Does Ear Advantage Changes With Age?

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Abstract

In young adults with normal hearing the right ear is more sensitive than the left to simple sounds and to processing complex sounds as speech. This gives a clear indication that they have right ear advantage at the peripheral as well as at central level. In the present investigation the effects of hearing loss and aging on this auditory asymmetry were examined at different levels of auditory system. Transient Evoked Otoacoustic Emissions (TEOAE) was used to assess peripheral changes. Test administered to assess brain stem level was auditory brain stem responses (ABR). Late latency responses (LLR) were used to monitor the changes in cortical level, Speech in noise test (SPIN) was performed to assess the central processing. A group of elderly subjects with normal hearing was compared to a group with sloping audiograms. A significant deterioration at all the levels of the auditory system functioning was noticed with the increase in age. The test results also indicated that the normal hearing adults showed significantly better performance in right ear, whereas individuals with hearing loss did not show any significant difference between the right and left ear for central/cortical level functioning. However it was observed that at the cochlear level the left ear performance was better than the right ear.

Introduction

The longer we live the more likely we will be adversely affected by the degenerative effects due to aging. Evidence suggests that aging declines hearing associated with various types of auditory system dysfunction (peripheral and central). Changes accompanying aging have been reported widely. Such changes could involve:

- The structural pathology of the aging ear, causes ranging from biochemical factors and metabolic changes
- The central nervous system based auditory processing/comprehension problems seen among many aging persons and
- Social and psychological problems faced by the elderly individual with presbycusis.

Changes in auditory system which accompanies aging are called as 'presbycusis'. The term 'presby' means elder, the word 'presbycusis' literally means the acuity of the elderly individuals.

The earlier studies consisted of observing changes in hearing level in accordance with increasing age. With advances in technology more detailed histopathological studies proved that the areas which might be affected more are cochlea, the spiral ganglion, the brainstem auditory pathways and the auditory cortex. (Willot, 1991)

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The normal auditory system is characterized by at least one functional asymmetry. The two hemispheres of the brain appear to be uniquely specialized for different aspects of auditory processing. One consequence of this hemispheric specialization is that the right ear enjoys a slight advantage over the left when exposed to acoustic stimuli. This preference of one part of the body over the other part is known as laterality (Coren & Porac, 1978). This asymmetry is observed in the auditory system also (Willot, 1991).

It has been reported that the right ear got better thresholds than that of the left ear when pure tone thresholds of both the ears were compared (Chung, Mason, Gannon & Wilson, 1983., Mc Fadden, 1993). Similar observation was made in oto-acoustic emissions, auditory brainstem responses, late latency potentials and central auditory processing test results. OAE amplitudes were higher in right ear than left ear in normal hearing indivuals (Sherif, et al, 2005; Bilger, Matthies, Hammel & Demoest, 1990; Chung et al., 1983; Mc Fadden, 1993). Sininger, Cone and Abdala (1998) observed right ear auditory brain stem response latencies were shorter than left ear latencies. Study by Bellis, Nicol and Kraus (2000) also reported right ear advantage at the cortical level. That is the right latencies were shorter than the left latencies based on their late potential results. Thus it suggests that right ear advantage is present in different levels of auditory system in normal hearing adults.

Sherif et al., (2005) using transient evoked oto-acoustic emissions found that left ear amplitudes were better than right ear amplitudes in individuals with age related sloping hearing loss. They attributed the changes in loss of ear advantage to the age related sloping hearing loss.

As there is a change in laterality at peripheral level in individuals with age related hearing loss it evokes the interest to understand the changes in other levels of the auditory system with aging and also age related sloping hearing loss.

Thus this study was undertaken to evaluate whether there is any change in laterality of auditory system across the ages and if so then what age and the level at which such changes in the auditory system takes place. And also to observe the age related deterioration in the performance of auditory perception across the ages.

Need for the study

- It is reported in literature that aging causes poor performance in auditory system and as there is lack of literature so it is necessary to see across the ages and also the extent to which the deterioration takes place.
- Sherif et al, (2005) observed altered laterality at peripheral level in subjects with age related sloping hearing loss. Hence it is essential to know whether such changes occur only in individuals with hearing loss or those without significant peripheral hearing loss.
- It is also necessary to see whether the change in laterality is purely peripheral or such changes can also occur at higher levels. So auditory system functioning need to be assessed at different levels in subjects with presbycusis.
- There is a need to identify appropriate tests to administer to know about ear advantage.

Aims of the study

The present study is taken up to investigate:

- Whether different levels of the auditory system functions similar through out the age

- Whether there is any change in laterality across the ages
- If so, level at which such changes occur
- What is the age at which one can expect such changes?

Method

To accomplish the above mentioned aims the study was done on two groups of subjects.

Subjects

a. Control group

Control group consisted of normal hearing adults. Normal hearing is operationally defined as 'pure-tone average of 15dB HL or less at octave frequencies between 250 Hz and 8000 Hz (ANSI, 1996)'. The following criteria were followed for subject selection:

- 'A' type tympanogram with reflexes present
- No history of otological or neurological symptoms
- Also made it a point that the physical condition of the subjects was fit for testing.

Participants were divided in to 4 subgroups based on their age as in table 1 below

Table 1: Age range and number of subjects in control group

Age	Number of subjects
30-40 years	10
40-50 years	10
50-60 years	10
60 years and above	10

b. Experimental group

Experimental group consisted of subjects with symmetrical sensorineural hearing loss acquired due to aging. The selection criteria for the subjects are as follows:

- No any history of significant noise exposure, ear infections and intake of ototoxic drugs
- Care was taken while selection that the subjects did not have previous otological history and history of head trauma, seizures, neurological disorders or chemotherapy
- All the subjects had 'A' type tympanogram with presence or elevated reflexes
- The physical condition of the subjects was fit for testing

Subjects were then distributed based on their age into 3 subgroups as shown in table 2 below:

Table 2: Age range and number of subjects in experimental group

Age	Number of subjects
40-50 years	5
50-60 years	5
60 years and above	5

Tests administered to observe age related changes of ear advantages were:

- Transient evoked otoacoustic emissions (TEOAE) to assess changes in peripheral level
- Auditory brainstem response (ABR) to assess changes at the brainstem
- Late latency responses (LLR) to assess changes at the cortical level
- Speech in noise test (SPIN) to assess changes in the central auditory processing

Instrumentation

The following instruments were used for the study:

- A calibrated two channel diagnostic audiometer to perform pure tone threshold and SPIN
- CD player to present recorded speech material
- A calibrated immittance meter to perform tympanometry and reflexometry
- Evoked potential system: Intelligent hearing system version 3140 to record ABR & LLR
- ILO 292 Echo port plus OAE system application software (version 5) to record and analyze TEOAEs.

Test material

To test speech perception in noise, a CD developed by Varghese (2004) was used. Speech materials developed Vandana (1996) was recorded in a CD in the presence of speech babble at 0 dB SNR.

Procedure

1. Transient Evoked Otoacoustic Emission

Responses were elicited using non-linear clicks. TEOAEs were recorded using 260 sweeps. The responses obtained were then subjected to time domain analysis. Reproducibility of greater than 65% and SNR of 3dB were considered to be the presence of TEOAE. TEOAE amplitude at each frequency band independently was noted.

Electro physiological testing

Table 3: Protocol used to elicit evoked potentials

Parameters	Auditory brainstem responses	Late latency responses
Stimuli	Clicks	Clicks
Stimulus polarity	Rarefaction	Rarefaction
Transducer	Head phones	Head phones
Repetition rate	30.1/s	3.1/s
Number of sweeps	1500	500
Transducer	Head phones	Head phones
Filter setting	30-3000Hz	1-30 Hz
Analysis window	10ms	300ms
Electrode montage	Vertical montage: Positive-C2: Negative- M1, M2: Ground-Nasion.	Vertical montage : Positive-C2 ; Negative-M1 , M2 : Ground-Nasion
Electrode impedance	< 5 Kohms	< 5 Kohms.

Electro physiological testing included recording of auditory brainstem responses and late latency responses. The parameters and electrode montage used for recording is given in table 3.

The information collected from the evoked potentials were wave III and V ABR latency and P1, N_1, P_2 and N_2 latencies from ALLR.

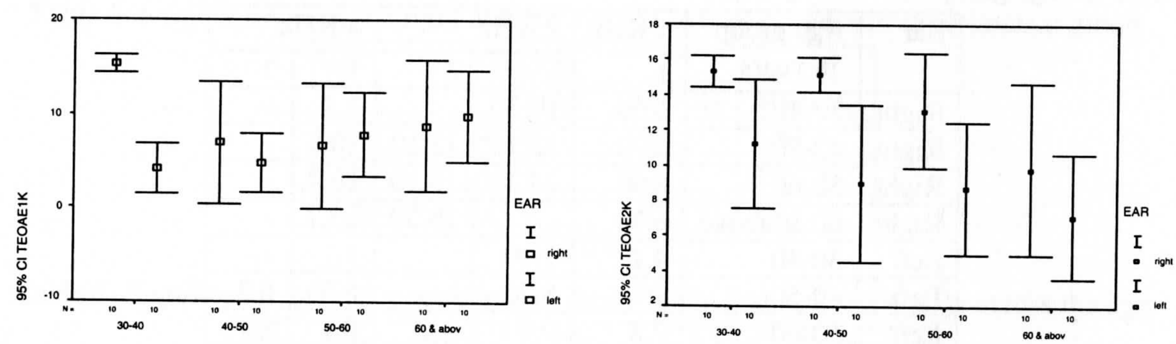
2. Speech perception in noise

To test speech perception in noise CD developed by Varghese (2004) was used. Subjects were instructed to repeat the words and scores obtained separately for right and left ear for monaural presentation through headphones were noted.

Results

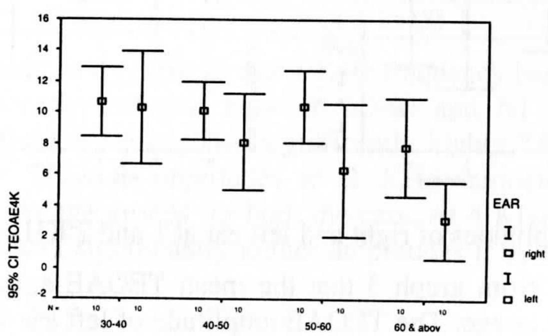
The data obtained in different audiological tests and in age groups were analyzed using the statistical package SPSS version 10.00. MANOVA was used to check for interaction effect because the data included number of variables. To compare the age groups and age related decline Post Hoc Tuky test was carried out. Paired t-test was administered to check for laterality between the ears. The level of significance was confirmed when the P value is greater than 0.05.

1. Transient evoked otoacoustic emissions



Graph 1: TEOAE amplitudes for right and left ear at 1 and 2 KHz in control groups across age

It can be seen in Graph 1 that the mean TEAOE amplitudes of right and left ear reduced with the increase in age especially for 2 KHz frequency band. Individual variations of TEOAE amplitudes were greater for older age group. TEOAE amplitudes were always higher for right ear than left ear. This difference in TEOAE amplitude between the ears was statistically significant which can be seen in table 4.



Graph 2: TEAOE amplitudes of right and left ear at 4 KHz in control group across age

TEOAE amplitude at 4 KHz also decreased with the increase in age. Right ear TEOAE amplitude was greater than that of left ear in all the age groups. This difference was significant in almost all the age groups.

Table 4: t-values between the right and left ear TEOAE amplitudes in control group

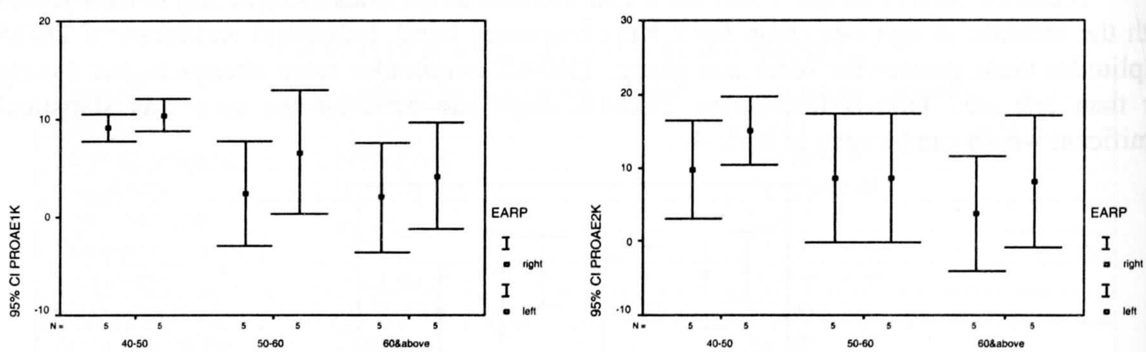
Age in years	TEOAE		
	1000 Hz	2000 Hz	4000 Hz
30-40	1.25	3.2*	0.61
40-50	1.3	3.8*	2.4*
50-60	0.5	2.7*	2.4*
60 & above	0.5	1.6	3.1*

$* p < 0.05$

MANOVA results indicated a significant interaction effect between the groups for TEOAE amplitudes of right ear at 2 KHz and at 4 KHz frequency bands for left ear. Other frequency bands did not indicate any significant interaction effect (Table 5).

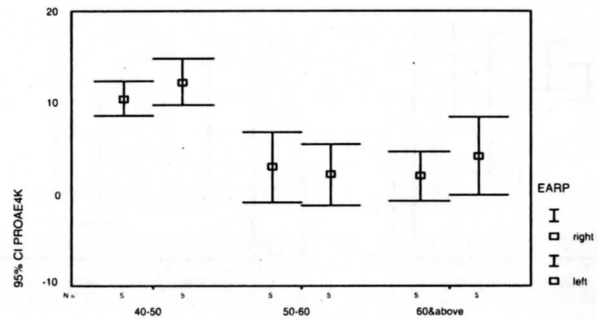
Table 5: Significance of difference between the mean for TEOAE amplitudes at 1, 2 and 4 KHz across the age group in control group

Ear	Age group in years	1 KHz	2 KHz		4 KHz	
		1	1	2	1	2
Right	30-40	6.60	10.30		7.8	-
Right	40-50	6.70	13.10	13.10	10.1	-
Right	50-60	6.90	15.10	15.10	10.4	-
Right	60 & above	6.70	-	15.30	10.7	-
Left	30-40	4.1	7.10		3.1	-
Left	40-50	4.8	8.70	-	6.3	6.3
Left	50-60	7.8	9.0	-	8.1	8.1
Left	60 & above	9.8	11.2	-	-	10.3



Graph 3: TEOAE amplitudes of right and left ear at 1 and 2 KHz in experimental groups

It can be inferred from graph 3 that the mean TEOAE amplitude of right and left ear reduced with the increase in age. The TEOAE amplitude of left ear was always higher than that of right ear. And the difference in amplitude was significant at 1 and 2 KHz frequency band. The individual TEOAE amplitude variation was more for older group than the younger group.



Graph 4: TEOAE amplitudes of right and left ear at 4 KHz in experimental groups

It can be seen in graph 4 that TEOAE amplitude at 4 KHz frequency band in experimental group followed the same pattern as seen in other 2 frequency bands. However, the TEOAE amplitude between the right and left ear did not differ significantly for older groups (Table 6).

Table 6: t-values between the right and left ear TEOAE amplitudes in experimental group

Age	TEOAE		
	1000 Hz	2000 Hz	4000 Hz
40-50	6.0*	3.8*	4.8*
50-60	9.7*	6.0*	1.2
60 & above	11.0*	5.2*	1.4

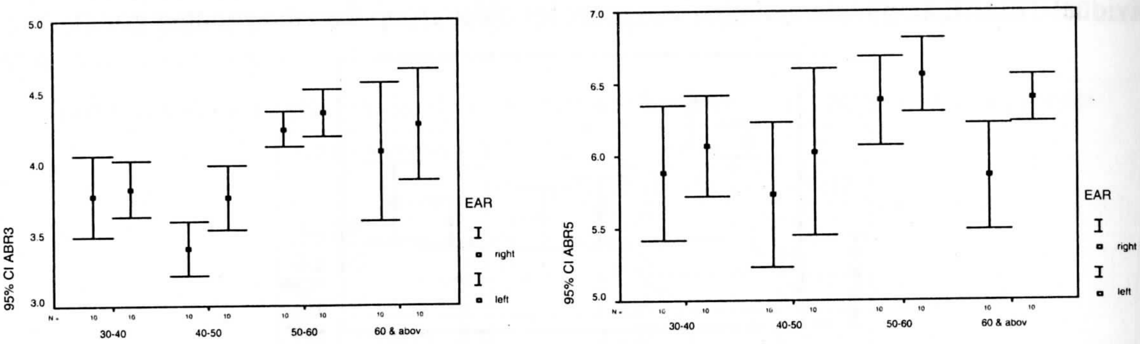
$p < 0.05$

Table 7: Significance of difference between mean TEOAE at 1, 2 and 4 KHz across the age

Ear	Age group	1 Khz		2 Khz	4 Khz	
		1	2	1	1	2
Right	40-50	9.2	-	3.8	2.0	-
Right	50-60	-	2.4	3.8	3.0	-
Right	60 & above	-	2.0	9.8		10.4
Left	40-50	10.4	-	8.20	2.2	-
Left	50-60	4.8	4.8	8.6	4.2	-
Left	60 & above	-	10.4	15.00	-	12.2

MANOVA results indicated (Table 7) that 1 KHz frequency band amplitudes in right and left ears were not significantly different between 50-60 and 60 above age group in the experimental group. But 40-50 age group had significantly higher TEOAE amplitude than the other 2 groups. However TEOAE amplitudes at 2 KHz frequency band did not differ significantly between any two age groups for both the ears. At 4 KHz frequency band TEOAE amplitudes of III group showed significantly higher amplitudes than other two groups for both right and left ear.

2. Auditory brainstem evoked responses (ABR)



Graph 5: Latencies of III and V peak of right and left ear obtained in control groups

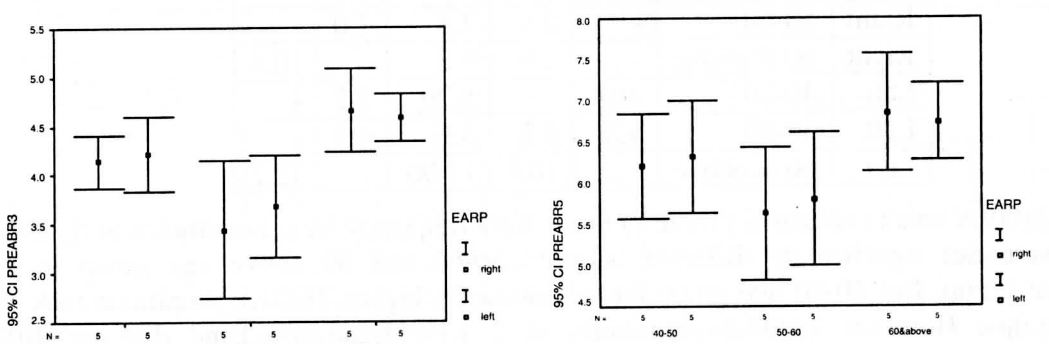
It is evident in graph 5 that there is increase in wave III and V latency with increase in age for both right and left ear. Right ear latencies were shorter than the left ear latency for all the age groups. The difference in right and left ear latencies were statistically significant in almost all the age groups which can be seen in table 8. The variation in peak latencies across the age group was not uniform.

Table 8: t-values between the two ear latencies in control group

Age	ABR wave	
	III	V
30-40	0.5	2.8*
40-50	3.1*	8.0*
50-60	1.9	4.7*
60 & above	4.3*	5.8*

* $p < 0.05$

MANOVA did not reveal any significant interaction in ABR wave latencies between the groups for right or left ear. When different age groups were considered there was an effect of interaction between the latency of III wave of right and left ears for different age groups.



Graph 6: Latencies of III and V wave of right and left ear obtained in experimental group

It can be seen in above figure that latency of wave III and V of experimental group did not show similar pattern that was observed in control group. Wave III and V latencies were minimum in 50-60 age group and maximum in 60 above age group. The difference in right and left ear wave III and V latency did not show any significant difference at any age group (table 9).

Table 9: t-values between the right and left ear latencies in experimental group

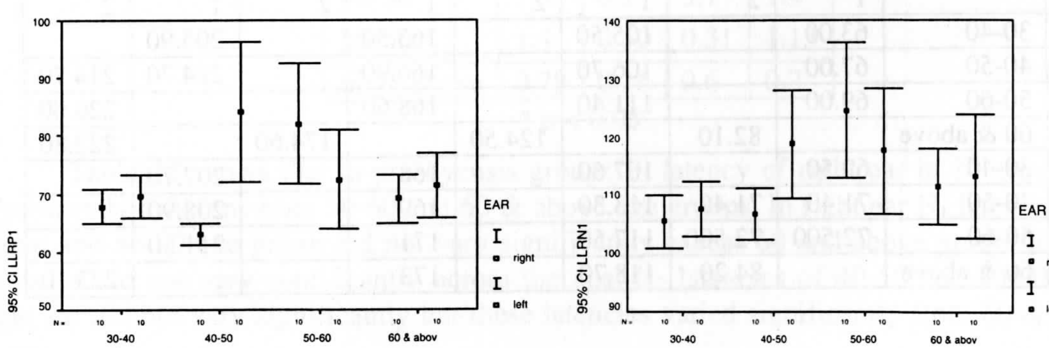
Age	Wave III	Wave V
40-50	1.6	2.0
50-60	1.1	0.5
60 & above	0.42	0.41

Table 10: The significance of difference between the mean for right and left ear wave latencies

Ear	Age group	Control group			Experimental group			
		III		V	III		V	
		1	2	1	1	2	1	2
Right	30-40	3.40		5.73	-	-	-	-
Right	40-50	3.77	3.77	5.85	3.44	-	5.634	-
Right	50-60	-	4.08	5.88	-	4.14	6.2	6.2
Right	60 & above	-	4.23	6.37	-	4.65	-	6.85
Left	30-40	3.75	-	6.02	-	-	-	-
Left	40-50	3.82		6.07	3.68		5.8	-
Left	50-60	-	4.264	6.39	-	4.2	6.32	6.32
Left	60 & above	-	4.34	6.55	-	4.58	-	6.79

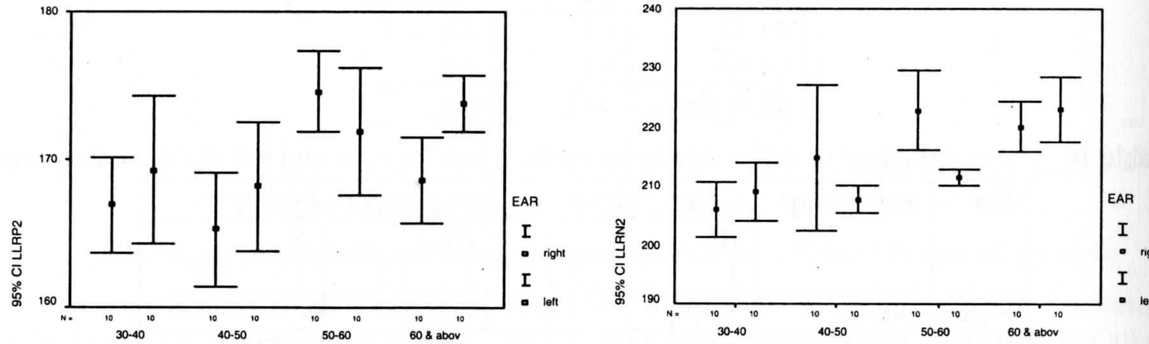
MANOVA tests results revealed (table 10) that there is no significant difference in wave V latency between any two subgroups of control group though there is increase in latency noticed with the increase in age. A significant increase in wave III latency was noticed in subjects with age above 50 years for right and left ear. In experimental group significant increase in latency is noticed for both waves III and V for both right and left ears. Increase in latency is significant above 60 years. Thus it can be concluded that age related changes are evident at the brainstem level which is more in individuals with hearing loss due to presbycusis. This effect is more evident after the age of 60 years. It can also be concluded that right ear latency is always shorter than the left ear latency in any age group in both experimental and control group. Hence, it can be concluded that the right ear advantage does not change with age and hearing loss due to aging at the brainstem level.

3. Late latency responses



Graph 7: The P_1 and N_1 latency of right and left ear obtained across age in control group

It can be seen in the graph 7 that the change of P_1 and N_1 latency did not show any specific pattern with the age. However, it is clear that P_1 and N_1 latency observed in right ear is usually shorter than that in left ear. The difference in right and left ear latency is significant for the subjects above 40 years which can be seen in the table 11.



Graph 8: The P_2 and N_2 Latency of right and left ear across age in the control group

It can be seen in the above graph that P_2 latency showed similar variation as seen for P_1 and N_1 for both in terms of latency changes with age and difference between right and left ear latency. However similar changes could not be obtained for N_2 indicating wide range of variability.

Table 11: t-values between the right and left ear latencies of P_1, N_1, P_2 and N_2 in control group

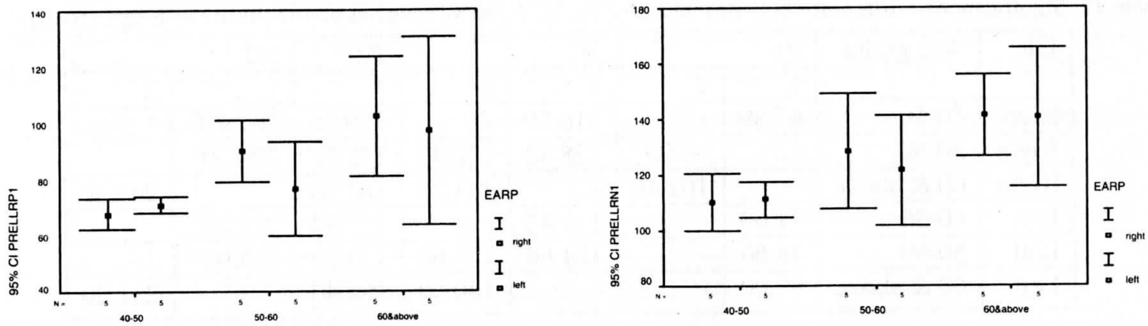
Age	P1	N1	P2	N2
30-40	1.9	2.1	0.9	2.4*
40-50	3.9*	3.0*	3.7*	1.36
50-60	1.6	0.91	0.97	3.5*
60 & above	3.0*	0.9	11*	1.3

* $p< 0.05$

MANOVA indicated that the interaction effect is significant between age groups within the control group in right ear for P_1, N_1, P_2 latencies. Left ear P_2 and N_2 also indicated significant interaction between the age groups (table 12).

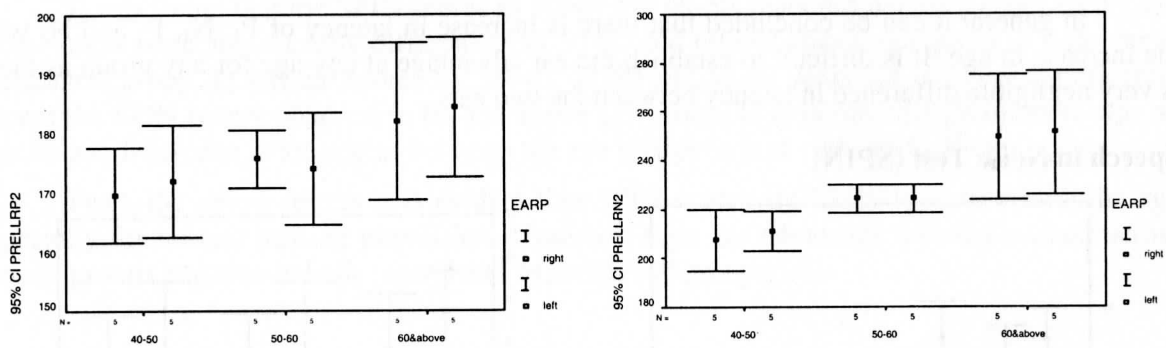
Table 12: Significance of difference between mean of P_1, N_1, P_2 and N_2 latencies of control group across the age

Ear	Age group	P1		N1		P2		N2	
		1	2	1	2	1	2	1	2
Right	30-40	63.00		105.50		165.30		205.90	
Right	40-50	67.00		106.70		166.90		214.70	214.70
Right	50-60	69.00		111.40		168.60			220.00
Right	60 & above		82.10		124.50		174.60		222.80
Left	30-40	69.50		107.60		168		207.70	
Left	40-50	71.40	71.40	113.30		169		208.90	
Left	50-60	72.500	72.500	117.50		171		211.50	
Left	60 & above		84.20	118.70		173			223.10



Graph 9: The P_1 and N_1 latencies of right and left ear obtained in the experimental group

Graph 9 illustrates that there is an increase in latency of P_1 and N_1 with increase in age in both right and left ear. The individual variation in P_1 and N_1 latency also increased with increase in age. However, the mean value of P_1 and N_1 latency of the right ear is shorter than that of left ear which has failed to reach the significance level as seen in table 11.



Graph 10: The P_2 and N_2 latencies of right and left ear obtained in the experimental group

Graph 10 also highlights the similar trend in P_2 and N_2 latency variation and individual variation in latency with age for both right and left ear as seen in N_1 and P_1 latency. However there is hardly any difference in P_2 and N_2 mean latency between the two ears. This failed to reach the significance level as seen in table 11 except for P_2 in I group.

Table 13: t-values between the right and left ear P_1, N_1, P_2 and N_2 latencies in experimental group

Age	P1	N1	P2	N2
40-50	1.6	0.7	3.7*	1.4
50-60	1.4	0.50	0.31	1.13
60 & above	0.79	0.16	0.6	0.2

* $p < 0.05$

Table 12 shows that in presbycusis groups P_1 latency of right ear in 1st group which is significantly different from 50-60 and 60 & above age groups. In right ear N_1 latencies of 40-50 group and 50-60 age group did not vary significantly except 60 and above group. Right ear P_2 latencies did not vary significantly across the age. N_2 latencies of 40-50 and 50-60 groups of right ear did not vary significantly but these latencies varied significantly from 60 & above age group.

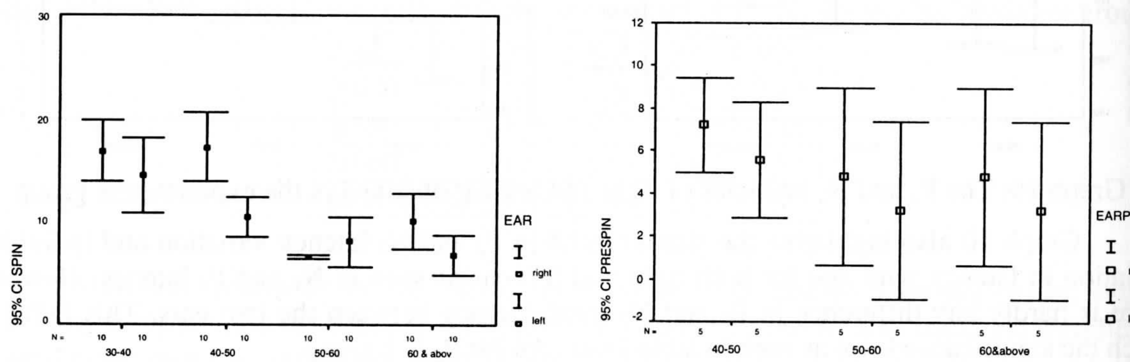
Table 12: Significance of difference between mean for P_1, N_1, P_2 & N_2 latencies across presbycusis age groups

Ear	Age group	P1		N1		P2	N2	
		1	2	1	2	1	1	2
Right	40-50	67.80	-	110.20	-	169.60	207.400	
Right	50-60	-	90.00	128.40	128.40	175.60	224.20	
Right	60 & above	-	102.40	-	141.20	182.00		249.40
Left	40-50	71.00	-	111.40	-	171.80	211.20	
Left	50-60	76.60	-	121.60	121.60	174.00	219.00	
Left	60 & above	97.00	-	-	140.60	184.40		251.20

Left ear latencies of P_1 peak shows that there is no significant difference between the age groups. It was observed that N_1 latency of 40-50 and 50-60 groups did not vary significantly where in 60 and above age group varied from 40-50 and 50-60 age group. There was no significant difference in left P_2 latencies between the age groups. It was also observed that N_2 peak latencies of 40-50 and 50-60 group did not vary significantly where as 60 and above age group varied from 40-50 and 50-60 age group.

In general it can be concluded that there is increase in latency of P_1, N_1, P_2 and N_2 with the increase in age. It is difficult to establish the ear advantage at any age for any group as there is very negligible difference in latency between the two ears.

Speech in Noise Test (SPIN)



Graph 11: SPIN scores of right and left ear in control group (A) and experimental group(B)

Graph 11 indicated that the mean scores of right and left ears reduced with the increase in age in control group and in experimental group. Scores were always higher for right ear than left ear. It can be seen from the significance table13. The variation in scores across the age groups was not uniform.

Table 13: t-values between the right and left ear scores of control group and experimental group

Age	Control Group	Experimental group
30-40	1.20	-
40-50	11.1*	1.63
50-60	3.7*	1.0
60 & above	4.0*	1.0

* $p < 0.05$

The interaction analysis (MANOVA) performed in SPIN showed that there is a significant effect of interaction between the whole group and SPIN scores of right and left ears. The interaction effect was also obvious between different age groups and both ears' scores.

Table 14: The right and left ear scores obtained in control and experimental group

Ear	Age group	Control group		Experimental group
		1	2	1
Right	30-40	10.0	-	-
Right	40-50	11.6	11.6	7.2
Right	50-60	- -	16.8	4.8
Right	60 & above	- -	17.2	4.8
Left	30-40	6.8	-	-
Left	40-50	8.0	-	5.6
Left	50-60	10.4	10.4	3.2
Left	60 & above	- -	14.4	3.2

It was found that the SPIN scores in 30-40 and 40-50 years did not vary significantly but these scores were significantly different from 50-60 and 60 and above age group in right ear in the control group. In left ear scores for 30-40, 40-50 and 50-60 years did not vary significantly except the SPIN scores obtained in 60 and above age group. In experimental group there was no significant difference in the scores between the age groups in both right and left ear.

From the above results it is evident that SPIN scores are likely to reduce with the age especially for normal hearing population. However, right ear advantage was maintained across the age groups and also in both control and experimental groups.

Discussion

Results of this study indicate that there is deterioration in audiological test results with aging. Such changes are noticed from peripheral to cortical level. It has been demonstrated that right side specialization which is widely accepted as a normal phenomena is being maintained in the normal hearing group across the age groups whereas presbycusis group showed left ear advantage at peripheral level. A significant change has been noticed above 60 years of age.

1. Changes observed at the peripheral level

It is observed that TEOAE amplitude is greater in the right ear than in the left ear in the control group across all the age range. This is suggestive of enhanced auditory processing in the right ear. This suggests that the peripheral right ear advantage is retained over the age. A similar observation was also reported by Sherif et al., (2005).

In the present investigation the peripheral right ear advantage was clearly evident in the normal hearing group. It was also significant that as the age progressed the amplitudes reduced in both the ears. It indicates that OHC motility and functionality had been equally affected in both ears with age. On the contrary in the presbycusis group the left ear otoacoustic emissions became more predominant (significantly higher TEOAE amplitudes). These results indicate that the deterioration in OHC function was greater in the right ear than the left ear in presbycusis.

The OHC of the cochlea is more vulnerable to ischemia than the inner hair cells (Kimura & Perlman, 1958). The aged ear has less capacity to maintain stable blood flow and thus may be more vulnerable to stress factors that affect cochlear function starting with deficits in OHCs. This might answer the findings reported in this study. However the reason for change in peripheral laterality in presbycusis is not clear.

2. Changes observed at the brainstem level

Auditory brainstem potentials were used to evaluate the function of brainstem. It was observed that as the age progressed there was a significant increase in the absolute latencies for right and left ears which is in support to the fact that aging affects the brainstem level adversely. Chu (1985) and Mamatha (2003) also observed the similar changes in latency with aging. Normal hearing group results reflected the fact that right ear advantage is maintained through out the age groups. The same has been observed and this supports the findings of Sininger et al (1998).

In presbycusis groups there was no significant difference obtained between the right and left ear latencies. This suggests symmetrical changes at the level of brain stem. However Bellis, Nicol and Kraus (2000) found that the pattern of left sided dominance in the neural representation of speech sounds seen in children and young adults is not evident in older adults.

3. Changes observed in cortical level

Results showed that there was significant age related deterioration in latencies for both the ears which is in support with the findings by Bahramai, Gordon, Lagopoulos and Lim (1999). Right ear advantage was maintained throughout the normal age groups which are in accordance with the study by Terry et al, (2000). There was an exceptional change found in N2 latency which would be due to state of arousal of the individual or attention paid to stimulus as N2 usually get affected by such factors. In presbycusis group it was observed that as the age increased the laterality was getting disappeared. This is in accordance with the findings reported by Tery, Trent and Kraus (2000). They explained that the right ear advantage is lost in elderly. Radouane, Patrick and Mireille (2005) also reported that as age progresses the ear advantage of right over left diminishes.

4. Changes observed in the central processing level

The SPIN tests are generally accepted as a measure to assess central auditory processing because of the obligatory involvement of central and brainstem binaural pathways. The test scores are consistent with the previous finding by Sherif et al, (2005) that aging causes progressive decline in the central processing of speech. The present study proved that the right ear advantage phenomenon in the normal hearing individuals is maintained across the age groups. The experimental group showed no significant difference between the ears across age. This is in contrary to the findings reported by Sherif et al, (2005). Thus it suggests that there might be shift in ear advantage in peripheral level due to age and hearing loss. However such changes may not be evident at the central nervous system.

Conclusions

The possible conclusions from the study are:

- It gives an idea that as the age increases there is significant deterioration at all the levels of the auditory system in normal hearing individuals.
- A significant increased performance of right ear over the left in normal hearing elderly can be expected.
- Ear advantage can alter in individuals with hearing loss due to aging at the peripheral level.
- A symmetrical function can be expected at the cortical level in elderly hearing loss individuals.

Thus it can be concluded that age related deterioration in auditory performance can take place at any level independently or at all level simultaneously. Change in audibility is likely to be more affected after 60 years of age.

Implications

- The information about ear advantage might be useful in hearing aid prescription and for training purpose.
- Appropriate remedial plan can be taken, may be more training is required depending upon the ear which is less advantageous.
- Gives an idea about choice of tests to be used to evaluate the age related changes and the levels at which the tests have to be evaluated.

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