

AUDITORY SPATIAL ATTENTION IN YOUNGER AND OLDER ADULTS: A COMPARISON OF LABORATORY AND SELF-REPORT MEASURES

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1. INTRODUCTION

A common situation for most people is to hear sounds coming simultaneously from different sources. Typically, each sound signal originates from a unique point in space. In order to make sense of the wall of sound arriving at our ears, mechanisms of attention serve to select relevant information for further information processing [e.g., 1]. Auditory spatial attention, or the process by which a listener focuses listening resources along a spatial vector to a target, represents one such mechanism [2-3].

Recent investigations of auditory spatial attention have examined the contribution of auditory and cognitive factors to age-related differences in auditory spatial attention [4]. We studied younger adult and older adult listeners with normal audiometric thresholds in the speech range (see Fig. 1) who were simultaneously presented with a target sentence and two competing sentences. All sentences had the structure: “Ready [CALLSIGN] go to [COLOUR] [NUMBER] now” with a closed set of options for callsign (e.g., Baron, Charlie), colour, and number [5]. Each sentence was presented from one of three different loudspeaker locations. Target callsign identity was cued on a visual display either before or after sentences were presented. One of four different probability specifications was visually displayed to indicate the likelihood of the target being presented at the left, centre, and right locations (0-100-0, 10-80-10, 20-60-20, 33-33-33), where 10-80-10 indicated that the target would be presented from the centre location on 80% of the trials and from each of the left and right locations on 10% of the trials.

Figure 2 shows the results from this study. Overall, younger adults outperformed older adults. Collapsing across

all conditions, mean word identification was approximately 6.5% better for younger than for older adults. Furthermore, for both age groups, performance improved with target location certainty and with *a priori* target cueing.

Interestingly, we did not observe a significant interaction of age with location certainty. This is noteworthy because the location certainty manipulation permits the examination of different attentional mechanisms. On trials where location certainty = 0.8 or 0.6, the target sentence would usually be presented from the more likely centre location, but occasionally it would be presented from the less likely, left or right loudspeaker location. Presumably, by inducing spatial expectation, if the target is presented at a ‘likely’ location, listeners are engaged in a focused attention task, unlike when the target is presented from an ‘unlikely’ location, and listeners must ‘shift’ attentional focus between locations, thus engaging attention switching processes.

Comparing performance on likely and unlikely trials, it was found that although younger adults performed better than older adults by an average of 9%, the cost of switching attention was equivalent for older and younger adults, suggesting a lack of age-related differences in the ability to switch attention when listening in a multi-talker environment. This finding agrees with evidence suggesting that for simple tasks, younger and older adults can switch attention equally well [6], but it does not agree with findings of greater age differences in more complex attention switching tasks [7]. In studies of vision, the general finding is that there is a disproportionate age-related difference for

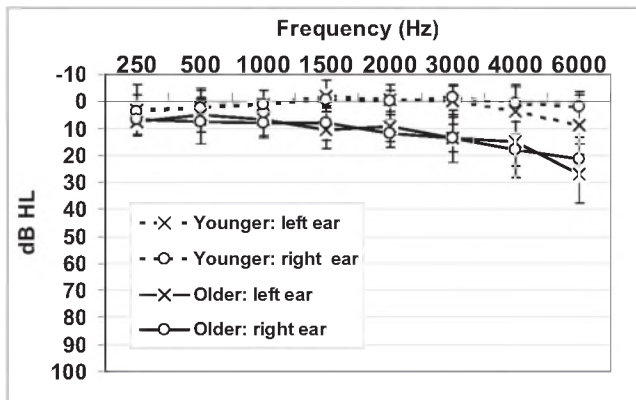


Fig. 1. Mean audiometric thresholds for younger (dashed lines) and older (solid lines) participants. Circles indicate right ears and crosses indicate left ears. Standard error bars are shown.

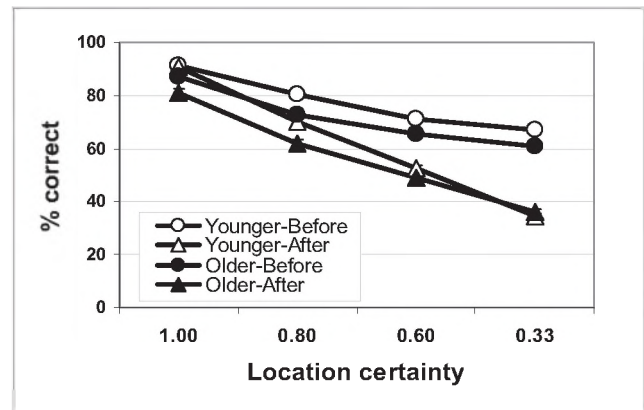


Fig.2. Mean percent correct identification scores and standard errors of the mean for younger (unfilled symbols) and older (filled symbols) adults across the four location certainties. Identification correct is calculated as the percentage of trials where participants identified the colour and number associated with the target callsign. Circles indicate the callsign was cued before stimulus presentation and triangles indicate the callsign was cued after stimulus presentation.

slower, more controlled behaviours, but not for faster, reflexive behaviours. It may be that speech perception in auditory spatial displays is at times relatively simple and/or reflexive and at other times more complex and/or automatic.

The main purpose of this report is to compare this laboratory data with performance on a self-report measure of auditory experience measuring a broad range of hearing functions, the *Speech, Spatial, and Qualities of Hearing* (SSQ) scale [8]. Whereas traditional self-report measures focus on listening situations where sound is predictable in both space and time, the SSQ is designed to address listening in more dynamic listening situations. The SSQ comprises three scales. The first (*speech*) assesses ability to hear speech in a variety of contexts. The second (*spatial*) assesses directional, distance, and movement components of spatial hearing. The third (*qualities*) assesses a range of hearing qualities including segregation (sounds are heard as separate and distinct), clarity, and naturalness. The subscales of the SSQ evaluate more peripheral (e.g., audibility) as well as more cognitively mediated (e.g., divided and switching attention) components of hearing [7].

2. METHOD

2.1 Participants

Participants from the laboratory study [4] also completed this study except for one younger adult and one older adult. Participants were 7 younger (mean age = 24.0 years, $SD = 3.1$) and 7 older adults (mean age = 71.0, $SD = 3.7$). All participants spoke English as a first language, and had pure-tone audiometric thresholds of ≤ 25 dB HL at frequencies from .25 to 3 kHz binaurally (see Fig. 1).

2.2 Questionnaire

After completing the laboratory measures obtained in [4], participants completed the SSQ, usually requiring about 20 minutes. An example question (question 8 of the *qualities* scale) is “When you listen to music, does it sound clear and natural?”. Responses are made on an 11-point ruler scale, where 0 represents a complete inability or absence of a quality, and 10 represents complete ability or presence of a quality. A research assistant was available to respond to questions.

3. RESULTS

3.1 SSQ

Table 1 shows the performance of younger and older adults. Older adults indicated significantly greater impairment on scales measuring *speech* [$F(1, 12) = 7.96, p \leq 0.05$], *audibility* [$F(1, 12) = 7.00, p \leq 0.05$], *divided and switching attention* [$F(1, 12) = 8.09, p \leq 0.05$], *qualities* [$F(1, 12) = 9.36, p \leq 0.01$], and *segregation* [$F(1, 12) = 5.73, p \leq 0.05$].

3.2 Covariate analysis

A final analysis was performed that compared the performance of the age groups on the SSQ, after statistically controlling for binaural pure-tone average (PTA). Older adults reported significantly greater impairment on scales measuring *divided and switching attention* [$F(2, 11) = 3.97, p \leq 0.05$] and *qualities* [$F(2, 11) = 4.41, p \leq 0.05$].

Table 1. Mean (SD) SSQ results. Asterisks indicate significant between-group differences * = ($p \leq 0.05$); ** = ($p \leq 0.01$). Bolded scales indicate significant between group-differences, after statistically controlling for binaural pure-tone average threshold ($p \leq 0.05$)

SSQ Scales& subscales	Younger	Older
<i>Speech</i> *	8.97 (0.57)	7.36 (1.40)
<i>Audibility</i> *	9.41 (0.53)	8.22 (1.07)
<i>Divided/switching attention</i>*	8.52 (0.82)	6.50 (1.69)
<i>Spatial</i>	8.53 (1.10)	7.59 (1.82)
<i>Qualities</i>**	9.35 (0.32)	8.55 (0.61)
<i>Segregation</i> *	9.73 (0.28)	9.29 (0.57)
<i>Clarity and naturalness</i>	9.46 (0.44)	8.06 (1.48)

4. DISCUSSION

The goal of the present study was to compare laboratory measures examining auditory spatial attention with self-report measures of auditory function. In general, the results are in agreement. On the SSQ, older adults reported significantly more trouble on the *speech*, *audibility*, *divided and switching attention*, *qualities*, *segregation*, and *clarity and naturalness* scales (see Table 1). This is comparable to the main effect of age observed in the laboratory [4], whereby younger adults outperformed older adults in all conditions (see Fig. 2). Interestingly, we observed significant age-group differences on the SSQ, despite both groups having ‘normal’ audiometric thresholds in the speech range (see Fig. 1). However, because there were minor between-group audiometric differences, we performed an analysis to statistically control for binaural PTA. Our assumption was that, after accounting for PTA, significant differences tapping more peripheral hearing phenomena (e.g., audibility) should be minimized, but not differences on scales that are less dependent on the cochlea (e.g., the divided and attention switching subscale). This pattern is precisely what we observed. These findings suggest that aspects of divided and attention switching are important contributors to age-related differences in the experience of listening in everyday contexts and environments.

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ACKNOWLEDGEMENTS

This research was funded by CIHR and NSERC.