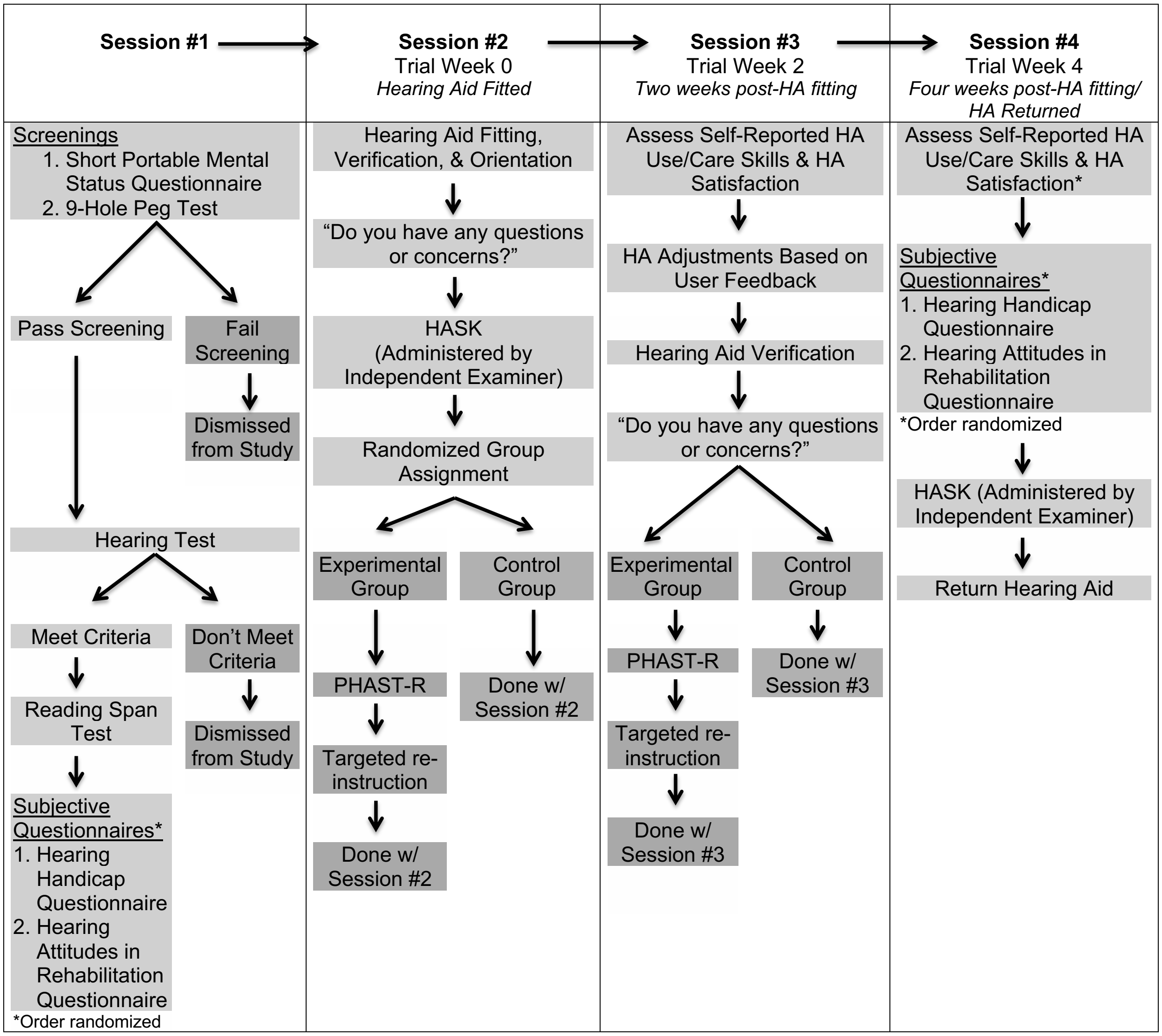
Measure	Group	
	Experimental	Control
Age		
60-64 years	1	2
65-69 years	2	4
70-74 years	7	3
75-79 years	1	3
80-85 years	2	1
Gender		
Male	8	7
Female	5	6
Education		
High school graduate	0	1
Some college, no degree	2	1
Associate degree	1	0
Bachelor's degree	6	6
Master's degree	3	4
Doctorate degree	1	1
Employment		
Employed	3	4
Retired	10	9

Note: Data are the number of individuals in each category.

Procedure

Participants in both the control and experimental groups participated in 4 test sessions. The study protocol is summarized in Figure 2.

Figure 2. Summarized study protocol.



Session #1.

At the start of session 1, all participants provided informed consent. Then all participants were administered the SPMSQ to screen for normal cognitive function and the 9-Hole Peg Test to screen for normal finger dexterity function. All participants passed these screenings and then underwent a standard hearing assessment consisting of air- and bone-conduction testing. All testing was performed in a double-walled, sound-attenuating booth with a Grason-Stadler GSI 61 clinical audiometer calibrated to American National Standards Institute (ANSI) standards (ANSI 2010). Any participants whose hearing did not meet the inclusion criteria (i.e. mild to severe sensorineural hearing loss) were ineligible to participate in the study and dismissed, but were compensated for their time. During the second part of session 1, participants who met the inclusion criteria were administered the Reading Span test (Daneman & Carpenter 1980), a measure of working memory function.

Reading Span test.

The Reading Span test is a working memory span task widely used to assess memory in adults. It has been shown to have good reliability and validity (Conway et al. 2005). In this study, a computerized version of the Reading Span test was administered via a web-based application (Loboda 2012). In the computerized version of the Reading Span test, a sentence is displayed on the computer screen and participants are asked to read the sentence as quickly as possible. Participants are then asked to respond if the sentence is syntactically and semantically correct. An example of a syntactically and semantically correct sentence is, "The policeman demanded to see Jim's license and registration," and an example of a syntactically and semantically incorrect sentence is, "The pudding destroyed houses in the village and left many people homeless." Once the participant has responded, a single letter (F, H, J, K, L, N, P, Q, R, S, T, or Y) is displayed on the screen. Participants are asked to remember this letter for later recall. A trial consists of two (i.e. 2-span) to seven (i.e. 7-span) sentence and letter presentations. At the end of each trial, participants are asked to recall each of the letters presented during that trial. The proportion of letters recalled correctly is calculated for each trial. Each participant completed 18 trials (3 trials each of 2-, 3-, 4-, 5-, 6-, and 7-span presentations in a randomized order). A participant's final score on the Reading Span test was computed by averaging the trial scores in order to devise a total score that represents the mean proportion of letters recalled correctly. This scoring method is consistent with recommendations by Conway et al. (2005) based on their methodological review of working span measures.

Following administration of the Reading Span test, participants were asked to complete subjective questionnaires measuring hearing handicap and hearing-related attitudes.

Hearing Handicap Questionnaire.

The Hearing Handicap Questionnaire (HHQ; Gatehouse & Noble 2004) was used to measure personal and social effects of hearing impairment. The HHQ consists of questions such as "How often do you feel worried or anxious because of your hearing difficulty" and "How often does your hearing difficulty restrict things you do." The 12-item questionnaire offers five response options: (1) Never, (2) Rarely, (3) Sometimes, (4) Often, and (5) Almost Always. Response values are added to determine a global handicap score, with a higher number indicating a greater handicap. Additionally, social restriction (SR) and emotional distress (ED) subscale scores can be calculated in order to measure the personal and social effects of hearing loss separately.

Hearing Attitudes in Rehabilitation Questionnaire.

Attitudes towards hearing loss and hearing aids were measured using the Hearing Attitudes in Rehabilitation Questionnaire (HARQ; Hallam & Brooks 1996). The HARQ is a 40-item self-report questionnaire that evaluates three general attitudes towards hearing impairment (i.e. personal distress/inadequacy, hearing loss stigma, and minimization of hearing loss) and four general attitudes towards hearing aids (i.e. hearing aid stigma, aid-not-wanted, pressure to be assessed, and positive expectation). Participants were asked to circle "true," "not true," or "partly true" in response to statements about hearing loss and hearing aids. For example, a personal distress/inadequacy (PDI) statement is, “My hearing loss makes me feel isolated from other people”; a hearing loss stigma (HLS) statement is, “When you have hearing difficulties, other people ignore you”; a minimization of hearing loss (MOL) statement is, “My hearing problems are really quite minor”; a hearing aid stigma (HAS) statement is, “I would stand out in a crowd wearing a hearing aid”; an aid not wanted/needed (ANW) statement is, “I don’t really want a hearing aid”; a pressure to be assessed (PTA) statement is, “It is due to pressure from my family and friends that I am having my hearing assessed”; and lastly, an example of a positive expectations (PE) statement is, “I suppose it would take some weeks or months to get used to using a hearing aid.”

The first test session was completed in approximately one and a half hours.

Session #2.

One to three weeks after the first test session, participants returned to the lab to participate in the second test session. During the second test session, ReSound Linx 3D 962 RIC-style hearing aids were programmed using the Desired Sensation Level (DSL) prescriptive fit method (Scollie et al. 2005) and fit on the participants. The initial hearing aid fitting was verified using the Audioscan Verifit real ear system (Dorchester, Ontario) and, if necessary, adjustments were made so that the output of the hearing aid was within ±5 dB of DSL targets. Additionally, the hearing aids were be equipped with a volume control and programmed with three manual programs: an all-around program, a noise program, and a telephone program.

After the fitting, all participants were given a hearing aid orientation, which included information about the parts of the hearing aids; hearing aid care, cleaning, and use; and general expectations and limitations for hearing aid use. The hearing aid orientation used in the present study was scripted based on the list of information covered in the VA hearing aid orientation outlined in Reese & Hnath-Chisolm (2005). The hearing aid orientation script used in the present study is included in Appendix A. All participants were aided during the hearing aid orientation in order to ensure that they were able to hear all of the information presented to them.

Following the hearing aid orientation, all participants were asked, “Do you have any questions or concerns about using or caring for your hearing aids?” The investigator answered any questions and/or addressed any issues raised by the participant. However, the investigator did not provide any information that the participant had not explicitly asked for. When all of the participant’s questions and/or concerns had been addressed, or if the participant did not ask any questions or express any concerns, then the HASK test was administered to objectively measure the participant’s ability to use and care for their hearing aids. To avoid examiner bias, the HASK test was administered by an independent examiner (a certified audiologist with 15 years of hearing aid fitting experience).

The HASK test.

During administration of the HASK test, participants were instructed verbally. The examiner judged participants’ performance on each skill using a 3-point Likert scale. A score of 2 (achieved with no difficulty on first attempt) was assigned when a participant performed a skill correctly on the first try, a score of 1 (achieved with some difficulty) was assigned when a participant completed a task but required more than one attempt and/or used deviant means to complete the task, and a score of 0 was assigned when a participant could not perform the task at all. The independent examiner judged participants’ knowledge using a 2-point scale. A score of 1 was assigned when a participant knew the information and a score of 0 was assigned when a participant did not know the information.

While the independent examiner was administering the HASK test, the investigator left the lab. During this time, the investigator randomly assigned each participant to either the experimental or control groups by drawing a sealed envelope containing a number (1-26). Drawing an envelope containing an odd number resulted in the participant being assigned to the control group and drawing an envelope containing an even number resulted in the participant being assigned to the experimental group. Once an envelope had been drawn, it was disposed of so that each number could only be drawn once. This was to ensure equal n-sizes among the two groups.

When the independent examiner finished administering the HASK test, the investigator returned to the lab. If the participant had been assigned to the control group, then the investigator told them that they had completed the session, paid them for their time, and scheduled them to return for the third session. If the participant had been assigned to the experimental group, then the investigator told them that there was one task left to complete before the end of the session. The investigator then administered the PHAST-R.

The PHAST-R.

The PHAST-R (Appendix B) was verbally administered to the participants. The investigator judged participants' performance on each skill using a 3-point Likert scale. When a task was performed correctly, a score of 2 (no difficulty) was assigned. When a task was performed with some difficulty, such that the participant made one or more mistakes and/or used deviant means to complete the task (i.e. removed the hearing aid in order to activate the directional microphone) a score of 1 was assigned. And last, when a participant could not perform the task at all then a score of 0 was assigned. The PHAST-R mobile app (Copyright Syracuse University 2017) was be used to generate a PHAST-R score for each participant.

PHAST-R App.

An app version of the PHAST-R was developed for use in this study. Electronic administration of surveys to evaluate hearing aid handling skills has been suggested by Bennett et al. (2015) in order reduce burden of administration and scoring on clinicians. Currently, the PHAST-R app is the only app available for this purpose. The app consists of the eight items on the PHAST-R and automatically calculates a participant's percentage score. Additionally, the PHAST-R app provides a detailed breakdown of the score so that the clinician can easily determine which tasks require re-instruction. The PHAST-R app is operational for iOS and Android operating systems with and without a wireless Internet signal for easy administration in a variety of clinical settings, and the scored data is automatically downloaded and stored in an online database where clinicians can access the information at a later date if desired, or scored data can be printed and included in a patient's chart.

Following administration of the PHAST-R, the primary investigator provided participants with targeted re-instruction on any PHAST-R skill for which they received a score of 1 (performs task with some difficulty) or 0 (cannot perform task) according to the re-instruction protocol described in Appendix C. After participants received targeted re-instruction, they were told that they had completed the session, paid for their time, and scheduled to return for the third session.

Upon discharge from the session, all participants were provided with a daily listening log (Appendix D) and asked to complete the listening log at the end of each day of the hearing aid trial period. This daily listening log asked participants if they encountered any of four common listening situations while wearing their hearing aids that day: 1) listening to the TV with other family or friends when the volume is adjusted to suit other people, 2) having a conversation with one other person when there is no background noise, 3) carrying on a conversation in a busy street or shop, and 4) having a conversation with several people in a group. These four common listening situations are the same situations used in the Glasgow Hearing Aid Benefit Profile (GHABP; Gatehouse 1999). The GHABP is a valid and reliable audiologist-administered survey that assesses the degree of benefit a hearing aid user receives when wearing his or her hearing aids (Gatehouse 1999). This daily listening log provided qualitative information about the types of listening situations that participants typically encountered while wearing the hearing aids.

The amount of time spent administering the PHAST-R and providing targeted re-instruction was measured and recorded for each participant so that the average amount of time that targeted re-instruction adds to an appointment could be determined. The second test session took approximately one and a half hours to complete.

Session #3.

Session 3 took place two weeks after the hearing aid fitting (session 2). At the start of the third session, participants were asked to complete a questionnaire (Appendix E) that asked whether they sought and/or received any outside help or assistance with using or caring for their hearing aids since the last session. This questionnaire asked if participants received help or assistance with the use and care of their hearing aids, consulted their hearing aid owner's manual, or consulted other sources (such as the Internet) for more information about using or caring for their hearing aids. After completing this questionnaire, all participants were asked to respond to two written statements: (1) "I feel that I know how to use my current hearing aid(s) well," and (2) "I am satisfied with my current hearing aid(s)." Participants were instructed to indicate whether they strongly agreed (3), agreed (2), disagreed (1), or strongly disagreed (0) with these statements. These statements have been used to assess self-reported hearing aid handling skills and satisfaction in a study by Doherty, Desjardins, Pellegrino, Kordas, and Kennedy (2010).

Participants were then asked, "Tell me about the last two weeks with the hearing aids. What did you like and what did you dislike?" If a participant complained about an issue that could only be addressed with changes to the hearing aid programming, then adjustments were made (i.e. if a patient reported that his own voice sounded hollow when wearing the hearing aids, then the low frequency gain was decreased). For all participants, real ear verification was performed a second time to ensure that the hearing aids were still working appropriately (i.e. frequency response was within ±5 dB of DSL targets). Additionally, data logging within the ReSound software was checked and the number of hours of daily use were recorded for each participant.

After real ear verification was performed, all participants were asked, "Do you have any questions or concerns about using or caring for your hearing aids?" The primary investigator addressed any questions or concerns raised by the participant. Participants in the control group were told them that they had completed the session, paid for their time, and scheduled to return for the fourth session once their questions and concerns had been addressed, or if they did not raise any questions or concerns.

For participants in the experimental group, the investigator told them that there was one task left to complete before the end of the session once their questions and concerns had been addressed, or if they did not raise any questions or concerns. The investigator then administered the PHAST-R and provided participants with targeted re-instruction on any PHAST-R skill for which they received a score of 1 or 0. After participants in the experimental group received re-instruction, they were be told that they had completed the session, paid them for their time, and scheduled to return for the fourth session.

The amount of time spent administering the PHAST-R and providing targeted re-instruction was measured and recorded for each participant so that the average amount of time that targeted re-instruction adds to an appointment could be determined. The third test session lasted approximately one hour.

Session #4.

Two weeks after Session #3, participants returned to the lab for Session #4, the final test session. During this final session, participants were re-administered the questionnaire (Appendix E) that asked about whether they received any outside help or assistance with the use and care of their hearing aids in the past two weeks. Participants were also asked to respond to the written statements (1) “I feel that I know how to use my current hearing aid(s) well,” and (2) “I am satisfied with my current hearing aid(s)” again. The HHQ and HARQ were also re-administered. The order in which these measures were administered was randomized for each participant. Then the HASK test was re-administered to all participants by the independent examiner. The independent examiner was blinded to the participants’ group assignments. Blinding of the examiner protects against the possibility of bias influencing the outcome measures (Schulz & Grimes 2002). The number of daily hours of hearing aid use was recorded for each participant from data logging in the ReSound software. Additionally, all participants returned the hearing aids and were provided with a brochure from the Hearing Loss Association of America with general information about hearing loss, hearing aids, and communication strategies. This final test session lasted approximately 30 minutes.

Treatment Fidelity

Video recording was used throughout the four test sessions in order to ensure treatment fidelity. Treatment fidelity allows investigators to isolate an intervention, determine its efficacy, contrast it to a standard form of treatment, and replicate findings (Hildebrand et al. 2012). A key component of treatment fidelity is treatment integrity, which consists of demonstrating that clinicians carry out the intervention with adequate adherence to the treatment protocol (Hildebrand et al. 2012). An important component of the treatment protocol for the proposed study was ensuring that all participants in both the control and experimental groups received the same hearing aid orientation. Therefore, all hearing aid orientations (in session 2) were video recorded so that fidelity could be assessed. Six of these video recordings (three control and three experimental; approximately 20% of the total) of the hearing aid orientation sessions were randomly selected to be reviewed by an independent reviewer (a graduate student with more than five years of hearing aid fitting experience) blinded to participants' group assignments. This independent reviewer watched the video recordings and completed the Hearing Aid Orientation Script Adherence Rating Form included in Appendix F. This Hearing Aid Orientation Script Adherence Rating Form is modeled on the Treatment Adherence and Competence Rating Form used by Hildebrand et al. (2012). The independent reviewer found that adherence to the Hearing Aid Orientation Script ranged from 96.4% to 100%, with an average of 98.8%. This indicates that there were very few protocol violations and fidelity was high (Persch & Page 2013).

Additionally, all administrations of the PHAST-R and targeted re-instruction were video recorded so that fidelity of the re-instruction protocol (Appendix C) could be determined. Six of these video recordings (approximately 20% of the total) of the PHAST-R administration and targeted re-instruction were randomly selected to be reviewed by the independent reviewer. The independent reviewer watched the video recordings and determined adherence to the re-instruction protocol by tracking the number of times that the investigator followed the re-instruction protocol compared to the number of times that the investigator did not follow the re-instruction protocol. The independent reviewer found that the investigator followed the re-instruction protocol 100% of the time, indicating excellent treatment fidelity (Persch & Page 2013).

Statistical Analysis

Data analysis was performed using SPSS v. 24 (IBM Corp., Armonk, NY) and SigmaPlot v. 14 (Systat Software, Inc., San Jose, CA). Normality testing (Shapiro-Wilk test) was performed for all interval variables (i.e. hearing aid use and care skills, hours of hearing aid use, Reading Span scores, hearing handicap scores, and hearing aid-related attitude scores). Hearing aid use and care skills and hours of hearing aid use were analyzed using independent- and dependent-samples t-tests. One-tailed t-tests were used when a directional relationship was predicted (e.g. for determining if average daily hours of hearing aid use was greater for the experimental group compared to the control group), whereas two-tailed t-tests were used when a predicted relationship was not direction-specific.

Hearing aid satisfaction and self-reported hearing aid use and care skills were measured on a 4-point Likert scale, and are therefore ordinal variables and were analyzed using nonparametric Mann-Whitney rank sum and Wilcoxon signed-rank tests (Jamieson 2004). Mann-Whitney rank sum tests and Wilcoxon signed-rank tests were also used in place of t-tests in cases where data were not normally distributed (i.e. when analyzing some hearing aid-related attitudes).

The relationships between hearing aid use and care skills and working memory; hearing aid use and care skills and hearing handicap; and hearing aid use and care skills and hearing aid-related attitudes were assessed using Pearson product-moment correlations (for normally distributed data) and Spearman rank-order correlations (for non-normally distributed data). A significance level of 0.05 was used for all analyses. Effect sizes were calculated for all statistically significant results and compared to Cohen's (1988) conventions for small, medium, and large effects.

Results

HASK Test and PHAST-R Scores

The HASK test was administered immediately following the hearing aid orientation and after four weeks of hearing aid use. There is no overall score for the HASK test, but instead two subtest scores, skills and knowledge. The mean skills and knowledge subtest scores for the control and experimental groups are shown in Table 2. Independent-samples t-tests indicated no significant differences between groups for initial and final HASK test knowledge subtest scores ($t(24) = -0.555$, $p = .584$, two-tailed and $t(24) = 1.410$, $p = .171$, two-tailed, respectively) or initial skills subtest scores ($t(24) = .643$, $p = .526$, two-tailed). However, an independent-samples t-test showed that the experimental group had a significantly higher final HASK skills subtest score compared to the control group ($t(24) = -2.119$, $p = .045$, one-tailed). The effect size for this analysis ($d = .83$) was found to exceed Cohen's (1988) convention for a large effect ($d = .80$). Thus, there was no difference in performance on the HASK test between the control and experimental groups when it was administered immediately following the hearing aid orientation (at 0 weeks of hearing aid use), but the experimental group did score significantly higher on the HASK skills subtest when it was administered at four weeks post-hearing aid fitting.

Table 2. Means and standard deviations on the HASK test for the experimental and control groups.

	Group			
	Experimental		Control	
Measure	Week 0	Week 4	Week 0	Week 4
HASK Test				
Skills Subtest	81.2 (8.8)	80.1 (6.1)	79.0 (8.0)	73.7 (9.1)
Knowledge Subtest	78.0 (9.4)	73.6 (8.6)	75.8 (10.7)	68.9 (8.4)
Targeted Skills	91.1 (6.7)	92.1 (6.6)	89.4 (7.9)	82.5 (9.8)

Note: Data shown are means with standard deviations in parentheses.

The PHAST-R was administered to only the experimental group, once at the hearing aid fitting and again at two weeks post-hearing aid fitting. Mean scores were 87.64 (SD = 6.54) and 87.10 (SD = 6.34) at the fitting and two weeks post-fitting, respectively. A paired-samples t-test indicated that there was no difference between these scores ($t(12) = .222$, $p = .828$, two-tailed) at either week it was administered.

The HASK test and the PHAST-R evaluate many of the same skills. However, the PHAST-R includes one skill, use of the noise program, that is not included on the HASK test. The HASK test includes several skills that are not included on the PHAST-R such as identifying the left versus right hearing aid, general program use, troubleshooting for feedback, troubleshooting a non-working hearing aid, and hearing aid storage. In the present study, targeted re-instruction was based only on a participant's performance on the PHAST-R. Therefore, only the skills that were included on both the PHAST-R and the HASK test had the potential to show improvement on the HASK test *as a result of* targeted re-instruction. These skills include (1) hearing aid removal, (2) opening the battery door, (3) selection of the correct battery size, (4) changing of the hearing aid battery, (5) cleaning of the hearing aids, (6) hearing aid insertion, (7) increasing the hearing aid volume, and (8) using the telephone with the hearing aids.

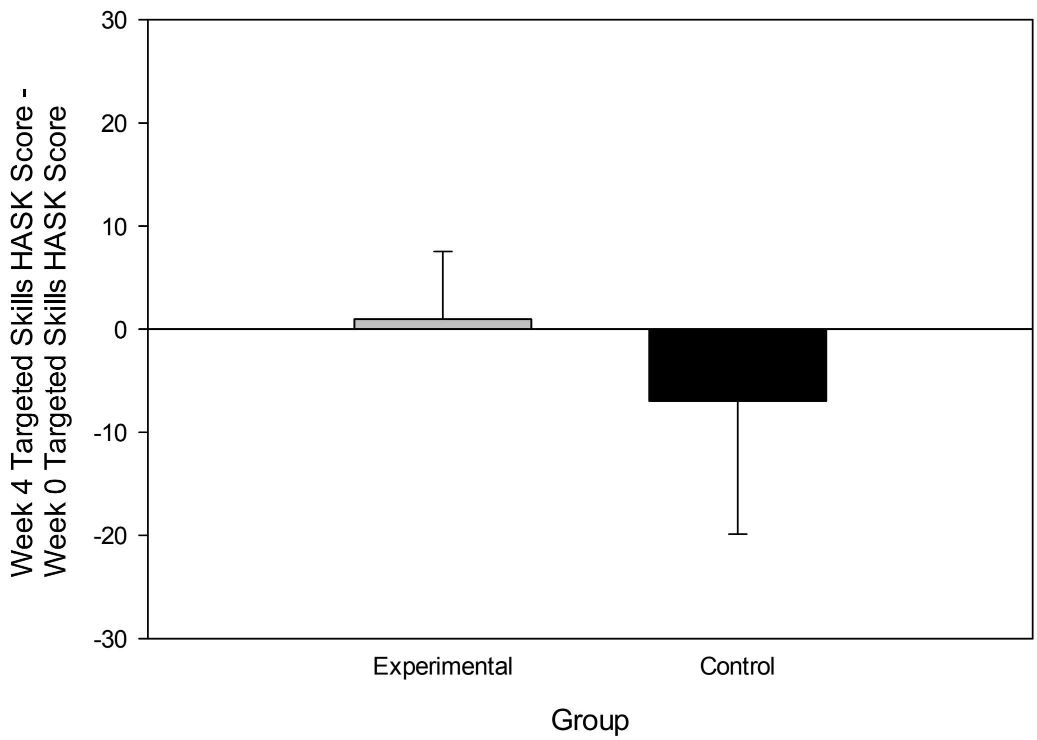
The HASK test was re-scored to reflect *only* the skills included on *both* the PHAST-R and the HASK test. To obtain this "targeted skills HASK score," all items *not* included on the PHAST-R were scored as "not applicable." Marking of items as "not applicable" can be accounted for when administering and scoring the HASK test because the HASK test scoring algorithm adjusts for non-applicable items.

Mean targeted skills HASK test scores for the two groups of participants are shown in Table 2. An independent-samples t-test indicated that mean targeted skills HASK test scores were not significantly different between groups immediately following the hearing aid orientation ($t(24) = -0.581$, $p = .567$, two-tailed), but the experimental group had a significantly higher targeted skill HASK test scores compared to the control group at four weeks post-hearing aid fitting ($t(24) = -3.002$, $p = .003$, one-tailed). The effect size for this analysis ($d = 1.15$) was found to exceed Cohen's (1988) convention for a large effect size ($d = .80$).

Hearing Aid Use and Care Skills Over Time

Differences between the targeted skills HASK test scores at the hearing aid fitting and four weeks post-hearing aid fitting were computed and an independent-samples t-test showed that the mean difference score for the experimental group (M = .977, SD = 6.553) was significantly different than the mean difference score for the control group (M = -6.977, SD = 12.899; $t(24) = 1.982$, $p = .030$, one-tailed). Specifically, the experimental group (i.e. the only group that received targeted re-instruction) maintained their hearing aid use and care skills over the four week hearing aid trial, whereas the control group (i.e. the group that did not receive targeted re-instruction) demonstrated a decline in their hearing aid use and care skills over the four week hearing aid trial period (see Figure 3). The effect size for this analysis (*d* = .78) was found to fall exceed Cohen's (1988) convention for a medium effect (*d* = .50).

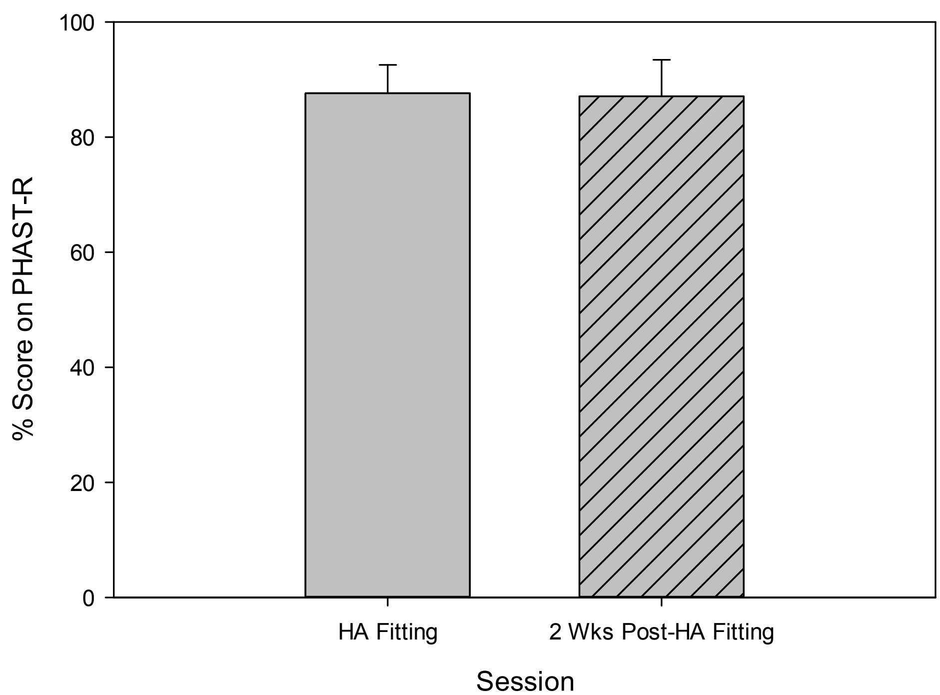
Figure 3. Mean change in HASK test scores for targeted skills for the experimental and control groups.



There were no significant differences in performance on the original HASK skills or knowledge subtests over time between the control and experimental groups. An independent-samples t-test showed that the mean change in HASK skills subtest score over time measured for the experimental group (M = -1.07, SD = 7.95) was not significantly different than the change measured for the control group (M = -5.39; SD = 13.18; $t(24) = 1.011$, $p = .161$, one-tailed). Similarly, an independent-samples t-test showed that the change in HASK knowledge subtest score over time observed for the experimental group (M = -4.46, SD = 9.19) was not significantly different than the change observed for the control group (M = -6.95, SD = 13. 43); $t(24) = -0.551$, $p = .293$, one-tailed).

Within the experimental group, there was also no difference in mean performance on the PHAST-R over time (see Figure 4). A paired-samples t-test indicated that the mean PHAST-R score at the hearing aid fitting (M = 87.6, SD = 6.5) was not significantly different than the mean PHAST-R score two weeks post-hearing aid fitting (M = 87.1; SD = 6.3; $t(12) = .222$, $p = .414$, one-tailed).

Figure 4. Mean score on the PHAST-R for the experimental group at hearing aid fitting and 2 weeks post-hearing aid fitting.



Participants in the experimental group needed targeted re-instruction on an average of 3 (min = 1, max = 5) PHAST-R skills at both the initial hearing aid orientation and at two weeks post-hearing aid fitting. All participants in the experimental group needed targeted re-instruction on at least one PHAST-R skill at the initial hearing aid orientation. A similar result was observed at two weeks post-hearing aid fitting, except that one participant performed all PHAST-R skills with no difficulty and therefore did not require any targeted re-instruction.

HASK Test Items

Some HASK test items were more difficult to learn than others (i.e. more participants did not know or were unable to perform some test items). Table 3 shows participants' performance on the five individual targeted skills on the HASK test that $\geq$25% of the participants, in at least one group, had difficulty performing or could not perform. In addition, the change over time in performance on these tasks is indicated by the difference column. Within the experimental group, the percentage of participants who could successfully perform a task remained stable or improved for all difficult to learn tasks except one (activating the phone program/t-coil). In contrast, the percentage of control participants who could successfully perform a task declined for three tasks: brushing the microphone port during cleaning, activating the phone program/t-coil, and changing the wax trap. Figure 5 shows the difference in the percent of participants at Weeks 0 and 4 who could successfully perform each of the targeted skills on the HASK test that were difficult to learn.

Table 3. Percentage of individuals who could successfully perform the targeted skills on the HASK test that ≥25% of participants had difficulty performing or could not perform.

	Group					
	Experimental			Control		
Skill	Week 0	Week 4	Difference	Week 0	Week 4	Difference
Brushing microphone port	69.2	92.3	23.1	84.6	46.2	-38.4
Properly positioning HA in R ear	92.3	92.3	0	69.2	84.6	15.4
Increasing HA volume	76.9	92.3	15.4	69.2	84.6	15.4
Switching to phone program	69.2	38.5	-30.7	53.8	7.7	-46.1
Changing wax trap	53.8	76.9	23.1	69.2	46.2	-23.0

Note: Data in the Week 0 and Week 4 columns are the percentages of individuals that could successfully perform each skill.

Figure 5. Difference between the percentage of individuals who could successfully perform each of the difficult to learn targeted skills on the HASK test at Week 4 and the percentage of individuals who could successfully perform each of the difficult to learn targeted skills on the HASK test at Week 0

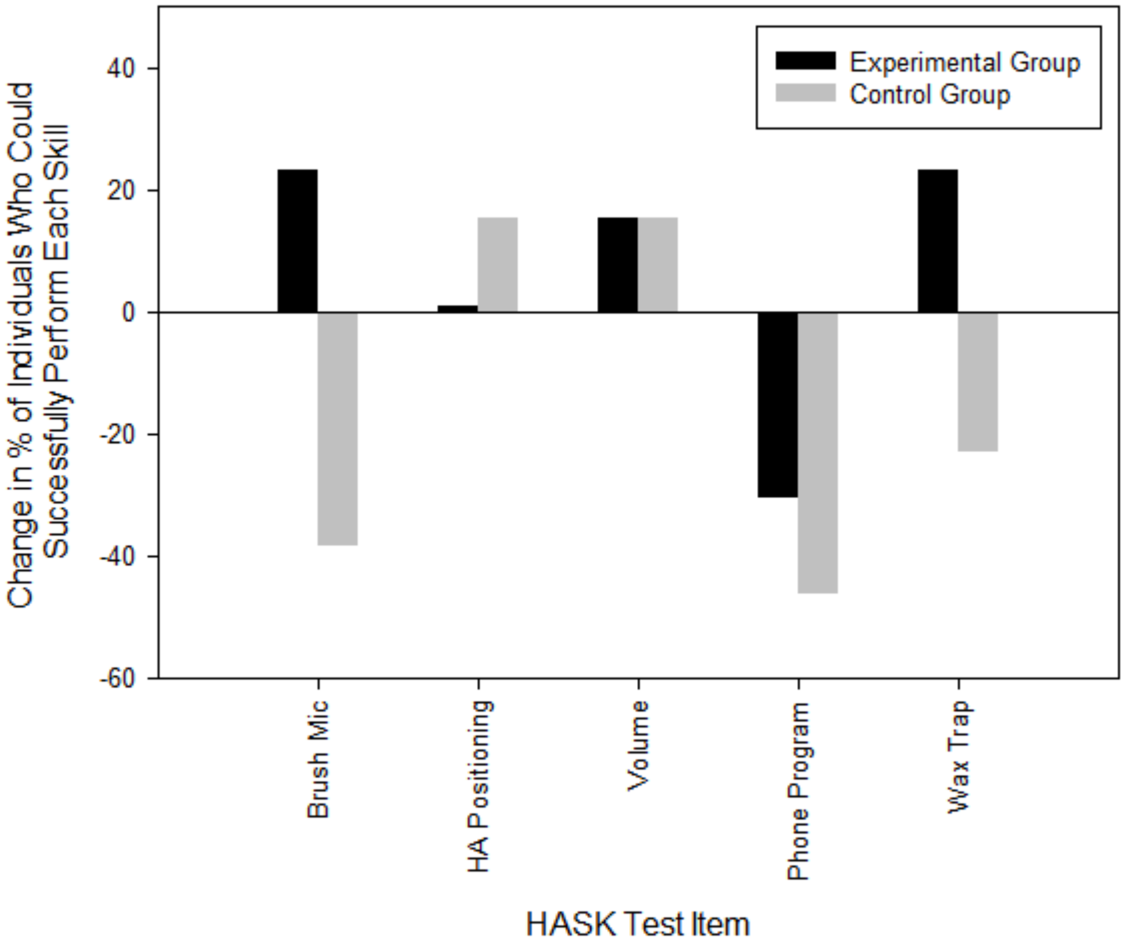


Table G1 in Appendix G shows all participants' performance on the original HASK skills and knowledge subtest items that ≥25% of participants in at least one group did not know, had difficulty performing, or could not perform. Similar to participants' performance on the targeted skills on the HASK test, participants performed poorest on items related to knowledge and skills associated with cleaning (including wiping the body of the hearing aid with a cloth and changing the wax trap) and use of the phone program (specifically switching to the phone program/activating the telecoil). In addition, participants performed poorly on the HASK items related to troubleshooting (including troubleshooting for feedback and checking the microphone port for blockage).

PHAST-R Test Items

Table 4 shows performance on the seven PHAST-R items on which ≥25% participants in the experimental group had difficulty performing or could not perform. At the hearing aid fitting appointment (Week 0), participants performed poorest on skills related to changing the wax trap, properly situating the hearing aid in the ear during hearing aid insertion, and switching to the phone program. Two weeks later, 85% of participants were able to properly situate the hearing aid in their ear, but participants still performed poorly on changing the wax trap and switching to the phone program. They also performed poorly on switching to the noise program at two weeks post-hearing aid fitting.

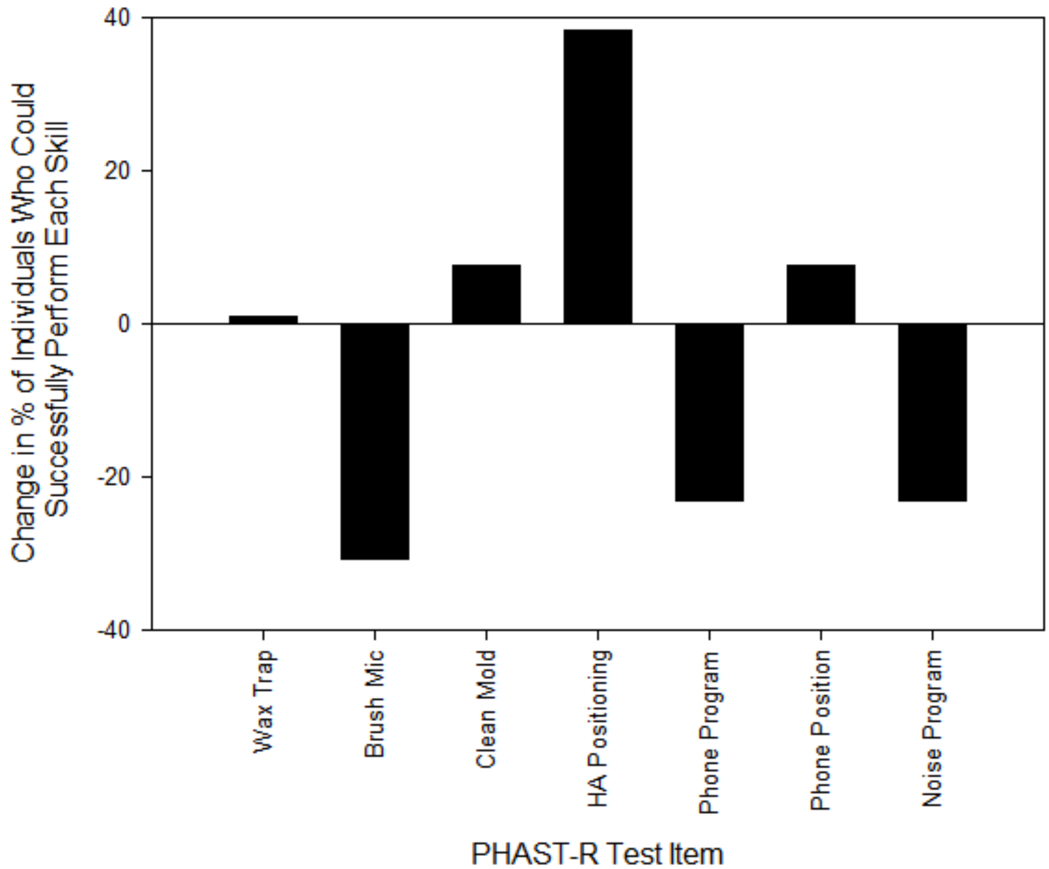
Table 4. Percentage of individuals who could successfully perform PHAST-R skills that ≥25% of participants had difficulty performing or could not perform.

	Weeks of HA Use		
Skill	Week 0	Week 2	Difference
Change wax trap	46.2	46.2	0
Brush microphone port	92.3	61.5	-30.8
Clean open fit mold	53.8	61.5	7.7
Properly position HA in ear	46.2	84.6	38.4
Switch to phone program	46.2	23.1	-23.1
Properly position phone	69.2	76.9	7.7
Switch to noise program	69.2	46.2	-23.0

Note: Data in Week 0 and Week 2 columns are the percentages of individuals that could successfully perform each skill.

Figure 6 shows the difference in the percent of participants at Weeks 0 and 2 who could successfully perform each of the difficult to learn items on the PHAST-R. The percentage of participants who could successfully perform a task remained stable or improved for four of the difficult to learn tasks, including changing the wax trap, cleaning the earmold/dome, properly positioning the hearing aid in the ear, and properly positioning the phone in relation to the hearing aid. The percentage of participants who could successfully perform a task declined for three tasks: brushing the microphone port during cleaning, activating the phone program/t-coil, and activating the noise program.

Figure 6. Difference between Weeks 0 and 2 in the percentage of individuals who could successfully perform each of the difficult to learn items on the PHAST-R.



Self-Reported Hearing Aid Use and Care Skills

In addition to using the HASK test to measure hearing aid use and care skills, self-reported hearing aid use and care skills were evaluated. Participants were asked to respond to the written prompt: "I feel that I know how to use my current hearing aid(s) well." Participants were instructed to indicate on a 4-point Likert scale whether they strongly agreed (3), agreed (2), disagreed (1), or strongly disagreed (0) with this statement. Participants were asked to respond to this statement at two weeks post-hearing aid fitting and at four weeks post-hearing aid fitting (see Table 5).

Table 5. Percentage of participants who indicated that they strongly agreed, agreed, disagreed, or strongly disagreed with the written statement: "I feel that I know how to use my current hearing aid(s) well."

	Group			
	Experimental		Control	
I feel that I know how to use my current hearing aid(s) well.	Week 2	Week 4	Week 2	Week 4
Strongly Disagree	0 (0)	0 (0)	0 (0)	0 (0)
Disagree	15 (2)	0 (0)	0 (0)	0 (0)
Agree	70 (9)	54 (7)	77 (10)	70 (9)
Strongly Agree	15 (2)	46 (6)	23 (3)	30 (4)

Note: Data shown are % of participants with *n* participants in parentheses.

There was no difference in self-reported hearing aid use and care skills between the control and experimental groups when participants were asked to rate their use and care skills at two weeks post-hearing aid fitting. A Mann-Whitney rank-sum test indicated that median self-reported hearing aid use and care skills for the control group and experimental groups were not statistically significantly different ($U = 68.0$, $p = .418$). The same result was observed when self-reported hearing aid use and care skills were assessed at four weeks post-hearing aid fitting. A Mann-Whitney rank-sum test determined that median self-reported hearing aid use and care skills for the control group at four weeks post-hearing aid fitting was not significantly different from that of the experimental group ($U = 97.5$, $p = .511$).

Of the 13 participants in the experimental group, eight self-reported the same level of hearing aid use and care skills at two and four weeks post-hearing aid fitting, and five participants reported better hearing aid use and care skills at four weeks compared to two weeks post-hearing aid fitting. A Wilcoxon signed-rank test indicated that for the experimental group there was a statistically significant median increase in self-reported hearing aid use and care skills at the end of the hearing aid trial compared to two weeks post-hearing aid fitting (z = 2.121, p = .034). The effect size for this analysis (r = .42) was found to exceed Cohen's convention for a medium effect size (r = .30). Of the 13 participants in the control group, 12 self-reported the same level of hearing aid use and care skills at two and four weeks post-hearing aid fitting, and only one participant reported better hearing aid use and care skills at four weeks compared to two weeks post-hearing aid fitting. A Wilcoxon signed-rank test indicated that there was not a statistically significant median increase in self-reported hearing aid use and care skills for the control group when measured at four weeks compared to two weeks post-hearing aid fitting (z = 1.000, p = .317). In summary, participants who received targeted re-instruction self-reported that their hearing aid use and care skills improved over time whereas no improvement was reported by participants who did not receive targeted re-instruction.

Table 6 shows sources of outside help or assistance consulted by participants during the four week hearing aid trial, as well as the information that they were seeking when they consulted those outside sources for help. At two and four weeks post-hearing aid fitting, participants were asked to report on whether they had sought help or assistance with their hearing aids from anyone other than the primary investigator since their last session. During the first two weeks of the hearing aid trial, three participants in the experimental group reported seeking outside help for tasks related to hearing aid use and care, whereas eight participants in the control group reported seeking outside help or assistance with tasks related to hearing aid use and care. The primary source consulted was the manufacturer's user guide. The only participant who sought outside help from a person other than the primary investigator was in the control group. This participant sought assistance from his wife with identifying the left hearing aid from the right hearing aid. Two weeks post-hearing aid fitting, he reported that he needed his wife's help with this task because he could not see the red and blue color indicators on the hearing aids. However, it was determined that the reason that he could not see the color indicators was because he was not looking for them in the correct place on the hearing aids. Even after the investigator reminded him of where the color indicators were located, he forgot this information and reported at four weeks post-hearing aid fitting that he still needed his wife's assistance with this task.

Table 6. Sources of outside assistance and information during the four week hearing aid trial.

	Group			
	Experimental		Control	
Source of Help Consulted and *Information Sought*	Weeks 0-2	Weeks 2-4	Weeks 0-2	Weeks 2-4
Individual Other Than the Primary Investigator				
ID'ing left and right hearing aid	0	0	1	1
User Guide				
General info about hearing aids	6	3	4	3
Troubleshooting	0	0	1	0
Volume control	1	0	2	0
Battery-related	1	0	2	0
Noise program	0	0	1	0
General program use	0	1	0	0
Phone-related	0	0	1	0
Info about app availability	1	1	0	0
Info about button function	0	1	0	0
Internet				
General info about hearing aids	2	1	0	1
Cost of hearing aids	1	0	0	0
Reviews of hearing aids	2	0	0	0

Notes: **Bold** indicates the source of outside help or assistance consulted. *Italics* indicates the information sought. Data are the number of individuals that reported seeking outside help or assistance or more information on each skill/topic.

Hours of Hearing Aid Use

Data logging within the ReSound software was used to objectively measure the average daily hours of hearing aid use for each participant. Data logging was recorded at two and four weeks post-hearing aid fitting. Hearing aid use ranged from 2 to 13 hours per day for the experimental group and 3 to 12 hours per day for the control group when measured at two weeks post-hearing aid fitting. At four weeks post-hearing aid fitting, the experimental group used their hearing aids for 2 to 12 hours per day and the control group used their hearing aids 3 to 11 hours per day. An independent-samples t-test indicated that average daily hours of hearing aid use at two weeks post-hearing aid fitting for the experimental group (M = 8.2, SD = 3.0) was not significantly different than that of the control group (M = 7.8, SD = 2.8; $t(24) = -0.269$, $p = .395$, one-tailed). There was also no significant difference between the experimental group's (M = 7.5, SD = 3.4) and control group's (M = 7.2, SD = 2.9) hours of hearing aid usage at four weeks post-hearing aid fitting ($t(23) = -0.233$, $p = .409$, one-tailed). Thus, there was no significant difference in average daily hours of hearing aid use between the control and experimental groups at two or four weeks post-hearing aid fitting.

Neither the experimental or control group changed their average daily hearing aid use over time. A paired-samples t-test indicated no significant difference in average daily hours of hearing aid use measured at two (M = 8.2, SD = 3.0) and four (M = 7.5, SD = 3.4) weeks post-hearing aid fitting for the experimental group ($t(11) = .845$, $p = .415$, two-tailed). Also no significant difference was observed between average daily hours of hearing aid use measured at two (M = 7.8, SD = 2.8) and four (M = 7.2, SD = 2.9) weeks post-hearing aid fitting for the control group ($t(11) = 1.682$, $p = .121$, two-tailed). Participants in the experimental and control groups used their hearing aids on average 7.8 (SD = 3.1) and 7.4 (SD = 2.8) hours per day, respectively. This was computed by averaging the two data logging recordings.

In addition to using data logging to track average daily hours of hearing aid use, participants were asked to complete a listening log at the end of each day during the hearing aid trial period. Participants were asked to use the daily listening log to identify which of four common listening situations they encountered while wearing their hearing aids: 1) listening to the TV with other family or friends when the volume is adjusted to suit other people, 2) having a conversation with one other person when there is no background noise, 3) carrying on a conversation in a busy street or shop, and 4) having a conversation with several people in a group. Twenty-five of the 26 participants completed the listening log for at least part of the hearing aid trial and returned the listening log to the primary investigator. The participant who did not return the listening log reported that he had completed it but forgot to bring it with him to his final appointment. Multiple requests were made to this participant to return the log, but attempts to retrieve the log from him were unsuccessful. Participants who did return the log completed the listening log for an average of 24 days (min = 5 days, max = 30 days, SD = 6.4 days). The percentage of days participants reported that they experienced each listening situation is shown in Table 7. A percentage was used because the number of days the log was completed varied considerably across participants.

All participants in both groups were exposed to all four listening situations except the TV listening situation. Two participants (one in the control group and one in the experimental group) reported that they never experienced this listening situation during the hearing aid trial. The most frequently and least frequently reported listening situations for both groups were 1-on-1 conversation and listening in background noise, respectively. Thus, both groups of participants experienced similar listening situations during the hearing aid trial period.

Table 7. Number of days each participant completed the listening log and percentage of those days they reported experiencing each of the four listening situations.

		Listening Situation			
Participant	**# of Days Log Completed**	TV	1-on-1	Noise	Group
E1	15	40.7	55.6	22.2	25.9
E2	29	17.2	31.0	75.9	72.4
E3	28	96.4	100.0	53.6	28.6
E4	20	85.0	100.0	70.0	70.0
E5	15	0.0	86.7	33.3	60.0
E6	25	88.0	100.0	52.0	72.0
E7	25	88.0	88.0	76.0	76.0
E8	11	9.1	36.4	36.4	18.2
E9	26	19.2	100.0	46.2	88.5
E10	29	96.6	100.0	65.5	93.1
E11	26	7.7	69.2	30.8	50.0
E12	30	100.0	96.7	20.0	30.0
E13	21	95.2	100.0	33.3	52.4
C1	27	7.4	63.0	29.6	74.1
C2	25	100.0	100.0	68.0	96.0
C3	26	26.9	92.3	46.2	73.1
C4	26	69.2	65.4	19.2	88.5
C5	29	3.4	100.0	20.7	41.1
C6	21	85.7	71.4	14.3	23.8
C7	28	28.6	85.7	71.4	71.4
C8	27	88.9	96.3	51.9	40.7
C9	29	0.0	72.4	62.1	20.7
C10	29	79.3	82.8	89.7	93.1
C11	29	34.5	96.6	65.5	79.3
C12	5	60.0	100.0	20.0	40.0
C13	0	-	-	-	-

Hearing Aid Satisfaction

Level of hearing aid satisfaction was assessed by asking participants at two and four weeks post-hearing aid fitting to respond to the written statement: "I am satisfied with my current hearing aid(s)." Participants were instructed to indicate on a 4-point Likert scale whether they strongly agreed (3), agreed (2), disagreed (1), or strongly disagreed (0) with this statement. Participants' responses are shown in Table 8. A Mann-Whitney rank-sum test indicated that there was a statistically significant difference in hearing aid satisfaction between the experimental and control groups ($U = 43.5$, $p = .034$), such that the experimental group was significantly less satisfied with their hearing aids than the control group at two weeks post-hearing aid fitting. The effect size for this analysis ($r = .45$) was found to exceed Cohen's convention for a medium effect size ($r = .30$). At four weeks post-hearing aid fitting, there was no longer a significant difference in satisfaction between the two groups ($U = 54.5$, $p = .125$).

Table 8. Percentage of participants who indicated that they strongly agreed, agreed, disagreed, or strongly disagreed with the written statement: "I am satisfied with my current hearing aid(s)."

	Group			
	Experimental		**Control**	
I am satisfied with my current hearing aid(s).	Week 2	Week 4	Week 2	Week 4
Strongly Disagree	8 (1)	0 (0)	0 (0)	0 (0)
Disagree	38 (5)	23 (3)	8 (1)	0 (0)
Agree	46 (6)	54 (7)	62 (8)	54 (7)
Strongly Agree	8 (1)	23 (3)	30 (4)	46 (6)

Note: Data shown are % of participants with *n* participants in parentheses.

Of the 13 participants in the experimental group, seven reported the same level of hearing aid satisfaction at four weeks post-hearing aid fitting compared to two weeks post-hearing aid fitting, and 6 participants reported improved hearing aid satisfaction over time. Results from a Wilcoxon signed-rank test for the experimental group indicated that there was a statistically significant increase in the median level of hearing aid satisfaction at four weeks compared to two weeks post-hearing aid fitting ($z = 2.449$, $p = .014$). The effect size for this analysis ($r = .48$) was found to exceed Cohen's (1988) convention for a medium effect size ($r = .30$). Of the 13 participants in the control group, eight reported the same level of hearing aid satisfaction at four weeks post-hearing aid fitting compared to two weeks post-hearing aid fitting, four participants reported improved hearing aid satisfaction over time, and one participant reported lower satisfaction at four weeks compared to two weeks post-hearing aid fitting. A Wilcoxon signed-rank test indicated that there was no significant difference in median hearing aid satisfaction rating over time for the control group ($z = 1.342$, $p = .180$).

Working Memory

All participants were administered the Reading Span test to measure working memory. The mean Reading Span scores for the control and experimental groups are shown in Table 9. An independent-samples t-test indicated there was no significant difference between the mean Reading Span test score for the experimental group (M = 67.8%, SD = 17.4%) and the control group (M = 65.3%, SD = 13.5%; $t(24) = .402$, $p = .691$, two-tailed).

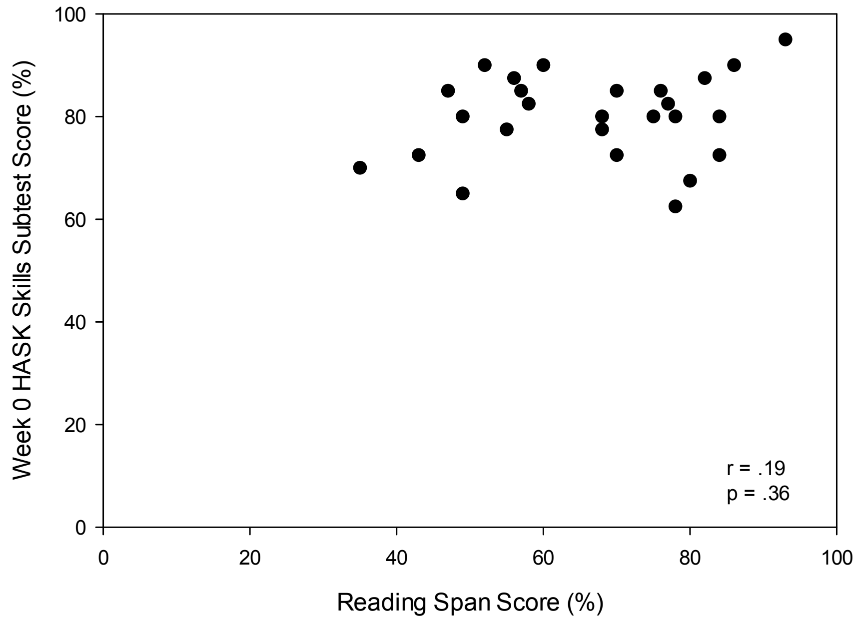
Table 9. Means and standard deviations on the Reading Span test for the experimental and control groups.

Group			
Experimental		**Control**	
M	SD	M	SD
67.8	17.4	65.3	13.5

Note: M = mean; SD = standard deviation

Pearson's product-moment correlations were run to assess the relationship between the Reading Span score and Week 0 HASK skills subtest scores. The mean Reading Span scores were not significantly different between the two groups of participants, and therefore, the data were collapsed across groups for further statistical analysis. No statistically significant correlations were observed between the Reading Span score and HASK skills subtest scores ($p > .05$). See Figure 7 for individual participants' Reading Span scores.

Figure 7. Reading Span scores and HASK skills subtest scores at initial hearing aid fitting.



Hearing Handicap

All participants completed the Hearing Handicap Questionnaire (HHQ) prior to being fit with a hearing aid and then again after the four week hearing aid trial. Social restriction (SR) and emotional distress (ED) subscale scores were calculated in order to measure the personal and social effects of hearing loss separately. Means and standard deviations of HHQ scores for the experimental and control groups prior to hearing aid fitting and post-hearing aid fitting are shown in Table 10. Independent-samples t-tests indicated that pre-hearing aid fitting HHQ scores ($t(24) = -0.557$, $p = .583$, two-tailed), HHQ SR scores ($t(24) = -0.804$, $p = .429$, two-tailed), and HHQ ED ($t(24) = .282$, $p = .780$, two-tailed) did not differ between the control and experimental groups. Also, independent-samples t-tests indicated that post-hearing aid trial HHQ scores ($t(24) = -0.274$, $p = .787$, two-tailed), HHQ SR scores ($t(24) = -0.769$, $p = .504$, two-tailed), and HHQ ED ($t(24) = .048$, $p = .962$, two-tailed) did not differ significantly between the control and experimental groups.

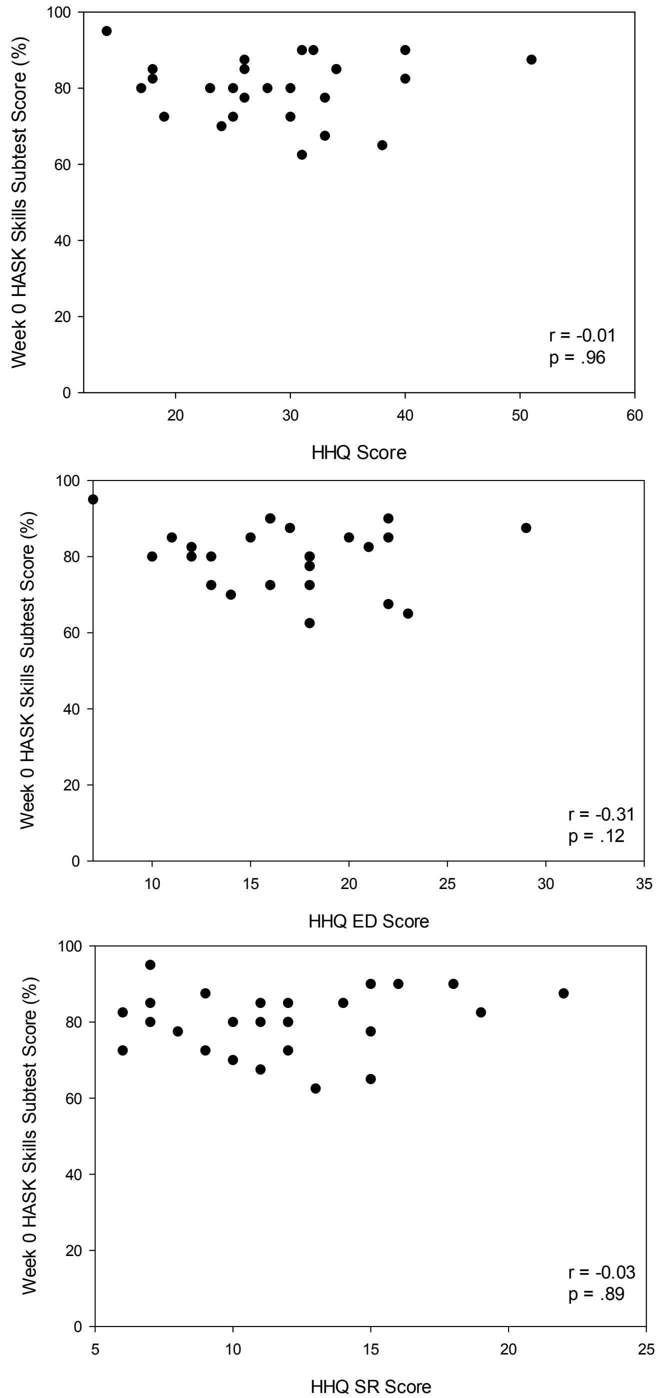
Table 10. Means and standard deviations on the Hearing Handicap Questionnaire (HHQ) and social and emotional subtests for the experimental and control groups.

	Hearing Handicap					
	Pre-Hearing Aid Fitting			Post-Hearing Aid Trial		
	HHQ	HHQ SR	HHQ ED	HHQ	HHQ SR	HHQ ED
Experimental	29.6 (9.8)	12.5 (4.8)	17.2 (5.4)	23.8 (7.8)	10.0 (3.4)	13.8 (4.7)
Control	27.8 (6.8)	11.2 (3.4)	16.6 (4.2)	23.2 (4.7)	9.2 (2.2)	13.8 (3.5)

Notes: Parentheses indicate standard deviations. ED = emotional distress; HHQ = Hearing Handicap Questionnaire; SR = social restriction.

To determine if hearing handicap was related to hearing aid use and care skills, correlations were obtained between HHQ scores and Week 0 HASK skills subtest scores. No significant differences in mean HHQ score observed between groups, and therefore HHQ data were collapsed across groups. Pearson's product-moment correlations were run to assess the relationship between HHQ score and initial HASK skills subtest scores. There were no statistically significant correlations between HASK skills subtest scores and the HHQ score or subtest (i.e. HHQ ED or HHQ SR) scores ($p > .05$). See Figure 8 for individual participants' HHQ scores.

Figure 8. Hearing handicap scores (HHQ, HHQ ED, and HHQ SR) and HASK skills subtest scores at initial hearing aid fitting.



To determine if there were changes in hearing handicap over time, dependent-sample t-tests were run to compare pre-hearing aid fitting HHQ scores to the four week post-hearing aid fitting HHQ scores. Again, data for these measures were collapsed across groups for statistical analysis. Dependent-samples t-tests showed that there were significant declines in HHQ score ($t(25) = 5.224$, $p < .001$, two-tailed), HHQ ED score ($t(25) = 5.882$, $p < .001$, two-tailed), and HHQ SR score ($t(25) = 3.718$, $p = .001$, two-tailed) over the course of the four week hearing aid trial. The effect sizes for these analysis ($d = .70$, $d = .70$, and $d = .62$, respectively) were all found to exceed Cohen's (1988) convention for a medium effect size ($d = .50$). Thus, wearing the hearing aids significantly reduced participants' level of hearing handicap.

Hearing Aid-Related Attitudes

Hearing aid-related attitudes were evaluated with the Hearing Attitudes in Rehabilitation Questionnaire (HARQ) prior to hearing aid fitting and then again after the four week hearing aid trial. Three general attitudes towards hearing impairment were assessed: personal distress/inadequacy (PDI), hearing loss stigma (HLS), and minimization of hearing loss (MOL). Also, four general attitudes towards hearing aids were assessed: hearing aid stigma (HAS), aid-not-wanted (ANW), pressure to be assessed (PTA), and positive expectations (PE). Mean HARQ scores for the experimental and control groups prior to hearing aid fitting and post-hearing aid fitting are shown in Table 11. One participant in the experimental group and two participants in the control group inaccurately completed the HARQ (i.e. by leaving one item blank on the PE, MOL, or HAS subscales) and their data were not included in the data analysis for these subscales.

Independent-samples t-tests indicated that pre-hearing aid fitting HARQ PE scores ($t(24) = .263$, $p = .795$, two-tailed) and HARQ MOL scores ($t(23) = -0.762$, $p = .454$, two-tailed) did not differ significantly between the control and experimental groups. Mann-Whitney rank sum tests indicated that median pre-hearing aid fitting HARQ PDI scores ($U = 82.5$, $p = .938$), HARQ HLS scores ($U = 76.5$, $p = .953$), HARQ PTA scores ($U = 65.5$, $p = .275$), HARQ HAS scores ($U = 77.0$, $p = .978$), and HARQ ANW scores ($U = 80.0$, $p = .832$) also did not differ between the two groups. There was also no significant difference in these hearing aid-related attitudes between the two groups at four weeks post-hearing aid fitting. For example, independent-samples t-tests indicated that post-hearing aid trial HARQ PE scores ($t(23) = -0.903$, $p = .376$, two-tailed) and HARQ MOL scores ($t(24) = .129$, $p = .899$, two-tailed) did not differ between the groups. Mann-Whitney rank sum tests indicated that median pre-hearing aid fitting HARQ PDI scores ($U = 69.0$, $p = .640$), HARQ HLS scores ($U = 77.0$, $p = .670$), HARQ PTA scores ($U = 84.5$, $p = 1.000$), HARQ HAS scores ($U = 71.5$, $p = .494$), and HARQ ANW scores ($U = 49.0$, $p = .058$) did not differ between the experimental and control groups. Thus, there were no significant differences in any of the hearing aid-related attitudes between the two groups.

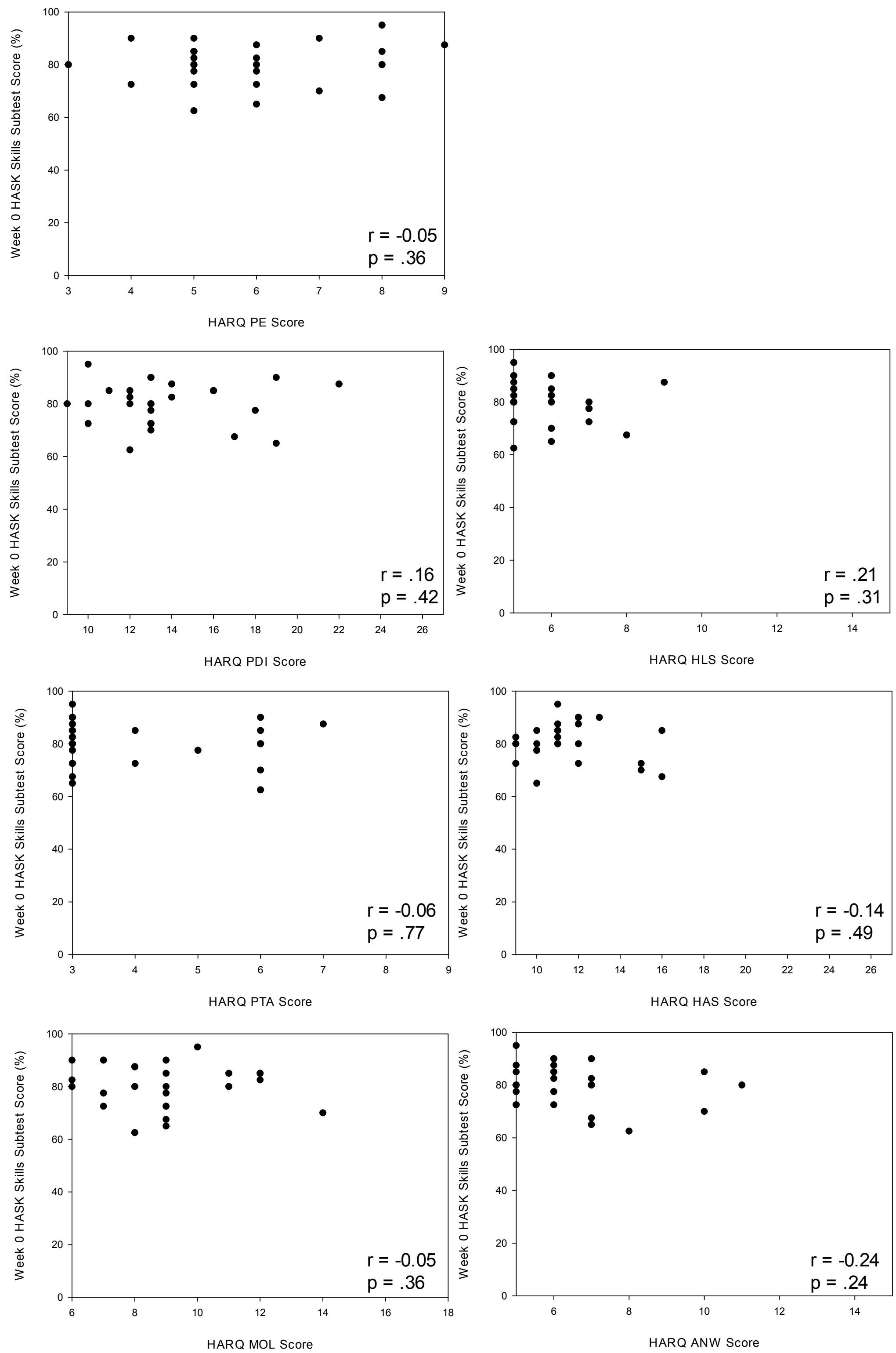
Table 11. Means and standard deviations on the Hearing Attitudes in Rehabilitation Questionnaire (HARQ) for the experimental and control groups.

	Hearing Aid Use			
	Pre-HA Fitting		Post-HA Trial	
Attitude Measure	Experimental	Control	Experimental	Control
Personal Distress/Inadequacy (PDI)	13.9 (3.4)	13.5 (3.1)	12.4 (3.7)	12.4 (2.9)
Hearing Aid Stigma (HAS)	11.6 (2.0)	11.5 (2.1)	10.1 (1.1)	9.8 (0.9)
Hearing Loss Stigma (HLS)	5.8 (1.2)	5.8 (1.1)	5.6 (1.0)	5.5 (0.9)
Aid Not Wanted (ANW)	6.5 (1.8)	6.5 (1.6)	7.8 (2.2)	6.2 (2.0)
Minimization of Loss (MOL)	9.3 (2.5)	8.7 (1.5)	10.5 (2.8)	10.6 (3.3)
Pressure To Be Assessed (PTA)	4.4 (1.6)	3.6 (1.1)	4.2 (1.9)	3.8 (1.1)
Positive Expectation (PE)	5.9 (1.6)	5.8 (1.4)	5.9 (2.0)	6.6 (2.0)

Notes: Parentheses indicate standard deviations.

To determine if hearing aid-related attitudes were related to hearing aid use and care skills, correlations between HARQ scores and HASK skills subtest scores were calculated. No significant differences in mean HARQ scores were observed between groups, and therefore the HARQ data were collapsed across groups for further statistical analysis. Pearson's product-moment correlations showed that there were no statistically significant correlations between Week 0 HASK skills subtest scores and HARQ MOL or PE scores ($p > .05$). See Figure 9 for individual participants' HARQ MOL and PE scores. Spearman rank-order correlations revealed that there were also no statistically significant correlations between Week 0 HASK skills subtest scores and the HARQ PDI, HLS, PTA, HAS, or ANW scores ($p > .05$). See Figure 9 for individual participants' HARQ PDI, HLS, PTA, HAS, and ANW scores. Thus, there was no significant relationship between any of the measured hearing aid-related attitudes and hearing aid use and care skills.

Figure 9. Hearing aid-related attitudes and HASK skills subtest scores at initial hearing aid fitting.



To determine if there were changes in hearing aid-related attitudes over time, dependent-samples t-tests and Wilcoxon signed-rank tests were run to compare pre-hearing aid fitting HARQ scores to post-hearing aid trial HARQ scores. Again, the HARQ data were combined across groups to yield a more robust analysis. Dependent-samples t-tests showed a significant decrease HARQ HAS scores ($t(24) = 5.237$, $p < .001$, two-tailed) and a significant increase in HARQ MOL ($t(24) = -2.326$, $p = .029$, two-tailed) when measured post-hearing aid trial compared to pre-hearing aid fitting and. The effect sizes for these analyses ($d = 1.01$ and $d = .60$, respectively) were found to exceed Cohen's (1988) conventions for large ($d = .80$) and medium ($d = .50$) effects, respectively. A Wilcoxon signed-rank test showed a statistically significant median decrease in HARQ PDI score when attitude was measured pre-hearing aid fitting compared to post-hearing aid trial ($z = -2.353$, $p = .018$). The effect size for this analysis ($r = .33$) exceeds Cohen's (1988) convention for a medium effect ($r = .30$). There were no significant changes in median HARQ HLS scores, HARQ PTA scores, or HARQ ANW scores over the course of the four week hearing aid trial ($p > .05$), nor was there a significant change in mean HARQ PE score ($p > .05$).

PHAST-R Administration & Targeted Re-Instruction Time

The amount of time spent administering the PHAST-R and providing targeted re-instruction to the experimental group was measured and recorded at Week 0 and Week 2 post-hearing aid fitting to determine the average amount of time that would be required to include targeted re-instruction in a hearing aid fitting appointment. The time it took to administer the PHAST-R using the PHAST-R app and provide targeted re-instruction ranged from 4 minutes and 34 seconds to 18 minutes and 24 seconds, with a mean administration time of 9 minutes and 15 seconds (SD = 3 minutes and 13 seconds).

Discussion

The present study is the first randomized control trial to demonstrate the clinical benefit of using targeted re-instruction to counsel on hearing aid use and care skills during a hearing aid fitting. The purpose of this study was to determine if participants who were provided targeted re-instruction would show greater improvements in hearing aid use and care skills, report higher levels of hearing aid satisfaction, and use their hearing aids for more hours per day compared to participants who did not receive targeted re-instruction. Additionally, this study determined the amount of time that it takes to provide targeted re-instruction, as well as assessed participant factors that may have some relationship to learning and remembering hearing aid use and care skills. The main findings of this study and implications of these findings, strengths and limitations of the study, and directions for future research are discussed below.

Hearing Aid Use and Care Skills

In the present study, regardless of whether or not the group of participants did or did not receive targeted re-instruction, neither of the groups showed improvements in overall hearing aid use and care skills over time. However, the primary finding was that the group of participants who received targeted re-instruction maintained their overall hearing aid use and care skills, and the group of participants who did not receive targeted-reinstruction showed a decline in their overall hearing aid use and care skills. This is consistent with the findings from Saunders et al. (2018) that there was no change in hearing aid use and care skills over time, but inconsistent with other studies that have shown hearing aid use and care skills to improve over time (Desjardins & Doherty 2017; Ferrari, Jokura, Silvestre, Campos, & Paiva 2015).

Additionally, participants who received targeted re-instruction in the present study demonstrated improvements in performance on a number of individual difficult to learn hearing aid use and care skills. For example, the percentage of participants in the experimental group who could successfully brush the microphone port and change the wax trap during cleaning increased by 23% whereas the percentage of participants in the control group who could perform those skills decreased by 38% and 23%, respectively. Switching to the phone program was a skill that was difficult for both the experimental and control groups, however, the percentage of participants in the experimental group that were able to successfully switch to their phone program (38.5%) was five times greater than the percentage of participants in the control group who could successfully perform this skill (7.7%).

The HASK skill subtest scores were the primary outcome measures used in the present study and were found to be comparable to those reported by Saunders et al. (2018). For example, mean scores on the HASK skills subtest at the hearing aid fitting in the present study were 79.0% (SD = 8.0%) for the control group and 81.2% (8.8%) for the experimental group, and the mean score reported by Saunders et al. (2018) on the HASK skills subtest for new hearing aid users was 79.7% (SD = 10.6%). Mean HASK knowledge subtest scores at the hearing aid fitting in the present study were 75.8% (SD = 10.7%) for the control group and 78.0% (SD = 9.4%) for the experimental group, which was higher than the 68.5% (SD = 12.6%) reported for new hearing aid users by Saunders et al. (2018). Saunders et al. (2018) measured knowledge using the HASK test four to eight weeks after participants had been fit with a hearing aid, but in the present study, the HASK test was administered immediately following the hearing aid orientation and then again at four weeks post-hearing aid fitting. In the present study significant declines in knowledge were observed over a four week period for the group that did not receive targeted re-instruction (i.e. the control group). Because Saunders et al. (2018) only measured knowledge with the HASK test between four and eight weeks post-hearing aid fitting, this may explain why the mean HASK knowledge subtest score in their study was lower. Their participants may have already forgotten some of the hearing aid use and care knowledge they had learned in the hearing aid orientation four to eight weeks prior.

In the present study, the HASK test was re-scored to represent performance on the HASK test items that addressed the skills that were also included on the PHAST-R (i.e. hearing aid insertion and removal, changing the hearing aid batteries, cleaning the hearing aids, increasing the hearing aid volume, and using the telephone with the hearing aids). Re-scoring the HASK test allowed for determining if the PHAST-R skills participants were re-instructed on improved *as a result of* targeted re-instruction. The PHAST-R, which the HASK test re-score was based on, was designed to assess skills that were determined to be the most basic, but essential, skills for hearing aid use and management (Desjardins & Doherty 2009; Doherty & Desjardins 2012). These are the skills included in the hearing aid user manuals from the major hearing aid manufacturers (Desjardins & Doherty 2009). The HASK test includes most of these same basic skills, but also more advanced skills, such as troubleshooting for feedback (Saunders et al. 2018). Results from the present study suggest that these more advanced hearing aid use and care skills are more difficult to remember and perform. For example, the targeted skills HASK mean scores were approximately 10% higher than the original scores. These additional advanced skills on the HASK test may not be necessary for basic hearing aid use and care. Also, considering participants in the present study were unable to learn and remember the most basic skills needed for effective everyday use, counseling on these more advanced hearing aid use and care skills may not be the most efficient way to use time with a new hearing aid user.

Interestingly, at the end of the four week hearing aid trial all of the participants reported that they felt they could use their hearing aids well regardless of the fact that they were unable to perform several of the basic hearing aid use and care skills. Desjardins and Doherty (2009) reported a similar finding such that 96% of the experienced hearing aid users in their study reported they could use their hearing aids well, but only 48% could correctly demonstrate basic hearing aid use and care skills. In the present study, the experimental group self-reported that their hearing aid use and care skills significantly improved over time even though their actual hearing aid use and care skills (as measured by the HASK test and the PHAST-R) did not improve. Thus, although participants who received targeted re-instruction did not demonstrate actual improvements in their overall HASK test score, they did feel more confident in their hearing aid use and care abilities over time. Hearing aid owners report that it takes an average of two visits with the audiologist before they feel that they are competent in using their hearing aids (Kochkin 2005). However, when actually measuring competency for hearing aid use and care, as in the present study, most participants could not successfully perform all of the basic hearing aid use and care skills necessary for successful hearing aid use after two visits. These findings reinforce the importance of not relying on patients to self-report their hearing aid use and care skills but instead using tools such as the PHAST-R to objectively identify which hearing aid use and care skills a patient can or cannot perform.

In the present study, some hearing aid use and care skills were observed to be more difficult for participants to perform than others. The most challenging tasks were related to cleaning and use of the phone program (specifically switching to the phone program/activating the telecoil). Other studies have found similar results. For example, Saunders et al. (2018) reported hearing aid cleaning tasks to be the most challenging, and Desjardins and Doherty (2009) and Desjardins et al. (2018) found cleaning and using the telephone to be the most problematic for participants. Bennett, Meyer, Eikelboom, and Atlas (2018b) reported that less frequently performed hearing aid use and care tasks such as telephone use were more difficult than more frequently performed tasks such as insertion and removal of the hearing aid. Audiologists should consider these findings when counseling patients on hearing aid use and care skills. For example, audiologists should spend more time explaining and demonstrating how to switch to the phone program and clean the hearing aids and provide their clients with printed handouts with instructions and reminders for performing these skills. Also, manufacturers should design their support materials to focus on these challenging use and care skills.

Seven of the experimental and 13 of the control participants in the present study reported that they looked in their hearing aid user manual for information about and/or support with their hearing aids during the first two weeks of the hearing aid trial. Many studies have examined how hearing aid user manuals can be improved to provide more useful information to hearing aid owners (Brooke, Isherwood, Herbert, Raynor, & Knapp 2012; Caposecco et al. 2015; Ferguson, Brandreth, Brassington, & Wharrad 2015; McMullan, Kelly-Campbell, & Wise 2018). Perhaps results from the present study and other similar studies can be used by manufacturers when they update their instruction manuals.

Hours of Hearing Aid Use

It was hypothesized that participants who received targeted re-instruction would wear their hearing aids for more hours per day on average than participants who did not receive targeted re-instruction, but this was not observed. Datalogging revealed that, on average, participants used their hearing aids for about 7.5 to 8 hours per day regardless of whether they were assigned to the experimental or control group. This is fewer hours per day of hearing aid use than was recently reported in Johnson, Jilla, Danhauer, Sullivan, and Sanchez (2018). They studied self-efficacy for hearing aid use and care skills and found that participants used their hearing aids for an average of 10.1 hours per day. However, Johnson et al. (2018) reported hours of hearing aid use based on self-report, and it is possible participants overestimated their daily use. Previous studies have shown that self-reported hearing aid use can overestimate actual daily usage by up to approximately 4 hours per day (Gaffney 2008; Humes, Halling, & Coughlin 1996; Laplante-Lévesque, Nielsen, Jensen, & Naylor 2014; Taubman, Palmer, Durrant, & Pratt 1999).

Desjardins & Doherty (2017) and Timmer, Hickson, & Launer (2017) used datalogging to determine average daily hours of hearing aid use. Timmer et al. (2017) reported average hours of hearing aid use based on more than 8,000 binaural hearing aid users and found users wore their hearing aids for an average of 8.5 hours per day, which is only slightly more than the 7.5 to 8 hours per day observed in the present study. Desjardins & Doherty (2017) found that new hearing aid users used their hearing aids for an average of 12 hours per day, which is higher than the average found in the present study. It is possible that differences in instructions and/or recommendations for daily hearing aid use may account for some of these discrepancies. In the present study, there were no requirements or specific recommendations for how long participants needed to wear their hearing aids. Instead, all participants were instructed during the hearing aid orientation to "try to wear the hearing aids most of the day every day."

Hearing Aid Satisfaction

At two weeks post-hearing aid fitting, participants in the experimental group were found to be less satisfied with their hearing aids than participants in the control group. One potential explanation for this result is that targeted re-instruction made participants in the experimental group aware of the skills they were not able to perform or performing incorrectly and this may have influenced their initial perceived satisfaction. In contrast, the control group was given no feedback about how well or poorly they performed. Perhaps the saying "ignorance is bliss" applies in this situation, such that the control group felt satisfied with their hearing aids because they did not know what they were doing incorrectly. However, when hearing aid satisfaction was measured again four weeks post-hearing aid fitting, the experimental group's level of hearing aid satisfaction had increased and there was no difference in level of satisfaction between the two groups.

Working Memory

In the present study there was no significant relationship between working memory scores and hearing aid use and care skill scores. This finding is in contrast to other studies, both within and outside of the field of audiology. For example, Wilson et al. (2010) explored the relationship between cognition, health literacy, and recall of information related to colorectal cancer screenings. They found that health literacy significantly predicted performance on a measure of recall of health-related information, and cognition explained most of the association between health literacy and immediate recall of health information. They assessed not only working memory, but also processing speed and long-term memory. Therefore, it is possible that by assessing only working memory, the present study failed to identify the specific factor, or combination of factors, related to memory for hearing aid use and care skills.

Desjardins et al. (2018) reported that hearing aid users with better working memory function performed significantly better on the PHAST-R, unlike in the present study. This difference may be due to when the relationship between working memory and hearing aid use and care skills was assessed. In the present study, this relationship was assessed immediately following the hearing aid orientation, whereas in Desjardins et al. (2018) it was assessed at least 30 days after the hearing aid orientation. Therefore, it appears that while working memory function is related to delayed recall of hearing aid use and care skills, the same relationship is not observed between working memory and immediate recall of that same information. Another interesting finding related to working memory was that only six participants (five experimental and one control) were able to successfully switch to the phone program and all of them had Reading Span scores that were above the average Reading Span score for this study.

It is difficult to directly compare performance on the Reading Span test across studies because there are multiple versions of the Reading Span test, and some of these versions differ in the length of the trials presented. For example, in the present study, trials consisted of two (i.e. 2-span) to seven (i.e. 7-span) sentence presentations. A version (in Swedish) used by Lunner and colleagues consists of trials that are between three (i.e. 3-span) and six (i.e. 6-span) sentences long (Foo, Rudner, Rönnberg, & Lunner 2007; Lunner 2003). Comparisons between Reading Span tests of differing trial lengths are not useful because versions of the test consisting of longer sentence spans are more difficult than versions consisting of shorter sentence spans. Another challenge is that there are four different methods that can be used to score the Reading Span test. In the present study, a participant's final score on the Reading Span Test was computed by averaging the trial scores in order to devise a total score that represents the mean proportion of letters recalled correctly. This scoring method was selected based on the recommendations by Conway et al. (2005) following their methodological review of working span measures. However, other studies that have used the Reading Span test have used a variety of other scoring methods (Foo et al. 2007; Lunner 2003; Souza & Arehart 2015) making it difficult to directly compare the results from those studies to results of the present study.

Hearing Handicap and Hearing Aid-Related Attitudes

Prior to being fit with a hearing aid, participants in the present study reported hearing handicap scores on the HHQ that ranged from 14 to 52 with a mean HHQ score of 28.7 (SD = 8.3). These scores are consistent with those reported in other studies that have reported on hearing handicap prior to intervention. Desjardins & Doherty (2017) found that, prior to being fit with a hearing aid, adults with hearing impairment reported a mean HHQ score of 30.9 (SD = 7.9) and Hickson, Worrall, and Scarinci (2007) reported a mean HHQ score of 27.97 (SD = 9.36) in 178 older adults. In the present study, after wearing hearing aids approximately eight hours per day for four weeks, participants mean hearing handicap scores decreased significantly to a score of 23.5 (SD = 6.3). Other studies have also demonstrated a significant reduction in hearing handicap after using hearing aids. Abrams, Hnath-Chisolm, Guerreiro, and Ritterman (1992) found that scores on the Hearing Handicap Inventory for the Elderly (HHIE) decreased after two months of being fit with a hearing aid and Desjardins & Doherty (2017) reported that mean HHQ score decreased after wearing hearing aids for six weeks 12 hours per day.

Participants' hearing aid-related attitudes also improved in the present study. Specifically, participants reported significantly lower levels of personal distress and inadequacy after wearing their hearing aids for four weeks. Desjardins & Doherty (2017) reported similar changes in personal distress and inadequacy following six weeks of hearing aid use. Many of the questions on the HARQ that assess personal distress and inadequacy are similar to questions on the HHQ that assess hearing handicap, and therefore it is not surprising that hearing aid use reduced both hearing handicap and personal distress and inadequacy.

Hearing aid stigma was also significantly reduced in the present study following four weeks of hearing aid use, similar to that reported in Desjardins & Doherty (2017). Reducing hearing aid stigma is important because hearing aid stigma contributes to people's resistance to seek help for hearing loss (Bennett, Laplante-Lévesque, & Eikelboom 2018; Southall, Gagné, and Jennings 2010). Kochkin (2012) reported that hearing aid stigma is the "the top psycho-social issue" hindering the adoption of hearing aids. Unfortunately it is estimated that nearly 23 million Americans over the age of 50 who have hearing loss do not use hearing aids (Chien & Lin 2012). As recently as a few months ago, hearing aid stigma has been reported as one of the main reasons people with hearing loss resist purchasing hearing aids (Aubrey 2018). Therefore, it is promising that hearing aid stigma can be significantly reduced in as little as a typical hearing aid trial period.

The present study is the first to investigate a potential relationship between hearing handicap and hearing aid use and care skills and hearing aid-related attitudes and hearing aid use and care skills. Neither hearing handicap or hearing aid-related attitudes were significantly related to hearing aid use and care skills. This suggests that even patients who have a positive attitude towards hearing aids or a high level of hearing handicap and likely more motivated to use hearing aids can struggle with hearing aid use and care. Thus, it is important to use tools like the PHAST-R with *all* patients to assesses if they have proficient hearing aid use and care skills.

PHAST-R Administration & Targeted Re-Instruction Time

The final aim of the present study was to determine the time it takes to administer the PHAST-R and provide targeted re-instruction. It took on average less than 10 minutes to administer the PHAST-R (using the PHAST-R app) and provide targeted re-instruction. Audiologists and hearing aid dispensers spend approximately 45 minutes instructing hearing aid users on use and care of their hearing aids, hearing aid features, and realistic expectations for hearing aid use (Kochkin 2005). Adding an additional 10 minutes to administer the PHAST-R might actually save time in the long run. The most common reason that patients return for hearing aid repair appointments is poorly maintained hearing aids (Block 2001). In the present study, participants who did not receive targeted re-instruction experienced declines in their ability to use and maintain their hearing aids. Over time this would likely result in poor hearing aid sound quality due to clogged microphone ports and wax guards. Therefore, future studies should investigate if participants who receive targeted re-instruction return for fewer hearing aid repair appointments compared to participants who do not receive targeted re-instruction and ultimately occupy less of an audiologist's time.

Study Strengths and Limitations

The present study is the first randomized control trial to demonstrate clinical benefit of targeted re-instruction used during a hearing aid fitting. Randomized control trials are considered the "gold standard" for evaluating the effectiveness of an intervention (Meldrum 2000). Previous studies have demonstrated the validity and reliability of tools for measuring hearing aid use and care skills, such as the PHAST-R (Desjardins & Doherty 2009; Doherty & Desjardins 2012), the HASK test (Saunders et al. 2018), and the newly developed Hearing Aid Skills and Knowledge Inventory (HASKI; Bennett, Meyer, Eikelboom, & Atlas 2018a). Ferrari et al. (2015) and Desjardins & Doherty (2017) administered the PHAST-R at multiple points in time, which allowed for comparison of performance across time, but determining the clinical effectiveness of the PHAST-R was not the aim of either of these studies. Also, neither of these studies included a control group. Thus, the present study is the first study to use a randomized control trial to show that targeted re-instruction can prevent a decline in hearing aid use and care skills.

An additional strength of this study was the well-controlled experimental design. The methodological quality of a clinical trial can be determined using the PEDro-P Scale (Togher 2013). This is an 11-item rating scale to judge the design of randomized and non-randomized control trials. The 11 items included on the PEDro-P Scale include: 1) Eligibility criteria were specified; 2) Subjects were randomly allocated to interventions; 3) Allocation was concealed; 4) The intervention groups were similar at baseline regarding the most important prognostic indicators; 5) There was blinding of all subjects; 6) There was blinding of all therapists who administered the therapy; 7) There was blinding of all assessors who measured at least one key outcome; 8) Measurements of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; 9) All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by “intention to treat”; 10) The results of between-intervention group statistical comparisons are reported for at least one key outcome; and 11) The study provides both point measurements and measures of variability for at least one key outcome. The PEDro-P Scale has been shown to have good reliability when used to assess studies in the field of communication sciences and disorders (Murray, Power, Togher, McCabe, Munro, & Smith 2013). The present study satisfies all items on the PEDro-P Scale except for “blinding of all therapists who administered the therapy.” The primary investigator administered the PHAST-R and provided targeted re-instruction in the present study because budgetary constraints prevented the hiring of another research staff member to perform this task. However, care was taken to randomize participants at the last possible moment (i.e. after the hearing aid orientation), in order to ensure that the primary investigator was blinded to participants’ group assignments for as long as possible. It should also be noted that the average of nine minutes spent administering the PHAST-R resulted in the primary investigator spending an unequal amount of time with the experimental and control groups.

Another limitation in the present study was related to the length of time for the hearing aid trial. This four week period of time was selected based on the fact that most states mandate a 30 day trial period for new hearing aid purchases (Dybala 2008). However, results from this study showed that the experimental group’s hearing aid use and care skills remained stable across the four week period and the control group’s performance decreased. It would be interesting to know if this trend would have continued beyond four weeks. If so, this would have negative clinical implications for the control group if their hearing aid use and care skills continued to decline. It would also strengthen the argument to use targeted re-instruction if it could prevent a decline in hearing aid use and care skills even after a longer period of time.

A final limitation of the present study is related to diversity. For example, 21 out of the 26 participants possessed an advanced degree (i.e. a bachelor's or higher degree). Health literacy has been shown to be related to education level such that lower educational level is associated with lower levels of health literacy (Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd 2005). Therefore, the results of the present study may have limited generalizability to the general U.S. population because although 81% of the participants in the present study possessed an advanced educational degree, only 33% of the U.S. population holds such a degree (Ryan & Bauman 2016). Additionally, all but two of the participants in the present study were white and all participants were native English speakers so it is unknown as to whether these results can be generalized to culturally and linguistically diverse populations.

Future Directions

Future studies should employ longer hearing aid field trials, perhaps as long as one year, and should also include both new and experienced hearing aid users. Another area for future study is to focus on other populations, such as parents of children with hearing loss. Parents of children with hearing loss are typically responsible for the care and maintenance of their children's hearing aids. However, in a survey of 318 parents of children with hearing aids, 40% of parents reported that they wanted more information on hearing aid use, care, and maintenance (Muñoz et al. 2016). It is likely that many of the hearing aid use and care skills that were identified in the present study as being particularly challenging for new hearing users, such as cleaning, may also be challenging for parents of children with hearing loss who care for their children's hearing aids. In fact, 24% of parents reported that they do not have a tool for cleaning their child's hearing aids (Muñoz et al. 2016). Pediatric audiologists do not always teach or address information about hearing aid use and maintenance skills with parents. For example, in a survey of 349 audiologists who reported that they fit hearing aids on children, almost half reported that they do not routinely teach parents skills for basic hearing aid maintenance (Meibos, Muñoz, White, Preston, Pitt, & Twohig 2016).

Another population that is especially vulnerable to difficulty with hearing aid use, care, and maintenance is older adults in long-term care facilities. Nearly half of nursing home residents report that their hearing aids are hard to put in or use, and 65% of residents need support with changing their hearing aid batteries and/or inserting and removing their hearing aids (Cohen-Mansfield & Taylor 2004). Future studies should explore the effectiveness of using targeted re-instruction with older adults in long-term care facilities, and could also explore using targeted re-instruction to teach nursing home staff to care for and maintain residents' hearing aids.

Conclusions

The primary goal of the present study was to evaluate the benefit of identifying specific hearing aid use and care skills that a hearing aid user cannot perform or has difficulty performing and providing re-instruction on only those skills (i.e. targeted re-instruction). This study also sought to explore patient factors that could influence learning and remembering or hearing aid use and care skills, and determine the amount of time that it takes to perform targeted re-instruction. Targeted re-instruction was shown to prevent a decline in hearing aid use and care skills after four weeks of hearing aid use, whereas participants who did not receive targeted re-instruction showed a decline in their hearing aid use and care skills. None of the patient factors explored in the present study, including age, hearing thresholds, working memory, hearing handicap, or hearing aid-related attitudes, were significantly related to hearing aid use and care skills. Last, it was determined that it takes an average of less than 10 minutes to administer the PHAST-R (using the PHAST-R app) and provide targeted re-instruction, which is a clinically feasible amount of time.

Appendices

Appendix A
Hearing Aid Orientation Script

VA HA Orientation Item (Reese & Hnath-Chisolm 2005)	***HA Orientation Script***
Landmarks	
Microphone position and function	Show (**patient name**) basic components of hearing aid and explain function of each part A. Hearing aid body B. Microphone C. Battery compartment D. Receiver E. Wax guard F. Dome
Right hearing aid has red printing on it, left has blue	Show (**patient name**) how to distinguish between left and right hearing aids A. Right hearing aid has red printing on it, left has blue Demonstrate to (**patient name**) how to insert and remove hearing aid A. Demonstrate insertion and removal of hearing aid Instruct (**patient name**) to practice inserting and removing hearing aids until he/she has done so successfully at least one time per ear
Batteries	
Color and size	Tell (**patient name**) color and size of hearing aid batteries Show (**patient name**) package of hearing aid batteries and point to where on packaging the color and size will be indicated
Remove battery tab before placing in hearing aid	Demonstrate to (**patient name**) how to remove battery tab from a new battery
Battery door won't close if battery is upside down	Demonstrate to (**patient name**) how to change battery Demonstrate to (**patient name**) that if battery is inserted upside down then battery door will not close Instruct (**patient name**) to practice inserting and removing battery until he/she has done so successfully at least one time
Opening battery door when hearing aids are not in use helps batteries last longer	Tell (**patient name**) to open battery door when hearing aids are not in use
Batteries should last *x* days and possibly longer	Tell (**patient name**) how many days they should expect batteries to last

Feedback	
Normally occurs with hand held against the hearing aid	Demonstrate to (**patient name**) that feedback will naturally occur if a hand is held against hearing aid
If feedback occurs while talking on the phone, reposition phone OR use telecoil switch	Tell (**patient name**) that if feedback occurs while talking on phone, then they should reposition phone or use telecoil A. Demonstrate to (**patient name**) the appropriate position for using phone with hearing aids B. Demonstrate to (**patient name**) how to activate telecoil/phone program on hearing aid a. Instruct (**patient name**) to practice activating telecoil/phone program on hearing aid until he/she has done so successfully at least once
If feedback occurs with jaw movement, hearing aid may not fit well	Tell (**patient name**) that if feedback occurs with jaw movement then hearing aid may not fit well and they should notify their audiologist
Cleaning and Care	
Hearing aids should be cleaned every day	Tell (**patient name**) that hearing aids should be cleaned daily
Greatest cause of hearing aid problems is ear wax accumulation in receiver tubes	Tell (**patient name**) that ear wax accumulation in receiver and/or dome is a common cause of hearing aid problems A. Demonstrate to (**patient name**) how to clean vent OR open fit mold B. Show (**patient name**) where to look to see if earwax is visibly blocking wax guard C. Demonstrate to (**patient name**) how to replace wax guard in case of ear wax accumulation D. Instruct (**patient name**) to practice replacing wax guard until he/she has done so successfully at least once
To clean hearing aids, use dry cloth/tissue or brush	Demonstrate to (**patient name**) how to brush microphone port
Store hearing aids overnight in a dry, safe place	Tell (**patient name**) to store hearing aids in a dry, safe place overnight
If hearing aids get wet, don’t dry it in an oven	Tell (**patient name**) that hearing aids are water resistant but not waterproof. A. Tell (**patient name**) to contact their audiologist if hearing aids get wet
If hearing aid isn’t working, try replacing the battery	Tell (**patient name**) that if hearing aid is not working then they should try replacing the battery
If that doesn’t help, call the clinic for an appointment	Tell (**patient name**) that if replacing the battery doesn’t help, then they should try cleaning hearing aid and and replacing wax guard. A. Tell (**patient name**) that if replacing wax guard doesn’t help then they should contact their audiologist
During Trial Period	

Read over the information provided by the audiologist	Show (**patient name**) user manual and quick guide Tell (**patient name**) that they can review manuals at home for more information
Pay close attention to what you do/do not like about the hearing aids so that the hearing aids may be adequately adjusted	Tell (**patient name**) to pay close attention to what he/she does/does not like about hearing aids so that hearing aids can be adjusted
Try to wear the hearing aids most of the day every day; it's OK to take the hearing aids off from time to time during the day or if otherwise instructed by audiologist	Tell (**patient name**) to try to wear hearing aids most of the day every day
Do Expect	
Listening to be easier	Tell (**patient name**) to expect that listening will be easier when they wear hearing aids
To hear better in many situations most of the time	Tell (**patient name**) to expect that he/she will hear better in many situations most of the time
Own voice may seem louder	Tell (**patient name**) to expect that his/her own voice may seem louder
May take several months to get used to	Tell (**patient name**) to expect that it may take several months to get used to hearing aids
Do Not Expect	
Hearing aid to be painful	Tell (**patient name**) that his/her hearing aids should not be painful A. Tell (**patient name**) that his/her hearing aids should not feel physically painful when he/she wears them B. Tell (**patient name**) that his/her hearing aids should not be painfully loud in any listening situations a. Tell (**patient name**) that he/she can adjust volume of hearing aid b. Demonstrate to (**patient name**) how to adjust volume of hearing aid softer c. Demonstrate to (**patient name**) how to adjust volume of hearing aid louder d. Instruct (**patient name**) to practice adjusting volume softer on the hearing aid until he/she has done so successfully at least once e. Instruct (**patient name**) to practice adjusting volume louder on the hearing aid until he/she has done so successfully at least once
To hear speech better in noise	Tell (**patient name**) that he/she should not expect to hear speech perfectly in background noise A. Tell (**patient name**) that there is a program in hearing aids that may help them hear better in background noise

	B. Demonstrate to (**patient name**) how to activate noise program on hearing aid C. Instruct (**patient name**) to practice activating noise program on hearing aid until he/she has done so successfully at least once

Appendix B

Practical Hearing Aid Skills Test - Revised (PHAST-R; Desjardins & Doherty 2009; Doherty & Desjardins 2012)

PRACTICAL HEARING SKILLS TEST - REVISED (PHAST - R)

Name: ____________ **Date:** ________ **Age:** ____ **Hearing Aid:** ____________

Audiologist: ____________ **Score:** _____ Session: ____________

Instructions :
Place the following items in front of the patient: A telephone, Different size batteries (10, 312, 13, etc.), Magnetic tool for battery removal, Cleaning tools: brush, cloth, wax loop.

Complete the ENTIRE PHAST (Reinstruct on items AFTER the PHAST is completed). Reinstruct patients on the tasks that he/she received a score of 1 or 0.

Scoring:
2 Performs the task without any problems.
1 Performs the task using 'deviant' means (e.g., takes aid out to adjust VC), needs some re-instruction.
0 Cannot perform task.

1 Ask the patient, "Please take out your hearing aid."						Comment
a Can he/she grasp the aid?	○ 0	○ 1	○ 2	○ N/A		______
b Can he/she remove aid properly?	○ 0	○ 1	○ 2	○ N/A		______
2 Ask the patient, "Open up the battery door."						Comment
a Can he/she locate the door on first try?	○ 0	○ 1	○ 2	○ N/A		______
b Can he/she open the door without difficulty?	○ 0	○ 1	○ 2	○ N/A		______
3 Ask the patient, "Please show me how you change your hearing aid battery."						Comment
a Can he/she Remove old battery?	○ 0	○ 1	○ 2	○ N/A		______
b Did he/she choose correct battery size?	○ 0	○ 1	○ 2	○ N/A		______
c Can he/she remove battery tab?	○ 0	○ 1	○ 2	○ N/A		______
d Can he/she correctly place new battery in battery compartment?	○ 0	○ 1	○ 2	○ N/A		______
4 Ask the patient, "Please show me how you clean your hearing aid."						Comment
a Can he/she clean sound bore or replace wax guard?	○ 0	○ 1	○ 2	○ N/A		______
b Can he/she brush microphone port?	○ 0	○ 1	○ 2	○ N/A		______
c Can he/she clean the vent?	○ 0	○ 1	○ 2	○ N/A		______
d Can he/she clean open fit mold?	○ 0	○ 1	○ 2	○ N/A		______
5 Ask the patient, "Please put your hearing aid back in your ear."						Comment
a Can he/she grasp aid?	○ 0	○ 1	○ 2	○ N/A		______
b Can he/she place the aid properly in the ear?	○ 0	○ 1	○ 2	○ N/A		______
6 Ask the patient, "Turn up the volume of your hearing aid."						Comment
a Can he/she correctly manipulate the VC?	○ 0	○ 1	○ 2	○ N/A		______
7 Ask the patient, "Show me how you use the telephone with your HA.(hand phone to patient)						Comment
a Can he/she choose correct program/t-coil?	○ 0	○ 1	○ 2	○ N/A		______
b Can he/she correctly place the phone in relation to the aid?	○ 0	○ 1	○ 2	○ N/A		______
8 Ask the patient, "Show me how you would adjust your hearing aid when you are in a noisy environment."						Comment
a Can he/she use correct program	○ 0	○ 1	○ 2	○ N/A		______

Appendix C

Re-instruction/Re-counseling Protocol

#	*PHAST-R Task*	*Examiner Response*
1. Ask the patient, "Please take out your hearing aid."		
1a	Can he/she grasp the aid?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
1b	Can he/she remove aid properly?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
2. Ask the patient, "Open up the battery door."		
2a	Can he/she locate the door on the first try?	If 0 or 1, show patient battery door once. If 2, move to next task.
2b	Can he/she open the door without difficulty?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
3. Ask the patient, "Please show me how you change your hearing aid battery."		
3a	Can he/she remove old battery?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
3b	Did he/she choose correct battery size?	If 0 or 1, show patient correct battery size once. If 2, move to next task.
3c	Can he/she remove battery tab?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
3d	Can he/she correctly place new battery in battery compartment?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
4. Ask the patient, "Please show me how you clean your hearing aid."		
4a	Can he/she clean sound bore or replace wax guard?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
4b	Can he/she brush microphone port?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
4c	Can he/she clean the vent?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
4d	Can he/she clean open fit mold?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
5. Ask the patient, "Please put your hearing aid back in your ear."		
5a	Can he/she grasp aid?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
5b	Can he/she place the aid properly in the ear?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
6. Ask the patient, "Turn up the volume of the your hearing aid."		
6a	Can he/she correctly manipulate the VC?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently.

		If 2, move to next task.
7. Ask the patient, "Show me how you use the telephone with your HA" (Hand phone to patient)		
7a	Can he/she choose correct program/t-coil?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, move to next task.
7b	Can he/she correctly place the phone in relation to the aid?	If 0 or 1, re-instruct and/or demonstrate proper placement of phone in relation to the aid. If 2, move to next task.
8. Ask the patient, "Show me how you would adjust your hearing aid when you are in a noisy environment."		
8a	Can he/she use correct program?	If 0 or 1, re-instruct and/or demonstrate as many times as necessary for patient to complete task once independently. If 2, PHAST-R is complete.

Appendix D

Daily Listening Log

Patient Code: _______

Daily Listening Situations Log

Did you encounter the following listening situations today while you were wearing your hearing aids?

Date: ____________________

Yes	No	
		Listening to the TV with other family or friends when the volume is adjusted to suit other people.
		Having a conversation with one other person when there is no background noise.
		Carrying on a conversation in a busy street or shop.
		Having a conversation with several people in a group.

Date: ____________________

Yes	No	
		Listening to the TV with other family or friends when the volume is adjusted to suit other people.
		Having a conversation with one other person when there is no background noise.
		Carrying on a conversation in a busy street or shop.
		Having a conversation with several people in a group.

Date: ____________________

Yes	No	
		Listening to the TV with other family or friends when the volume is adjusted to suit other people.
		Having a conversation with one other person when there is no background noise.
		Carrying on a conversation in a busy street or shop.
		Having a conversation with several people in a group.

Appendix E

Outside Help/Assistance Questionnaire

Participant Code: _______

Session #: _______

Date: ________

Did anyone help you or assist you with using or caring for your hearing aids in the past two weeks? (Circle one.)

Yes No

If **yes**, who helped you or assisted you? What tasks, specifically, did they help or assist you with?

Did you read or consult your hearing aid owner's manual/user guide in the past two weeks?

Yes No

If **yes**, were you looking for general information (e.g. you just wanted to know more about your hearing aids), or were you looking for specific information (e.g. you wanted to know more about changing the hearing aid battery)?

General Info **OR** Specific Help

Which tasks?

____

____

____

TURN PAGE OVER

Did you consult any other resources (besides your hearing aid owner's manual/user guide) for more information about using or caring for your hearing aids in the past two weeks (e.g. the Internet)?

Yes No

If **yes**, were you looking for general information (e.g. you just wanted to know more about your hearing aids), or were you looking for specific information (e.g. you wanted to know more about changing the hearing aid battery)?

General Info **OR** Specific Help

Which tasks?

____

____

____

Appendix F

Hearing Aid Orientation Script Adherence Rating Form

Directions: Place a ✓ in the box next to each item that the clinician performed. Place an X in the box next to any items that the clinician did not perform. If necessary, note comments in the right-hand column.

HA Orientation Script	***Comments***
Landmarks	
● Show (**patient name**) basic components of hearing aid and explain function of each part ❑ Hearing aid body ❑ Microphone ❑ Battery compartment ❑ Receiver ❑ Wax guard ❑ Dome	
● Show (**patient name**) how to distinguish between left and right hearing aids ❑ Right hearing aid has red printing on it, left has blue ● Demonstrate to (**patient name**) how to insert and remove hearing aid ❑ Demonstrate insertion and removal of hearing aid ❑ Instruct (**patient name**) to practice inserting and removing hearing aids until he/she has done so successfully at least one time per ear	
Batteries	
❑ Tell (**patient name**) color and size of hearing aid batteries ❑ Show (**patient name**) package of hearing aid batteries and point to where on packaging the color and size will be indicated	
❑ Demonstrate to (**patient name**) how to remove battery tab from a new battery	
❑ Demonstrate to (**patient name**) how to change battery ❑ Demonstrate to (**patient name**) that if new battery is inserted upside down then battery door will not close ❑ Instruct (**patient name**) to practice inserting and removing battery until he/she has done so successfully at least one time	
❑ Tell (**patient name**) to open battery door when hearing aids are not in use	
❑ Tell (**patient name**) how many days they should expect batteries to last	

Feedback	
❑ Demonstrate to (**patient name**) that feedback will naturally occur if a hand is held against hearing aid	
❑ Tell (**patient name**) that if feedback occurs while talking on phone, then they should reposition phone or use telecoil ❑ Demonstrate to (**patient name**) the appropriate position for using phone with hearing aids ❑ Demonstrate to (**patient name**) how to activate telecoil/phone program on hearing aid ❑ Instruct (**patient name**) to practice activating telecoil/phone program on hearing aid until he/she has done so successfully at least once	
❑ Tell (**patient name**) that if feedback occurs with jaw movement then hearing aid may not fit well and they should notify their audiologist	
Cleaning and Care	
❑ Tell (**patient name**) that hearing aids should be cleaned daily	
❑ Tell (**patient name**) that ear wax accumulation in receiver and/or dome is a common cause of hearing aid problems ❑ Demonstrate to (**patient name**) how to clean vent OR open fit mold ❑ Show (**patient name**) where to look to see if earwax is visibly blocking wax guard ❑ Demonstrate to (**patient name**) how to replace wax guard in case of ear wax accumulation ❑ Instruct (**patient name**) to practice replacing wax guard until he/she has done so successfully at least once	
❑ Demonstrate to (**patient name**) how to brush microphone port	
❑ Tell (**patient name**) to store hearing aids in a dry, safe place overnight	
❑ Tell (**patient name**) that hearing aids are water resistant but not waterproof. ❑ Tell (**patient name**) to contact their audiologist if hearing aids get wet	
❑ Tell (**patient name**) that if hearing aid is not working then they should try replacing the battery	
❑ Tell (**patient name**) that if replacing the battery doesn't help, then they should try cleaning hearing aid and and replacing wax guard. ❑ Tell (**patient name**) that if replacing wax guard doesn't help then they should contact their audiologist	
During Trial Period	
❑ Show (**patient name**) user manual and quick guide	

❑ Tell (**patient name**) that they can review manuals at home for more information	
❑ Tell (**patient name**) to pay close attention to what he/she does/does not like about hearing aids so that hearing aids can be adjusted	
❑ Tell (**patient name**) to try to wear hearing aids most of the day every day	
Do Expect	
❑ Tell (**patient name**) to expect that listening will be easier when they wear hearing aids	
❑ Tell (**patient name**) to expect that he/she will hear better in many situations most of the time	
❑ Tell (**patient name**) to expect that his/her own voice may seem louder	
❑ Tell (**patient name**) to expect that it may take several months to get used to hearing aids	
Do Not Expect	

❑ Tell (**patient name**) that his/her hearing aids should not be painful
  ❑ Tell (**patient name**) that his/her hearing aids should not feel physically painful when he/she wears them
  ❑ Tell (**patient name**) that his/her hearing aids should not be painfully loud in any listening situations
    ❑ Tell (**patient name**) that he/she can adjust volume of hearing aid
    ❑ Demonstrate to (**patient name**) how to adjust volume of hearing aid softer
    ❑ Demonstrate to (**patient name**) how to adjust volume of hearing aid louder
    ❑ Instruct (**patient name**) to practice adjusting volume softer on the hearing aid until he/she has done so successfully at least once
    ❑ Instruct (**patient name**) to practice adjusting volume louder on the hearing aid until he/she has done so successfully at least once	

❑ Tell (**patient name**) that he/she should not expect to hear speech perfectly in background noise
  ❑ Tell (**patient name**) that there is a program in hearing aids that may help them hear better in background noise
  ❑ Demonstrate to (**patient name**) how to activate noise program on hearing aid
  ❑ Instruct (**patient name**) to practice activating noise program on hearing aid until he/she has done so successfully at least once	

Total Number of ✓s	
	÷ 56
Percent Adherence	=

Appendix G

Table G1. Performance on HASK test items on which ≥25% of participants in at least one group did not know, had difficulty performing, or could not perform.

	Group					
	Experimental			Control		
Skill	Week 0	Week 4	Difference	Week 0	Week 4	Difference
Skill - patient can successfully demonstrate ...						
Brushing microphone port	69.2	92.3	23.1	84.6	46.2	-38.4
Wiping body of aid with cloth	23.1	15.4	-7.7	23.1	15.4	7.7
Properly positioning HA in R ear	92.3	92.3	0	69.2	84.6	15.4
Increasing HA volume	76.9	92.3	15.4	69.2	84.6	15.4
Switching to phone program	69.2	38.5	-30.7	53.8	7.7	-46.1
Changing programs	76.9	76.9	0	69.2	61.5	-7.7
Troubleshooting for feedback	53.8	30.8	-23.0	30.8	30.8	0
Checking mic for blockage	7.7	7.7	0	38.5	7.7	-30.8
Changing wax trap	53.8	76.9	23.1	69.2	46.2	-23.0
Knowledge - patient knows to ...						
Aerate battery for one minute	61.5	38.5	-23.0	92.3	61.5	-30.8
Wipe body of HA with cloth	23.1	15.4	-7.7	30.8	30.8	0
Brush microphone port	100.0	84.6	-15.4	76.9	53.8	-23.1
Switch to phone program	69.2	46.2	-23.0	69.2	30.8	-38.4
Troubleshoot for feedback	46.2	30.8	-15.4	46.2	30.8	-15.4
Check battery door is closed	46.2	38.5	-7.7	61.5	38.5	-23.0
Check mic for blockage	15.4	7.7	-7.7	38.5	15.4	-23.1
Check sound bore for blockage	38.5	53.8	15.3	46.2	38.5	-7.7
Change wax trap	61.5	53.8	-7.7	69.2	30.8	-38.4

Note: Data are the percentages of individuals that did know the information or could successfully perform each skill.

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Vita

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Education

Ph.D.	Audiology **Syracuse University**, Syracuse, NY Doctoral Advisor: Dr. Karen A. Doherty	(expected) 2018
Au.D.	Audiology **Syracuse University**, Syracuse, NY	(expected) 2018
B.S.	Communication Sciences & Disorders **Nazareth College**, Rochester, NY	2012

Professional Experience

- **Assistant Professor**, Dept. of Communication Sciences & Disorders 2018-present
  Nazareth College, Rochester, NY

Publications

1. **Alicea, C.C.M.**, & Doherty, K.A. (2017). Motivation to address self-reported hearing problems in adults with normal hearing thresholds. *Journal of Speech, Language, and Hearing Research, 60,* 3642-3655.

2. Desjardins, J.L., **Alicea, C.**, & Doherty, K.A. (in press). The effect of working memory and manual dexterity on hearing aid handling skills in new and experienced hearing aid users. *American Journal of Audiology*

Peer-Reviewed and Professional Presentations

1. **Alicea, C.C.M.**, & Doherty, K.A. (2018). Targeted re-instruction for hearing aid use and care skills. Poster. American Speech-Language-Hearing Association Annual Convention, Boston, MA.

2. **Alicea, C.C.M.**, & Doherty, K.A. (2018). Targeted re-instruction for hearing aid use and care skills. Oral presentation. Academy of Rehabilitative Audiology Meeting, Pittsburgh, PA.

3. **Alicea, C.C.M.**, Singh, J., & Doherty, K.A. (2016). Variation in hearing aid troubleshooting software recommendations and accuracy of adjustments across manufacturers. Poster. American Speech-Language-Hearing Association Annual Convention, Philadelphia, PA.

4. Singh, J., **Maldonado, C.C.**, & Doherty, K.A. (2016). Inaccuracy of hearing aid software adjustments. AudiologyNOW! Poster. Annual Convention of the American Academy of Audiology, Phoenix, AZ.

5. **Maldonado, C.C.**, & Doherty, K.A. (2015). Difficulty hearing during the early stages of age-related hearing loss and motivation to take action. Poster. Seventh Biennial National Center for Rehabilitative Audiology Research Conference, Portland, OR.

6. **Maldonado, C.C.**, & Doherty, K.A. (2015). Early age-related changes in high frequency Hearing thresholds, hearing handicap, and motivation to take action. Poster. New York State Speech-Language Hearing Association Annual Convention, Rochester, NY.

7. **Maldonado, C.C.**, & Doherty, K.A. (2015). Motivation for change during early stages of hearing loss. Poster. Neuroscience Research Day, Syracuse University, Syracuse, NY.

8. **Maldonado, C.C.**, & Doherty, K.A. (2015) Motivation for change during early stages of hearing loss. Poster. American Auditory Society Annual Meeting, Scottsdale, AZ.

Professional Affiliations

- National Student Speech Language Hearing Association
- Student Academy of Audiology
- New York State Speech-Language Hearing Association
- American Auditory Society

Awards and Honors

- Graduate Fellowship, Syracuse University (2013-2018)
- Audiology/Hearing Science Research Travel Award (ARTA), American Speech-Language-Hearing Assoc. (2016)
- Student Travel Award, National Center for Rehabilitative Audiology Research (2015)
- NIH Mentored Student Travel Award, American Auditory Society (2015)
- Best Student Poster Award, Syracuse University Neuroscience Research Day, Syracuse University (2015)
- PhD Student Scholarship, New York State Speech-Language Hearing Assoc. (2015)
- Minority Student Leadership Program (MSLP) Award, American Speech-Language-Hearing Assoc. (2014)
- Graduate Student Scholarship, Central New York Speech-Language Hearing Association (2013)