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# Speech audiometry in English, Portuguese, and Spanish

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# SPEECH AUDIOMETRY IN ENGLISH, PORTUGUESE, AND SPANISH.

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Speech Audiometry in English, Portuguese and Spanish.

The usefulness of a direct measurement of an individual's ability to hear speech is "well enough attested not only by its increasing use in this country but also by development of similar tests on the basis of similar principles in at least eight other languages "(Danish, Finnish, French, German, Italian, Portuguese, Spanish, and Swedish).(4).

Here we shall see what is being done in speech audiometry in the English language, and then we will compare this to the work done in Spanish and in Portuguese in this field; from these works we shall see what directions could be taken for further work in the Spanish language.

First let us see what are the functions of speech audiometry, and second, if these purposes are being fulfilled in the three languages mentioned above.

The purposes of speech audiometry are: "1) to confirm the amount of hearing loss on the audiogram, particularly for the mid-frequency range; 2) to yield diagnostic and prognostic information not given by the audiogram; 3) to provide a more direct approach to a valid estimate of socially adequate hearing, which is chiefly the hearing of speech."(4).

Speech Audiometry in English.(3-4)

Since there has been a considerable amount of work done in speech audiometry for the English language, I will not go into detail about types of speech materials experimented with, etc., but I will describe the tests that are actually being used in speech audiometry for English at the Central Institute for the Deaf.

There are many types of speech materials that could be used for speech audiometry, but the ones that have proved more useful are monosyllabic words and disyllabic words having a spondaic stress pattern. Following are the uses of both types of words:

Spondees: It was found that the lists of spondees have an articulation curve with a gain function that is steeper than that of any other types of words. Lists of spondees have been grouped to form tests that measure the Threshold of Intelligibility(level at which speech must be presented in order that the listener may repeat correctly 50% of the items) and Hearing Loss for speech (the difference in decibels between the speech levels at which the average normal ear and the defective ear, respectively, reach the same intelligibility, often arbitrarily set at 50 per cent). These lists of spondees are recorded by groups at successively lower intensity levels.

The lists have to be presented to the subject, through a speech audiometer, at a high enough intensity so that he will repeat correctly the words in the first group; then the Hearing Loss for speech may be estimated on the basis of the

number of words that the subject hears correctly out of such a list.

Obtaining such a measure as Hearing Loss for speech is only valid as far as its confirming the hearing loss on the audiogram for the mid-frequency range; this measure does not give any additional information on how a patient hears above his threshold of intelligibility or if he could benefit from surgery or from amplification with a hearing aid. In other words, it does not tell us if the patient can discriminate among different speech sounds.

Monosyllabic words: It was found that monosyllabic words were the least analytic unit of speech that could be used in English speech audiometry. There is a great number of such words in English, and when they are presented to an untrained listener it is easier for him to repeat them than nonsense syllables.

Members of the Psycho-Acoustic Laboratory of Harvard University arranged monosyllabic words in lists that are phonetically balanced, which means that the consonant and vowel sounds are distributed in a manner that approximates their distribution in conversational American English.

Monosyllables are more difficult than spondees to hear correctly. Almost all individuals will repeat 100% of the spondees correctly if these are presented at a high enough intensity, but only a few individuals will get 100% articulation scores on the monosyllabic words -even when they are presented at so high an intensity that more increase of volume would not

improve the score.

The nature of the speech stimulus will determine how effective a diagnostic distinction is being made; the nature of the speech stimulus means not only the type of speech material used, but also the talker.

The recordings of P.B.Lists done by Rush Hughes arethe ones that are more valid, because they seem to cause individuals who have non-conductive types of hearing losses to show considerable discrimination losses.

Discrimination loss is not measured in dbs, "it is the difference between 100% and the percentage of words of a P.B.List that a listener repeats correctly at an intensity that is so high that a further increase in intensity will not increase the articulation."

Discrimination loss is determined as follows: a P.B.List, or two, is presented at 100 db SPL. A score of 90% or above is considered normal. A score of below 90% indicates a discrimination loss, and supplies a valuable datum for diagnosis and prognosis.

Thus,we see that the most important test in speech audiometry is the one that can single out a discrimination loss.

SPEECH AUDIOMETRY IN PORTUGUESE (2).

Dr. Geraldo De Sa's paper deals with three different aspects of speech audiometry.

The first part of the paper deals with the importance of speech regardless of the language used and thus the importance of the measurement of how much speech is heard and understood by individuals. Dr. De Sa then points out the magnitude of speech audiometry, mentioning lightly the work that has been done in this field not only in the English language, but also in French and Spanish.

The second part comprises a phonetic analysis of the Portuguese language as spoken in Brazil (Cariocan pronunciation). Two aspects of the phonetic analysis were taken into consideration: a qualitative analysis, identifying all the phonemes of the language, indicating certain differences of pronunciation in the country and trying to get the maximum possible uniformity; and a quantitative analysis using 10,000 words taken from newspapers and magazines. These words were broken into groups of 500 words each and then analyzed. Phonemes having dubious pronunciation were discarded.

The third and final part of the paper deals with speech audiometry itself. After having accomplished the phonetic analysis of the language, Dr. De Sa arranged word lists to be used in speech audiometry, basing his work on the work done for the English language.

Three phonetically balanced lists of monosyllabic words were constructed to be used in discrimination tests; The scarcity of monosyllables in Portuguese made it difficult to balance the lists phonetically, and only 147 words were found. Three words not phonetically balanced were added to make three lists of 50 words each. These three lists, as stated previously, would be used to detect discrimination losses, in determining the S.A.I. and for diagnostic purposes.

To determine the Threshold of Intelligibility of Hearing Loss for Speech

six lists were made. Such lists consisted of trochaic words, as there are no spondees in the Portuguese language. Each list was made of 50 such words, and the initial vowels and consonants were distributed within 95% of phonetic balance.

Finally, Dr. De Sa explains the plotting of the S.A.I. in the English language and then explains the use ofthe P.B.Lists and the lists of trochees to determine Discrimination losses and Hearing losses for Speech respectively.

At the time this paper was written there were neither time nor subjects; therefore, the previously described lists were not used in actual testing. It was left for the future use of them to accumulate data on their clinical value.

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Although there are no results available to me on the clinical use of the material devised by Dr. De Sa, I would conclude that the use of these lists would be valuable, bacause Dr. De Sa's work is very similar to the work being done in English Speech Audiometry. There is one doubt in my mind however: Is Dr. De Sa really going to determine discrimination losses with his P.B.Lists when there is such a scarcity of monosyllables in the Portuguese language? His subjects would have to discriminate out of a lesser number of words than would subjects presented with the English P.B.Lists. Perhaps one way of checking to see if both lists are measuring the same would be to give both the Portuguese and the English P.B.Lists to a number of bilingual listeners and then compare their scores.

SPEECH AUDIOMETRY IN SPANISH (5).

There are three chapters in the appendix of Dr. Tato's Book dedicated to speech audiometry.

In the first chapter* the great importance of speech is emphasized, as well as its usage in tests whose purpose is to determine auditory acuity for speech. A review is then given of how speech audiometry has reached the point it has (1949). In this review the speech materials that can be used are indicated:

a) continuous discourse or paragraphs,

b) sentences,

c) words,

given at different levels of intensity:

a) whispered voice: 20 db

b) normal speaking voice: 40 to 50 db

c) strong or loud voice: 60 db

d) shouted voice: 70 db

These materials could be given using either live voice or recordings.

Finally information is given about the Work Davis, Stevens and collaborators have done in speech audiometry in the English language using monosyllabic and disyllabic words, sentences and paragraphs and their application for diagnostic purposes.

The second chapter° deals with the Acoustic Characteristics of the Spanish language.

In order to have available data to construct phonetically balanced lists, xxd other types of lists and samples representative of everyday speech a thorough phonetic analysis ofthe Spanish language with emphasis on the Ríoplatense pronunciation was done.

* Tato, J.M.Sr.

° Tato, J.M.Sr., F. Lorente Sanjurjo, J.A. Bello and J.M. Tato Jr.

The authors used 10,000 words taken from newspaper articles, magazines, pieces from modern and classic novels, etc. The following were analyzed:

a) the number of syllables, consonants and vowels found in the 10,000 words;

b) the number of syllables to a word,

c) the number of letters to a word,

d) the ratio of consonants to vowels,

e) the percentage of consonants,

f) the percentage of vowels,

g) the ratio between consonants,

h) the ratio between vowels,

i) the place of occurrence of a letter within a word.

"Mute" letters were not taken into consideration.

Having such data about the phonetic structure of Spanish, they devised three types of lists.

The first type of lists devised were those made of trochaic words. Twelve such phonetically balanced lists containing 25 words each were made. These lists would be used to determine articulation scores.

The second type of list would be used to determine the intelligibility of consonants in words and as articulated with different vowels. The sample list had 75 words with a trochaic stress pattern. The consonants change, but the vowels remain constant by groups.

Finally, the third type of lists were those made with monosyllabic words. Monosyllables are very rare in Spanish, because there are only five vowel sounds; therefore, the lists were not phonetically balanced, but they had "difficult" words. Three such lists having 50 words each were constructed. Although their use is not specified, one is led to assume that they would be used in discrimination tests, since this work is based on the work done for the English language.

Following this is the acoustic analysis of vowels and consonants, as well as the minimal duration needed to perceive a phoneme. For the present purpose it is not necessary to go into great detail on this, except that it is interesting to note that the vowels are more spread (from 512 to 4096 cps) in relation to speech frequencies than the vowels in English.

The final part of this chapter has to do with Testing Technique; the patient should be seated a meter away from and with the ear to be tested towards the loudspeaker. The phonetically balanced lists should be given to the subject, and his answers should be recorded on a master sheet. Correct repetition of 40% of the words is considered normal, because this is equivalent to 90 % of the sentences. If a hearing aid is to be evaluated the test should be done in the same fashion, but the words should be presented at 50 db (normal conversational intensity level). No mention is made in this part regarding the clinical use of the other two types of word lists previously described.

The third and final chapter° deals with the establishment of the Articulation Curve for Spanish.

This chapter covers the different stages of speech audiometry through its growth into what it was in 1949. Also, the work done in the United States at Central Institute for the Deaf and at Harvard University is mentioned - especially the work done with P.B.Lists to establish a normal articulation curve and, therefore, a normal threshold of intelligibility. The three other thresholds that have been established are the threshold of detectability (individual detects voice without understanding what is being said), the threshold of detectability of words (individual is able to repeat one or several words), and the discrimination percentile (individual able to hear correctly 100 % of the words. This will vary with type of hearing loss).

° Tato, J.M.Sr., and A.Alfaro.

After mentioning Dr. Davis' establishing of the S.A.I. they proceed to say that people with conductive hearing losses will repeat 100% of the words if the intensity is high enough but that individuals with non-conductive hearing losses will not reach 100% of the words no matter how high the intensity, bacause of their discrimination losses.

Having a similar plan, Dr. Tato and his collaborators tried to establish the articulation curve for Spanish using his P.B. trochaic word lists to determine his results. The lists were given to five subjects that had normal hearing. The following results were obtained: threshold of detectability at 17 db; threshold of intelligibility at 27 db; and discrimination percentile at 57 db. They then compare these results to the results obtained on the similar work done with the P.B. monosyllabic word lists in English, whose threshold of detectability is at 19 db, threshold of intelligibility at 33 db and discrimination percentile at 70 db. They come to the conclusion that a person will be more deaf for English than for Spanish.

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The work done by Dr. Tato and collaborators has great merit if we remember when it was written, but when we go to it seeking information on speech audiometry for Spanish today, we have several criticisms to make:

a) Tato does not clearly specify the clinical use of the phonetic material constructed - especially the lists of monosyllabic words.

b) The testing technique used is obsolete.

c) The use of the trochaic word lists not only to determine threshold of intelligibility, but also to determine discrimination losses. More difficult material is needed to determine discrimination losses.

d) Comparing the thresholds and articulation curve of the trochees in Spanish to the thresholds and articulation curve obtained for the monosyllabic

words in English and coming to the conclusion that a person will be more deaf for English than for Spanish is preposterous, because the materials compared are in no way comparable.

SPEECH AUDIOMETRY IN SPANISH (1).

The work done by Dr. Berruecos and his collaborators deals with determining the Threshold of Intelligibility for the Spanish Language.

The phonetic materials used were the lists of trochees made by Dr. Tato (5), with some modifications to omit words peculiar to the Spanish spoken in Argentina. Eight lists were compiled from Dr. Tato's twelve lists; these eight lists had from 32 to 50 words each.

Ten subjects were used; these subjects were between the ages of 16 and 23 and had normal hearing. All but one were tested on both ears; the other one was tested on the right ear only.

It was found that the threshold of intelligibility - the level at which speech must be presented in order that the subjects repeat correctly 50% of the words - was at 26 db.

Then a graph is presented, which compares the articulation curve for the spondees in English with that one for the trochees in Spanish. The gain function for the trochees is not as steep as it is for the spondees.

There is also a part of this work devoted to self criticism in which it is pointed out that due to phonetic materials used or errors due to the equipment used might be factors reducing the validity of the experiment.

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Despite the questionable validity of the above presented work, the results obtained check with those Dr. Tato obtained in 1949 regarding threshold of intelligibility. Dr. Berruecos found the threshold of intelligibility at 26 db, whereas Dr. Tato found it at 27 db, a difference of 1 db is not significant although this could be caused by the difference in pronunciation of the Spanish spoken in both countries or to the different number of subjects used (Dr. Berruecos used 10, Dr. Tato 5).

Another thing that Dr. Berruecos did was to compare gain function and

articulation curves of the same things - disyllabic words although with different stress pattern; but Dr. Tato compared the gain function and articulation curve of monosyllabic words to the gain function and articulation curve of disyllabic words.

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Conclusions

At the beginning of this paper I stated the purposes of speech audiometry, and through the presentation done in this field in English, Portuguese and Spanish we have seen how these purposes are fulfilled for each language. Of the three English speech audiometry as we have seen, is the one that best attains the purposes. Portuguese speech audiometry makes an honest attempt to attain the purposes, but as was stated in my criticism of Dr. De Sa's work, it is questionable whether his lists to determine discrimination loss are doing a valid singling out of individuals with such losses. From the works in Spanish speech audiometry we see that the only valid work is that one to determine hearing loss for speech and thus the confirmation of the amount of hearing loss on the audiogram particularly for the mid-frequency range.

Regarding the directions that could be taken for further work in speech audiometry in Spanish, we have seen that it is not necessary to do any work at the moment with tests that will check hearing loss for speech, since Dr. Tato's lists of trochaic words can be used for that purpose. We also saw that the work done in México and the work done in Argentina to establish the threshold of intelligibility check within 1 db; therefore, we should only be concerned with discrimination tests.

We have seen that Dr. Tato constructed some lists of monosyllabic words, but a) he does not clearly state their clinical use; b) they are not phonetically balanced; c) there are not enough monosyllabic words in Spanish and subjects would have to discriminate out of a comparatively small number of words. Therefore, a new test should be constructed.

Perhaps phonetically balanced lists of nonsense syllables would make a valid discrimination test if we remember that a)"the use of nonsense syllables

in the study of intelligibility represents an analytic approach in which our interest is focused on the intelligibility or repeatability of specific phonetic elements, because nonsense syllables are devoid of meaning and hence their intelligibility is in no way dependent upon the vocabulary of the observer."(3), and b) in Spanish subjects would not have to know a phonetic alphabet to transcribe what they are hearing as there is in this language a rather constant correspondence between the everyday graphical signs of the language and their relating phonemes.

The final step would be to check to see if we would be measuring th same thing that is measured with the P.B.Lists with our nonsense syllables. One way to check this would be to plot and compare the gain function and articulation curve of the Spanish nonsense syllables to that of the P.B.Lists and then to give both sets of lists to bilingual listeners and compare their scores.

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# B I B L I O G R A P H Y


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