

THE EFFECT OF AGING ON SPATIAL HEARING

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1.0 INTRODUCTION

The ability to localize sounds is available at birth.¹ It is known that auditory spatial acuity improves rapidly during the first few years of life but begins to deteriorate by middle age.^{2,3} Later deficits may reflect age-related degeneration of the peripheral and central auditory pathways.⁴ Such changes could interfere with the encoding of binaural and spectral cues that are essential for accurate sound localization.⁵ To test this hypothesis, an experiment was conducted to measure the utilization of these cues from adolescence to old age.

2.0 METHODS AND MATERIALS

2.1 Subjects

Seven groups of sixteen subjects, aged 10-19, 20-29, 30-39, 40-49, 50-59, 60-69 and 70-79 years, respectively, participated. All were screened for hearing loss in the region of 0.5-4 kHz.

2.2 Apparatus

Subjects were tested individually in a semi-reverberant sound proof chamber that modelled real-world listening in a small office. The specifications of the chamber and stimulus generating and loudspeaker systems have been described previously.⁶ Subjects responded using a laptop response box with a set of microswitches in the same configuration as the loudspeaker array.

2.3 Procedure

The subject's task was to identify the direction of a 75 dB SPL 300-ms sound (1/3 octave noise band centred at 0.5 or 4 kHz or broadband noise), randomly emanating from a set of four or eight loudspeakers, surrounding her/him at a distance of 1 metre. For the 4-speaker array, speakers were placed either close to the midline or the interaural axis, in each quadrant. For the 8-speaker array, the separation between pairs of speakers, placed within each quadrant, was varied (15, 30, 45 or 60 deg).

One block of sixteen random presentations of the stimulus through each speaker in the array was given for each of the 18 listening conditions. A trial began with a 0.5-s warning light on the response box, followed by a 0.5-s delay, and then the presentation of the stimulus. The warning light was the subject's cue to keep the head steady and fixate a straight-ahead visual target attached to the wall of the booth. A maximum of 7 s was given for the

choice of response key corresponding to the speaker that had emitted the stimulus. No feedback was given about the correctness of the judgements.

3.0 RESULTS AND DISCUSSION

Within each condition, accuracy in speaker identification was highest with broadband noise and lowest with the 1/3 octave noise band centred at 0.5 kHz. The greater the number of speakers in the array (4 vs 8), the lower the percent correct. The mean percent correct achieved by the 16 subjects in the 20-29, 40-49 and 60-69 year old groups is shown in Fig. 1 for the 8-speaker arrays. There was an overall trend toward poorer localization with aging.

Table I shows the effect of aging on correct identification of spatial quadrant for the 8-speaker arrays. Low-frequency left frontal (LF) superiority displayed by the 20 and 40 year olds was absent in the elderly. At the higher frequency, a progressive inability to perceive that sounds had come from behind (B) was apparent by middle age. In front (F), accuracy in quadrant identification was higher on the left (L) than the right (R) side of space.

Sound source identification was best when both binaural and spectral cues were available (broadband noise). Inter-aural level differences with 4 kHz were more effective than time-of-arrival differences with 0.5 kHz. With aging, there was a decline in the use of binaural cues, and greater difficulty with front/back discrimination. Left frontal superiority may reflect a right hemisphere advantage either for spatial acuity or for the processing of complex spectral information.⁷

Acknowledgements

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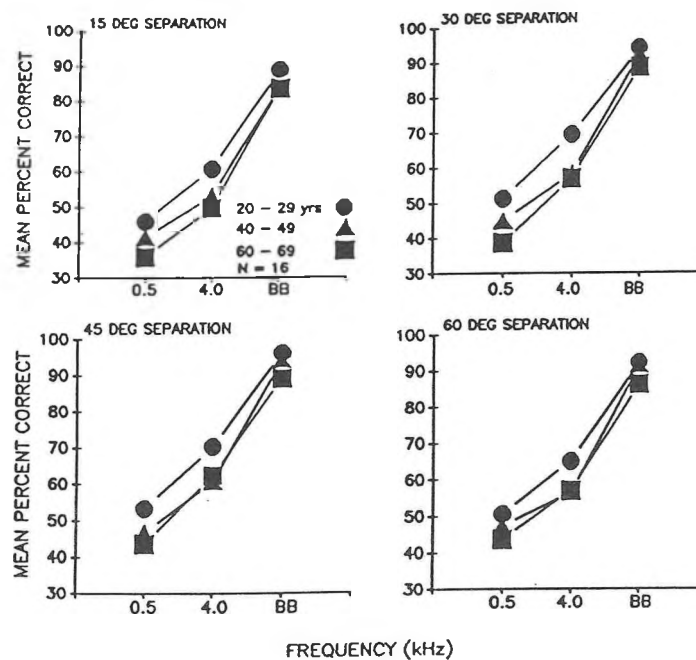


Fig.1 The effect of age on sound source identification for the 8-speaker arrays.

Table I. The effect of age on quadrant accuracy for the 8-speaker arrays.

Age (yrs)	Quad	1/3 Octave Bands				Broadband Noise			
		0.5 kHz		4 kHz		L		R	
		L	R	L	R	L	R	L	R
20-29	F	67*	54	61	80	72	76	99	99
	B	57	54	56	86	84	85	97	97
	Avg	62	54		83	78		98	98
40-49	F	71	63	67	83	72	78	98	99
	B	37	43	40	60	60	60	96	97
	Avg	54	53		72	66		97	98
60-69	F	48	48	48	84	77	81	97	99
	B	53	52	53	61	62	62	92	86
	Avg	51	50		72	70		95	93

* Percent correct/quadrant