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Hearing Aid Use and Cognitive Function: A Systematic Review

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by

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ABSTRACT

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This systematic review analyzed the research relating the use of hearing aids to cognitive function. Hearing aid use was examined to see if wearing hearing aids improves cognitive function, if the length of time hearing aids are worn impacts cognitive ability, if the type of hearing aid used has any impact on cognitive function, and if hearing aid use slows down cognitive decline. Ten studies met the criteria for this review. An analysis of the research revealed some evidence to support wearing hearing aids improves cognitive function, however, there is substantial evidence that shows no impact between wearing hearing aids and cognitive function. The length of time people wear hearing aids or the type of hearing aids could not be determined as a factor in change in cognitive function. More research needs to be conducted, and is currently underway, to prove the impact hearing aid use has on cognitive ability.

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Introduction

The Centers for Disease Control (CDC) does not include hearing loss in disability surveys. Vision problems have been accepted in society as contributing to problems in all aspects of life. The impact of hearing loss is not publicly viewed as important even though it has been shown to be associated with social isolation and an increased risk of falls (Weinstein & Ventry, 1982; Lin & Ferrucci, 2012). 360 million people around the world have hearing loss and we are only first learning about the full impact it can have on a person's life (Looi et al., 2015). Audiologists have been assisting in diagnosing medical pathologies associated with the ear for decades, but appropriate medical reimbursement has yet to come. If audiologists could offer treatment for medical conditions, perhaps they would be more appropriately compensated by insurance companies.

A way that audiologists can be appropriately acknowledged in the health care field is if audiologists are able to treat medical conditions without going beyond their scope of practice; hearing aids may be the gateway. Over the past few decades, researchers have been able to associate hearing loss with cognitive decline (Lin et al., 2013). The purpose of this review is to determine if hearing aids can be used to treat cognitive decline in the future. However, before that can be addressed, the relationship between hearing loss and cognitive decline must be understood.

In 1989, Richard Ulman and colleagues determined that the more significant a hearing loss, the greater risk there is of having dementia. The researchers also found hearing loss to be associated with cognitive decline in people without dementia (Ulman et al., 1989). Baltes and Lindenberger (1997) found a relationship between sensory (auditory and visual) function and cognitive function in the aging by using a cognitive test battery. However, due to the fact that the

correlation was not strong in the younger groups tested, hearing loss and cognitive function could not be independently associated. Baltes and Lindenberger (1997) did find vision and hearing loss accounted for shared variance in cognitive function. Australian researchers found similar results in 2006 when a correlation was found between sensory and cognitive function in the elderly (Tay et al., 2006).

Gates, et al. (2011) found that dysfunction in the central auditory system can be a precursor to dementia. The Dichotic Sentence Identification Test, Dichotic Digits Test, and the Synthetic Sentence Identification with Ipsilateral Competing Message Test were used to measure central auditory dysfunction (Gates et al., 2011). Gurgel, et al. (2014) proved that elderly adults with hearing loss have an increased rate of developing dementia as well as an increased decline in performance on cognitive tests.

Compared to people with normal hearing, people with hearing loss have a 30 to 40% increased rate of cognitive decline. Hearing loss has been independently associated with accelerated cognitive decline. This was determined using a cognitive test battery over time (Lin et al., 2013). Hearing loss has been associated with decreased volume in auditory centers in the cortex as well as an increase in the risk of incident all cause dementia (Lin et al., 2014; Lin et al., 2011). It is not yet evident why hearing loss had this impact on the brain. Peelle and colleagues (2011) believe that the lack of neural activation from the reduced auditory signal results in a restructuring of the brain. Kiely, et al. (2012) did a study that examined predicting factors for a change in hearing thresholds. Cognitive impairment was one of the factors found to be associated with worse hearing. Bush and colleagues (2015) found a significant relationship between peripheral hearing and cognitive function.

The potential mechanism behind the association of hearing loss and cognitive function must be understood to appropriately evaluate the relationship. Hearing loss and cognitive decline can come from a common etiology like aging, inflammation, trauma, or microvascular disease. The common etiology may also lead to reduced social engagement or a change in brain structure, thus, forming a web of interconnected neural networks (Lin & Albert, 2014). The common cause model linking the association between hearing loss and cognitive function hypothesizes that normal neural degeneration from aging impacts hearing and cognition. The cascade theory suggests that hearing loss leads to sensory deprivation as well as social isolation. Social isolation may lead to decreased neural activity which can lead to reduced cognitive function (Dawes et al., 2015). The two models can be seen in Figure 1. The cascade model suggests the cognitive decline may not be a direct result of hearing loss.

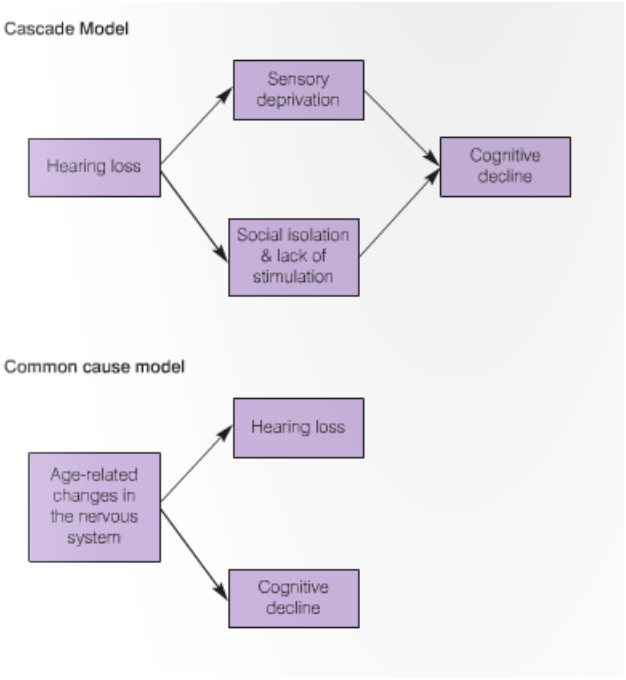

Figure 1. Cascade and Common Cause Model Linking Hearing Loss and Cognitive Decline (Dawes et al., 2015)

Hearing loss is associated with social isolation and social isolation has been associated with cognitive decline (Weinstein & Ventry, 1982, Gates & Mills, 2005, Plassmen et al., 2007). Therefore, even if the link between hearing loss and cognitive decline may not be direct, that does not rule out the possibility that treating hearing loss can improve cognitive function. A person can withdraw from society due to hearing loss and not be physically or mentally active. The hearing loss can cause social isolation, but the social isolation may lead to the reduced cognitive function due to lack of stimulus and activity of the neural network. In 2016, Weinstein and colleagues found that after four to six weeks of wearing hearing aids, people had a decline in perceived loneliness. Social isolation is negatively associated with cognitive function (Shankar et al., 2013). The study by Weinstein, et al. (2016) is fundamental in supporting the cascade model linking hearing loss and cognitive function.

Research shows that cochlear implant recipients showed increased cognitive function post-implantation (Mosnier et al., 2015). This study did not meet the criteria for this systematic review because hearing aids were not administered to the participants. However, cochlear implants and hearing aids provide similar stimulus to the brain so the results may relate to hearing aid users.

Ng, et al. (2013) conducted a study to measure the impact of noise reduction technology in hearing aids on the ability to recall words. 26 participants were used in the study, all of which wore hearing aids and had a pure-tone average of 49.77dB. The sentence final word identification and recall test required the participants to report the final word in a sentence after listening to it. The test was administered in conditions with background noise (with and with-out noise reduction) and in quiet. Noise reduction technology reduced the negative impact of noise

on memory (Ng et al., 2013). A smaller study in 2011 also showed improved cognitive function in noisy situations while wearing hearing aids (Choi et al., 2011). Although improved speech in noise recognition may not be a direct indicator of cognitive function, it may reduce overall cognitive workload and improve cognitive fatigue.

Providing amplification to patients with hearing loss may reduce their cognitive load by enabling the patients to hear the speech signal. Unaided people with hearing loss strain to hear the speech signal and use extra cognitive energy to determine what is being said. Visual and spatial cortical networks may become overloaded in people with untreated hearing loss.

Audiologists are often forced to focus on hearing aid sales. The important diagnostic work that audiologists conduct is not compensated proportionately to other health care fields due to a general lack of insurance coverage. Behind canes and eyeglasses, hearing aids are the next most used assistive medical device (Whipple, 2015). If hearing aids are proven to help cognitive ability, they may become more affordable and accessible to people with hearing loss. Also, if hearing aids are used to treat cognitive decline, health care costs can be reduced globally by means of prevention.

Objectives and Research Questions

The objective of this current systematic review is to determine if wearing hearing aids impacts cognitive function. Recent literature is critically evaluated to answer the following questions:

1) Does wearing hearing aids improve cognitive function?

2) Does the length of time a person wears hearing aids change the impact on cognitive decline?

3) Does the manufacturer or style of hearing aid impact the relationship to change in cognitive function?

4) Does hearing aid use slow down cognitive decline?

Methods

Evaluating Eligible Studies

A comprehensive database search was conducted using MEDLINE, Pub-Med, CINAHL, Google Scholar, and SCOPUS. Search terms consisted of “hearing aids”, “amplification”, “hearing impairment”, “cognitive decline”, “cognitive ability”, “cognitive function”, “senile”, “dementia”, “Alzheimer's disease” and “memory”. Abstracts and some full articles were read to determine if the studies were relevant to this review. Studies needed to be about adults with hearing impairment that wear hearing aids. Participants of all cognitive levels were included. The independent variable needed to be a measure of cognitive function. Type of hearing aid was not an inclusion criteria for the study.

Types of Studies

Every study was assigned a level of scientific evidence based on the research design. Studies analyzed in this review are Level II (randomized controlled trial), Level III (non-randomized controlled trial), Level IV (case control and cohort), or Level VI (single descriptive or qualitative study).

Table 1. Rating System for the Hierarchy of Evidence. (Melnyk & Fineot-Overholt, 2005)

Level I: Evidence of a systematic review of all relevant randomized controlled trials, or evidence-based clinical practice guidelines based on systematic reviews of randomized controlled trials
Level II: Evidence obtained from at least one well-designed randomized controlled trial
Level III: Evidence obtained from well-designed controlled trials without randomization, quasi experimental
Level IV: Evidence from well-designed case-control and cohort study
Level V: Evidence from systematic reviews of descriptive and qualitative studies
Level VI: Evidence from a single descriptive or qualitative study
Level VII: Evidence from the opinion of authorities and/or reports of expert committees

Types of Outcome Measures

This review consisted of studies that measured change in cognitive function from wearing hearing aids using one or more of the following measures: Mini-Mental State Examination (MMSE) (Folstein et al., 1975); Short Portable Mental Status Questionnaire (Mulrow et al., 1990); Delayed Word Recall Test (Knopman & Ryberg, 1989); Incidental Learning Test (Kaplan et al., 1991); mental fatigue defined as a "decrement in performance" of cognitive tasks over time (Hornsby, 2013); Stroop Colour-Word Test (Stroop, 1935); the Concept Shifting Task (Vink & Jolles, 1985); Letter-Digit Substitution Test (Lezack, 1995); Visual Verbal Learning Test (Brand & Jolles, 1985); Verbal Fluency Test (Strauss et al. 2006); incidence of cognitive impairment if reported by participant or proxy; Trail Making Test (Bowie & Harvey, 2006); the Digit Symbol Substitution Test (Wechsler, 1991); modified cognitive tests from the Berlin Aging Study (Tesch-Romer, 1997); and the Auditory Verbal Learning Test (Schmidt, 1996).

Results

A total of 10 articles were identified, using the keywords and database search described earlier. The articles were reviewed to address the four research questions addressed earlier.

Certain studies initially appeared to be qualified for this review. Doherty & Desjardins (2015) conducted a study to test the impact of hearing aid use on working memory. Participants were tested in aided and unaided conditions. There were 24 participants in the study who were all part of a larger study. This was everyone in the studies first time wearing hearing aids. The Listening Span Test and the n-back were used to measure working memory, they are word recall tests in noise. Participants' scores on auditory working memory tests improved with hearing aids (Doherty & Desjardins, 2015). This study was not included because cognitive function improved with hearing aids only in noise. Due to noise reduction technology in hearing aids, improvement in speech and noise should not be used to as an outcome measure for cognitive function.

Table 2. Level of Evidence

Authors	Level of Evidence	Inclusion/Exclusion Criteria	Participants
Tesch-Römer, C. (1997).	Level IV	Yes	N=148
Allen et al., (2003)	Level VI	Yes	N=31
Van Hooren et al., (2005)	Level II	Yes	N=102
Hornsby (2013)	Level VI	Yes	N=16
Acar et al., (2011)	Level VI	Yes	N= 34
Wong et al., (2014)	Level IV	Yes	N=34
Deal et al., (2015)	Level IV	Yes	N=253

Amieva et al., (2015)	Level IV	Yes	N=3,670
Dawes et al., (2015)	Level IV	Yes	N=666
Mulrow et al., (1990)	Level II	Yes	N=188

Table 2 shows the Level of Evidence for each study analyzed, if there was inclusion criteria and the amount of participants.

Research Question 1: Does wearing hearing aids improve cognitive function?

Six of the ten studies in this review showed no impact of hearing aid use on cognitive function (Tesch-Romer, 1997; Allen et al., 2003; Van Hooren et al., 2005; Dawes et al., 2015, Wong et al., 2014; Amieva et al., 2015). The Wong, et al. (2014) study showed an improvement in MMSE scores after wearing hearing aids, it disqualified that improvement due to the fact the testing instructions were administered verbally to people with hearing loss. Hearing aids provide improved audibility and may give participants a better understanding of the task at hand, rather than improving their cognitive abilities. Another two studies showed that hearing aid use

improved cognitive function were based on tests where the outcome measure was administered verbally, so it was possible that the participants merely had a better understanding of the tasks rather than an improvement in cognitive ability because they were aided when tested (Mulrow et al., 1990; Acar et al., 2011)

The Hornsby (2013) study suggests that wearing hearing aids can reduce the negative impact of cognitive fatigue by reducing listening effort. Deal, et al. (2015) found that for participants in their study, cognitive decline was greater for those that did not wear hearing aids.

Table 3. Psychological Impact of Hearing Aids

Author	Intervention	Cognitive Outcome Measures	Timeframe	
Tesch-Römer, C. (1997)	Hearing aids (unknown) from ENT in Germany Control group chose no amplification	Modified versions of tests for Berlin Aging Study Digit symbol substitution, Digit letter, animals test, letter "s", Spot-a-word	6 months	

In 1997, Tesch-Romer conducted a 6 month intervention study that analyzed the impact of wearing hearing aids on cognitive function. Elderly hearing aid users were compared to people with similar hearing loss (mild to moderate), that chose not to wear amplification, as well as to normal hearing adults of the same age. The experiment was non-randomized because the researcher wanted the participants to decide if they were going to wear amplification or not. 6 months after being fit with hearing aids the participants were retested. As seen in Table 3, the type of hearing aids are unknown but likely analog. Participants were excluded from the study if they had severe visual impairment, no audiologic information or if they were unilaterally deaf. Participants were at least 51 years old and the oldest was 87. Three areas of cognitive ability were measured in this test; speed, fluency and vocabulary. The tests were adapted from the Berlin Aging Study and included; the Digit Symbol Substitution test, the Digit Letter Test, the Animals Test, the Letter "s" test and the Spot-a-word test. In the digit symbol substitution and digit letter test participants had to transcribe and name letters according to a template. In the animals and letter "s" test, participants had to name as many different things as possible with the letter S. In the spot-a-word test the participant had to find a word mixed within non-words. The researcher found there to be no significant intervention effect of hearing aid use on cognitive ability (Tesch-Romer, 1997).

Table 4. Dementia and Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Allen et al., (2003)	monaural	Mini-mental State Exam(MMSE)	6 months	

Allen, et al. (2003) analyzed the impact of using hearing aids on people with dementia. All participants had a diagnosis of primary dementia. A diagnosis of dementia was based on the Diagnostic and Statistical Manual of Mental Disorders. It was a convenience sample of participants from Central Manchester Hospitals and from Tameside Hospital. Participants were only included if they had pure tone averages in the speech frequencies of 40 dB or worse and were initially screened using a whisper test. Occluding cerumen was removed from all participants. Participants were excluded if they had a functioning hearing aid. There was no control group in this study. 31 participants completed the study. There was no reference to the type of hearing aids that were given to the participants. The study was conducted over a 6 month period as seen in Table 4. The MMSE was used as the outcome measure. The MMSE was administered 1, 3, and 6 months after fitting. The MMSE measures cognitive function in terms of

orientation to time, orientation to place, registration, attention, calculation, recall, language, repetition and complex commands. There was no significant improvement in cognitive function after wearing hearing aids (Allen et al., 2003).

Table 5. Cognitive Function and Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Van Hooren et al., (2005)	Hearing aids (unknown)	Stroup Color-Word Test Concept Shifting Task Visual Verbal Learning Test Verbal Fluency	12 months	

Van Hooren, et al. (2005) analyzed the effect of hearing aid use on memory, attention, executive function and processing speed. As seen in Table 5, the study was conducted over a 12 month period. Participants were from the University Hospital Maastricht and Health Centre Neerbeek. 56 participants were fit with hearing aids compared to 46 participants in the control group. Participants were not randomly assigned due to ethical reasons of not administering hearing aids. All participants had a pure-tone averages of at least 35dB at 1, 2 and 4k Hz. Participants were 60 years or older and had a minimum score of 24 on the MMSE. People with neurologic diseases or psychiatric disorders were not included in the study. The Stroup Colour-

Word Test and the Concept Shifting Task measured cognitive speed. The Visual Verbal Learning Test and the Verbal fluency test measured memory. There was a baseline cognitive test and then the participants were retested after wearing hearing aids for one year. Dual baseline measurements were performed to reduce the learning effect. Different versions of the Visual Verbal Learning Test were used at follow up sessions to counter the learning effect. Hearing aid use did not improve cognitive performance over a 1 year period (Van Hooren et al., 2005).

Table 6. Cognitive Fatigue and Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Hornsby (2013)	Phonak Micro Exelia BTE	Modification of serial recall test (McCoy et al., 2005) Single Task Visual RT	NA	

In 2013, Hornsby conducted a study on 16 adults that tested the impact of hearing aid use on cognitive fatigue. Participants were from the Vanderbilt Bill Wilkerson Center. Mental fatigue was defined as a decrease in performance in word recognition, word recall, and visual reaction times over the course of the experiment. As seen in Table 6, participants were aided with Phonak Micro Excelia BTEs. Participants were tested in an unaided condition, an omni-directional hearing aid condition, and in a condition with directional processing and digital noise

reduction. Participants had bilateral symmetric mild to severe sensorineural hearing loss. While wearing amplification, the participants' scores on speech-based recognition and recall remained relatively stable over time. On the contrary, these abilities decreased when the participants were unaided. This study was included even though it measured performance of speech in noise because that was not the outcome variable; the fatigue was the variable measured (Hornsby, 2013).

Table 7. Cognitive Function, Depression and Hearing Aid Use

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Acar et al., (2011)	hearing aids (unknown)	MMSE	3 month follow up	

Acar, et al. (2011) conducted a study on people with hearing impairment over the age of 65. There were 34 participants and only four were female. It was all of the participants' first time using a hearing aid. The participants had a moderate to severe hearing loss. The hearing loss had to be predominantly sensorineural. In addition to other outcome measures not directly related to cognition, participants took the MMSE, as seen in Table 7, at baseline and again after three

months of wearing hearing aids. After wearing the hearing aids for three months, participant's scores on the MMSE significantly improved. The study also showed that hearing aid use reduced depressive signs in the participants as there were other outcomes measure not directly relating to cognitive function

Table 8. Cognitive Function for Monaural Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Wong et al., (2014)	monaural	MMSE	NA/ compared to normative data	

Wong, et al. (2014) studied 34 Cantonese speaking people over the age of 60 with bilateral, mild to severe hearing loss with any etiology. The participants were monaural hearing aid wearers, as seen in Table 8, who had been wearing hearing aids for at least one year. Non-Cantonese speakers and people with poor physical or mental health were excluded from the study. The results showed an improvement in MMSE scores for people with hearing impairment who wore hearing aids. However, auditory factors like length of hearing aid use and aided sound field thresholds were predictors of measurement outcomes that required the understanding of

verbal instructions. The results were improved in areas that required listening to instructions so the authors did not associate that with improved cognitive function (Wong et al., 2014).

Table 9. Cognitive Decline and Hearing Aid Use

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Deal et al., (2015)	Hearing aids (unknown)	Delayed Word Recall Test Incidental Learning Test Logical Memory Test Digit Symbol Substitution Test Digit Span Backwards Test Trail Making Tests	20 years	

Using the Atherosclerosis Risk in Communities Neurocognitive Data, Deal, et al. (2015) conducted a study to analyze a population of 253 individuals with hearing loss. The study was conducted over a 20 year period as seen in Table 9. Participants were from Washington County, Maryland. The larger study was a cohort study with 15,792 participants between the ages of 45-

64 years old. There was no data on duration of hearing impairment but 29% of participants had no hearing impairment, 37% had a mild hearing impairment, and 34% had a moderate or severe hearing impairment. Memory was tested using the Delayed Word Recall Test, Incidental Learning Test, and Logical Memory Test I and II. Processing speed was measured using the Digit Symbol Substitution Test, the Digit Span Backwards Test and Trail Making Tests Parts A and B. The test battery included visual and auditory stimuli. Over the course of the 20 year period, cognitive decline was greatest for the people who reportedly did not wear hearing aids (Deal et al., 2015).

Table 10. Cognitive Decline, Self-Reported Hearing Loss and Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe
Amieva et al., (2015)	Hearing aids (unknown)	Mini-Mental State Exam	25 years

Amieva, et al. (2015) conducted a study over 25 years analyzing the association between hearing aid use and cognitive decline as seen in Table 10. Participants were randomly selected French elderly adults. The MMSE was used as the outcome measure. Participants were evaluated

at baseline, after 1, 3, 5, 8, 10, 13, 15, 17, 20, 22, and 25 years. Every visit included a neuropsychological evaluation and a dementia diagnosis completed by a psychologist. Hearing loss was assessed based on a question about how the patients would rate their hearing status. Participants were asked whether or not they had hearing loss and wore a hearing aid. 3,414 participants were eligible in the final model. This study showed that self-reported hearing loss is associated with accelerated cognitive decline. Cognitive decline of people with hearing loss that wore hearing aids was reduced relative to those that did not wear amplification. Sociodemographic variables such as measures of depression, social network size and social isolation mediated the relationship between hearing aid use and reduced cognitive decline (Amieva et al., 2015).

Table 11. Cognitive Function, Social Engagement and Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Dawes et al., (2015)	Hearing Aids (unknown)	Mini-Mental State Exam Trail Making Auditory Verbal Learning Digit-Symbol Substitution Verbal Fluency Incidence of Cognitive impairment	16 years	

Dawes, et al. (2015) conducted a study that analyzed the impact of hearing aid use on cognitive function. As seen in Table 11, the study was conducted over a 16 year period. Participants were part of a larger Epidemiology of Hearing Loss Study. Participants were from Beaver Dam, Wisconsin. Participants were tested 5 years prior to baseline, at baseline, 5 and 11 years after baseline. Participants needed to have hearing impairment with no hearing aids at pre-baseline. Hearing impairment was defined as thresholds greater than 40dB at 3 and 4k Hz in the better ear. All participants had a high level of self-reported hearing handicap based on scores greater than 8 on the Hearing Handicap Inventory for the Elderly and for Adults- Screening version. There was no significant difference in cognitive function between hearing aid users and non-users (Dawes et al., 2015).

Table 12. Quality of Life and Hearing Aids

Author	Intervention	Cognitive Outcome Measure	Timeframe	
Mulrow et al., (1990)	Hearing aids (unknown) 98% ITE 97% monaural	Short Portable Mental Status Questionnaire	4 months	

Mulrow, et al. (1990) conducted a randomized controlled trial of people with hearing impairment who were put into a hearing aid group or a wait list group. Most of the participants were from the Veterans Hospital in San Antonio. The participants were over the age of 64. People with comorbid diseases and hearing aid users were disqualified from the study. Hearing impairment was defined as a threshold of 40dBHLor more at 2k Hz. Participants were tested at baseline, 6 weeks and 4 months. As seen in Table 12, 98% of the hearing aids were in-the-ear (ITE) and 97% were monaural. After 4 months of hearing aid use, participants showed an improved score on the Short Portable Mental Status Questionnaire at the short and long term follow up. The questionnaire is administered verbally and is intended to be used as a screener.

Most of the evidence does not support that wearing hearing aids directly improves cognitive function.

Research Question 2: Does the length of time a person wears hearing aids change the impact on cognitive decline?

The studies that measured change in cognitive function relating to wearing hearing aids over the course of 1 year or less all showed no impact of hearing aid use on cognitive function (Allen et al., 2003; Tesch-Romer, 1997; Van Hooren et al., 2005) except for two studies, as seen in Tables 7 and 12, where the task was presented verbally (Mulrow et al., 1990; Acar et al., 2011). Three of the studies measured cognitive function for more than 15 years. The Dawes, et al. (2015) study, which was over 16 years not 11 due to the pre-baseline test, showed no improvement in cognitive function from hearing aids. Deal, et al. (2015), which was over 20 years, found that for participants in their study, cognitive decline was greater for those that did not wear hearing aids. Amieva, et al. (2015), which was over 25 years, found that the cognitive decline of hearing aid users was similar to that of people who no hearing impairment but the

relationship was modified by depression and social factors such as social engagement and isolation.

There were not enough data to determine if the length of time a person wears a hearing aid impacts cognitive function.

Research Question 3: Does the manufacturer or style of hearing aid impact the relationship to change in cognitive function?

Only one study listed the specific hearing aids used. As seen in Table 6, Phonak Micro Exelia BTEs were used in one study that showed a reduction in cognitive fatigue while wearing the hearing aids (Hornsby, 2013). Mulrow, et al. (1990) found that 98% of the hearing aids were in-the-ear units and 97% of the participants were fit monaurally. The latter group wore analog hearing aids. Two of the studies reported only that the hearing aids were monaural (Wong et al., 2014; Allen et al., 2003). In all of the other studies analyzed in this review there was no specific information on the type of hearing aids used. Therefore, there were not enough data to determine if manufacturer or style of hearing aid had any impact on cognitive function.

Research Question 4: Does hearing aid use slow down cognitive decline?

Six of the studies in this review show no impact of wearing hearing aids on cognitive function (Tesch-Romer, 1997; Allen et al., 2003; Van Hooren et al., 2005; Dawes et al., 2015, Wong et al., 2014; Amieva et al., 2015) , therefore, they did not show anything to support hearing aid use slows down cognitive decline.

Mulrow, et al. (1990), Acar, et al. (2011), and Deal, et al. (2015) suggest using hearing aids slow down cognitive decline. Hornsby (2013) suggested that wearing hearing aids reduces cognitive fatigue, however, that was just measured over the duration over the testing experience and cannot translate into overall cognitive function.

Discussion

The purpose of this review was to determine if hearing aid use improves cognitive function. There is not enough evidence to support the hypothesis that wearing hearing aids directly improves cognitive function. Several of the studies suggested cognitive improvement from wearing hearing aids but the outcome measures were administered verbally prior to hearing aid fitting (Mulrow et al., 1990; Acar et al., 2011; Wong et al., 2014). Hearing loss could have been a confounding variable to cognitive function. The study by Deal, et al. (2015) was the most significant in this review for a positive relationship between hearing aid use and cognitive function because part of the cognitive outcome measures were visual stimuli so the hearing aids did not help to interpret the task. A problem with the results are that non-hearing aid users had a higher comorbidity of hypertension and diabetes at a younger age than their hearing aid using counterparts (Deal et al., 2015).

Cognitive fatigue was shown to be reduced from wearing hearing aids (Hornsby, 2013). Perhaps the digital noise reduction technology within hearing aids can help cognitive function but this study only translates to the testing period.

The cascade model linking cognitive decline and hearing loss may give insight as to why some of the research supports wearing hearing aids improves cognitive function. If the cascade model holds true, hearing aids may be able to treat cognitive decline through reducing social isolation, thus, increasing mental activity (Weinstein & Ventry, 1982; Shankar et al., 2013; Weinstein et al., 2016). As Shankar and colleagues (2013) proved, social isolation is negatively associated with cognitive function. Wearing hearing aids may be able to improve cognitive ability by reducing social isolation and preventing the cascade effect.

Conclusion

There was inconclusive evidence to show a strong relationship between wearing hearing aids and cognitive function. A cognitive screener was used in one instance that is not indicative of changes in cognitive performance (Mulrow et al., 1990). Wong and colleagues, in 2014, found improvements in cognitive tests after wearing hearing aids but attributed that increased performance to a better understanding of the test stimulus from wearing hearing aids. This discredited some of the other studies results that attribute increased cognitive performance from wearing hearing aids based on the fact that they may have just understood the task more (Mulrow et al., 1990; Acar et al., 2011).

Deal and colleagues (2015) found that cognitive decline was accelerated for those who did not wear hearing aids based on auditory as well as visual stimuli. However, to counter that, a comprehensive study by Dawes in 2015, found no relationship between hearing aid use and cognitive function. Hornsby, in 2013, related hearing aid use to improved cognitive function in terms of cognitive fatigue.

Hearing loss can make people socially isolated which can in turn reduce the amount of mental activity a person performs. This reduction of mental activity can accelerate cognitive decline. So if wearing hearing aids improves a person's social life, which can increase the amount of mental activity, then hearing aids may be able to indirectly improve cognitive function.

The clinical implications of this review can be used to inform eligible hearing aid candidates the impact wearing hearing aids can have on their life. Informing patients that untreated hearing loss is associated with accelerated cognitive decline can be misleading as they may assume this means that treating the hearing loss improves cognitive function. Patients can be informed on how treating hearing loss can reduce social isolation and that reduction may be able to decrease cognitive decline

More research needs to be conducted to interpret a relationship between wearing hearing aids and the impact on cognitive function. A randomized controlled trial is currently underway that is examining if a hearing loss treatment group has a reduced risk of cognitive decline and dementia (Lin et al., 2015).

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