HEARING AND MEMORY DEFICITS IN OLDER ADULTS USING TELEHEALTH

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1 Introduction

It is well known that hearing abilities decline with age, and this is due to changes in both the physical structures of the cochlea as well as central processing of incoming acoustic information [1]. Age-related hearing difficulties often manifest in challenging listening situations, such as trying to understand speech in a noisy environment [2]. In these situations, older adults engage top-down cognitive processes to help overcome age-related reductions in the quality of incoming acoustic information [3]. For example, if the final word of a sentence is predictable, age-related differences in understanding that word are reduced compared to when the final word of the sentence is not predictable [4]. Interestingly, the use of these additional cognitive processes to understand speech leads to increased difficulty remembering speech because there is a limited pool of cognitive resources available [5].

One situation where this memory deficit may manifest is when older adults use Telehealth for their healthcare. Telehealth systems connect patients with healthcare providers by using video-conferencing equipment. Telehealth systems rely on audio compression algorithms to facilitate transmission of acoustic information through the internet/telephone lines, resulting in mild to moderately degraded speech signals. Older adults living in rural communities, where specialist physicians are limited, often have to rely on Telehealth to access healthcare. Telehealth has been operating in Newfoundland and Labrador for over 30 years, and includes more than 57 sites across the province [6]. Given previous research, it is possible that older adults may not remember all of the information provided via Telehealth due to the effort required to listen and understand what is said during the session.

Forgetting what was said during Telehealth sessions can have significant health consequences for older adults. Thus, the goal of the present study was to assess the impact of hearing abilities on the ability to retain information provided via Telehealth in older adult users of Telehealth

2 Method

2.1 Participants and procedure

Thirty-one participants completed the study. Participants ranged in age from 48-82 (*M*=63.9; *SD*=8.2) and 15 were female. All participants were older adult users of Telehealth from the province of Newfoundland and Labrador. Over 500 surveys were mailed to Telehealth sites across the province. After an individual completed a Telehealth session, an assistant would ask the patient if they would like to complete a survey. If they agreed they were given a copy of the survey, an information sheet about the research and a return envelope. An online version of the survey was also available via surveymonkey.com, and additional participants were recruited to complete this survey through advertising on social media and ads posted at Telehealth sites across the province. Ethics approval was obtained from the provincial Health Research Ethics Board (HREB) of Newfoundland and Labrador and the Research Review Committees of Labrador-Grenfell, Western, Central, and Eastern Health.

2.2 Materials and data analysis

Participants completed a 29-item self-report questionnaire online or on paper. In addition to basic demographics, participants were asked to rate how often they had trouble remembering something in the past year (*Memory*), how well they could remember health information provided during Telehealth sessions (*TeleMemory*), and how well they could hear the healthcare provider during Telehealth sessions (*TeleHear*), all using 5-point Likert-type scales, where higher numbers indicate better memory or hearing. The survey also included the Hearing Screening Inventory (HIS) [7]. The HSI is a reliable and cross-validated predictor of the 0.5 - 4 kHz pure-tone average. A HSI score above 27 is suggestive of hearing impairment (i.e., > 25 dB hearing loss). Using HSI scores with 27 as a cut-off, participants were divided into two groups: (1) Hearing-Loss group (HL; N=15), and (2) Normal-Hearing group (NH; N=16). Within the HL group, 5 participants wore hearing aids (3 bilateral), while none of the participants in the NH group wore hearing aids. *TeleMemory* was analyzed using an ANOVA that included Group (NH, HL) as a between subject factor, and *Memory* and *TeleHear* as covariates.

Table 1: Demographics.

Variables	Hearing-Loss	Normal-Hearing	*p-value*
Age	66.40 (9.15)	61.56 (6.61)	ns
Gender (% Female)	53.3%	43.8%	ns
Years of Education	11.13 (2.17)	9.56 (2.87)	ns

3 Results

Groups were matched in terms of age, gender and years of education (see Table 1). The HL group, compared to the NH group had lower *Memory* scores (t (29) = 2.61, p = .014) and lower *TeleHear* scores, although this was only significant at a trend level (t (29) = 1.89, p = .07). Participants in the HL group also had lower *TeleMemory* scores, (t (29) = 3.52, p = .001). Most importantly, the difference between the HL and NH group for *TeleMemory*

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remained significant when controlling for both *TeleHear* and *Memory* (F (1, 27) = 5.73, p = .024; see Figure 1).

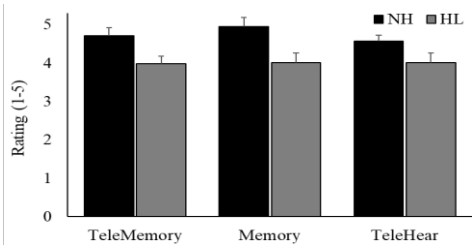

Figure 1: Self-report ratings for the *TeleMemory*, *Memory* and *TeleHear* variables across Group. Higher scores = better ability.

4 Discussion

Older adults with hearing loss, as identified by the HSI [7], reported more difficulty remembering information provided via Telehealth compared to older adults with no hearing loss. This effect remained significant after controlling for self-reported memory difficulties over the past year and the ability to hear the healthcare provider during Telehealth sessions. This pattern of results suggests that older adults with hearing loss have a specific memory deficit for information provided via Telehealth.

Individuals with hearing loss have to exert more cognitive effort to understand speech compared to normal hearing listeners [8]. Previous work has shown that this increased cognitive effort reduces the cognitive resources available to remember speech in difficult listening situations [5]. Thus, older adults with hearing loss likely remember less from Telehealth sessions because they have to use extra cognitive resources to process speech from Telehealth.

The sound quality of the speech presented via Telehealth sessions is degraded compared to the sound quality of in-person speech. In Newfoundland and Labrador, the Telehealth system relies on professional grade teleconferencing equipment (e.g., Polycom), that uses a proprietary algorithm to compress and transmit digital audio/video via the internet. Each Telehealth session is compressed at a level that is dependant on the amount of bandwidth available, thus each Telehealth session may have a different level of sound quality. Due to privacy concerns, data regarding the quality of individual Telehealth connections were not available for the present study; however, most participants rated their ability to hear the Telehealth session as good (i.e., ≥ 4/5). There was however, a trend for the HL group to rate their ability to hear the Telehealth session as lower than the NH group. Even when controlling for this trend-level difference in *TeleHear*, the HL group reported a subjective memory deficit for information provided via Telehealth that was greater than the NH group. This suggests that older adults with hearing loss use more cognitive resources to understand Telehealth sessions compared to older adults without hearing difficulties. In turn, this reduces the cognitive resources available to encode Telehealth information into memory.

A second complimentary explanation of the subjective memory deficit in the HL group is that the Telehealth system reduces the supportive and contextual visual cues that can assist in speech understanding. Previous work has shown that speech understanding is better when mouth movements match the speech, and hand gestures are visible, particularly for those with hearing difficulty [9,10]. Although all participants rated the visual quality of Telehealth to be good (i.e., ≥ 4/5), it is possible that there is a reduction in the visual cues available to assist in speech understanding when using Telehealth. For example, a small delay between visual and auditory information could reduce the ability to match mouth movements to speech, and a limited field of view could impair the ability of patients to see hand gestures from healthcare providers. These small differences in visual input would require increased use of cognitive resources to process and understand speech, especially for those with hearing loss, and could contribute to a subjective deficit in the ability to remember health information provided via Telehealth.

5 Conclusion

Older adults with hearing loss report increased difficulty remembering information provided via Telehealth. This memory deficit is likely due to having more difficulty understanding speech presented via Telehealth, which results in increased use of cognitive resources that take away resources required to encode information into long-term memory. Forgetting what was said during Telehealth sessions can have a significant impact on the health of older adults who rely on Telehealth. Given the necessity of Telehealth for older adults in rural locations, future work should identify ways to mitigate this memory deficit.

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