

# BINAURAL INTERFERENCE IN HEARING AIDS FITTING PROCESS: A SYSTEMATIC REVIEW

## *Interferência binaural no processo de seleção e adaptação de próteses auditivas: revisão sistemática*

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### ABSTRACT

The background of this study is the binaural interference and the purpose is to describe, by a systematic review of the literature, the phenomenon known as binaural interference. A systematic review of the literature was carried out in electronic databases LILACS, MEDLINE, PUBMED and SCIELO. The binaural interference is a phenomenon reported in the literature which needs to be investigated. This phenomenon can be confirmed by specific auditory processing tests, the most reported in the literature was the dichotic digit test.

**KEYWORDS:** Hearing Loss; Hearing Aids; Auditory Perception

### ■ INTRODUCTION

Hearing is one of the primordial senses for human beings to establish the relationship with what surrounds them. As a child in development, as an adult who established relationships need this ability to communicate with others. However, in some cases, there is decrease of this function for several causes.

When the hearing loss is detected and diagnosed, it emerges the necessity of a resource to minimize this damage. The hearing aids are a proposal to decrease this deficiency<sup>1</sup>.

The natural hearing process is binaural. So, the binaural aids implantation is more indicated because it enables many benefits. Thus, the patients would use all the advantages of the interaural differences,

time and spectrum of the sound stimuli, what propitiates clues to approximate the patient of normal hearing experiences<sup>1</sup>.

The technological advances and the resources used in hearing devices have helped professionals of the area to perform adjustments, enabling the decrease of complains about speech comprehension difficulties and reestablishing hearing skills closer to normality. Nevertheless, even with all available resources, several patients, users of hearing aids, with proper adjustment for their hearing loss and with continuous monitoring, present complaints which are not compatible with their hearing findings.

These complaints may be related to a phenomenon called binaural interference, in which the patient refers better performance and confrontation using only one hearing aid. In this case, the communicative performance, with the use of two aids, is worse than one, because one ear interferes negatively in the other, what damages the whole individual's performance<sup>2,3</sup>.

As this phenomenon started to be described recently and only in consistent way, in national literature, there is the need of better studies about the topic to understand the factors which are related to it. So, the purpose of this study was to describe the phenomenon called binaural interference, through a systematic review about the topic.

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Conflito de interesses: inexistente

## METHODS

In the present study, it was performed a systematic review for collection of data and studies about the phenomenon called binaural interference.

The bibliographic review was performed in electronic data basis, online magazines in the area of audiology, congress annals and complementary bibliography such as books in the area of knowledge.

Initially, it was performed bibliographic collection in the data bases LILACS, MEDLINE, PUBMED and SCIELO. For the collection of descriptors, it was used the structured and trilingual vocabulary - *Descritores em Ciências da Saúde* (DeCS), created by Bireme.

Figure 1 presents the search strategies used for the bibliographic survey.

In the bibliographic survey from the last five years, the following results were found, according to Figure 2.

Search Strategy	
Descriptors in English	Descriptors in Portuguese
<i>Auditory perception and hearing loss and hearing aids</i>	Percepção auditiva and perda auditiva and auxiliares de audição
<i>Auditory perception and hearing aids</i>	Percepção auditiva and auxiliares de audição
<i>Hearing loss and hearing aids</i>	Perda auditiva and auxiliares de audição

Figure 1 – Search strategy (descriptors) used in this study

SCIELO data basis:		
Descriptors:	Obtained results:	Relevance for the topic:
Percepção auditiva and perda auditiva and auxiliares de audição	0	0
Percepção auditiva and auxiliares de audição	2	0
Perda auditiva and auxiliares de audição	32	2
LILACS data basis:		
Descriptors:	Obtained results:	Relevance for the topic:
Percepção auditiva and perda auditiva and auxiliares de audição	1	0
Percepção auditiva and auxiliares de audição	2	0
Perda auditiva and auxiliares de audição	22	0
MEDLINE data basis:		
Descriptors:	Obtained results:	Relevance for the topic:
Percepção auditiva and perda auditiva and auxiliares de audição	23	0
Percepção auditiva and auxiliares de audição	46	0
Perda auditiva and auxiliares de audição	237	0
PUBMED data basis:		
Descriptors:	Obtained results:	Relevance for the topic:
<i>Auditory perception and hearing loss and hearing aids</i>	990	6
<i>Auditory perception and hearing aids</i>	1344	7
<i>Hearing loss and hearing aids</i>	2029	13

Figure 2 – Research in the data bases

It was performed critical analysis of each article, based on the title and summary contents. The topics with no relationship with the study focus were excluded as, for example, asymmetrical hearing loss, unilateral adaptations, cochlear implant, tinnitus and neurological alterations. In the end of this survey, 28 studies were selected, all related with the topic and purpose of this study, binaural interference and monaural and binaural adaptation. However, repeated articles were excluded, what resulted in 21 relevant articles for the study.

In the end of the studies' collection, it was observed that there were not articles with fundamental importance for the topic, which would not be found through the descriptors of health sciences. Thus, it was performed a second survey in the data bases LILACS, MEDLINE, PUBMED and SCIELO, using as main words "binaural and interference" and as complementary words "bilateral and hearing and aids".

During the research of the first words, all the results were analyzed, obtaining a total of 55 publications. The second research, because it presented broader words, was investigated in the last five years, with a total of 790 publications. Only 25 publications were included, in the total, regarding the studied topic. The studies which were already found were excluded, with a total of 10 relevant studies for the systematic review.

It was also used as complementary bibliography books in the area of knowledge and some periodical articles related to the studies topic, published out of the described period.

The selected articles were described through chain of ideas.

## ■ LITERATURE REVIEW

Normal hearing occurs in binaural way, in which the subject hears normally with both ears. This process helps the individual to better locate the sound source and to understand speech in the noise. It occurs by binaural summation, ability of the central hearing processing to integrate the information when they are perceived by both ears. With the same sensitivity in both ears, the binaural auditory threshold is better 3 dB than the monaural<sup>1</sup>.

Hearing represents for human beings the most important way to perceive information and it allows that they relate themselves with what surrounds them. The hearing loss is among the most disabling diseases, depriving subjects from communication, what causes impact in quality of life. This may be a cause of isolation and depression<sup>4</sup>.

To minimize the consequences of hearing loss in patients' lives, it is known that the individuals'

rehabilitation is possible with the use of hearing aids<sup>5</sup>. The adaptation of hearing aids may result improvements in the subjects' quality of life, as well as in their mental health, vitality and social life<sup>4</sup>.

The bilateral hearing aids should be indicated for all patients with symmetrical hearing loss, because they present binaural advantages, such as better location of the sound source, shadow effect, ability to separate sounds from environmental noise, better recognition of speech in the presence of noise and binaural summation, because the sound which is presented in both ears is perceived with more intensity than monaural hearing<sup>1-6</sup>. So, unless there is contraindication, the use of two hearing aids is always the best alternative.

For the professionals of the area, the indication of binaural use is safe, because it avoids hearing privation, described as a reduction of the indexes of speech recognition, from hearing loss without the use of amplification, and consequent sensorial privation. The gradual deterioration along time in hearing performance is associated to the reduction of the available acoustical information, what occurs independently of hearing aging<sup>1,7,8</sup>.

However, even after professional orientation, several patients decide to use only one hearing aid, either for esthetical or for financial issues, or even because of handling with patterns and aids<sup>1,9</sup>. A current study shows that 25% of the population, users of bilateral hearing aids prefer to use only one aid<sup>2,8,10</sup>.

Patients report that with the use of hearing aids, the difficulty is not in hearing, but in understanding, mainly in noisy environments<sup>11</sup>. The responsibility of the professional is to guide and to use strategies to minimize the communication problems and to control the patient's expectancy, with a true relation of confidence<sup>12</sup>.

Studies have related patients fit with a hearing aid in a proper way and with complaints which are incompatible with the audiological findings, with auditory processing alterations, regarding difficulty in the perceptual process of information in the central nervous system, result of improper performance by one or more auditory skills, or even the occurrence of binaural interference<sup>13</sup>.

The auditory processing is related not only to hearing, but also to understanding what is heard. It is necessary the integrity of the auditory and central nervous systems, to process the information, to analyze the characteristics of the auditory stimuli and to interpret them<sup>14,15</sup>.

In the 90s, Jerger described a phenomenon called binaural interference, condition in which the performance with two hearing aids is more damaged than the performance with just one. Such phenomenon

was identified after case reports, in which the patients showed better performance in communicative situations in the condition of monaural amplification. For the author, this phenomenon is related to an alteration in the hearing process, what results in worse capacity of speech comprehension. This may reach 8 to 10% of the population<sup>16</sup>.

To verify the occurrence of binaural interference, professionals of the area have used, initially, the speech recognition test. It is applied the percentage index of speech recognition (PISR), supraliminal measurement, which determines the listeners' ability to understand speech in ideal hearing conditions<sup>17</sup>, verifying the subjects' auditory behavior in situations of communication<sup>18</sup> first in one ear, then in the other one, and finally in both ears<sup>19</sup>.

The basic audiological evaluation, which consists of tonal threshold audiometry, speech audiometry and imitanciometry, does not make possible to identify, even in cases of symmetrical hearing loss, if the patient will have benefits with monaural or binaural aids.

Considering that the binaural influence was described as a hearing processing alteration, it is necessary to have specific evaluation to help the audiological diagnosis. So, to evaluate one of the abilities of the auditory processing, related to binaural interference, literature has described the Dichotic Digits Test<sup>8,9,20,21-23</sup>.

This test evaluates the binaural integration, with the purpose of verifying the ability of grouping the components of the acoustic signal in figure-to-ground and of identifying them, and the binaural separation, what enables directed evaluation and listening for each ear separately<sup>20,24</sup>. It is applied in the free attention stage, in which the individual has to repeat four stimuli and, then, in the stage of directed attention, in which the involved auditory abilities are of binaural integration and separation<sup>24</sup>.

For the authors<sup>10</sup>, more specific studies are necessary to identify the performance of speech recognition in dichotic tests, which indicates binaural processing alterations, being directly connected to binaural aids' rejection.

A strategy to improve the results and benefits with amplification may be the need of identifying the auditory processing alteration before the use of hearing aids. Thus, once several cases of failure can be related to the presence of binaural interference, its identification may be determinant for the success in the process of selection and adaptation of hearing aids.

In a case study, a patient with complaints of communication difficulties, mainly in noisy environments, was evaluated with the dichotic digit test. In the end of the evaluation, it was verified alteration in

the binaural integration, because the performance in the right attention was 65%, in the left attention was 69% and in the integration, when the stimuli was presented in binaural way, it was 8%. In this case, it would be indicated the monaural aids, because when both ears have to work together, the performance was not satisfactory<sup>25</sup>.

In a research performed with 100 patients, using the dichotic digit test, those who presented results with three pattern deviations under the average, showed interest in unilateral aids<sup>26</sup>. It may be justified, because as the hearing loss increases, the degree of alteration in auditory processing also increases<sup>21</sup>.

In another study with 28 elderly people, with symmetric sensorial hearing loss, it was applied the speech recognition test in noise. The evaluation was performed in three stages: with hearing aid in the right ear, with hearing aid in the left ear and in both. The author concluded that not always the binaural aids are an advantage for elderly people, mainly in situations of noise. So, it reflects the need of evaluating each case individually<sup>27</sup>.

The use of speech tests in silence and in noise, with the use of questionnaires are also described as a suggestion to evaluation before auditory rehabilitation, verifying the speech recognition and the possible complaints which may guide better conduct in the choice or not of binaural aids<sup>8,16,23,28</sup>.

Through subjective tests and questionnaires, it was researched the acceptance of one or two hearing aids in 214 patients, evaluated in the experience period; 93% of the individuals preferred binaural aids, while 7% preferred the unilateral aids. The subjects who referred improvements with the use of two hearing aids, expressed several benefits, except in relation to strong sounds<sup>6,29</sup>.

In another study, 94 subjects with symmetric sensorial hearing loss, with mild and moderate degrees were evaluated. From these, 46% preferred to use only one hearing aid, and the ones who preferred aids in both ears presented more positive performance in daily living activities<sup>22</sup>.

Researchers performed a study applying speech audiometry in patients with monaural and binaural aids, after acclimatization. The results showed that there was performance difference in the group of monaural users, evidencing that the aided ear presents better performance, but the not aided ear presents a possible auditory deprivation. The authors suggest that auditory deprivation and acclimatization are relevant aspects for further research<sup>30</sup>.

Among 20 users of binaural hearing aids, after evaluation of the speech recognition in noise, 80% of them presented better performance for speech



recognition with binaural aids and only 20% with monaural aids<sup>28</sup>.

The lack of benefits with binaural aids among elderly people has been associated with the deficit of auditory processing. A great part of the patients, who look for selection and adaptation of hearing aids, with symmetric hearing loss, are adapted with two hearing aids, but researches have referred that in case of elderly people, the performance is, at least, so positive, if not better, with unilateral aids<sup>3,23,26,31</sup>.

In the aging process, a difference of performance between the ears happens, showing improvements in the performance of the right ear, what justifies, in some cases, the patient's preference of using a hearing aid in only one ear<sup>23,31</sup>.

A research performed to evaluate the speech recognition in noise between adults and elderly people without hearing loss demonstrated that the elderly people required more auditory cognitive and processing resources to understand speech in noise<sup>32</sup>. The preference and the benefit reported with one or two hearing aids are not related to the level of technology of the hearing aids<sup>6-22</sup>. Neither the age is limit factor to obtain benefits with digital technology<sup>33</sup>. However, the benefit may be associated with the regular use of hearing aids<sup>34</sup>. Independently of the used technology, adjustments of algorithms and the aid prescription should be proper for each patient<sup>35</sup>.

So, it is recommended that patients with binaural aids, with complaints in competitive noise, use only one of the hearing aids (in these specific situations), preferentially in the right side<sup>23</sup>.

The greatest challenges for the professionals who work with hearing aids are the patients who seem to be candidates to use two aids, but prefer to use only one. However, those who present better results, product of the binaural summation and fusion, are more proper to choose two aids<sup>22</sup>.

Based on these findings, the adaptation in both ears is rethought, not to be generalized for all patients with bilateral hearing loss<sup>22</sup>. Studies have shown probable alteration of auditory processing in elderly people, what may result in the presence of binaural interference, affecting the processes related to the perceptual organization of the auditory information<sup>16,36</sup>. The alteration of these processes can be considered a contra-indication to this type of aid<sup>9</sup>.

The hearing training may be a resource to improve the performance in the abilities of hearing processing and to decrease the degree of difficulty presented by the patients<sup>37,38</sup>. In cases of unilateral aid, when there is hearing privation in the not aided ear, it is indicated a hearing training after the adaptation of the hearing aid<sup>39</sup>.

## ■ FINAL COMMENTS

Observing this phenomenon, which has become more frequent and which may be the cause of failure in the adaptation of hearing aids, it is a role of the professionals to investigate it, in order to clarify/confirm its presence, because this will help them to the best conduct in particular.

In cases of symmetric hearing loss, with complaints of severe difficulties of speech recognition, the binaural adaptation should be seen with care. Specific tests of evaluation should be used, among them it is suggested the monosyllable one, which, although it was found in only one reference in literature, it seems to be used in the clinical practice. Besides, with a higher number of references, there is the auditory processing test called dichotic digit test. These are the two tests found to verify the occurrence of the binaural interference phenomenon.

So, it seems a consensus among the analyzed authors that in the situations in which it is detected the presence of that phenomenon, the use of aid in only one ear may be an option associated with the strategy of auditory training to improve the performance with the hearing aid and to minimize the patients' complaints.

It is emphasized that the strategy of auditory training improves the performance of the aided ear and it stimulates the not aided ear, avoiding the hearing privation. In cases which the hearing privation was already detected, the rehabilitation is possible through this auditory training, with the purpose of adapting both ears when it is possible.

Such patient's report should be considered, remembering that each patient will have specific complaints, so he or she should be evaluated individually.

## ■ CONCLUSION

The phenomenon of binaural interference is a fact which has been confirmed by clinical practice, but it is still not enough reported either in national, or in international literature, what shows the need of more investigation about the topic. The way of evaluation which is the most described in literature to check this phenomenon is the dichotic digit auditory processing test.

Even with several studies about the questioning of monaural versus binaural aids, it remains the necessity of studies to clarify this phenomenon and to develop a careful evaluation protocol of each patient's auditory abilities.

It is emphasized the importance of using auditory processing tests before starting the process of hearing aids selection, mainly in cases that the basic auditory evaluation and the patient's complaints indicate any alteration which is questionable to binaural aids.

## RESUMO

O tema deste estudo é a interferência binaural e tem como objetivo descrever, por meio de revisão teórica, o fenômeno caracterizado por interferência binaural. Será realizada revisão sistemática por meio de pesquisa nas bases de dados LILACS, MEDLINE, PUBMED e SCIELO. O fenômeno interferência binaural é uma realidade relatada na literatura, que precisa ser investigado. Pode se confirmar por testes específicos de processamento auditivo, o mais descrito foi o dicótico de dígitos.

**DESCRIPTORIOS:** Perda Auditiva; Auxiliares de Audição; Percepção Auditiva

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Received on: July 04, 2012

Accepted on: November 20, 2012

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