

# Age-related changes in auditory and cognitive abilities in elderly persons with hearing aids fitted at the initial stages of hearing loss

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## Abstract

In this study, we investigated the relation between the use of hearing aids at the initial stages of hearing loss and age-related changes in the auditory and cognitive abilities of elderly persons. 12 healthy elderly persons participated in an annual auditory and cognitive longitudinal examination for three years. According to their hearing level, they were divided into 3 subgroups - the normal hearing group, the hearing loss without hearing aids group, and the hearing loss with hearing aids group. All the subjects underwent 4 tests: pure-tone audiometry, syllable intelligibility test, dichotic listening test (DLT), and Wechsler Adult Intelligence Scale-Revised (WAIS-R) Short Forms. Comparison between the 3 groups revealed that the hearing loss without hearing aids group showed the lowest scores for the performance tasks, in contrast to the hearing level and intelligibility results. The other groups showed no significant difference in the WAIS-R subtests. This result indicates that prescription of a hearing aid during the early stages of hearing loss is related to the retention of cognitive abilities in such elderly people. However, there were no statistical significant correlations between the auditory and cognitive tasks.

## Introduction

Most elderly people typically experience difficulties in hearing and understanding conversations (Pichora-Fuller, 2003a; Pichora-Fuller,

2003b). Three hypotheses have been proposed for the age-related decline in hearing: the peripheral hypothesis, central-auditory hypothesis, and cognitive hypothesis (CHABA, 1988). A few studies have also proposed a relationship between perception and cognition as the cause (Baltes & Lindenberger, 1997; Pichora-Fuller, 2003b). In the presence of various viewpoints, there is a need to evaluate these relations in detail to understand age-related hearing problems. Many people who experience difficulties in understanding speech resort to hearing aids. However, for various reasons, some elderly persons suffering from hearing loss do not use them. If we assume a relationship between perception and cognition, the use of hearing aids at the initial stages of hearing loss will help the elderly communicate with others and also retain their cognitive abilities. In this study, we investigated the relation between the use of hearing aids at the initial stages of hearing loss and age-related changes in the auditory and cognitive abilities of elderly persons.

## Materials and Methods

### Subjects

The study population comprised 12 healthy elderly persons (mean age: 71 years) who had no history of neurological trauma. They were right handed and did not use hearing aids to begin with. These elderly people participated in an annual auditory and cognitive longitudinal examination for 3 years. According to their hearing level, they were divided into 3 subgroups - the normal hearing group (NH group), the hearing loss without hearing aids group (non-HA user group), and the hearing loss with hearing aids group (HA user group). During the first-year examination, the subjects of the third group whose pure-tone average was less than 40 dBHL were given hearing aid fittings after receiving their confirmation to use the aids, and were followed up. There was no difference on age and education between 3 subgroups.

### Procedures

All the subjects underwent 4 tests: pure-tone audiometry, syllable intelligibility test, dichotic listening test (DLT), and Wechsler Adult Intelligence Scale-Revised (WAIS-R) Short Forms. The syllable intelligibility test is a hearing task performed using 50 Japanese monosyllables. The subjects wrote the syllables they heard on sheets; the answers were checked and scored. The DLT, which is a noninvasive technique of studying lateralized information processing in the 2 hemispheres of the brain, involves the simultaneous presentation of different stimuli to both ears. The dichotic presentation of verbal auditory stimuli typically yields a right ear advantage (REA) when the participants are requested to report what they perceive on each trial (Kimura, 1961). The stimuli used in these tests were selected Japanese monosyllables recorded by a woman. In the DLT, 2 stimuli were combined and synchronized for intensity and onset. The stimuli

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Table 1. Hearing level and syllable intelligibility of all subjects.

Group		Hearing level (dB)						Syllable intelligibility (%)					
		Right ear			Left ear			Right ear			Left ear		
		1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr	1yr	2yr	3yr
NH	Mean	15.4	12.8	17.2	13.8	13.5	17.2	93.8	87.0	87.5	82.0	88.0	83.5
	SD	6.1	4.9	7.1	10.0	6.1	10.4	14.7	22.3	14.7	7.7	19.6	13.9
Non HA	Mean	34.2	35.7	36.3	31.5	29.4	33.5	73.5	65.5	57.0	80.5	67.5	76.5
	SD	4.6	8.4	3.1	13.7	12.0	13.2	16.4	18.2	12.7	8.1	13.4	8.2
HA user	Mean	46.6	48.2	51.0	51.6	51.6	54.4	71.0	63.0	66.5	60.5	56.5	57.0
	SD	10.8	7.9	8.0	8.9	12.1	6.3	11.8	13.2	7.7	24.4	20.6	17.2

Table 2. The correlations of each task.

	Mean hearing level	Syllable hearing intelligibility	Dichotic listening test	Verbal task of WAIS-R	Performance task of WAIS-R
Mean hearing level					
Syllable hearing intelligibility	*				
Dichotic listening test	**	**			
Verbal task of WAIS-R					
Performance task of WAIS-R				**	

\*P<0.05; \*\*P<0.01

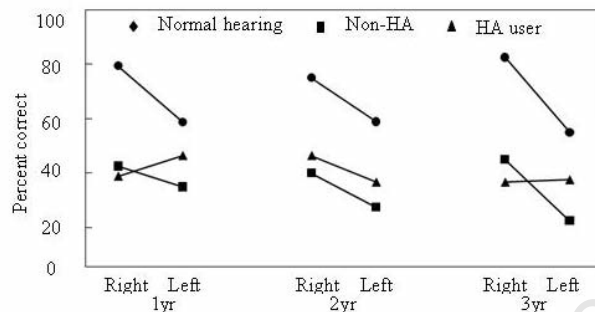


Figure 1. The dichotic listening test performances of the 3 groups.

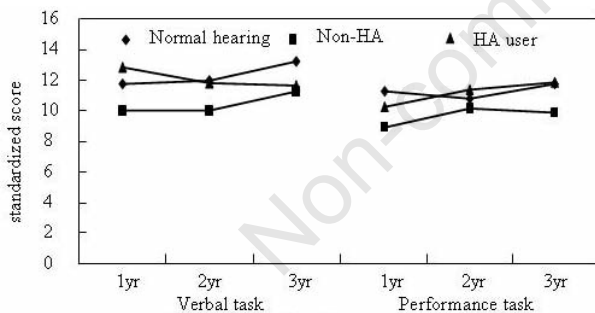


Figure 2. The standardized score of verbal and performance task in WAIS-R.

were presented in a random order. The next stimulus was presented only after the subjects reported what they had heard at the previous instance. The DLT had 40 trials. The subjects were instructed to repeat the stimuli received simultaneously in both the ears in any order. For these auditory tasks, the subjects were seated in a sound-attenuated chamber. The stimuli presented to the subjects were played on a CD player or a personal computer (Windows XP) through an audiometer (AA-76; RION), and the subjects heard these stimuli through headphones. The stimuli for syllable intelligibility test and DLT were played at a volume that was 40 dB above the mean hearing threshold. We selected 4 subtests in WAIS-R: Vocabulary, Comprehension, Object assembly, and Block Design, and calculated the scores for each of these tests and the mean score of 2 verbal tasks and 2 performance tasks.

## Results

Table 1 shows the mean hearing level by pure-tone thresholds and syllable intelligibility in each group. The thresholds tended to increase every year. According to the increase in the hearing level, syllable intelligibility in each group also declined. In contrast, the results of DLT and WAIS-R did not show the same tendency in the hearing level and intelligibility. The DLT performances for each of the 3 groups are presented in Figure 1. All the elderly subjects exhibited a significant REA every year. The non-HA user group showed the lowest score. With respect to the WAIS-R results (Figure 2), in contrast to the hearing level and intelligibility results, the non-HA user group showed the lowest scores for the performance tasks. The NH group and HA user group showed significantly higher scores in the verbal and performance subtests, and no significant difference was observed in these subtests between these 2 groups. Further, significant correlations were observed between the auditory tasks, but no significant correlations were noted between auditory and cognitive tasks (Table 2).

## Conclusions

Comparison between the 3 groups revealed that the WAIS-R performance task scores of the HA user group were higher than those of the non-HA user group. This result indicates that prescription of a hearing aid during the early stages of hearing loss is related to the retention of cognitive abilities in such elderly people. However, there were no statistical significant correlations between the auditory and cognitive tasks. This study had some limitations. Since the sample size of this study was small, another study with a larger population is required to verify these findings. Further, to completely understand the hearing problems experienced by elderly persons on a routine basis, we need to conduct a longitudinal study of their auditory and cognitive functions. However, such a study would be challenging owing to reasons such as changes in the health status of the elderly; therefore, we have to investigate individual auditory and cognitive functions in detail in future studies.

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