

# Dichotic Hearing in Elderly Hearing Aid Users Who Choose to Use a Single-Ear Device

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## Abstract

**Introduction** Elderly individuals with bilateral hearing loss often do not use hearing aids in both ears. Because of this, dichotic tests to assess hearing in this group may help identify peculiar degenerative processes of aging and hearing aid selection.

**Objective** To evaluate dichotic hearing for a group of elderly hearing aid users who did not adapt to using binaural devices and to verify the correlation between ear dominance and the side chosen to use the device.

**Methods** A cross-sectional descriptive study involving 30 subjects from 60 to 81 years old, of both genders, with an indication for bilateral hearing aids for over 6 months, but using only a single device. Medical history, pure tone audiometry, and dichotic listening tests were all completed.

**Results** All subjects (100%) of the sample failed the dichotic digit test; 94% of the sample preferred to use the device in one ear because bilateral use bothered them and affected speech understanding. In 6%, the concern was aesthetics. In the dichotic digit test, there was significant predominance of the right ear over the left, and there was a significant correlation between the dominant side with the ear chosen by the participant for use of the hearing aid.

**Conclusion** In elderly subjects with bilateral hearing loss who have chosen to use only one hearing aid, there is dominance of the right ear over the left in dichotic listening tasks. There is a correlation between the dominant ear and the ear chosen for hearing aid fitting.

## Keywords

- hearing aids
- auditory perception
- aged
- deafness
- hearing

## Introduction

Hearing loss mostly affects older individuals and directly affects the ability of people to relate to each other. It can lead to social isolation, depression, and inactive communication, which can seriously affect the quality of life for the individual.<sup>1</sup> Technological resources, such as hearing aids, can minimize the negative effects of hearing loss in the elderly. Several studies have demonstrated that the quality of life for the wearer and his family improves after adopting and

adapting to the device.<sup>2–6</sup> However, several aspects may influence the use of these resources, such as poor user guidance, lack of counseling, inappropriate expectations about the benefits of hearing aids, and individual limitations caused by peripheral and central hearing problems.<sup>5</sup>

Studies show that elderly patients may have central auditory processing disorders, due to the process of aging of the peripheral and central auditory pathways. This process results in a decrease in auditory information processing, leading to difficulties in processing verbal and nonverbal information.<sup>7,8</sup> Because of this, auditory processing tests have been

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routinely used in speech-language pathology to prescribe hearing aids. By knowing the skills and auditory disabilities of the user, in addition to issues related to hearing, the speech-language pathologist can guide the counseling sessions, adaptation, and adjustment of the device.<sup>9</sup> The speech protocol selection and fitting of hearing aids for adults and seniors shows that a greater amount of information collected provides real expectations, better guidance, and greater effectiveness in advising patients on the use of their hearing aids, favoring auditory performance, satisfaction, and benefits to the user.<sup>10</sup>

Furthermore, the performance of dichotic listening in elderly patients with peripheral hearing loss is important and should be investigated, because central hearing decreases the likelihood of understanding speech, especially in situations where the sound signal is degraded when the environment or sound is unfavorable.<sup>11</sup> In the elderly population, asymmetry in verbal dichotic tests increases with age and influences failure in interhemispheric transfer and cognitive functions. The introduction of dichotic tests in the assessment of elderly hearing can aid in the early identification of peculiar degenerative processes of aging.<sup>12</sup>

Finally, there is consensus that in individuals with bilateral hearing loss, the use of two devices is ideal as it gives the user the ability to localize sound events in the environment and promotes resolution of frequency.<sup>13</sup> However, in clinical practice it is not rare that audiologists and physicians encounter patients who, despite the bilateral use recommendation, benefit from and prefer unilateral use. Thus, the established goal of this study was to evaluate the dichotic listening of a group of elderly hearing aid users who are not comfortable with binaural use of the devices and to check the correlation between ear and hand dominance with respect to the side chosen to wear the device.

## Methods

This descriptive cross-sectional study was approved by the Research Ethics Committee under the number CEP/027/2008. All participants signed a consent form authorizing the use of the collected data. Participating in the survey were 30 individuals from 60 to 81 years of age, with a mean age of 74, and 60% of the subjects were women with 40% men.

Inclusion criteria were diagnosis of moderate to moderately severe symmetrical sensorineural hearing loss<sup>14</sup> and having bilateral hearing aids for over 6 months, with an effective use of only one device. Excluded from the study were subjects who did not use the two devices effectively because of complaints related to diseases of the ear (otitis, dermatitis, etc.), systemic disorders, or dementia, as these conditions may influence the quality of hearing aid use.

Data collection occurred in two accredited speech clinics in the Brazilian Unified Health System (SUS), and the sample was selected from the analysis of users' medical records and follow-up consultations. All participants gave a specific medical history, which gathered data about the effective use of hearing aids and why they do not use devices in both ears. After that, the subjects underwent pure tone audiometry for

air and bone conduction and a dichotic listening test using single-digit numbers (TDD),<sup>15</sup> which was applied under the selective attention condition in 50-dB SL (sensation level).

The TDD was analyzed considering the overall score and ear, with the goal of establishing the dominant ear. The results were statistically analyzed by the difference of proportions and Fisher tests, at a significance level of 0.05.

## Results

All research participants had bilateral prescriptions for hearing aid use, given by SUS, but only used a device in one ear. All subjects in the sample had abnormal results on the TDD, considering that the normal range is 90% at 100%.<sup>15</sup>

The test results per participant relating to the dominant ear and the preferred ear for hearing aid use are presented in ►Table 1.

The types of devices that were prescribed and the justifications for unilateral use are shown in ►Table 2.

## Discussion

Auditory processing tests show how listening helps us construct a consciousness of the world. Tests that use degraded or sensitized material to assess the auditory pathways of the tested individual may show changes consistent with dysfunction and aging pathways.<sup>16</sup>

The TDD used in this study is a dichotic test (in other words, a verbal stimulus), and in this case a number is presented to one ear and at the same time, a second number is presented to the other ear. We use the same level of auditory sensation, that is, 50 dB above the pure tone average, obtained in pure tone audiometry. The evaluated individual must repeat the two presented numbers. In subjects without auditory processing disorder, correct responses are expected more than 90% of the time in both ears. The proper identification of received stimuli in the right ear indicates neurobiological integrity, including the interhemispheric communication at the level of the corpus callosum. Altered results in both ears suggest changes in the left hemisphere.<sup>17</sup>

In this study, the overall results of the TDD revealed that all participants had abnormal results. This was expected, because the sample is characterized as having bilateral hearing loss associated with aging, or presbycusis.

Other studies corroborate this finding: a survey of 110 elderly subjects evaluated interaction with verbal and non-verbal sounds and considering those with and without hearing loss by means of auditory processing tests. Those with hearing loss had difficulty in the binaural interaction process, because their auditory information was not complete<sup>18</sup>; another study demonstrated that sensorineural hearing loss cannot be considered as a determinant of auditory processing in the elderly, but it can be considered an aggravating factor.<sup>19</sup> In that study, the majority of cases in the control group were abnormal using an Spondaic Staggered Words test (SSW) test, inferring that age suggests alterations in auditory processing, independent of hearing loss.

**Table 1** TDD results with preferred ear for hearing aid use

Subject	Dominance in TDD	Ear chosen for hearing aid use
1	Right ear	Right ear
2	Right ear	Right ear
3	Left ear	Left ear
4	Left ear	Left ear
5	Right ear	Right ear
6	Indifferent	Right ear
7	Left ear	Right ear
8	Right ear	Right ear
9	Left ear	Right ear
10	Left ear	Left ear
11	Right ear	Right ear
12	Left ear	Left ear
13	Right ear	Right ear
14	Right ear	Right ear
15	Right ear	Left ear
16	Left ear	Left ear
17	Left ear	Left ear
18	Right ear	Right ear
19	Right ear	Right ear
20	Right ear	Right ear
21	Right ear	Right ear
22	Left ear	Left ear
23	Right ear	Right ear
24	Indifferent	Right ear
25	Right ear	Right ear
26	Right ear	Right ear
27	Right ear	Right ear
28	Right ear	Left ear
29	Left ear	Left ear
30	Right ear	Right ear
<i>p</i> value	0.0426 <sup>a</sup>	0.0005 <sup>b</sup>

Abbreviation: TDD, dichotic test for ear dominance.

<sup>a</sup>Using difference in proportions test, with a significance level of 0.05, there was significant dominance found ( $p = 0.0426$ ) for the right ear in TDD.

<sup>b</sup>Using Fisher test, with a significance level of 0.05, there was significant dominance found ( $p = 0.0005$ ) of the right ear for hearing aid use, being consistent with the dominant ear and the chosen ear.

The literature explains that in the auditory system, the destruction of the outer hair cells results in striking and immediate changes in the frequency tuning of auditory nerve fibers and neurons along the auditory pathway. These changes are a direct result of the elimination of cochlear amplification. As with mechanisms for processing frequency, stimulus deprivation in the auditory system due to sensorineural hearing loss results in changes in some aspects of

**Table 2** Type of hearing aid and justifications for using only one device

Complaint	ITE	BTE
Difficulty in understanding speech	11	7
Makes a lot of noise	7	3
Aesthetic reasons	0	2
Total	18	12
<i>p</i> value	0.0004 <sup>a</sup>	0.0003 <sup>a</sup>

Abbreviations: BTE, behind the ear; ITE, in the ear.

<sup>a</sup>Through a test of difference in proportions, with the significance level of 0.05, it is found that there is no significant difference ( $p > 0.05$ ) between the type of device and the justification for not using it.

temporal processing.<sup>20</sup> Aging not only represents a loss of hearing sensitivity, but also decreases the efficiency of all auditory abilities.<sup>21</sup> In research conducted on elderly people who say they hear well, inferior results compared with normal standards were found for adults in an auditory processing test (SSW, which assesses dichotic listening) and suggest impairment of the auditory pathways of the right hemisphere, the left hemisphere, and the corpus callosum areas, which are responsible for carrying out the task of dichotic listening<sup>22</sup>; this allows us to infer that the difficulties in auditory perception often are not associated with the presence of peripheral hearing loss.

In this study, with regard to the score for each ear, we found that 60% of the subjects showed dominance of the right over the left ear, and the difference was statistically significant. Other literature agrees with this finding and claims that binaural interference, inefficiency in interhemispheric transfer, and left ear deficit in dichotic tasks provide better right ear performance.<sup>23</sup> Comparing the performance of older adults with sensorineural hearing loss with mono- or binaural device use, for the recognition of sentences during noise, researchers concluded that most participants showed better performance in noise with unilateral amplification, and this trend is more evident with increasing age. The researchers also observed that speech recognition was better in the right ear than in the left.<sup>24</sup> In a study comparing cognitive processing in older adults before and after the use of hearing aids, better recognition of single-digit numerals in dichotic listening could be found in the right ear.<sup>25</sup>

The ideal condition of an individual's hearing, in addition to the presence of normal audiometric thresholds, happens when both ears work together in a balanced and symmetrical way in the detection and management of the sound wave. Bilateral hearing favors a series of auditory skills. Research conducted in patients with unilateral hearing loss observed difficulties in locating, closing, resolution, and temporal ordering. Also, it could be concluded that individuals with unilateral hearing loss on the right complain more than those with loss on the left.<sup>26</sup>

When, in the same individual, the performance of one ear is superior, the performance in the worse ear can hinder the performance of the other, which is called *binaural interference*.<sup>27</sup> Binaural interference is a condition in which binaural

performance is more impaired than monaural. In the sample studied here, 100% of the participants reported that they do not use two hearing aids because simultaneous use disrupts the process of auditory perception.

The justifications submitted by participants for nonbilateral use were analyzed. The majority, 62%, claimed that the use of both devices made it difficult to understand speech, followed by the complaint that bilateral use caused a lot of noise, which 32% of participants complained about. The literature explains that individuals who exhibit poor performance in dichotic listening tasks can get better utilization with the use of unilateral amplification, because the response of the worse ear seems to affect the response of the better ear, providing superior performance with unilateral amplification.<sup>28</sup> This fact is corroborated by other consulted authors. In a group of 28 subjects with bilateral hearing loss, 71% reported better speech understanding in noise with the use of one hearing aid compared with two.<sup>29</sup> In another group, comparing the performance of speech recognition in the presence of background noise in listening situations with one and two hearing aids, 82% of the respondents said results were superior when using one hearing aid.<sup>24</sup> A recent study evaluated 94 subjects in which 46% of the participants had the preference of using a single device instead of two, even when using a latest-generation hearing aid.<sup>30</sup>

In our sample, 6% did not use two devices due to aesthetic issues, and those two respondents were prescribed behind-the-ear hearing aid models. The literature reveals that, in response to questionnaires evaluating the performance of hearing aids, the worst scores refer to issues related to self-image and the stigma of hearing loss, where the visibility of the hearing aid is taken as a negative.<sup>31–33</sup> In clinical practice, it is common to see teenagers and elderly patients stop using their devices as a function of aesthetics.<sup>34</sup> However, a qualitative data analysis has shown that the two participants in this study who complained of aesthetic considerations also had dominance of the right ear and used the device in this ear. This fact implies that, despite the undesirable appearance, use of a hearing aid makes for a better auditory pathway for the patient.

This study allows us to infer that any audiological evaluation for the elderly not only must involve tests for hearing thresholds of the individual such as audiometry, but also should consider the patient's perception regarding his or her functional hearing loss along with social, family, and daily activities, which agrees with the literature. Studying auditory processing abilities can help with adaptation protocols for hearing aid use as well as the reduction of complaints from users and an increase in quality of hearing and of life for the subjects.<sup>35</sup> The use of dichotic tests to establish the dominant ear and the best way of fitting a hearing aid are recommended.

## Conclusion

In elderly subjects with bilateral hearing loss who have chosen to use only one hearing aid, there is dominance of the right ear over the left in dichotic listening tasks. There is a

correlation between the dominant ear and the chosen ear for hearing aid fitting.

The consensus is that in bilateral hearing loss, the use of amplification in both ears is ideal because the stimulation of the central auditory pathways promotes binaural summation and improves auditory processing. Based on the results obtained in this study, conducting auditory training of weak auditory pathways to prepare patients for fittings can be important.

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