ABSTRACT

Title of Document: THE BENEFITS OF CLOSED CAPTIONING FOR ELDERLY HEARING AID USERS

Julia Susan Callahan, Au.D., 2007

Directed By: Professor Sandra Gordon-Salant, Department of Hearing and Speech Sciences

The purpose of this study was to determine the effects of closed captioning and hearing aid use on word recognition of televised materials in a sample of 15 older adults with hearing loss, who use hearing aids. Participants viewed television segments in four viewing conditions: 1) without hearing aids or closed captioning (BSLN), 2) with hearing aids (HA), 3) with closed captioning (CC), and 4) with hearing aids and closed captioning (HA+CC). Three types of programming (game show, drama, and news) comprised the stimulus sentences.

Anecdotal reports suggest older hearing impaired people do not use closed captioning, despite its potential benefit in understanding television. The extent to which listeners use closed captioning and hearing aids on a daily basis was examined. It was expected that listeners would have considerable difficulty in the BSLN condition, because the primary cue is speechreading alone. The HA condition was expected to produce significantly higher scores, because listeners would be able to

combine information from two modalities: vision (speechreading) and hearing. It was predicted that CC would yield higher scores than these two conditions, because the visual text signal provides unambiguous information, and that the combined HA+CC condition would produce the highest scores. In addition, differences in speech recognition scores were expected for different program types. One prediction was that drama programming would result in consistently lower speech recognition scores due to reduced availability of visual cues compared to game show or news programming.

Results indicated that 77% of participants reported never using the closed captioning when watching television, although most wore hearing aids during television viewing. There was a significant effect of listening/viewing condition for all three program types. For all program types, participants achieved higher word recognition scores in the CC and HA+CC conditions than in HA or BSLN conditions. There was no significant difference in performance between the BSLN and HA conditions. These findings indicate older people with hearing loss do not receive significant benefit from hearing aid use while watching television. However, closed captioning appears to provide significant benefit to older hearing aid users, even though they seldom use this technology.

THE BENEFITS OF CLOSED CAPTIONING FOR ELDERLY HEARING AID USERS.

By

Julia Susan Callahan

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Advisory Committee:
Professor Sandra Gordon-Salant, Chair
Assistant Professor Tracy Fitzgerald
Assistant Professor Monita Chatterjee
Adjunct Professor Peter Fitzgibbons
Professor Robert Dooling

Dedication

This work is dedicated to my parents, Robert and Susan Callahan, who taught me the most important lesson I will ever learn, the love and grace of Jesus Christ.

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Chapter 1: Introduction

Like the car and the telephone, television has become a daily part of the lives of many Americans. Since its introduction to the household around 1948, television has become increasingly commonplace (Marc & Thompson, 2005). Watching television is the leisure activity continued the most as older adults age (Strain, Grabusic, Searle, & Dunn, 2002). On average, elderly individuals watch about three to five hours of television per day (Davis & Edwards, 1975; Davis, Edwards, Bartel, & Martin, 1976; Rubin & Rubin, 1982, 1983). Hearing loss can influence an older person's ability to access the televised signal, negatively affecting the quality of the viewing experience for older persons.

Reports have shown that many older adults experience hearing loss as they age (Cruickshanks et al., 1998; Pearson et al., 1995; National Council on Aging, 2000; Wallhagen, Strawbridge, Shema, Kurata, & Kaplan, 2001). The aging process alone can interfere with an older person's ability to fully access a speech signal when the quality of the speech signal is degraded, and this is especially problematic for older adults with hearing loss (Gordon-Salant & Fitzgibbons, 1993, 1995). Televised speech signals are often degraded, particularly by a fast rate of speech (Uglova & Shevchenko, 2005; Wingfield & Tun, 2001). Older adults with hearing impairment report difficulty understanding the television (Barcham & Stephens, 1980; Stephens, Gianopoulos, & Kerr, 2001). After hearing aid fitting and use, some people report a decrease in problems understanding the television; however, others still report dissatisfaction with the television viewing experience (Brooks, Hallam, & Mellor, 2001; Kochkin, 2000; Stephens, France, & Lormore, 1995; Tyler, Baker, &

Armstrong-Bednall, 1983). To date, there have not been any published studies investigating the benefit of hearing aid use while watching television. However, wearing a hearing aid while watching television should be quite beneficial, because speech recognition performance with bimodal sensory input is usually quite high (Grant & Seitz, 1998; Grant & Walden, 1996; Grant, Walden, & Seitz, 1998; Sommers, Tye-Murray, & Spehar, 2005; Walden, Grant, & Cord, 2001).

For older persons who experience difficulty understanding the television, even while using hearing aids, an additional assistive device or tool is needed to help. One tool, readily available to virtually all older persons who own a television set, is closed captioning. The text message provided by closed captioning should present an unambiguous signal to the listeners. However, anecdotal reports suggest that older people with hearing loss do not use closed captioning.

The purpose of this study was to determine the effects of closed captioning and hearing aid use on recognition of televised speech materials in a sample of older adults with hearing loss. Participants viewed television segments in four viewing conditions: 1) without their hearing aids on or the closed captioning activated (BSLN), 2) with their personal hearing aids on and the closed captioning deactivated (HA), 3) with the closed captioning activated and without their hearing aids (CC), and 4) with their hearing aids on and the closed captioning activated (HA+CC).

It was expected that listeners would have difficulty in the BSLN condition, because the primary cue is speechreading alone. Use of personal hearing aids was expected to result in higher word recognition scores than no assistance, because listeners would be able to combine information from two modalities: vision (speechreading) and amplified hearing. It was also predicted that use of closed captioning would yield higher word recognition scores than either the BSLN or HA conditions, because the visual text signal would provide unambiguous information. Additionally, it was hypothesized that the combined use of both the amplified auditory signal (hearing aids), and the visual text signal (closed captioning) would produce the highest scores. The implications of this research for the geriatric population, particularly those who may not be able to afford additional assistive devices beyond hearing aids, and those residing in assisted care facilities, will be discussed.

Chapter 2: Literature Review

Television and Older People

Watching television is the most commonly reported leisure activity of older adults (Cowgill & Baulch, 1962; De Grazia, 1961; Schramm, 1969). Several researchers evaluated the amount of time spent by older adults watching television, and found that older adults watch an average of 3-5 hours of television per day (Davis, 1971; Davis et al., 1976; Rubin, 1984; Rubin & Rubin, 1982, 1983). Most of these studies were surveys; however, one study objectively evaluated television viewing.

A study of viewing levels utilizing video recording technology reported that the average amount of time spent viewing television by senior citizens was 3.41 hours per day (Davis et al., 1976). Taken as a whole, it can be said that older adults spend anywhere from 3-5 hours per day watching television. Additionally, the amount of time spent watching television has been reported to increase as older adults age (Strain et al., 2002).

Strain et al. (2002) recorded the leisure activities of older adults to determine if changes occurred in the types of leisure activities enjoyed by older adults as they age. The study was longitudinal, over an 8-year period. Participants rated their leisure activity participation for 10 activities. Results from the analyses showed that in 1985, the most frequently reported leisure activity was watching television (99.5% of the participants reported watching television as one of their leisure activities). Results indicated that watching television was the most continued leisure activity.

Television plays many roles in the lives of older adults, but is primarily watched for information and entertainment (Fouts, 1989). Davis et al. (1976) found the types of television programs most often watched by older adults were news/public affairs, game shows, comedies, and dramas. Television not only serves as a means of gathering information and entertainment, but in a survey by Davis (1971) of persons aged 55-80 years, 63.3% reported that television served as a form of companionship for them.

In summary, television plays a significant role in the lives of elderly individuals, is watched on a daily basis, continues to be a leisure activity as they get older, and serves various functions in the lives of elderly individuals. However, enjoyment of television is likely to be reduced if the viewer has a significant hearing loss, as discussed below.

Prevalence of Hearing Loss in Older Adults

Hearing loss is one of the most prevalent chronic health conditions experienced by persons over the age of 65 (National Council on Aging, 2000). The National Council on Aging (2000) reported that over nine million Americans over the age of 65 have a hearing loss. Additionally, Desai, Pratt, Lentzner, and Robinson (2001), found that one-third of noninstitutionalized persons over 70 years of age reported having a hearing impairment. They also found that about 25% of individuals 70-74 years old reported hearing loss, but that this number rose to almost 50% for individuals 85 years of age and older. These data, based on self-report, do not entirely reflect the prevalence rate of measurable hearing loss in the elderly population.

Cruickshanks et al. (1998) reported on the audiometric results obtained from 3,753 residents of Beaver Dam, Wisconsin, participating in an Epidemiology of Hearing Loss Study. The presence of hearing loss was defined as a four-frequency (500, 1000, 2000, and 4000 Hz) pure-tone average (PTA) greater than 25 dB in the poorer ear. The results of this study indicated the prevalence of hearing loss was 45.9%. The majority of losses were mild (58.1%) or moderate (30.6%). The prevalence of hearing loss increased with age, such that at 80 years of age, the prevalence of hearing loss was 89.5% and, according to predictions based on a logistic regression model, the risk of hearing loss increased by almost 90% every five years. Participants with hearing loss were more likely to report hearing handicap, as measured by the Hearing Handicap Inventory for the Elderly-Screening version (Ventry & Weinstein, 1983) and the percentage of people who reported a hearing handicap increased with the severity of loss.

An earlier study on hearing loss by Moscicki, Elkins, Baum, and McNamara (1985) also reported on measured hearing loss in an adult population. Results from 2,293 participants were used in data analysis. Hearing loss was defined as a loss greater than 20 dB for at least one frequency from 500 to 4000 Hz. Using these criteria, the results indicated that the prevalence of hearing loss in this cohort was 83%, higher than that found by Cruickshanks et al. (1998). However, when Cruickshanks et al. (1998) applied the Framingham definition to their own cohort, they found that the prevalence of hearing loss for the Beaver Dam cohort was 80.2%, close to the 83% found by Moscicki et al. (1985).

These cross-sectional data do not necessarily reflect the effects of aging alone on measured hearing loss; however, a longitudinal study by Morrell, Gordon-Salant, Pearson, Brant, and Fozard (1996), documented the presence of changes in hearing threshold related to the aging process. Participants included 681 men and 416 women who were screened for otologic disease and noise-induced hearing loss. Age at the time of beginning the study ranged from 17 to 90 years, and participants remained in the study for 2-15 years. Participants were tested every two years with self-administered, Bekesy audiometry at 500, 1000, 2000, and 4000 Hz. Data were analyzed to provide age, gender, and frequency-specific longitudinal percentile curves for changes in hearing threshold level. The results showed that, in their sample, hearing thresholds declined simply due to age.

An earlier study by Pearson et al. (1995) used the same information obtained from the Baltimore Longitudinal Study of Aging to assess specifically the age-related differences in hearing threshold between men and women. Pearson et al. (1995) found that for men, age-related changes in hearing begin at all frequencies by about age 30 and "hearing sensitivity declines more than twice as fast in men as in women at most ages and frequencies" (p. 1196). For women in the study, changes in hearing sensitivity at 500 and 8000 Hz began around the same time as changes in hearing for men, age 30; however, for other frequencies, changes in hearing did not begin in women until 60-70 years of age.

Given that age-related changes in hearing level as measured by pure-tones and self report do occur, do these changes in hearing level affect the recognition of speech, and particularly, speech presented through a television? The following sections describe the rate of televised speech, impact of hearing loss on speech perception in older adults, and difficulty listening to television as reported by older adults with hearing impairment.

Televised Rate of Speech

Uglova and Shevchenko (2005) reported on the televised rate of speech as compared to normal conversational speech. They measured speech-to-pause ratios for different news broadcasts in New York, Boston, Philadelphia, and Dallas and measured speech-to-pause ratios for normal conversational speech in those geographical areas. They found that for normal conversational speech, the average speech-to-pause ratio for New York and Boston was 2.22:1, i.e., there were 2.22 seconds of uninterrupted speech, for every one pause that was taken. In Philadelphia, the average speech-to-pause ratio for normal conversational speech was 2.66:1, and in Dallas, the ratio was 3.07:1. The average talk-to-pause ratio for news broadcasts was, however, much longer. The overall average was 14:1, with New York and Boston having an average talk-to-pause ratio for news programming of 11.4:1; Philadelphia had an average of 16.6:1, and Dallas averaged 15.3:1.

Their sample of news programs was also evaluated for the number of words per minute, and it was found that each one-minute sample contained approximately 200 words. This study suggests that the rate of televised speech is faster than that of normal conversational speech. Additionally, Wingfield and Tun (2001) noted that average speech rates in normal conversation range between 140-180 words per minute (WPM), and that televised speech for the news can reach 210 WPM. One difficulty experienced by older adults with hearing impairment is difficulty understanding fast rates of speech.

Impact of Hearing Loss on Speech Recognition in Older Adults

The consequences of age-related changes in hearing level for the recognition of speech have been documented. Specifically, studies indicate that hearing loss and aging affect the ability to perceive rapid speech (including its simulation with time compression), which, as noted above, characterizes at least some televised programming.

Gordon-Salant and Fitzgibbons (1993) evaluated the effects of three different types of distortion (time-compression, reverberation, and interruption) on the speech recognition abilities of elderly listeners with and without hearing loss and young listeners with and without hearing loss. They found that both groups of elderly listeners, including elderly listeners with normal hearing, performed more poorly than younger listeners on all distortion tasks. The researchers pointed out that poorer performance in reverberation and for time-compressed speech puts elderly individuals at a disadvantage when listening in everyday situations, especially in highly reverberant areas, such as restaurants, and when listening to people who speak quickly.

Gordon-Salant and Fitzgibbons (1995) examined effects of multiply degraded speech signals on speech recognition scores of young normal-hearing listeners, elderly normal-hearing listeners, elderly hearing-impaired listeners, and young hearing-impaired listeners. There were seven listening conditions: 1) quiet, 2) undistorted sentences in noise (+16 dB SNR), 3) 40% time compression, 4) reverberation (0.3 s reverberation time), 5) time-compressed sentences in noise, 6) reverberant sentences in noise, and 7) time-compressed and reverberant sentences. Results showed significant age effects for the combined conditions employing time-compression (i.e., time compression and noise, and time-compression and reverberation). This was true for both the normal hearing and hearing loss groups, such that younger listeners performed better in these conditions than older listeners. Significant age effects were also observed for the listeners with normal hearing for the time-compressed speech presented in quiet. This indicates that older listeners, even those with normal hearing, experienced more difficulty understanding speech presented at a fast rate, in a quiet environment, compared to younger listeners. No significant age effects were reported for the other conditions.

In addition to these studies, others have manipulated the speech amplitude, presentation rate, and presence of background noise, and consistently reported that older adults exhibit considerable difficulty understanding degraded speech (Gordon-Salant & Fitzgibbons, 2004; Sommers, 1997; Wingfield, McCoy, Peelle, Tun, & Cox, 2006). It is clear from these studies that even older individuals with normal hearing have difficulty understanding speech signals that are degraded and that those difficulties are even more pronounced in the presence of multiple degradations of the speech signal, as is common in everyday life. These age-related difficulties understanding speech are likely to affect functioning in everyday life, including watching television.

Benefits of Bimodal Sensory Input

Several researchers have shown that the combined use of speechreading and audition enhances participants' ability to derive information from speech signals (Grant & Walden, 1996; Grant & Seitz, 1998; Grant, et al., 1998; Sommers et al., 2005; Walden et al., 2001). This was found to be true for both normal hearing, and hearing impaired listeners. Studies have shown that for normal-hearing young and older participants, the addition of visual cues via speechreading greatly improved percent correct scores for filtered speech signals presented at unfavorable signal-to-noise ratios (SNRs), compared to percent correct scores with auditory input alone (Grant & Walden, 1996; Grant & Seitz, 1998; Grant, et al., 1998; Sommers et al., 2005).

Walden et al. (2001) also evaluated improvements in consonant recognition for adults using amplification, and found that combining both amplification and speechreading resulted in higher percent correct scores than those observed with amplification alone. Their study evaluated consonant recognition in four different listening/viewing conditions similar to those used in the current study: 1) unaided auditory only (Unaided-A), 2) aided auditory only (Aided-A), 3) unaided auditory + visual (Unaided-AV), and 4) aided auditory + visual (Aided-AV). The participants were 25 males age 49-73 (M=66.2 years), whose hearing loss was bilateral, sensorineural, acquired. Most participants had noise-induced hearing impairment. Participants were long-time hearing aid users, and wore GN ReSound BT2 hearing aids for the purposes of the study. All participants wore these hearing aids for 10 weeks prior to beginning the study.

Stimuli consisted of 14 English consonants, spoken via a female talker in vowel, consonant, vowel (VCV) presentation. Stimuli were presented via a loudspeaker in the soundfield at 50 dB SPL. Stimuli were presented at a different, pre-determined SPL level for some participants, to ensure they could achieve 30-50% correct unaided consonant recognition. The loudspeaker was mounted atop a 19-inch color television monitor, 1.5 meters from the participant, which was used to present the visual portion of the task. Visual stimuli consisted of the female talker's head and neck, with on-camera overhead and direct lighting. Participants listened to/viewed the stimuli and chose their answer from a touch-screen monitor. The order of test conditions was counter-balanced across the participants, and consonant stimuli presentation was randomized to each participant.

The approximate mean percent correct consonant recognition scores in the four conditions were as follows: Unaided-A score = 50%, Aided-A score = 79%, Unaided-AV score = 90%, and Aided-AV score = 95% correct. Performance for Unaided-AV for individual consonants was reported, and indicated that improvement in recognition of individual consonants varied. In other words, speechreading, while it is helpful, is not uniformly beneficial for all consonant sounds.

Grant et al. (1998) evaluated the extent to which listener performance on a consonant recognition task predicted sentence recognition. Participants were 29 listeners with hearing impairment, recruited from the patient population at the Army Audiology and Speech Center at Walter Reed Army Medical Center. Participants ranged in age from 41-88 years (mean age = 65), and most were experienced hearing aid users; however, stimuli for the experiment were presented binaurally under headphones at 85 dB SPL. Results showed that for the A and AV conditions respectively, 52% and 54% of the variance in sentence recognition could be accounted for by consonant recognition. However, as was the case for the Walden et al. (2001) study, the visual stimuli for Grant et al's study were highly visible with full face shots and excellent lighting, two conditions that do not often characterize all communication situations, including televised speech.

The Impact of Hearing loss on Television Viewing

Many researchers have sought to define, through the use of questionnaires, the problems that hearing loss creates for a person. Results of these studies have shown that television viewing is difficult and often listed as a problem for those with hearing loss (Barcham & Stephens, 1980; Gatehouse, 1999; Stephens, Jones, & Gionopoulos, 2000; Stephens et al., 2001).

Gatehouse (1999) utilized a self-report measure of disability and benefit, the Hearing Disability and Aid Benefit Interview, which contained 14 “pre-specified” listening circumstances. Two of these listening circumstances involved the television, and were “Listening to the television on your own,” and “Listening to the television with family or friends.” Of the 943 respondents, 60.2% reported difficulty “Listening to the television on your own,” and 63.7% reported difficulty “Listening to the television with other family or friends” (Gatehouse, 1999, p. 94).

Several studies by Stephens and colleagues have also shown that difficulty understanding television/radio is a common problem for adults with hearing impairment (Barcham & Stephens, 1980; Stephens et al., 2000; Stephens, et al., 2001). Barcham and Stephens (1980) found that understanding television/radio was listed by 48% of respondents as a problem. Additionally, Stephens et al. (2000) found that electronic sources of speech, which included television, was the second-most commonly listed problem, behind speech from a live talker. Finally, Stephens et al. (2001) found that the most commonly reported activity limitation on the questionnaire was hearing the television. Although no studies have been found which objectively investigate older adults' ability to understand the television, these self-report measures indicate this is a concern for persons with hearing impairment.

Hearing Aids and Television Viewing

Tyler et al. (1983) surveyed two groups of hearing-impaired persons (n = 250), hearing aid wearers and hearing aid candidates, to determine the difficulties they experienced as a result of their hearing loss. The mean age of the participants was 64.7 years. Participants were asked to list the difficulties they experienced due to their hearing loss in a questionnaire. Watching television was the most troublesome situation for both groups, with 47.2% of the hearing aid candidates reporting difficulty, and 37.6% of the hearing aid users reporting difficulty. Average length of use for the hearing aid users was 12.7 years. Even with extended use of hearing aids, and the benefit of hearing aid use during television viewing, this group had difficulty watching television.

Kochkin (2000) reported that over the course of three different MarkeTrak V surveys (1991, 1994, & 1997) of hearing aid users, approximately 11% of users reported dissatisfaction with their hearing aids while watching television. A more recent MarkeTrak VII survey (Kochkin, 2005) showed that 10% of hearing aid users, whose instruments were no more than five years old, reported dissatisfaction when watching television. Additionally, 8% of hearing aid users reported that they felt neutral about the ability of their hearing aids to assist when watching television. All of these studies indicate that hearing aids may be of limited benefit while watching television. However, a study has not yet been published that directly evaluated hearing aid users' speech understanding performance while watching television.

Closed Captioning

Captions are words that appear on the television screen and completely or closely mimic the audio portion of a television program. Captions are produced in two main forms, open captions and closed captions. Open captions consist of captions that are always on the television screen, such as identifying information when a person is interviewed on the news, or subtitles on foreign films. Closed captions differ from open captions in that they must be activated by the viewer and do not automatically appear on the screen. The type of captions currently available for television programs is closed captioning. To access closed captions, the television must be equipped with a closed caption decoder (NIDCD, 2002). This decoder can be built into the television (as a computer chip) or it can be a separate piece of equipment that is attached to the television, similar to a VCR or DVD player. Closed captions are currently available on most television sets and for most television programs.

The clarity, accuracy, and speed of closed captioning has been evaluated in recent years. In 2003, Jordan, Albright, Brannen, and Sullivan reported to the National Captioning Institute on "The State of Closed Captioning in the United States," evaluating the availability, quality, and accuracy of closed captioning, together with viewer perceptions regarding closed captioning. They found that 62% of the broadcast and cable television programs sampled were captioned, while 100% of national and local news programs sampled were captioned (Jordan et al., 2003). This result is particularly important to the current study, because a review of the literature on television viewing habits of older adults has shown that the type of television programming older adults watch most is the news (Fouts, 1989).

Both general programming and news programming were analyzed for clarity, accuracy, and understandability. Jordan et al. (2003) reported that clarity of captioning was judged with the sound off; that is, could the coder understand the meaning of the show when no sound was on. Accuracy of closed captioning was judged with the sound on, and comparisons were made between the closed captioning and the audio to determine if any problems existed. The evaluators were young listeners described as college students. It was not reported whether their hearing had been tested to ensure it was within normal limits, however, it was implied that hearing was within normal limits for this group.

Greater than half of closed captioning for general programming was judged to be clear (75.9%) and accurate (63.8%). For news programming, clarity and accuracy results for local and national news differed. For local news programming, only 25% was judged to be clear (Jordan et al., 2003). The results for national news programming were somewhat better, with 82.4% of the national news sample judged as clear (Jordan et al., 2003). Accuracy of national news was also better than that of local news programming, with all of local news programming showing some problems with accuracy (53.6% "minor problems;" 46.4% "major problems").

National news programming, on the other hand, had only 5.9% “major problems,” 64.7% “minor problems,” and 29.4% “no problems” (Jordan et al., 2003, pgs. 10-11).

In addition to caption clarity and accuracy, other researchers have investigated caption presentation speed and vocabulary. Jensema, McCann, and Ramsey (1996) evaluated these characteristics by recording and analyzing 205 television programs, including regular programs (children’s shows, prime-time dramas, situation comedies, or news) and music videos. Start and end times were attached to each line of caption data in order to measure the caption speed in words per minute (WPM). Programs were analyzed for the type of captioning, caption speed, caption editing, and type of words (common or unique).

The type of captioning refers to the mode in which the lines of captioned text are presented. Jensema et al. (1996) found two common methods for presenting captions, roll-up captions and pop-on captions. Roll-up captions are presented by scrolling the text lines up the screen, usually three at a time, while pop-on captions are presented by showing (popping-on) one to four lines of captioning at a time, leaving them on the screen for a few seconds, and then popping them off. Pop-on captions were the most common type of captioning for regular programming. Roll-up captions presented more words per minute (i.e., were faster), than pop-on captions (roll-up = 151 WPM; pop-on = 138 WPM). Roll-up captions were also used for a wider range of audio speeds. The average caption speed for all programs was 141 WPM. Sports programs and music specials had the slowest caption speeds (74-94 WPM), while soap operas, news programs, and talk shows had the fastest caption speeds (154-177 WPM).

The amount of editing performed on closed captions is a way to determine the accuracy of the captions, and for this measure, two programs were randomly selected from each program category and a 10-minute segment was analyzed. This analysis determined the percentage of words that were present in the audio, but were not part of the closed captioning. Percentage of captioning ranged from 81% to 100%, with soap operas and documentaries showing the lowest percentages of editing (i.e., almost all of the audio for these shows was captioned verbatim). The average was 95%, meaning that roughly 95% of the program audio was captioned.

Word analyses were performed via computer analysis to determine whether the words were common or unique to the English language. Results showed that relatively few unique words (16,102 unique words out of 834, 726 total words) were used. From this analysis, the researchers concluded that most adults should be able to read captioned television with knowledge of about 500 English words.

In another experiment by Jensema (1998), 578 participants (mean age = 31.7 years, range = 20.3 years; male = 301, female = 277) were evaluated for their subjective reaction to different captioning speeds. The participant group included deaf (n = 205), hard of hearing (n = 110), and hearing (n = 262) individuals. No specific information was given regarding the mean age and age ranges for the different groups of participants (deaf, hard-of-hearing, and hearing). Participants viewed three videos containing segments that were captioned at different speeds (96-200 WPM). After watching each segment, participants marked on a response form whether they considered the caption speed to be "too fast, fast, OK, slow, or too slow." Responses were given a number from 1-5, with 1 being "too slow" and 5 being "too fast." A score of 3 indicated that the caption speed was "OK."

Results indicated that for most viewers, 145 WPM was the speed noted as "OK," in other words, the most comfortable. In the study mentioned previously, Jensema et al. (1996) found that 141 WPM was the most common caption speed; therefore, the most comfortable caption speed for most people (145 WPM) was close to the most common caption speed actually presented. Additionally, statistical analyses revealed no correlation (r=.11) between preferred caption speed and age, suggesting that older and younger participants did not differ according to the caption speed they felt was most comfortable.

The overall picture of closed captioning is that it is clear and accurate, the presentation speed is comparable to that preferred by viewers, and vocabulary is such that most adults should be able to understand captioning. This indicates that closed captioning is not only a widely available tool for persons with hearing impairment, it is also a suitable tool in terms of clarity, accuracy, presentation speed, and vocabulary.

Demographics of Closed Caption Viewers

In 1987, Jensema evaluated the demographic profile of closed caption television viewers and reported that older viewers were underrepresented. Jensema (1987) collected demographic information from 28,415 owner identification cards included with the first generation of TeleCaption decoders. Although these demographic data are from users who purchased the decoder before the Telecommunications Act of 1996, and may not fully represent demographic data of closed caption viewers now, these are the only known demographic data available for the closed caption television audience.

Analysis of information from the owner identification cards showed that for the years 1980 through 1984, 42% of the hearing-impaired viewers were age 45 or older, and of that group, only 18% were over the age of 64. Jensema (1987) noted that “older viewers were clearly under-represented: At least 75% of the hearing-impaired population is 45 years of age or older” (p. 390). Data for all closed caption users also indicated that older viewers were under-represented. Forty-two percent of total viewers were over the age of 45 years and only 20% of the total viewers were 64 years of age or older.

Several studies have evaluated the characteristics of closed captions, the effects of those characteristics on different groups of listeners, and the demographic profile of closed caption viewers. However, no studies have evaluated the use of closed captioning by older adults with hearing impairment. Jensema's study (1987) suggests that a relatively small proportion of older people with hearing loss use closed captioning, although this has not been demonstrated empirically.

Potential Benefit of Closed Captioning for Older Adults

The use of closed captioning among older adults who use hearing aids has not been investigated previously. However, one study addressed the use of closed captioning and its benefits for older adults in an institutionalized setting. Ball (1988) reported on research conducted by Freeburg and Leavitt between 1985 and 1986 on the benefits of closed captioning for institutionalized adults. The researchers provided TeleCaption decoders to nursing homes in Oregon, Idaho, Montana, and

Alaska. The Activity Directors at each site were asked to record the behaviors of the residents. Over half of the Activity Directors who responded to the study reported that "several residents who did not previously watch television began leaving their rooms to watch captioned programming in the central viewing area" (as cited in Ball, 1988, p. 42). Approximately 70% of the Activity Directors reported that closed captioning provided improved access to television for their residents, which they felt improved the residents' quality of life by allowing them to participate in group discussions about television programming and by improving group activity participation. One limitation of this study, however, is that direct sampling of the residents' behaviors and opinions was not conducted.

Despite this concern, closed captions appeared to improve resident well-being, as reported by this sample of Activity Directors. This study was conducted before closed caption decoders were integrated into television sets; accessing closed captions is much easier now than it was at the time this study was conducted.

Summary

Older adults spend a considerable amount of time watching television. Because most older people have hearing loss, they may have difficulty hearing and understanding the televised message. The use of hearing aids is expected to improve audibility of the televised speech signal. Also, the availability of speechreading cues coupled with an amplified speech signal usually results in excellent speech recognition scores.

Some speechreading cues are available on television, due to full-face camera shots, which are particularly common in news and game show programming;

however, televised speech also lacks many opportunities for speechreading, such as on-camera movement, the presence of dark backgrounds, and instances when the speaker is not the person on-camera.

Televised speech is also fairly rapid and may be difficult for older people with hearing loss to understand, even those who use hearing aids. However, recognition of televised speech by older hearing-impaired listeners, with and without hearing aids, has not been reported previously. Closed captioning is a text representation of the auditory message, and is therefore not affected by degradations to the auditory signal, such as background noise, and distortion from personal hearing loss. Additionally, closed captioning is not affected by the presence or absence of speechreading cues, or the speed of the auditory message. Some evidence suggests that older people with hearing loss do not use closed captioning frequently. Nevertheless, older adults with hearing loss may experience considerable improvements in recognition of televised speech with the addition of closed captioning, compared to unaided and aided television viewing.

Chapter 3: Statement of Research Questions and Hypotheses

The purpose of the current study was to evaluate the benefit of hearing aids for older hearing aid users for televised programming, as well as the benefit of closed captioning for this group. Studies suggest that the televised speech signal is rapid, with inconsistent opportunities to receive speechreading cues. Hence, watching television even with hearing aids may be quite difficult for the older listener. Closed captioning is readily available on televisions, but at least one report suggests that older hearing impaired people do not use closed captioning to a great extent. However, if it can be shown that older people with hearing loss understand television well with closed captioning, it may be worthwhile for this population to consider utilizing closed captioning in daily television viewing. Another purpose of this investigation was to evaluate the combined use of closed captioning and hearing aids in a population of older adults who are experienced hearing aid users to determine whether the combination of these two assistive devices provides greater comprehension of televised speech (as measured by percent correct word recognition scores) than either of these devices alone.

Participants' word recognition scores for televised material were measured in four different listening/viewing conditions: 1) without hearing aids or closed captioning, which serves as a baseline measure (BSLN), 2) with their hearing aids on and the closed captioning deactivated (HA), 3) with the closed captioning activated and without their hearing aids (CC), and 4) with their hearing aids on and the closed captioning activated (HA+CC). Word recognition scores were measured for three types of television programming: news (N), game show (G), and drama (D). In addition, a questionnaire was administered to determine individual hearing aid use, television viewing preferences, and frequency of closed captioning usage. The following questions were addressed in this research:

1. Does the use of personal hearing aids yield greater word recognition scores than watching television without assistive listening devices (i.e., HA vs. BSLN)?

2. Does the use of CC yield greater word recognition scores than watching television without CC, either with or without hearing aids (i.e., CC vs. BSLN, and CC vs. HA)?

3. Does the combined use of closed captioning and personal hearing aids yield greater word recognition scores than hearing aids or closed captioning alone (i.e., HA+CC vs. CC and HA)?

4. Is there a difference in word recognition score for different program types (news, drama, game show), and does this effect interact with the effect of listening/viewing condition?

5. Is the word recognition score obtained across conditions correlated to:

    a) the amount of time spent watching television

    b) the frequency of hearing aid use when watching television

    c) the frequency of closed caption use when watching television?

The first hypothesis was that use of personal hearing aids would yield higher word recognition scores than use of no assistance. This was also expected to be true for all program types, because it was thought that use of hearing aids would provide enhanced auditory information to participants and they might be able to couple this information with speechreading cues available on-screen to result in higher word recognition scores. Walden et al. (2001) also found that aided audition resulted in higher percent correct scores than a baseline condition without amplification for the participants in their study as well.

It was also expected that use of closed captioning would result in higher word recognition scores than use of either HA alone or BSLN, for all program types. This was anticipated because the closed captioning used for this task was very clear, and participants' sensory difficulties involved primarily audition, and not vision. Therefore, it was expected that this group of older adults would perform better with closed captioning than with hearing aids, as hearing aids cannot overcome all difficulties experienced by older adults with hearing impairment, for instance, difficulty understanding fast rates of speech.

Thirdly, the combined use of personal hearing aids with closed captioning was expected to yield higher intelligibility of televised material, as measured by word recognition scores, than either hearing aids or closed captioning used alone. This was expected to be true for all program types.

The combined use of both assistive devices was expected to outweigh any differences in the program types, such as the duration of the speaker's face on camera. In other words, despite differences between programs in the availability of speechreading cues, the combined use of two assistive devices was expected to be beneficial. Additionally, it was expected that the input from two assistive sources, one auditory, and one visual, would combine to fill in gaps in the information presented that either device used alone would not fully convey. For instance, prosody of speech and its emotional content might be better picked up by hearing aid use, but individual word understanding might be better supplemented with closed caption information.

The fourth hypothesis was that differences in word recognition scores between different program types might exist. For instance, word recognition scores for drama programming were expected to be lower across all conditions compared to those obtained for news and game show. This was expected because the amount of speechreading that could be accomplished from program to program would vary due to the nature of the programming. For instance, full-face shots may be more prevalent on news and game show programming than for drama programming, allowing more chances to take advantage of speechreading cues. Additionally, speakers for the news and game show program types may speak more slowly and clearly than those on the drama program, and that might also influence word recognition scores, such that they would be significantly different from one program type to another. Finally, the game show might have additional non-spoken cues (e.g., lights flashing, scores boards) that could aid in understanding the televised message.

Information was also collected from a questionnaire, including the amount of time spent watching television per day, use of hearing aids while watching television, and use of closed captioning while watching television. It was expected that a significant correlation between frequency of closed caption use and word recognition scores in closed caption conditions would exist (i.e., persons who frequently utilize closed captioning are expected to achieve higher word recognition scores in closed captioning conditions than those who report they do not regularly use closed captions). No other significant correlations were expected (i.e., between word recognition scores and amount of television viewing per day, or between word recognition scores and the amount of time hearing aids were used when viewing television).

Chapter 4: Method

Participants

Participants were included in the study if they had a bilateral, sensorineural hearing loss, were current users of binaural hearing aids, and had worn their hearing aids for at least two months to increase the likelihood that hearing aid benefit and acclimatization had occurred. Acclimatization refers to better speech perception in noisy environments following a period of hearing aid use, compared to that seen at the fitting (Cox, Alexander, Taylor, & Gray, 1996). Vision problems were reported by the participants to be corrected to 20/20 by contact lenses or glasses. Participants were native speakers of American English. Four practice sentences presented at the beginning of testing ensured participants could adequately read and write the sentences presented during testing.

Participants were recruited from audiology and hearing instrument service sites in the Birmingham, metropolitan area. Letters (Appendix A) were sent to local audiology and hearing instrument service sites introducing the researcher, and describing the project. Information included a list of potential participant criteria (Appendix B), a copy of a letter to potential participants (Appendix C), and a flyer (Appendix D) describing the project and providing the researcher's contact information. Audiology and hearing instrument service sites were contacted via telephone after information was mailed to their site. Service providers were asked if they would be interested in assisting with this project through potential participant referrals. Flyers were also posted in local places of worship, Senior citizen's centers, meeting places of special interest groups, such as the Hearing Loss Association of

America (formerly Self-help for the Hard of Hearing), and various buildings on the University of Alabama at Birmingham (UAB) campus. These sites were contacted via telephone to inquire if a flyer could be posted, and flyers were provided to participating sites as needed. Participants were also recruited from the metropolitan Atlanta, Georgia area via word of mouth. When potential participants contacted the researcher, they were asked preliminary questions (Appendix E) to ensure that they met basic participant criteria, and for informational purposes.

Participants included 22 older adults aged 57-82 (Mean age = 73.68, SD = 7.71, Male = 14; Female = 8). Six participants had conductive components to their hearing loss; therefore, data collected from these participants were not used in the final analyses. Exclusion of participants with conductive components to their hearing loss was performed in order to include a representative sampling of individuals with age-related hearing loss (which is sensorineural in nature). Additionally, data obtained from one participant (57 years old) was considerably deviant from those obtained from other participants and hence was removed from the final analyses. Data from 15 participants, age 59-82 (Mean = 74.53, SD = 7.33, Male = 9, Female = 6) were used for the main analyses. This age group was chosen because reports have shown that hearing loss begins to affect both males and females at the higher frequencies around the age of 60 (Pearson et al., 1995). Figure 1 represents the average audiogram of these participants. Tables 1 and 2 present specific participant information. Please note that the pure-tone average was calculated using 500, 1000, 2000, and 4000 Hz. This average was used because research has shown that hearing loss typically begins in the high frequencies for older adults (Pearson et al., 1995).

Electroacoustic analyses of the hearing aids, described more fully in the Procedures section, included a measure of full on gain. However, the full-on-gain (FOG) measurements reported here for participants' hearing aids may not be accurate estimates of true hearing aid performance for all of the hearing aid models. Current hearing aid technologies sometimes require that a computer-programmed change be made in order to run electroacoustic analyses. Access to a computer for programming purposes was not available; therefore, the FOG measurements for some of the hearing aids in this study may not be accurate estimates of the actual FOG for these hearing instruments. For all hearing instruments, a listening check was performed, and revealed good sound quality for the Ling 6 sounds (Ling, 1976 & 1989). The Ling 6 sound test was developed to test for audibility of a range of speech sounds and includes the sounds [m], [oo], [ah], [ee], [sh], and [ss]. It provides a quick way to ensure hearing aids are amplifying sounds in the speech spectrum.

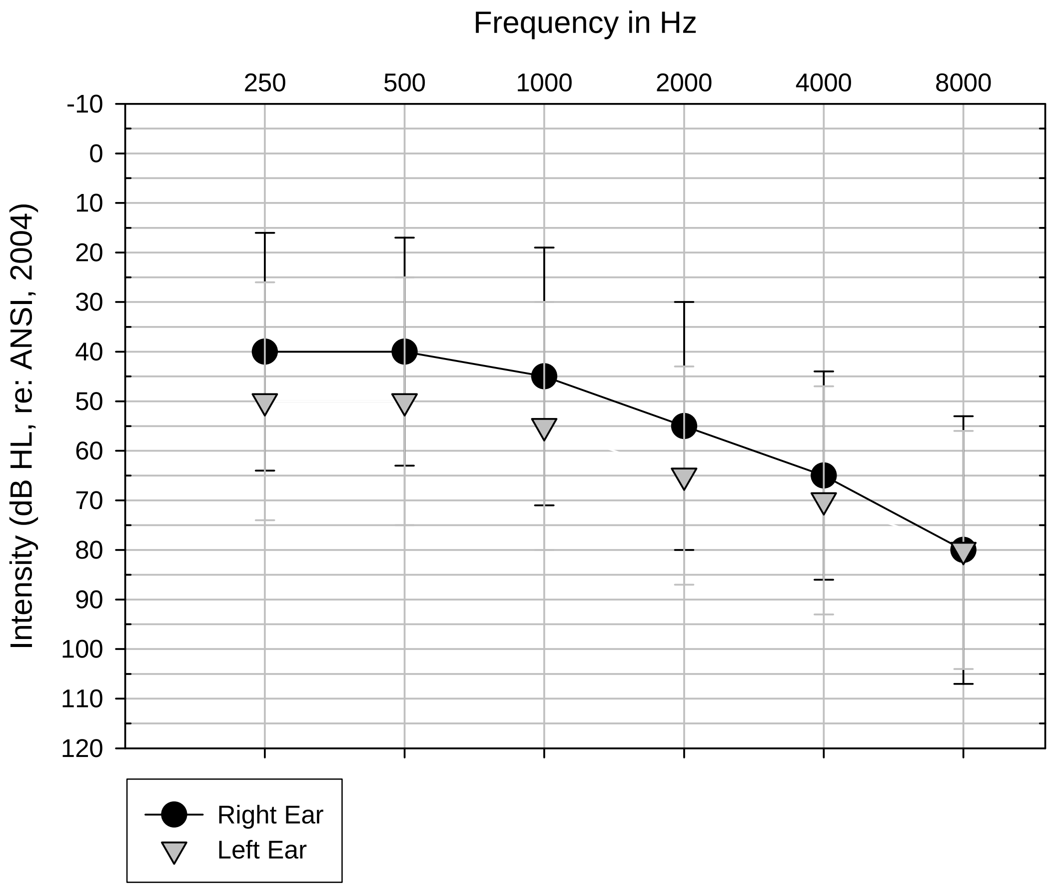

Figure 1. Average audiograms for right/left ears of 15 elderly participants

Table 1

Background Information and Hearing Characteristics for 15 Elderly Participants

Participant Number	Age	Gender	PTA R/L	Aided NU-6	ME Disease	Eye Disease	Corrected Eye Disease	Vision Problems	Corrected Vision
1	78	Female	101/93	6 %	No	Yes	Yes	Yes	Yes
2	82	Male	40/49	74 %	No	Yes	No	Yes	Yes
3	82	Female	56/60	78 %	No	Yes	Yes	Yes	Yes
4	80	Female	33/75	62 %	No	Yes	No	Yes	Yes
5	71	Male	65/75	22 %	No	No	N/A	Yes	Yes
7	71	Male	95/95	16 %	No	No	N/A	Yes	Yes
8	74	Female	34/33	96 %	No	Yes	Yes	Yes	Yes
9	81	Male	61/66	10 %	No	Yes	No	Yes	Yes
10	74	Male	53/54	76 %	No	No	N/A	Yes	Yes
11	67	Female	40/44	78 %	No	No	N/A	Yes	Yes
14	63	Male	43/55	62 %	No	No	N/A	Yes	Yes
17	73	Male	39/41	74 %	No	Yes	Yes	Yes	Yes
19	81	Female	49/49	48 %	No	Yes	Yes	No	N/A
20	82	Male	55/59	58 %	No	Yes	Yes	Yes	Yes
21	59	Male	20/30	84 %	No	No	N/A	Yes	Yes

PTA = pure tone average (500, 1000, 2000, and 4000 Hz). NU-6 = Northwestern University Test # 6. ME = middle ear. N/A = not applicable.

Table 2

Hearing Aid Information for 15 Elderly Participants

Participant Number	Length of Hearing Aid Ownership (years)	Hearing Aid Manufacturer	Model	Type/Style	FOG (R/L)
1	1	Siemens	LS	ITE	53/44
2	5	Argosy	HS	ITE	CNP
3	9 mos	Audibel	Unknown	CIC	12/11
4	7	Telex	MCAC	BTE	22/19
5	3	Audina	Foundation	ITC	30/35
7	4	Phonak	Supero	BTE	36/52
8	2	Oticon	GO	CIC	21/22
9	4 mos	MicroTech	CA-D	ITC	8/18
10	2	Widex	Diva	ITC	17/7
11	2.5	Siemens	LS	ITC	19/10
14	2 mos	MicroTech	CA-D	ITC	22/28
17	2	ReSound	Air	BTE*	CNT
19	3	Oticon	AT-I	ITE	9/12
20	RE-2; LE-5	Audibel	Unknown	ITE	17/15
21	8 mos	Siemens	Cielo	BTE*	CNT

ITE = in-the-ear; ITC = in-the-canal; CIC = completely-in-the-canal; BTE = behind-the-ear; BTE* = open-fit BTE. FOG = full on gain (rounded to nearest whole number). CNT = could not test. CNP = Could not print.

Stimuli

Stimuli included 124 sentences or parts of sentences from three different television programs, representing three different types of television programming: ABC World News Tonight (news), Jeopardy (game show), and the West Wing (drama). These types of television programming were chosen based on results of a study by Davis et al. (1976), indicating that these shows were viewed the most by older individuals. Additionally, ABC World News Tonight was chosen to represent the news programming because a study by Jordan et al. (2003) indicated ABC and NBC news programs relied heavily on scripts, which meant that these news programs were at a slower pace and the audio and captions were in sync with one another.

Ten sentences were recorded for each show and each condition, yielding 120 score-able sentences (3 television shows x 10 sentences per show x 4 conditions). Four sentences were practice sentences. Shows were recorded onto VHS tape via a Sylvania 20 inch, flat-screen color television (Model: 6420FF) and a Toshiba combination VHS/DVD player (Model: SD-V392SU). Shows were recorded in Fall, 2005, and Winter, 2006. Approximately seven hours of total television programming were recorded. DVD copies of shows were made to aid in the process of selecting and editing stimulus sentences. Additionally, Jordan and colleagues (2003) reported that replaying VHS tapes corrupts the closed captions on those tapes over time; hence, the DVD format is preferable. DVD copies were made by attaching the Toshiba combination VHS/DVD player to a Toshiba Satellite laptop computer (Model: A15-S127), via a TEAC USB 2.0 TV Tuner/Personal Video Recorder. Video was saved onto the computer's hard drive through Ulead Video @ Home (version 2) software included with the USB TV tuner. A DVD copy of stored material was made utilizing Ulead Video @ Home (version 2) software and a U-Storage external DVD burner drive.

Sentences were considered for inclusion as stimuli if they contained at least four content words that could be used for scoring and no more than six non-scoreable words. Content words included nouns, verbs, adjectives, adverbs, and prepositions, while articles, pronouns, and conjunctions were considered non-content words. Additionally, no single sentence contained speech from more than one speaker. In other words, each sentence was spoken by one person at a time. However, several different speakers were used to provide the set of sentence stimuli in a given sentence list.

Selected sentences were edited from original video using Adobe Premier Pro (version 1.5) video editing software. Editing involved starting and stopping each sentence at an appropriate location that was free of distortion. Thirty seconds of silence and blank, black screens were inserted between each sentence to provide time for listeners to record their response on an answer form provided to them. The audio channel of the video recordings was edited further utilizing Cool Edit Pro (version 2) software to remove distortion and noise, and to equate the sentences in rms level. The final waveform file for each sentence was then added back to the video in Adobe Premier Pro.

An attempt was made to preserve the closed captions from the original video; however, the video editing process removes original captions from the video. Therefore, “closed captions” were added to the sentences utilizing Adobe Premier

Pro's title effects. After digital editing, a main menu and submenu were added to the DVD utilizing Adobe Encore (version 1.5) and this program was used to burn a master DVD containing all sentence lists. A different randomization of the sentence lists was created for each participant. Each sentence list could be selected individually from the DVD's menu.

A pilot study was conducted to ensure that the sentence lists (lists 1, 2, 3, and 4) within each program type yielded equivalent scores. Six young normal hearing listeners were recruited to participate. Hearing was tested via standard audiometric evaluation (250-8000 Hz bilaterally) to ensure participants' hearing was within normal limits for young adults. No participant had hearing thresholds greater than 20 dB HL for either ear. All sentence stimuli (124 sentences) were presented without closed captioning, then with closed captioning, via a Sylvania 20 inch, flat-screen television (Model: 6420FF) in a quiet room at the student investigator's home. The volume level on the television was set at a constant level for all participants.

Participants were instructed to watch the television and record the sentences presented on an answer form. Twenty seconds of blank, black screen were inserted between each sentence to allow time to record answers. Data analyses indicated a significant difference between sentence lists for news and game show programming types without closed captioning. Participant performance on individual news and game show sentences was reviewed, to determine which sentences were most commonly correct and most commonly incorrect. A sentence that was commonly incorrect in a list that yielded lower overall percent correct scores was switched with a sentence that was commonly correct in a list yielding higher overall percent correct scores. Sentences were subsequently altered in Adobe Premier Pro. This resulted in one news sentence list with one additional male spoken sentence, and one news sentence list with one additional female spoken sentence.

Additionally, it was noted during preliminary testing that 20 seconds in between each sentence provided very little time for participants to record their answers. Given that the eventual target participant group was elderly individuals, whose writing speed is sometimes slower, the amount of time between sentences was increased to 30 seconds.

Five additional young, normal hearing listeners were recruited to evaluate list equivalency for the altered news and game show programming lists without closed captioning. Participants' hearing thresholds were tested via standard audiometry as noted above. Sentence list testing was conducted in a quiet room at the UAB Spain Rehabilitation Center. Participants were seated 80 inches from a 20-inch flat screen television (Sylvania, Model: 6420FF). Sentence stimuli were set at 60 dBA using a calibration tone equivalent in rms to the overall level of the sentences. This was calibrated with a ½ inch free field microphone and sound level meter (Extech, Model: 407740). This level remained constant throughout testing. A unique randomization of the sentence lists was created for each participant. The student investigator left the room at the start of each sentence list and returned only after the list had played, to reduce potential for bias.

Each list of 10 sentences contained 50 scoreable words, except one news programming list, which contained 48 scoreable words. Additionally, each list contained an equal number of male-spoken and female-spoken sentences, except for two lists within the news programming. One list contained one additional male spoken sentence, and one list contained one additional female-spoken sentence. This measure was taken when initial testing of list equivalency indicated the news programming lists were not equivalent. Further testing after sentences were re-arranged ensured list equivalency. Sentence length, or rate, varied, with an overall average sentence length of 2 seconds (range: 0.91 – 4.74 seconds). The average sentence lengths for news, game show, and drama programming were 2.15, 1.93, and 1.91 seconds respectively. The following sections describe the results obtained for sentence list equivalency testing. See Appendix I for sentence lists.

Sentence List Equivalency

Pilot Study 1: Interlist Equivalence

An initial pilot study was conducted to ensure interlist equivalency of sentences within each program type. The data were percent correct word recognition scores from six young, normal-hearing listeners obtained without the closed captions, and with closed captions. Percent correct scores were arc-sine transformed prior to analyses, to ensure they met the requirements of parametric data. One-way Analyses of Variance (ANOVA) were performed for each program type (game, drama, news) on results obtained without closed captioning, and with closed captioning. Therefore, six one-way ANOVAs were performed. When the sentence lists were presented with closed captions, results of one-way ANOVAs showed no significant differences between sentence lists for any of the program types [Game: $F(3, 20) = 2.32$, $p>.05$; Drama: $F(3, 20) = .47$, $p>.05$; News: $F(3, 20) = .86$, $p>.05$]. When sentence lists were presented without closed captioning, results of one-way ANOVAs showed no significant differences between the sentence lists for drama programming, [$F(3, 20) = .81$, $p>.05$]; however, significant differences were present for news and game show programming, [$F(3,20) = 16.52$, $p<.01$, and $F(3,20) = 7.05$, $p<.01$], respectively. Figures 2 and 3 present the pilot data of the normal-hearing listeners for the sentence lists presented with and without closed captioning, respectively.

Bonferroni post-hoc analyses of main effects of list for game show and news indicated that for game show programming, list 4 resulted in significantly higher word recognition scores ($p<.05$) than lists 1 and 2. There was no difference between lists 3 and 4 for game show programming ($p>.05$). For news programming, list 4 resulted in significantly higher word recognition scores ($p<.01$) than all of the other lists (1, 2, and 3).

Pilot Study 2: Interlist Equivalence

Figure 4 presents the pilot data of normal-hearing listeners for the revised game and news sentence lists presented without closed captioning. Data were arc-sine transformed prior to analyses, to ensure they met the requirements of parametric data. One-way ANOVAs were performed for each program type, and indicated no significant differences between sentence lists for either the news, [$F(3, 16) = 2.02$, $p>.05$], or game show, [$F(3, 16) = 2.86$, $p>.05$] programming. These results were confirmed using Bonferroni post-hoc analyses. It should be noted that the mean level of performance for young normal-hearing listeners was quite high, even without closed captioning. See Table 3 for mean percent correct scores and standard deviations for young normal-hearing listeners for all sentence lists presented without closed captioning.

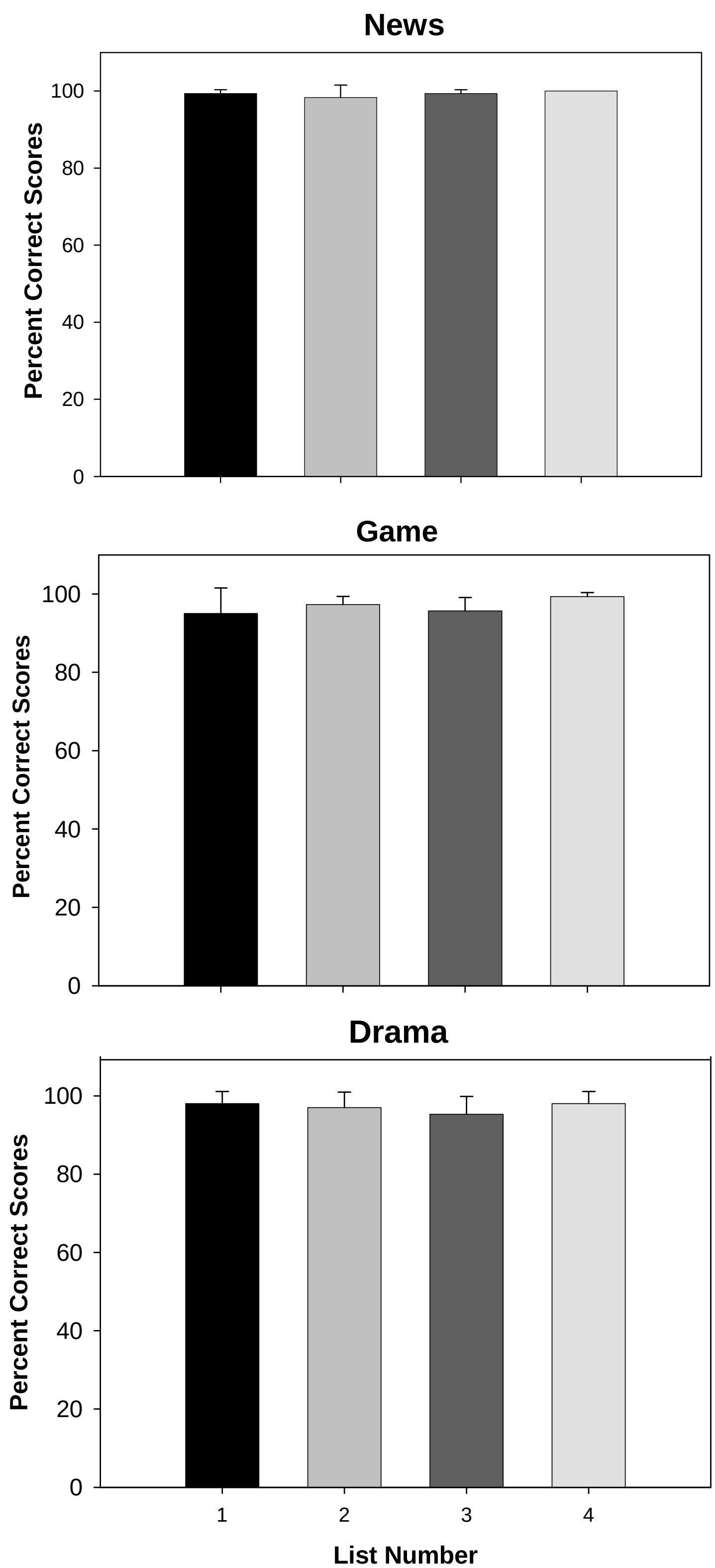

Figure 2. Percent correct scores among young normal-hearing listeners for 4 sentence lists presented with closed captioning, for 3 different television programs.

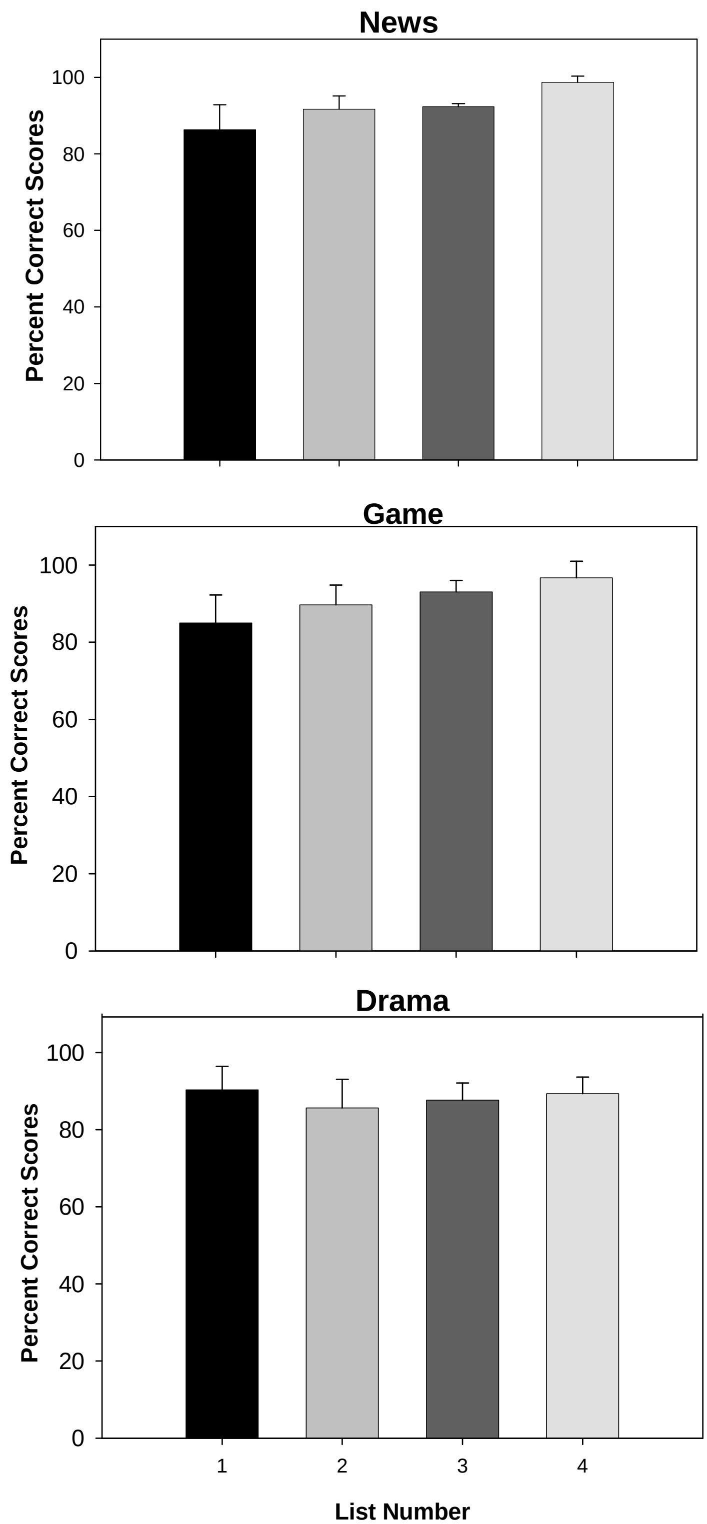

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Figure 3. Percent correct scores among young normal-hearing listeners for 4 sentence lists presented without closed captioning, for 3 different television programs.

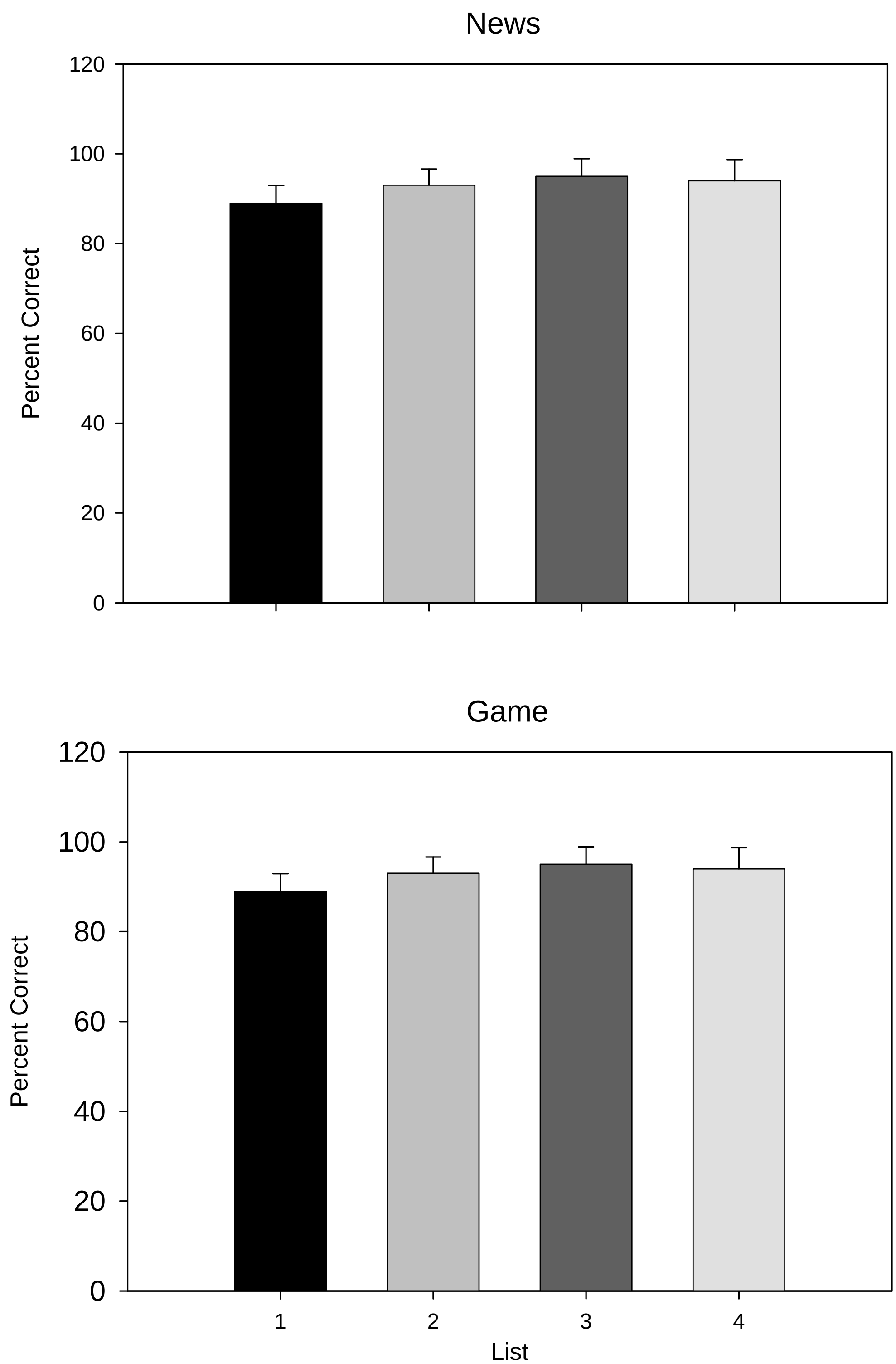


Figure 4. List effects for News and Game show programming without closed captioning, following sentences changes.

Table 3

Performance of Young Normal-Hearing Adults on Sentence Lists from Three Different Types of Programming

Program Type	Mean Percent Correct	Standard Deviation
Drama		
List 1	90	6
List 2	86	7
List 3	88	4
List 4	89	4
Game		
List 1	92	4
List 2	93	8
List 3	98	2
List 4	96	1
News		
List 1	89	4
List 2	93	4
List 3	95	4
List 4	94	5

Lists presented without closed captioning.

Procedure

Preliminary Testing

Elderly participants filled out an informed consent form and questionnaire (Appendix F), including birth date, television use, closed-captioning use, and television preferences. Participants were able to understand instructions presented orally. Written instructions (Appendix G) were available in the event that oral instructions were not understood. Participants underwent audiometric testing, including acoustic immittance measurements (tympanometry and ipsilateral acoustic reflex testing at 500, 1000, and 2000 Hz), speech recognition threshold or speech detection threshold (SRT or SDT), pure-tone testing (250-8000 Hz) for each ear, and bone-conduction testing (500-4000 Hz). Additionally, each participant was presented with a 50-word recognition list from the Northwestern University Auditory Test No. 6 (NU-6) word lists (Tillman & Carhart, 1966) in quiet at 50 dB HL in the soundfield while wearing their hearing aids set to their everyday use settings. This measure was included to observe the level of the participant's speech recognition performance while using their hearing aids set to normal usage settings. The average score for the participants on the NU-6 aided was 56%, with a range of 6-96%.

Participants' hearing aids were tested electroacoustically using a Frye Electronics FP 35 hearing aid analyzer. A listening check of each hearing aid was also conducted to ensure proper functioning. Of the 15 participants whose data were used for statistical analyses, hearing aid testing could not be completed for two participants due to the type (open-fit) of their hearing aids. The hearing aids that could not be tested were open-fit hearing aids for which a special coupler must be used to run electroacoustic analysis. The student investigator did not have access to these couplers. A listening check was performed on these hearing aids, and they were found to be in good working condition. All of these procedures took place at the University of Alabama at Birmingham's (UAB) Spain Rehabilitation Center.

Experimental Testing

All testing was performed in a quiet room at the UAB Spain Rehabilitation Center. For the experimental measures, participants were seated in a comfortable chair 80 inches from a Sylvania 20 inch, flat-screen color television (Model: 6420FF) and viewed segments from three types of television programming in four viewing conditions.

Participants were given four practice sentences with the captions on, and the sentences paused. The sentences were paused while the captions were on-screen, and participants were asked to record the captioned sentences on their answer form (Appendix H). Participants were required to record three of the four sentences correctly to ensure the captions could be seen and read. Jensema (1998) used this type of procedure to ensure adequate viewing of the closed captions in his research.

For practice and experimental sentences, a Pioneer DVD player (Model: DV-490V) was used to present the video segments. The Pioneer DVD player was used for participants 1-20; however, it stopped working while participant 20 was being tested; therefore, participants 20, 21, and 22 viewed the DVD utilizing an LG DVD Player (Model: DN191H). The speech signal was presented through the speakers of a standard, 20 inch television set (Sylvania, Model: 6420FF) at a level of 60 dBA. The level of a calibration tone, equivalent in rms to the overall level of the sentences was calibrated with a ½ inch free field microphone and sound level meter (Extech, Model: 407740). This level remained constant throughout testing (i.e., was not changed for any of the conditions or participants) and was chosen because a study by the Environmental Protection Agency (EPA) in 1977 indicated that speech levels measured in homes remained at approximately 55 dBA as long as background noise levels were below 48 dBA. The background noise level in the room was also measured for each participant, and was no greater than 40 dBA for each participant. Following each stimulus presentation, participants were asked to write down the sentence on an answer form (see Appendix H). Participants were given 30 seconds of blank, black screen in which to record their answer. In other words, the interstimulus interval (ISI) was 30 seconds.

Answer forms were scored for percent correct of select score-able words. Thirty sentences (10 sentences x 3 programs) containing four to six score-able words each comprised the stimuli for each viewing condition, yielding a total of 150 score-able words per condition. Additionally, participants were asked at the end of each sentence list if they had seen any of the programming presented to them.

Within a list of 10 sentences, the sentence order remained the same; however, sentence lists were randomized to the different conditions. The order of sentence lists assigned to conditions was randomized across participants. Thus, each participant had a unique randomization order of conditions with sentence lists. The entire procedure was completed in one session of two and half to three hour's duration. Breaks were given as needed or requested.

Chapter 5: Results

Primary Analyses

The primary hypothesis examined in this experiment was that elderly listeners who use hearing aids would demonstrate different speech recognition scores for televised programming across the different listening/viewing conditions. To that end, word recognition scores obtained from the 15 participants measured for three types of programs and four listening/viewing conditions were analyzed to determine if the combined use of closed captioning and hearing aids would yield greater word recognition scores than the use of either of these assistive devices alone. The dependent variable for this analysis was word recognition score, and the independent variables were program (3 levels) and condition (4 levels).

Prior to data analysis, word recognition scores were transformed utilizing an arc-sine transformation procedure. The rationale for this procedure was that the percent correct scores were not normally distributed, and therefore did not meet the requirements of parametric data. Mauchly's test showed that the assumption of sphericity was violated for the main effect of condition, [$\chi^2(5) = 22.13$, $p<.01$]. Therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .50$). Repeated measures ANOVA revealed a significant main effect of program [$F(2,28) = 11$, $p<.01$], significant main effect of condition [$F(1.51, 21.13) = 48.24$, $p<.01$], and a significant interaction between program and condition [$F(6, 84) = 4.16$, $p<.01$]. These results indicated word recognition scores for the different program types were significantly different from one another, as were word recognition scores for the different conditions, and that the independent variables of program and condition interacted to produce some of these scores. Post-hoc testing was conducted to determine the effect of condition separately for each program, and the effect of program type for each condition.

Simple main effects analyses revealed a significant effect of listening/viewing condition for each program type [Game: $F(3, 56) = 13.19$, $p<.01$; Drama: $F(3,56) = 25.14$, $p<.01$; News: $F(3,56) = 23.10$, $p<.01$]. Multiple comparison tests were conducted subsequently utilizing Bonferroni post-hoc testing to determine the significances of differences in performance between each pair of conditions. These results are shown in Table 4 and Figure 5, and indicated that the scores obtained in the HA+CC and CC conditions were significantly higher than scores obtained in the BSLN and HA conditions, for all programs. There were no differences in scores obtained in the HA+CC vs. CC conditions across programs. Similarly, there were no significant differences in the scores measured between the BSLN and HA conditions for all three program types.

Examination of the paired comparison results indicated that a possible source of the interaction effect was the magnitude of the difference in scores measured in the CC vs. HA only conditions. For both drama and news programming, these differences were highly significant at the $p<.001$ level, whereas for the game show, this difference was significant only at the $p<.05$ level. This notion was supported by additional post-hoc testing with the Scheffe multiple comparison testing. Please see Table 4 for detailed significance values for each condition comparison within each program type.

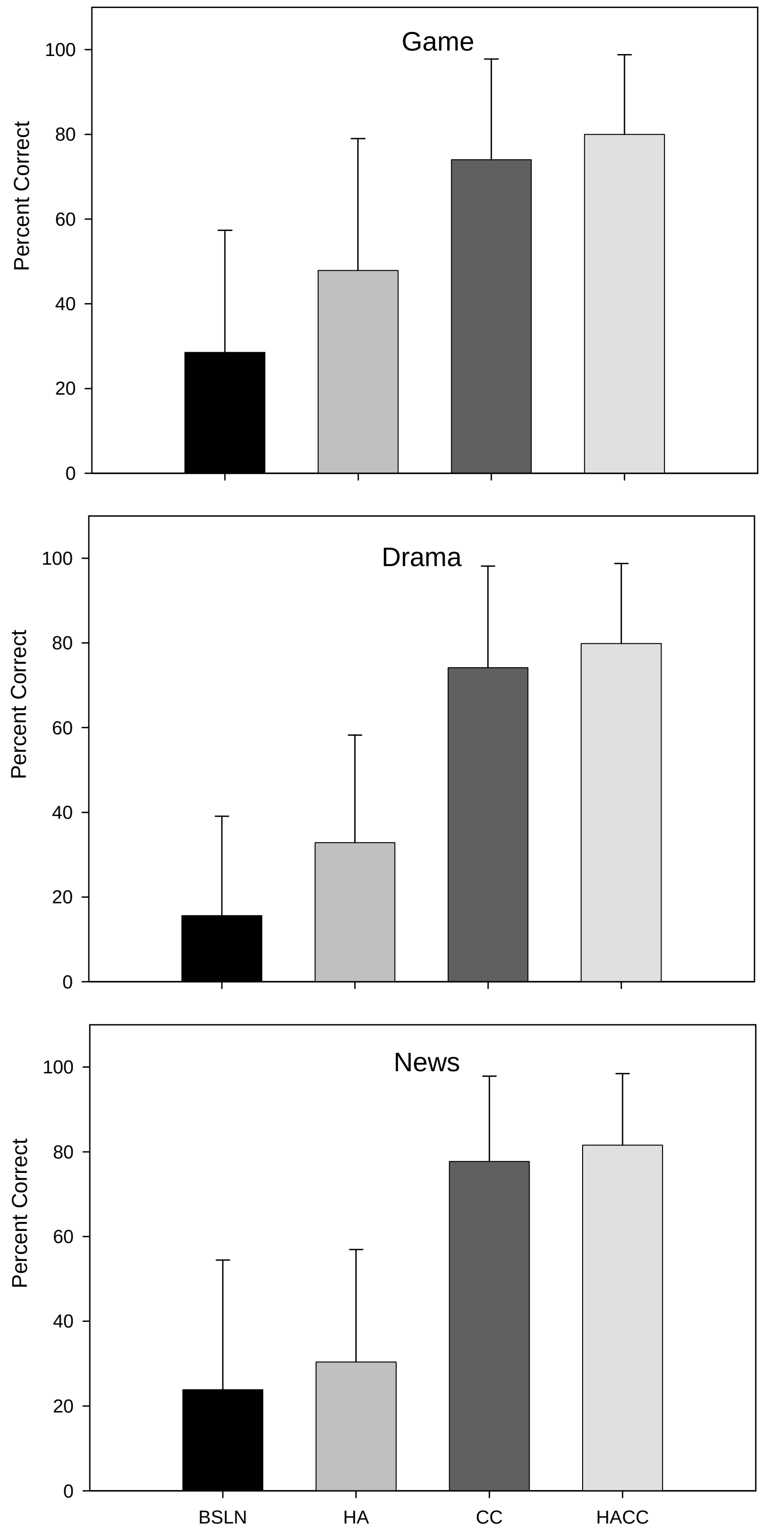


Figure 5. Percent correct scores of older listeners in four listening/viewing conditions, for three program types.

Table 4

Comparison of Significance Values for each Program Type and Condition

Condition Comparisons		Program Types		
		Game	Drama	News
BSLN	HA	.225	.300	1.00
	CC	.000**	.000**	.000**
	HA+CC	.000**	.000**	.000**
HA	BSLN	.225	.300	1.00
	CC	.040*	.000**	.000**
	HA+CC	.008*	.000**	.000**
CC	BSLN	.000**	.000**	.000**
	HA	.040*	.000**	.000**
	HA+CC	1.00	1.00	1.00
HA+CC	BSLN	.000**	.000**	.000**
	HA	.008*	.000**	.000**
	CC	1.00	1.00	1.00

* = p<.05, ** = p<.01, BSLN = baseline condition (no closed captioning or amplification), HA = hearing aid condition (hearing aids used, no closed captioning), CC = closed captioning condition (closed captions, no hearing aid use), HA+CC = hearing aids and closed captioning condition (hearing aids used and closed captioning activated)

The Scheffe post-hoc testing indicated that scores obtained during the CC condition were not significantly different from those obtained in the HA condition, for game show programming only. In other words, there did not appear to be a significant difference in scores when closed captioning was used alone, compared to the use of hearing aids, although scores measured with CC alone were significantly higher than scores measure in the BSLN condition. These results differ from those obtained for the game show programming using Bonferroni post-hoc analyses, and may have contributed to the interaction effect shown in repeated measures testing.

For all programming types, post-hoc testing (both Scheffe and Bonferroni) showed that performance in the baseline and HA conditions was not significantly different. In other words, these results indicated that use of hearing aids during television viewing did not significantly increase participants' ability to understand televised programming.

A secondary hypothesis was that different program types might produce significantly different word recognition scores. Simple main effects analyses were performed to investigate the main effect of program for each listening/viewing condition. Figure 6 presents the mean performance data for the three program types. These analyses indicated no significant differences between word recognition scores for the different types of programming [BSLN: $F(2,42) = .78$, $p > .05$; HA: $F(2, 42) = 1.45$, $p > .05$; CC: $F(2,42) = .01$, $p > .05$; HA+CC: $F(2, 42) = .01$, $p > .05$]. Multiple comparison tests also showed no significant differences between the program types for each condition ($p > .05$ for all program type comparisons within each condition).

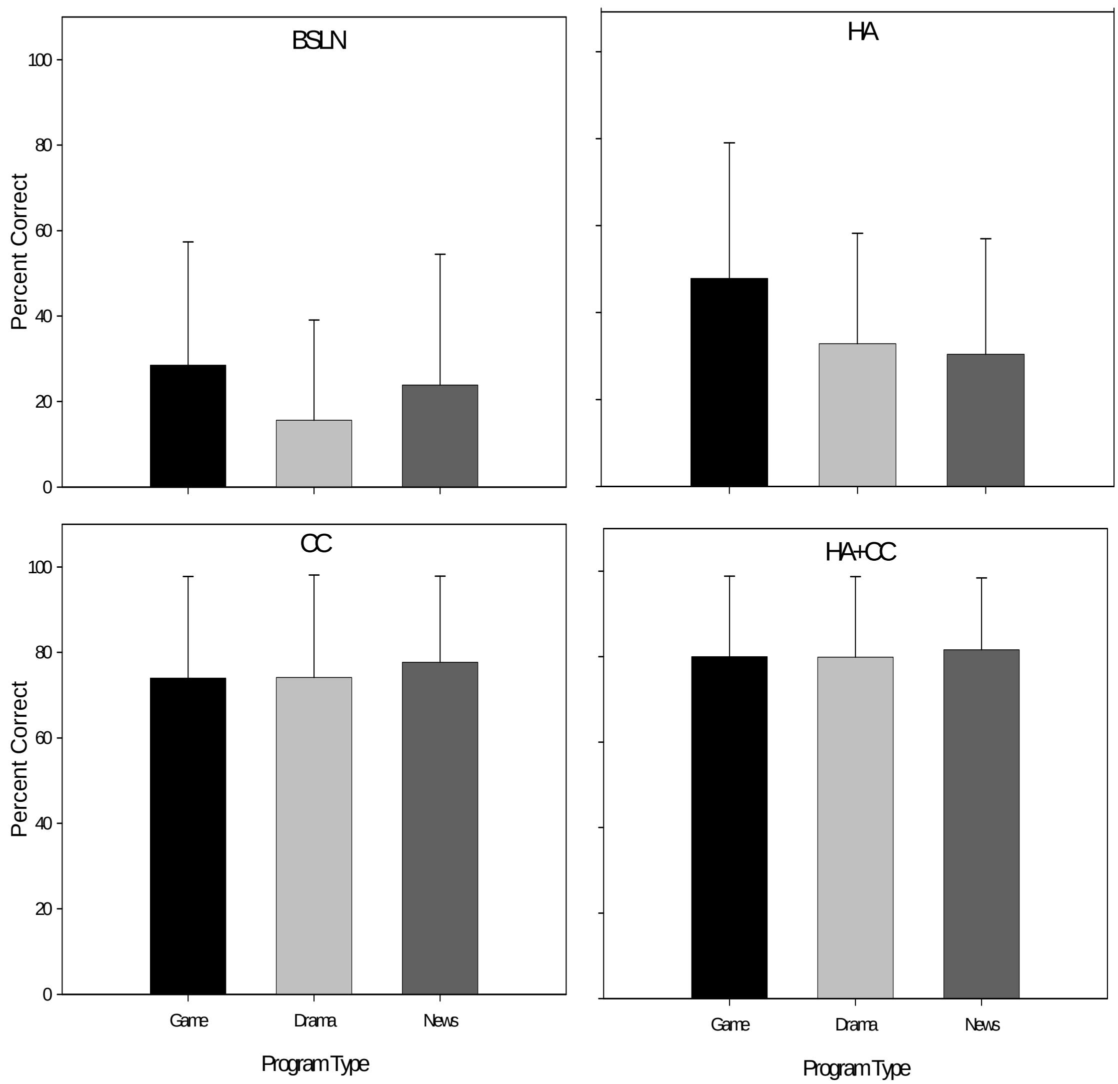


Figure 6. Percent correct scores of listeners for three different program types, in four different listening/viewing conditions.

Additional Analyses

It was also hypothesized that word recognition scores might be correlated with the following variables: a) the amount of time spent watching television, b) the frequency of hearing aid use while watching television, and c) the frequency of closed caption use when watching television. Bivariate correlation analyses of the amount of television viewed and performance in each condition are shown in Table 5. None of the correlations were significant, indicating that hours of television use were not related to word recognition scores in the various conditions.

Figure 7 shows the frequency of hearing aid use among participants. Fourteen participants, or approximately 63%, reported “always” using their hearing aids when watching television, while 3 participants (14%) reported “usually” using their hearing aids, 3 (14%) reported “sometimes” using their hearing aids, and 2 (9%) reported “never” using their hearing aids when watching television. It is evident that, in this random sample of participants, well over half of participants who owned hearing aids reported wearing them when they watch the television.

Figure 8 shows the frequency of closed caption use among participants. Four participants (18%) noted “always” using the closed captioning when watching television, while one (5%) reported “sometimes” using the captioning, and 17 participants (77%) reported “never” using the captioning when watching television. No participants reported using the captions “usually” when watching television.

Table 5

Correlation Between Hours of Television Viewing and Condition/Program

Condition/Program	Correlation Coefficients (r, *p* values)
BSLN Game	r = -.408, *p*>.05
BSLN Drama	r = -.323, *p*>.05
BSLN News	r = -.409, *p*>.05
HA Game	r = -.422, *p*>.05
HA Drama	r = -.381, *p*>.05
HA News	r = -.432, *p*>.05
CC Game	r = -.162, *p*>.05
CC Drama	r = -.227, *p*>.05
CC News	r = -.245, *p*>.05
HA+CC Game	r = -.033, *p*>.05
HA+CC Drama	r = -.190, *p*>.05
HA+CC News	r = -.210, *p*>.05

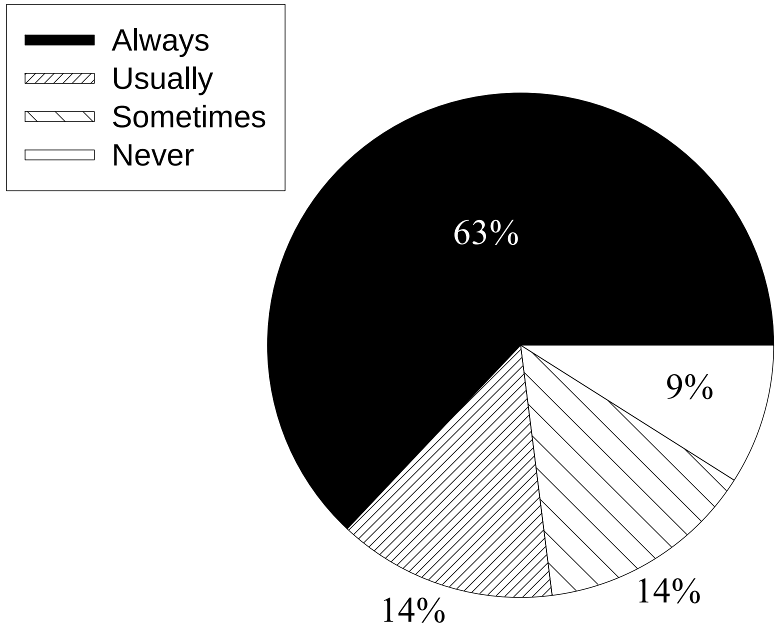


Figure 7. Frequency of participants' self-reported hearing aid use while watching television. Data from 22 participants.

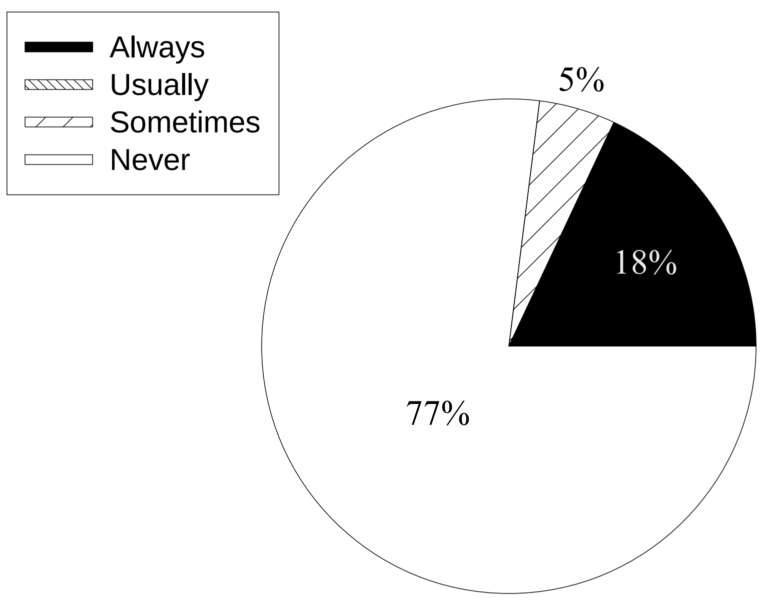


Figure 8. Frequency of participants' self-reported closed caption use while watching television. Data from 22 participants.

Anecdotally, all of the participants who reported utilizing closed captioning had very positive things to say about their experiences with closed captioning. Because most participants reported using their hearing aids when watching television and most reported never using the closed captions, the data were too skewed to conduct meaningful correlation analyses of the relationships between hours of television use or CC use and word recognition scores in the various experimental conditions.

Multiple regression analyses were conducted to determine the amount of variance that could be accounted for by different factors, such as performance on aided NU-6, age, and high frequency (1, 2, and 4 k Hz) pure-tone average (PTA) in the better and poorer ear, in relation to scores in the HA condition. For game scores in the HA condition, 86.6% of the variance was accounted for by aided NU-6 scores, and participant age accounted for an additional 6% of the variance. Together, aided NU-6 score and age accounted for 92.8% of the variance for game show programming in the HA condition. Additionally, 66.6% of the variance for the drama programming, and 55.5% of the variance for the news programming in the HA condition was accounted for by aided NU-6 scores. None of the other examined variables (i.e., age, high frequency PTA) accounted for additional variance in the drama and news programming. Therefore, 33.4% of the variance in drama programming, and 44.5% of the variance in news programming was unaccounted.

Chapter 6: Discussion

Performance with Hearing Aids

Perhaps the most striking finding from this study was that the performance of the older adults did not improve significantly with the use of hearing aids over performance in the baseline condition. In the study by Walden et al. (2001) reviewed in the Literature Review, the researchers found that amplified speech and its combined use with visual speechreading cues provided benefit to listeners. Indeed, amplification alone resulted in higher consonant recognition compared to the baseline condition in which no assistive devices were utilized (Walden et al., 2001). Even without amplification, listeners (both normal hearing and hearing-impaired) have been shown to perform better with a combination of audition and speechreading (Grant & Walden, 1996; Grant & Seitz, 1998; Grant, et al., 1998; Sommers et al., 2005; Walden et al., 2001). Therefore, it would be expected that the addition of amplification in the HA condition of the current study would yield higher word recognition scores compared to the baseline condition; however, this was not the case.

For the baseline condition, percent correct scores were 29%, 16%, and 24% for game, drama, and news programming, respectively, for an overall average of 23%. This level of performance is obviously quite poor and indicates that without any assistive listening device, elderly people with hearing impairment understand a very small portion of a spoken televised message. Though there appeared to be improvement with hearing aids, such that scores were 48%, 33%, and 30% for game, drama, and news, respectively (37% average of the three), this improvement was not statistically significant. This lack of significance may be related to several factors, including differences between the stimulus used in this study compared to stimuli used in previous studies, large between-subject variability, methodological constraints, and/or age-related deficits in auditory processing and/or cognitive abilities.

The stimulus material used in this study differ considerably from materials used in previous studies, particularly since the stimulus material for this study was adapted from a real-world stimulus, television. The stimulus materials for many of the studies on audition and speechreading were individual consonants, words, or sentences, usually spoken by one talker, with their head and neck always on-camera and good on-camera lighting. Therefore, the visual speechreading stimuli for these studies was consistent and favorable for good speechreading. However, the televised stimulus materials for the current study did not have consistent speechreading cues, which may have contributed to the inability of participants to integrate auditory and speechreading cues in the HA condition. Hence, HA scores were not significantly different from scores in the baseline condition. In addition, the speed of the sentences used in this study was quite fast, and varied from one speaker to another.

Sommers (1997) indicated that older adults have difficulty adapting to changes in stimuli (i.e., different talkers and speech rates), referred to as perceptual normalization. In the current study, stimulus materials consisted of different talkers, both in terms of gender, and individuality. In other words, while each sentence was only spoken by one talker at a time, and amplitude was normalized across the sentences; multiple talkers of both male and female gender comprised the stimulus sentences. These talkers also varied in terms of their rate of speech and dialect, therefore comprising an extremely variable stimulus set. Perceptual normalization difficulties that older adults experience may have contributed therefore, to the poor performance observed by older listeners in the HA condition.

Additionally, some limitations of the current study may have contributed to the variability in scores between participants in the hearing aid condition. In particular, four participants obtained word recognition scores greater than 50% correct for at least two of the three programming types in the baseline condition. All other participants scored well below 50% correct for all three program types in the baseline condition. Therefore, scores from participants who achieved greater than 50% correct may have added to between-subject variability. A larger sample size and/or more stringent hearing loss criteria may yield different results, specifically, significantly higher scores with hearing aids alone than a baseline condition.

It is also unknown whether the participants' hearing aids in this study were properly fit to their hearing losses. Listening checks and electroacoustic analyses were performed to ensure appropriateness of amplification; however, because participants were fit at multiple hearing centers, and by multiple clinicians, appropriateness of hearing aid fit may have varied.

The level of performance with hearing aids for watching television was lower than aided word recognition in quiet, as measured during the audiological assessment. The mean performance of participants, while using hearing aids, on the NU-6 word lists presented in the soundfield without competing noise, was 56%, whereas average performance of participants for all program types in the HA only condition was 37%. Considering the fact that some visual cues were present due to the nature of television programming, this observation is quite intriguing. It suggests that television viewing presents an extra level of speech degradation, for which hearing aid use alone cannot compensate. This may be due to the fact that televised speech is presented at a fast rate (Uglova & Shevchenko, 2005; Wingfield & Tun, 2001), and that fast rates of speech, or time-compressed speech, are difficult for older adults to process with a high level of accuracy (Gordon-Salant & Fitzgibbons, 1993, 1995).

As stated in the Results section, multiple regression analyses were conducted to determine what factors may have contributed to the variance in listener performance in the HA condition. These results indicated that for all three programming types, aided scores on the NU-6 accounted for greater than 50% of the variance in scores. Therefore, some of the variability in the HA condition could be contributed to participants' performance on the aided NU-6. Additionally, for the game show programming, age also contributed significantly to the variance. However, there are still unknown factors affecting the variance and these factors may include age-related changes in functions not tested during this experiment, such as working memory and executive function.

Working memory essentially involves the storage and processing of information. Older adults perform more poorly on complex memory tasks, like the tasks in this study, than do younger adults, for both audition and reading (Kemper & Liu, 2007; McDowd & Birren, 1990; Wingfield et al., 2006). The task in the HA condition represents a complex memory task because older adults are required to process a rapid speech stimulus, hold this information in memory, and then write it down. Additionally, the televised information received by listeners is incomplete due to auditory distortions created by their hearing loss, minimal contextual cues, and variation in speaker. Working memory was involved, such that for the HA condition, the participant would need to hold the information heard through the auditory system in memory, while obtaining and utilizing any available contextual or speechreading cues to fill in the gaps where information was missed in the auditory input.

Another aspect of cognitive decline that may have contributed to poor performance of the elderly listeners in the HA condition is executive function. Executive function involves the ability to divide attention among different stimuli, switch attention to monitor different sources of information, and effectively sort out irrelevant information. Older adults have been shown to experience difficulty with all of these tasks, particularly dividing attention and sorting out relevant from irrelevant information (Kemper & McDowd, 2006; Kemper, Herman, & Lian, 2003; McDowd & Birren, 1990). In the HA condition, all of these executive functions are taxed. For example, participants must divide their attention between the auditory input they are receiving and the visual input from the television screen, while at the same time switching their attention to intake information from one source to the other. Additionally, irrelevant information on the television screen, such as identifying information for the newscasters or changes in the camera angle from the person speaking to another person or object, must be sorted out from the relevant auditory information.

Performance with Closed Captioning

Older Adults

Older listeners demonstrated significantly higher word recognition scores in the CC and HA+CC conditions compared to HA alone, or the BSLN condition. The mean percent correct scores for the different programs presented with closed captioning were 74% for game and drama programming, and 77% for news programming, for an average of 75%. For closed captioning plus hearing aids, the mean percent correct scores were 80% for game and drama programming, and 82% for news programming, yielding an average of 81%. Although there appeared to be some improvement in scores from the CC to HA+CC conditions, this improvement was not statistically significant. Recall that overall percent correct scores for the BSLN and HA conditions were 23% and 37% respectively. Clearly the 75% and 81% achieved in the CC and HA+CC conditions respectively show that older adults performed significantly better when closed captioning was available. This may be due to differences in bottom-up versus top-down processing and/or inherent advantages of the closed captioning signal.

Top-down processing is the process by which information is interpreted based on prior knowledge and ideas, or conceptions or expectations a person has regarding the information. Bottom-up processing, on the other hand, involves obtaining perceptual information and processing it at higher and higher levels of cognition. Bottom-up processing is, therefore, reliant on accurate processing of the incoming information. In the current study, bottom-up processing was involved in interpreting the audio signal, which, due to hearing loss, was distorted, whereas when the closed captioning was available, more top-down resources could be relied upon to help interpret the information because this signal represented an unambiguous and consistent signal. In other words, it was not affected by the participants' hearing impairments, therefore overcoming limitations created by distortion of the auditory signal, and thereby enhancing the auditory signal. Additionally, the visual text signal provided more information than the speechreading signal, because the visual text signal was not limited by the inconsistency of speechreading cues.

However, although the visual text signal presented by the closed captions was consistent and unambiguous, it may not fully convey important emotive information available through audition, and if focused on too stringently, may take away from a person's ability to watch the television show. Therefore, a combination of all the inputs available (audition, speechreading, and text) is needed, and results, although not indicating a significant difference, were better (81%) with HA+CC compared to CC alone (75%).

Given the consistency of the closed caption signal and its clear representation of the stimulus, it is curious that performance with closed captioning was not 100%. The speed with which some sentences appeared on screen may have been too fast for older viewers to process the information. Studies have shown that older readers process text, particularly complex text, at a slower rate than younger readers (Kemper & Liu, 2007; Smiler, Gagne, & Stine-Morrow, 2003). Additionally, older adults have difficulty focusing on relevant information when irrelevant information is present, which is hypothesized by some as a reduced ability to inhibit irrelevant information (Kemper & McDowd, 2006; Kemper et al., 2003; McDowd & Birren, 1990). While the closed captioning was consistent and unambiguous, the televised picture was not. It may be that the televised picture, which contains varied and ever-changing visual information, could actually impede correct identification of the closed captioning by making it more difficult for older adults to parse relevant from irrelevant information, particularly since these stimuli were very short in duration. Additionally, the presence of three inputs (auditory, visual-speechreading, and visual-closed captioning) may have placed a cognitive load on older adults such that these inputs could not be adequately integrated. It may also be that difficulties with perceptual normalization of the auditory input influenced older viewers' ability to adjust to the next talker despite the presence of closed captioning.

Previous research has shown that, in addition to older adults with hearing loss, older adults with normal hearing have difficulty processing degraded speech, such as time-compressed speech (Gordon-Salant & Fitzgibbons, 1993, 1995). This suggests that older adults with normal hearing may benefit from viewing television with CC as well, although these participants were not evaluated in the current investigation. Clearly, closed captioning did make a difference in the viewing experience for older adults with hearing loss by significantly improving their ability to gain information about the programming over performance with hearing aids alone.

Younger Adults

Mean percent correct scores for the young normal-hearing listeners while viewing sentence lists without closed captioning was 92% (range 86%-98%), for all of the different programming types, verifying that these stimuli are highly intelligible for young people without hearing loss. Even with hearing aids, older adults understood much less of the programming than the younger adults with normal hearing (30-48%). Mean performance for the young normal-hearing listeners with closed captioning was 98% (range 95%-100%). The lists presented with closed captioning yielded consistently high percent correct scores from the young normal hearing listeners; therefore, there were no outlying data for this task. However, for the task of listening without closed captioning, while it would be expected from audiological data that scores would be in the 90-100% range, this was not always the case; however, no noticeable outliers were observed. It was observed though, that for each list presented without closed captioning, at least one person (although not the same person consistently) scored in the 80% range, which may have influenced results for this task.

Percent correct scores for the young normal hearing listeners were higher (98%) with the addition of closed captioning, compared to performance without closed captioning (92%). This result was expected, given that performance without closed captioning was not 100%, and indicates that even young normal hearing listeners can take advantage of the visual text signal provided by closed captioning.

Effect of Television Program Type on Speech Recognition Performance While Viewing Television

A second hypothesis was that speech recognition scores of elderly hearing aid users would be significantly different for different television programs. It was originally thought that drama programming may result in significantly lower word recognition scores due to the nature of the programming, i.e., speakers usually are not facing the camera, or the lighting is dark, making speechreading difficult. In addition, some speakers do not always talk clearly or enunciate, and the rate of speech appears to be relatively fast compared to game show and news programming. Game show and news programming were expected to be easier due to the presence of more visual cues, particularly with game show programming (score boards). Additionally, the talkers remain more constant and tend to face the camera often, making it relatively easy to utilize speechreading cues. Although statistical analyses revealed a significant main effect of program type and a significant interaction between program type and listening/viewing condition, post-hoc analyses with Bonferroni correction failed to reveal a significant effect of program type for any of the listening/viewing conditions. Examination of mean data suggests that in the BSLN and HA conditions, performance for the game programming appears to be higher than performance of the other two programs. That this difference failed to reach significance may be associated with substantial inter-subject variability in scores.

It may be that the statistical power of the current study was not sufficient to show an actual difference. Additional testing with a larger number of participants or stimuli may reveal some difference in program type. In addition, there was considerable variability in the data, which may have obscured possible differences between the programs. Mean differences appeared to be substantial, but did not reach statistical significance, perhaps because of considerable between-subject variability. No other reports regarding differences in understanding of different program types have been found. This is the first report indicating no significant differences in intelligibility across different program types.

The implication of the present findings, particularly in the baseline and hearing aid conditions, is that different television programs do not differ significantly in their intelligibility. It appears that televised programming, which involves multiple talkers, a fast rate of speech, and poor speechreading cues, is generally a difficult medium for older adults to obtain information, regardless of program type. For the CC only and HA+CC conditions, the observation of no differences in performance scores for the different program types is most likely related to the addition of the closed caption technology. At least for this controlled study, closed captioning technology was free of the variability found in speech presented through televised programming, and therefore may be an easier method for obtaining information.

Factors Contributing to Television/Viewing Speech Recognition

While the main analyses provided clear evidence that listeners exhibited significantly different performance in the various listening/viewing conditions, it is possible that other factors contributed to these differences. To that end, correlation analyses were also performed to determine whether hours of time spent watching television correlated significantly with word recognition scores. It was hypothesized that no significant correlation would be found between hours of television use and word recognition score, and that no significant correlation would exist between frequency of hearing aid/closed caption use and word recognition scores. Data analyses revealed no significant correlation between hours of television viewing and word recognition score, suggesting that increased television viewing does not predispose older adults to greater understanding of televised programming. Additionally, the factors of frequency of hearing aid use and use of CC were considered as possible variables that could influence performance. However, the vast majority of participants reported using hearing aids most of the time when watching television. Thus, there was not sufficient variation in this factor to permit a meaningful correlation analysis. For frequency of CC use, 77% of participants reported never using the closed captions. This finding underscores the original premise for this study, that older people with hearing loss rarely use CC, despite its apparent benefit for understanding television. This lack of variability also did not permit a meaningful correlation analysis.

Television Viewing Habits

In addition to the data collected regarding time spent viewing television, participants were also asked to rank their television programming preferences from a list of 12 possible programming choices. Although these data were not analyzed statistically, they provide additional information about the television viewing preferences of older adults. Questionnaire information was gathered for all participants, even those with conductive components to their hearing loss, and therefore results from this information were evaluated for all 22 participants. The average amount of time spent watching television, was 4.34 hours per day (SD = 1.9, range = 2-8). This is consistent with previous reports of 3-5 hours of television viewing per day as mentioned in the literature review (Davis, 1971, Davis et al., 1976, Rubin & Rubin, 1982, 1983, 1984). Local news was listed by the greatest number of participants as their number one or number two program preference, followed by national news. This finding is also in agreement with previous researchers' results (Davis et al., 1976, Fouts, 1989).

Older adults, even those with normal hearing sensitivity, have difficulty understanding time-compressed speech (Gordon-Salant & Fitzgibbons, 1993, 1995).

Televised speech is presented at a much faster rate than that of normal conversational speech (Uglova & Schevchenko, 2005; Wingfield & Tun, 2001). It is clear that the effects of hearing loss among older people (i.e., reduction in the intensity of sounds, distortion of sound), and the difficulty older adults experience with time-compressed speech, render television viewing quite difficult for older people without any assistive technology. These problems in understanding televised messages cannot be fully overcome by hearing aids alone. The level of performance with closed captioning alone was 75% (averaged across all three program types). For HA+CC, the level of performance was 81%. When compared to baseline and hearing aid alone, whose levels of performance were 23% and 37%, respectively, the benefit of closed captioning is truly remarkable. Closed captioning, which relies on visual-textual, rather than auditory information, provides considerably more information about the spoken message than can be received using unamplified listening or hearing aids alone. The average percent correct score obtained with CC (average of percent correct scores for CC alone and HA+CC) was 78%, suggesting that use of CC is a powerful technique to overcome the limitations of age-related hearing loss. However, as previously discussed, closed captioning cannot convey the emotional content of a spoken message, and/or may be distracting for some people; therefore, combined use of closed captioning and amplification could be used by older adults to extract all of the different kinds of information present in a televised message.

The group tested for this study was already at a disadvantage for understanding televised speech because of their hearing loss. Vision problems were, for the most part, corrected, and as previously stated, practice sentences were utilized to ensure the captions could be adequately seen and read. It could be argued then that vision was the stronger of the two senses for these participants. A further assessment of the hypothesized predominance of the visual modality in older listeners would entail testing a group of older adults with normal hearing and corrected vision to determine if they achieved higher word recognition scores with closed captioning compared to a baseline condition. One would hypothesize that if the benefit of closed captioning is universal, these older adults would also perform significantly better with closed captioning than without the use of closed captioning.

Limitations of Study

Some limitations of the current research include the sample size, use of a new measurement tool, and variability introduced by that tool. The sample size was small, with data collected from only 15 participants used in the final analyses. This limits the statistical power of the study and makes it difficult to generalize these findings to a larger population. Future studies should attempt to test at least 20 participants, use more stringent hearing loss criteria, and ensure participants' hearing loss is attributable to age alone. These selection variables may be useful in reducing between-subject variability.

Some variability was introduced by the use of the DVD for this project. While the sentence lists within each type of programming were found to be equivalent to each other, all lists were not tested against one another. This was done purposefully, with the hope that sentence lists within each program type would be representative only of that program type and would therefore provide a more real-world comparison of the different program types. However, sentences within program types were not evaluated to determine whether they were representative of programming for that particular program type. In other words, while efforts were made to pick sentences with an appropriate number of scoreable and non-scoreable words, and to ensure equal numbers of male/female talkers, no attempt was made to ensure that sentence lists within the programming types represented the proportion of types of shots (i.e., full-face, side view, speaker not in view of the camera) that actually occur during the show. For example, news and game show lists may not have had full-face shots in proportion to the amount of time this occurs during those shows.

Additionally, the sentences were presented in isolation and out of context, and this is not the way in which people typically view television. Typically, listeners viewing television are able to glean information from context and do not view only one sentence at a time; therefore this was a novel task for listeners. An alternative approach would be to have listeners view a longer portion of televised material and answer questions regarding their comprehension of that material. However, this technique has disadvantages as well, particularly that it might place excessive memory demands on older adults, who have been shown to experience difficulty recalling specific information from sentences, even when asked to read text for later recall (Stine-Morrow, Shake, Miles, & Noh, 2006).

Another concern is that the closed captions used in this experiment were not actual closed captions from the shows, but rather were made by the researchers to imitate closed captions. Although attempts were made to closely mimic true closed captions, there are differences in the size of both text and background, and duration on the screen for the closed captions used in this experiment compared to closed captions from actual programs. This was done because a method of preserving the closed captions during the video editing process was not available. However, newer methods to preserve CC are now available when editing video; hence, future research into this field could utilize actual closed captions from television programs.

Practical Implications

Although no previous studies have included direct investigation of older adults' performance without hearing aids and with hearing aids when watching television, surveys have been conducted to assess perceived benefit. As discussed previously, adults with hearing impairment report listening to/watching television, both alone and with significant others, as a major problem area prior to hearing aid use (Barcham & Stephens, 1980; Gatehouse, 1999; Stephens et al., 2000; Stephens et al., 2001). Additionally, the significant others of persons with hearing impairment also report listening to/watching television as a problem area prior to hearing aid use (Brooks et al., 2001; Stark & Hickson, 2004; Stephens et al., 1995). While some hearing aid users perceive benefit from the use of hearing aids when watching television, others do not, and report dissatisfaction with their hearing aids when watching television (Kochkin, 2000; Tyler et al., 1983). The current data confirm these self-reports of hearing aid users regarding the limited benefit of hearing aids during television viewing, by convincingly demonstrating that objective speech recognition scores of hearing aid users are poor (< 50% correct) when watching television with hearing aids. Although use of hearing aids may improve scores somewhat over unaided scores, this improvement was not significant.

The most beneficial assistive device in this study was closed captioning. Percent correct scores for the HA+CC and CC conditions were significantly higher than those for either BSLN or HA alone for all three programming types. No previous research has investigated the advantage of closed captioning for elderly hearing aid users. One study (Freeburg & Leavitt as reported in Ball, 1988) addressed the use of closed captioning for older adults in an institutionalized setting, and found that the use of closed captioning resulted in improved access to television as reported by Activity Directors, but this study did not directly assess older adults' performance with closed captioning. The current data confirm the subjective opinion of the Activity Directors, with objectively assessed information.

The fact that percent correct scores obtained with HA+CC and CC do not differ significantly has important practical implications for the geriatric population and those who serve them. Because closed captioning provided assistance to older adults with hearing impairment regardless of whether hearing aids were used, it has the potential to be an excellent assistive device for older adults, particularly those who may not be able to afford hearing aids, or who are not ready for hearing aid purchase. The prevalence of hearing loss in the geriatric population is high, and most persons with hearing loss wait several years before obtaining assistance for their hearing loss. Additionally, the aging population in the United States is growing, such that reports estimate that the older population will be approximately 40 million by the year 2010, and 55 million by the year 2020 (Administration on Aging, 2005). As this population grows, it will be incumbent upon primary care physicians, geriatricians, and audiologists to alert patients to use assistive devices that may be beneficial to them, particularly when those assistive devices are readily available at no cost. Even for older adults who may have difficulty accessing the closed captions themselves, another family member or friend could program the person's television so that it shows the captions. For many television sets, the captions will continue to display unless they are turned off.

Future Directions and Summary

The data clearly show that the use of CC results in significantly higher word recognition performance than use of hearing aids alone. Factors such as hours of television watching, frequency of hearing aid use, or frequency of CC use do not appear to influence these data, as the participants were reasonably similar in these characteristics. These findings suggest that the investigation of the benefits and limitations of CC use for hearing-impaired listeners is a fruitful area of research. Future directions for research are numerous, and include obtaining updated information regarding older adults' television viewing habits and preferences, as well as more information regarding the rate of televised speech for different programming types that is most beneficial for elderly viewers. Regional differences may also exist in the rate of speech in television programs, and hence, performance of older listeners may also vary regionally.

The research presented in this report suggests that one type of assistive device, closed captioning, is beneficial for older hearing-impaired adults while watching television, in that it results in significantly higher word recognition for televised programming. Other research should assess the benefit of closed captioning for elderly normal-hearing adults. This benefit could be evaluated in quiet, competing noise, reverberation, and/or both. Due to the difficulties older adults have in processing degraded speech signals, it may be that older adults with normal hearing would experience benefit from the use of closed captioning during television viewing.

Additionally, for older adults with hearing loss, the benefit of closed captioning compared to other assistive listening devices, such as FM, loop induction, or infrared listening systems could be assessed. Some of these devices work separately from a person's hearing aids (e.g., some infrared devices), while others can work in conjunction with a person's hearing aids (e.g., FM system, loop system). It may be that the use of additional assistive devices would result in higher word recognition scores compared to closed captioning used alone, because these devices directly amplify the target televised signal, whereas hearing aids amplify all incoming signals including background noise. These devices could be compared with hearing aids as well as closed captioning, to determine if there are other combinations of assistive devices (e.g., closed captioning and FM) that result in higher word recognition than the use of either device alone. Comparisons could also be made between different types of hearing aid technology, such as programmable versus digital, as well as performance of different hearing aid listening programs. These comparisons could be evaluated for data collected in quiet, competing noise, and/or reverberation.

The benefits of closed captioning for adults in assistive living environments could also be assessed. Assessments could be made of participant understanding in different, degraded listening environments, such as with background noise, reverberation, and/or both. Adults living in nursing home facilities made up 4.5% of the population over 65 years of age in 2000, according to the Administration on Aging's Profile of Older Americans (2005). This number increased with age, with 18.2% of persons 85 years or older living in nursing home facilities. Additionally, about 5% of elderly persons lived in assistive living environments, which provide some level of support to residents. It is likely that background noise levels in the common rooms of such residences are louder than those found in the homes of individual elderly persons. Therefore, the availability of closed captioning is even more important, as this technology is not affected by noise, reverberation, or other characteristics which degrade speech signals.

In addition, research could be conducted regarding the type of closed captions that are most easily recognizable by older adults. For instance, investigation into the size of closed caption lettering, background color and size, and type of presentation (i.e., rolling captions or pop-on captions) could be conducted to determine which font size, background, and type produces the greatest comprehension by adults. This information could be analyzed for adults in different age groups, to determine if there are age differences in the most adequate captions. Additionally, since the current study did not use actual closed captions from television programs, these could be used as stimuli to determine whether results are the same for actual closed caption stimuli.

The stimulus sentences utilized in this study could also be re-made, so that they are more representative of actual television programming. Samples of different types of television programs could be taken, and analyzed for the amount of time speakers are on-camera, on-camera movement, and lighting characteristics, and new stimulus sentences could be created which closely represent these properties.

Differences in different program types might emerge if stimulus sentences were more representative of the characteristics of those program types.

Additionally, cognitive tasks could be completed by participants to investigate whether a correlation exists between performance on word recognition tasks in different listening/viewing conditions and performance on different cognitive measures of selective and divided attention, and working memory. It has been previously stated that the closed captioning may have resulted in top-down processing, and this could also be evaluated in future research by using eye-tracking technology.

Theoretically, if the closed captioning is more of a bottom-up process, then the eyes would have to fixate on all words in a sentence, whereas if comprehension of closed captioning is achieved primarily through top-down processes, then words could be skipped and guessed at using hypotheses based on prior lexical and world knowledge (Treiman, 2001). Treiman (2001) in a meta-analysis of literature on top-down and bottom-up processes in reading noted that results of eye-tracking have suggested that both top-down and bottom-up processes are at work in reading tasks, such that readers fixate on all words in a sentence (bottom-up), but spend less time fixating on words that are predicable from sentence context (top-down).

In addition to further investigation of the benefits of closed captioning for older adults, an investigation into whether the benefits of closed captioning increase with increased use could be conducted by comparing older adults who rarely or never use closed captioning to cochlear implant users. Cochlear implant users, even older cochlear implant users, have been said to frequently use closed captioning to supplement the electrical signal received through their devices, and may therefore, represent a good comparison group to investigate benefits of continued caption use. Additionally, eye-tracking technology could be used to examine whether experienced closed caption users are reading the captions, or also paying attention to the televised picture. Jensema, Danturthi, and Burch (2000) in a study on eye movements of closed caption viewers, did find that viewers watched the captions 84% of the time, and the video picture 14% of the time. However, this study was conducted with deaf listeners and no auditory signal, therefore it may be that combined use of two inputs would result in a lower amount of time spent watching the captions for users obtaining information from both inputs.

In summary, the results of this study indicated that hearing aid use did not provide significant improvement compared to a baseline condition. Closed captioning however, did result in improved word recognition for older adults with varying degrees of hearing impairment. However, most older adults (77%) indicated they never utilize closed captioning technology. This technology has the potential to improve enjoyment of television dramatically for older adults. Because the aging population is growing, primary care physicians, geriatricians, and audiologists need to be aware of simple assistive tools such as closed captioning that could greatly enhance their patient's quality of life without adding extra financial strain to these individuals. Closed captioning appears to be an excellent way to provide a low-cost, high-quality assistive tool to older adults when watching television, which may ultimately improve quality of life for older persons.

Appendix A

University of Maryland Department of Speech and Hearing
College Park, Maryland 20742

[Insert Date]

Dear [Insert Audiologist/Hearing Instrument Specialist's Name] OR,
To Whom It May Concern:

My name is Julia Callahan and I am an audiology intern at The University of Alabama at Birmingham and am completing graduate studies through the University of Maryland-College Park for my Au.D. I am conducting research for my dissertation on the benefits of closed captioning for older adults who use hearing aids, and would like to invite you to contribute to this study by providing referrals of potential participants. My only means for obtaining participants is through referral; therefore, your assistance in this matter would be greatly appreciated.

I have included a brief review of the study procedure, a list of criteria that potential participants must meet, a copy of a letter to potential participants that you may give to your patients who meet the criteria, and a copy of a flyer you may post in your clinic.

The study involves a one-time visit of approximately two hours (including breaks) to the University of Alabama at Birmingham's Spain Rehabilitation Center. The study procedure involves viewing three different types of television programming (news, drama, and game show) in four different viewing conditions and completing a short questionnaire regarding television viewing habits and preferences. The purposes of this study are (1) to determine which combination of assistive devices provides the greatest amount of television comprehension across four different viewing conditions; and (2) to determine whether one type of programming results in a greater amount of comprehension across viewing conditions. Participants will be reimbursed for their time at a rate of $10 per hour.

Enclosed is the list of criteria that participants must meet in order to be included in the study. If any of your patients meet all of the criteria, I would greatly appreciate it if you would supply them with a potential participant letter (also enclosed). I have also enclosed a copy of a flyer that you may post in your clinic.

I appreciate the time you have taken to read this information, and I will contact you by phone in one week to discuss the opportunity to contribute to this research, and answer any further questions you may have regarding the study. Please feel free to contact me before that time using the information listed below, if you would like to discuss this opportunity, and/or request more copies of the enclosed information.

Sincerely,

Julia Callahan
Doctor of Audiology Student
The University of Maryland
Sparks Clinics Audiology Trainee
Birmingham, Alabama

Contact Information:
2004 Molton Ct. Apt. 1
Vestavia, AL 35216
(205) 934-0658
jcallahan@hesp.umd.edu

Appendix B

University of Maryland Department of Speech and Hearing
College Park, Maryland 20742

November 26, 2006

The benefits of closed captioning for elderly hearing aid users
Primary Investigator: Julia Callahan (205) 934-0658

Participant Criteria:

Age: 60-85 years

Hearing Loss:
-Bilateral, sensorineural (any degree and configuration)

Participants must be native speakers of English

Current user of binaural hearing aids (any make and style)

Must have owned their current aids for at least two months

Participants DO NOT have to wear their hearing aids on a regular basis

Appendix C

University of Maryland Speech and Hearing Clinic
College Park, Maryland 20742

Dear Sir or Madame:

My name is Julia Callahan and I am an intern at The University of Alabama at Birmingham and am completing graduate studies through the University of Maryland-College Park. I am conducting research on the benefits of closed captioning for people who use hearing aids. I have asked your audiologist to provide you with this letter because he or she has identified you as a good candidate for the study.

The study procedure involves viewing three different types of television programming (news, drama, and game show) in four different viewing conditions and completing a short questionnaire regarding your television viewing habits and preferences. The study takes approximately two hours (including breaks) to complete. The purposes of this study are (1) to determine which combination of assistive devices provides the greatest amount of television comprehension across four different types of programming; and (2) to determine whether one type of programming results in a greater amount of comprehension across viewing conditions.

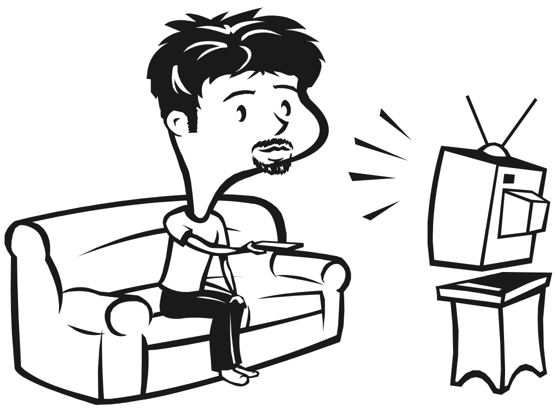
If you are interested in participating, please contact me using the information listed below. If you qualify for participation in this study, and decide to participate, you will be reimbursed for your time at a rate of $10 per hour. I thank you for your time and hope that you consider joining this study.

Sincerely,

Julia Callahan
Doctor of Audiology Student
The University of Maryland
Sparks Clinics Audiology Trainee
Birmingham, Alabama

Please contact me at:
2004 Molton Ct. Apt. 1
Vestavia, AL 35216
(205) 934-0658
jcallahan@hesp.umd.edu

Appendix D



TV GIVING YOU TROUBLE?

If you are between the ages of 60 and 85 years old, use hearing aids, and are having problems hearing the television clearly, then we need you!

The University of Alabama at Birmingham, in conjunction with the University of Maryland, is investigating the benefits of using closed captioning and hearing aids together when watching television. If you qualify for participation in this study, you will be reimbursed for your time at a rate of $10 per hour. If you are interested in participating or want more information, please contact:

Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658	Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658	Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658	Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658	Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658	Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658	Julia Callahan jcallahan@hesp.umd.edu (205) 934-0658

Appendix E

Preliminary Participant Questionnaire

1. Who referred you for participation in this study? ____________________

2. What is your date of birth (MM/DD/YYYY)? ______________________

3. Have you ever experienced middle ear disease, such as otosclerosis (hardening of the bones in the middle ear), that may have required surgery?
   YES/NO

4. Have you ever experienced significant dizziness or vertigo (you felt like the room was spinning around you), that required you to see your doctor, undergo testing, and/or use medication?
   YES/NO

5. Do you have a history of eye disease such as cataracts or glaucoma? _____
   If yes, has this problem been corrected by surgery or medication? ___________

6. Do you have any other vision problems such as near or far-sightedness? __
   If yes, has this problem been corrected to 20/20 with glasses or contact lenses? ___________

7. Do you currently own hearing aids for both ears? YES/NO

8. How long have you owned your current hearing aids? ________________

9. How many hours during the day do you wear your hearing aids?
   a. Less than 4
   b. Between 4 and 6
   c. Between 6 and 8
   d. More than 8

10. Have you completed high school or received your GED? ____________

11. What is your highest level of education?
    f. High school
    g. Some college
    h. College
    i. Some graduate school
    j. Graduate school

12. Is English your first language? _________

Appendix F

Participant Questionnaire

1. What is your date of birth (MM/DD/YYYY)? _______________________

2. What is your gender? Male Female

3. How many hours per day do you spend watching television?
   a. In the morning (5am-12pm)? ___________
   b. In the afternoon (12pm-4pm)? ___________
   c. In the evening (4pm-8pm)? ___________
   d. At night (8pm-1am)? ___________

4. How often do you wear your hearing aids while watching television?
   a. Always
   b. Usually
   c. Sometimes
   d. Never

5. When you watch television, is the room quiet or noisy? ________________

6. Do you ever use the closed captioning? _________________

7. If you answered yes to number 13, how often do you use the closed captioning?
   a. Always
   b. Usually
   c. Sometimes
   d. Never

8. Please rank the television programming you view in order with 1 representing the
programming you view the most and 12 the programming you view the least.

a. Game shows	1. __________
b. Local news	2. __________
c. Day time dramas	3. __________
d. National news	4. __________
e. Reality television	5. __________
a. Prime time dramas	6. __________
b. Prime time comedies	7. __________
c. Documentaries	8. __________
d. Home and garden programming	9. __________
e. Religious programming	10.__________
f. Home shopping	11.__________
g. Sports	12.__________

Appendix G

Instructions

Part 1: Informed Consent Form and Questionnaire

Please take a moment to review the Informed Consent form I have given you. This form states that you are over the age of 18 and describes the procedures that will be performed as part of this experiment. It also states that you understand that there are no direct benefits to you as part of participating in the study. If, after reviewing the form, you would still like to participate, please initial both pages in the top right corner and sign your name and the date at the end of the second page. Thank you.

Next, I have a short questionnaire for you to fill out. It asks some questions about you, including your date of birth, education level, etc. and about your television viewing preferences. Please answer each question to the best of your ability and do not hesitate to ask me if you have any questions.

Part 2: Hearing Test and Hearing Aid Check

Now we will do a quick test of your hearing abilities and of your hearing aids to make sure they are working properly. Please leave your hearing aids in until I ask for them.

For the hearing test, I will put a set of headphones on you and you will hear different pitches of sound. The pitches will sound like “beep, beep, beep.” As soon as you hear a beep, please raise your hand. The sounds will start out at a comfortable listening level and will get softer. If you think you hear a beep, raise your hand. It is important that you guess if you think you heard one. Do you have any questions? Please hand me your hearing aids and I will place them on the table while we are testing your hearing.

Now that we are finished checking your hearing, I am going to run a test on your hearing aids. Please relax and wait here while I check them.

Now we are going to see how well you recognize words with your hearing aids on. You will hear a woman’s voice on a tape from the speaker in front of you. She will say a phrase like “Say the word cat.” Please repeat back the last word she says. So in the previous example, you would say “cat.” Please remember to guess even if you are not completely sure that you understood the word. Do you have any questions?

Part 3: Television Viewing Conditions

In this part of the experiment, you will be watching segments from three different types of television shows. Some of the segments will have captions and some will not. You will be wearing your hearing aids for some of the segments, and not for others.

I will present one sentence from a segment at a time. Please record the sentence on the answer sheet I have given you. If you do not understand all of the sentence, but only part, please record that part. Please take a guess even if you are unsure. We will do three sentences for practice. Each of these sentences will have the captioning on. Please let me know if you cannot see the captions.

Now we will start the experiment. For this section, please
- leave your hearing aids in
- take your hearing aids out

For the next section, please
- leave your hearing aids in
- take your hearing aids out

For the next section, please
- leave your hearing aids in
- take your hearing aids out

For the last section, please
- leave your hearing aids in
- take your hearing aids out

The experiment is now completed, do you have any questions?

Are you interested in receiving a copy of the results?

Appendix H

Participant Answer Form

Please record the sentence that was presented to you in the space below. There are two spaces for each sentence.

Practice Sentences

1. ____

____

2. ____

____

3. ____

____

4. ____

____

Condition 1 (HA, HA+CC, CC, BSLN)
Program Type 1 (N, D, G, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 2 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 3 (N, G, D, List 1, 2, 3, 4)

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

5. ______________________________

____

6. ______________________________

____

7. ______________________________

____

8. ______________________________

____

9. ______________________________

____

10. ______________________________

____

Have you ever seen any of the television segments that you just viewed? Yes No

Condition 2 (HA, HA+CC, CC, BSLN)

Program Type 1 (N, D, G, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 2 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 3 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Condition 3 (HA, HA+CC, CC, BSLN)

Program Type 1 (N, D, G, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 2 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 3 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Condition 4 (HA, HA+CC, CC, BSLN)

Program Type 1 (N, D, G, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 2 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Program Type 3 (N, G, D, List 1, 2, 3, 4)

1. ____

____

2. ____

____

3. ____

____

4. ____

____

5. ____

____

6. ____

____

7. ____

____

8. ____

____

9. ____

____

10. ____

____

Have you ever seen any of the television segments that you just viewed? Yes No

Appendix I- **Sentence Lists (**Underlined words are scoreable words)

Jeopardy

List 1

1. They started playing their instruments along with us.
2. Good, you're back on the plus side.
3. You leave knowing fur trappers, beer, Packers.
4. The group consists of about two or three of us.
5. He's my forty five mile an hour couch potato.
6. This young man folks got lost.
7. These were the only pair that came close to fitting.
8. I spent an hour wandering around the base.
9. Primarily Social Studies and writing.
10. Anybody who saw me would have recognized me.

List 2

1. We actually only bought it for thirty dollars.
2. How can you mend a broken heart?
3. They're a symbol of this holy month of daylight fasting.
4. Annual events for four hundred.
5. Wait a minute; it was sitting in your lap?
6. We were both backstage together.
7. The group went down I stayed up.
8. My husband has duty, and they invited the families.
9. My sister was standing in the door.
10. Happy trails for one thousand.

List 3

1. I teach seventh grade Texas history.
2. You and I have something in common.
3. They are a pair of red shoes.
4. Did you ever begin to wonder how important you were?
5. You can buy some unique jewelry.
6. All right, you didn't lose too much.
7. Words about writing, sixteen hundred.
8. Years later, she'd be idolized by millions.
9. I was eligible to apply once we'd been married.
10. You took a five-month camping trip.

List 4

1. Each correct response will begin with the letter A.
2. Languages and dialects for eight hundred.
3. Remember, she was in that rolled up carpet.
4. We were staying there because it was also a dormitory.
5. I came back, and I heard a noise, and I stopped.
6. Pour off the hot water.
7. The most rewarding thing I've ever done.
8. You get to go into the short line.
9. So, I ran down a little bit.
10. Together they had six more children.

West Wing

List 1

1. I'm starting to see weird colors.
2. Will you get her a glass of water, please?
3. They don't want our peace-keeping mission to succeed.
4. Good, let's wake some people up.
5. Last one to get a subpoena is a rotten egg.
6. No one believed in miracles.
7. I don't need a lawyer if I haven't done anything wrong.
8. It pretty much screwed him up for life.
9. I need at least ten minutes of quiet time.
10. One is based on science.

List 2

1. One is based on faith.
2. He was a twenty-three year old medical student.
3. We pursued the challenge of a brave and just peace.
4. I'll take anything over train wreck.
5. He never figured out we were taping?
6. I just need half an hour.
7. Put me on the phone with this publisher.
8. I teach tenth grade science here at the school.
9. Now that I'm running for office, all I talk is money.
10. All my friends are in this room.

List 3

1. The language was a bit dense.
2. I'd rather take it easy, rest up.
3. I need less coffee and more sleep.
4. They have their noses pressed against the windows.
5. You two should work that out.
6. We are in an information age.
7. Makes it look like I don't pick up after you.
8. We have to raise standards for teachers.
9. I never know when I'll need an extra set of everything.
10. No one here will care that he is gone.

List 4

1. We have to pay them like professionals.
2. All I hear is people laughing.
3. Our goal was a better future for the children.
4. You are seriously misjudging the mood of your audience.
5. Can we talk about this when you're not so upset?
6. We're close to having a full house.
7. Hatred and fear took our friend.
8. No one's been able to track him down.
9. He takes a day off you reaffirm every concern.
10. Heading back to my apartment and a nice, hot, bath.

ABC World News Tonight

List 1

1. They have uttered those famous four words.
2. We can encourage employees to carpool.
3. Caught on film for the first time.
4. He says the country needs more refineries.
5. Sales have slipped this past year.
6. And they seriously considered covering up that information.
7. There's nothing like the joy on their faces.
8. At least nine of them have now returned.
9. The government rolled out a child-friendly version.
10. They are six times more successful.

List 2

1. They're not going to get money.
2. The creature has eyes as big as dinner plates.
3. Sales have definitely dropped off.
4. Caffeine has so many side effects.
5. This one comes with a computer game.
6. Tonight, some of the promising new treatments.
7. Really, what we're facing is sort of a great unknown here.
8. There's no way to shelter children.
9. I think it's a great time to be independent.
10. What a sweet sixteen she will have.

List 3

1. Today she decided to turn professional.
2. Oil and gasoline is primarily used in transportation.
3. She’s not old enough to drive a car.
4. Prices will go down if there’s cable choice.
5. It’s time for Barbie to undergo a dramatic, romantic, makeover.
6. Drivers are searching hard for bargains.
7. There is big money in her decision.
8. Ken is, quite literally, a boy toy.
9. We really need to involve mom and dad.
10. The markets are finally opening up.

List 4

1. This is a case that involves tens of millions.
2. There are warmer waters off-shore.
3. Critics and the public don’t get to vote.
4. One drug that could be on the market.
5. And it goes on to other things.
6. Doctors are now planning further studies.
7. The company denies any wrongdoing.
8. There are some clear winners and losers.
9. They are all over the map.
10. The new law will not take effect.

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