# SPEECH AUDIOMETRY

Pure tone Audiometry provides only a partial picture of the patient's auditory sensitivity. Because it doesn't give any information about it's ability to hear and understand speech. To find out the person's ability to hear and understand speech. We do this testing with speech stimulus and this process is called *Speech Audiometry*.

According to ANSI S-36 1996 – The characteristics of audiometers including those used to do speech audiometry are given in the ANSI specification for audiometry.

Speech Audiometry is a technique where standardized a sample of language are presented through a calibrated system in order to measure some aspects of hearing abilities. The standard (standardized) materials can be through live wire or recorded system.

Here are the process which are involved in the speech audiometry or these are the components which are required for the speech audiometry process for an individual. These are the following :
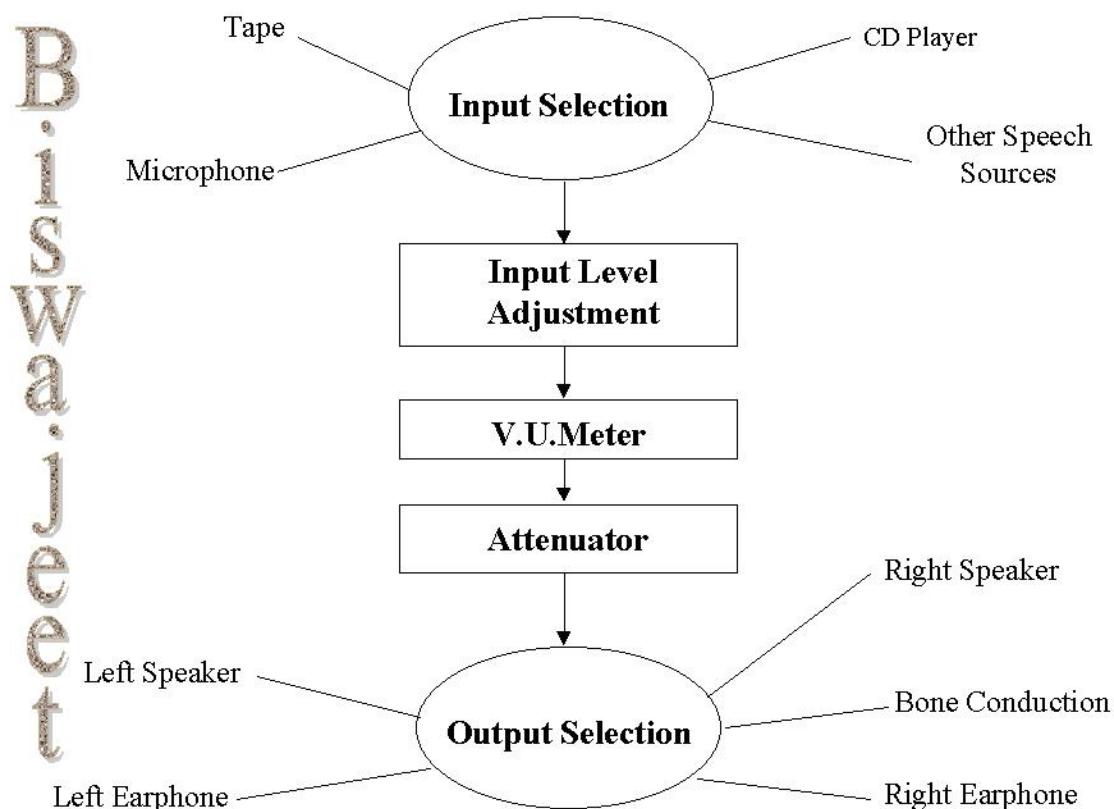
**Input Selection :**

To select the desired source of speech material
Tape, deck, CD player = For recorded speech.
Microphone              = For live voice.

**Input level control :**

Which is used with the V-U (Volume Unit) meter to ensure that the speech signal are of at the level necessary for them to being properly calibrated.

**Attenuation :**

To control the level of speech being presented to the patient.

**Output selector :**

Through which mode you want to present the speech signal to the patient.

**FEW IMPORTANT TERMS**

- ❖ **CARRIER PHASE :** It is the phase which proceeds the stimulus word, during speech audiometry. It is designed to prepare the patient for the test word and to access the clinicians fault, controlling the input loudness of the test word.
- ❖ **SRT :** (Speech Reception Threshold). The threshold of a person for speech at the lowest level at which the presence of speech signal can be heard or recognized or identified 50% of the time.
- ❖ **SDT :** (Speech Detection Threshold). The lowest level at which the presence of speech signal can be detected 50% the time is called as SDT or speech awareness threshold.
- ❖ **SPONDIAC WORDS :** It is 2 syllable word pronounciated with equal stress on both the syllables. E.g. "dhoop-chhawn", "khel-kud", "daud-dhup".
- ❖ **SPONDIAC THRESHOLD :** The lowest level at which 50% of the spondiac word is correctly identified.
- ❖ **UCL :** (Un Comfortable Level). It is sound pressure level at which the speech become uncomfortably loud.

**CLINICAL FUNCTIONS OF SPEECH RECEPTION THRESHOLD :**

- ➢ To serve as a measure for cross checking the pure tone threshold. ( SRT & PTA co-relation is +/- 12dB)
- ➢ To determine hearing aid needs and performance.
- ➢ To evaluate the functional hearing loss/ malingerers. If the patient has Functional hearing loss then the difference with SRT may be more or less than 12 dB. If more than 12dB = conductive hearing loss. If it's less than 12dB then = sensory and If lower than that then the hearing is neural hearing loss.

➢ To serve as reference point for deciding in appropriate level at which to administer supra threshold speech recognition test.

## MATERIALS NEEDED FOR SPEECH AUDIOMETRY :

❑ **Spondaic words** : Most of the SRT are obtained using the Spondaic words.
❑ **Sentence Test** : Although spondaic words are used usually for SRT but they are not only the materials for SRT purpose. Sentences are the principle alternative used for SRT testing, especially in noise. Given by PLOMP and MIMPIN – 1979.
❑ **Other materials used :**
    ➢ **Monosyllabic words**
    ➢ **Disyllabic words**
    ➢ **Paired words**
    ➢ **Sentences with key words**

## SPEECH SPECTRUM/ ARTICULATION INDEX :

Each sound consists of particular frequency and to perceive the particular frequency, intensity is required. Each sound in each place is different. Noise differs in terms of manner of articulation rather than the place of articulation. Each sound has got 3 parameters :

- Frequency
- Intensity
- Duration of sound

These 3 are different for each speech sounds. It differ from individual to individual, time to time, and also varies depending upon proceeding sound and following sound.

If this is presented on the audiogram it will be called as *"Articulation Index"*. Speech spectrum level of normal speaker from 1 meter distance is 65dB SPL. Speech spectrum is also called as *"Speech Banana"*.



Low Frequency     High Frequency
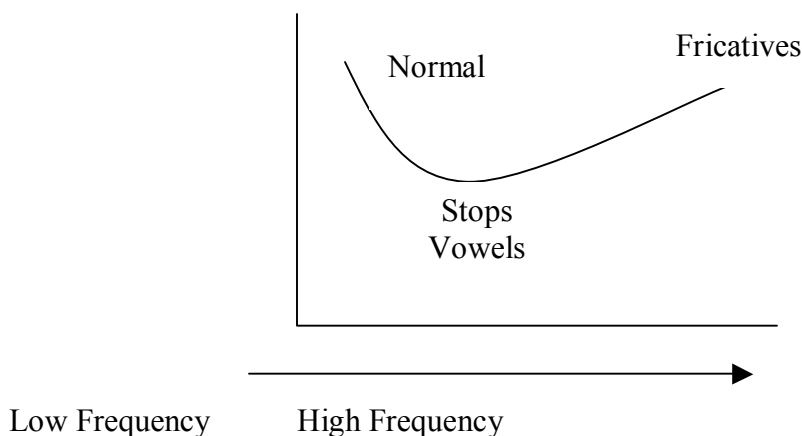
# Fricative = High Frequency **Stop, Vowel = Mid Frequency**      Nasal = Low frequency
But the speech concentration energy is not same. Maximum energy concentration will be around 2KHz. At 4KHz = 50dB, 1KHz = 52dB, and at 500Hz = 26dB. Normal conversation falls within 50 – 60dB.

## APPLICATION OF ARTICULATION INDEX

- ➤ To find out type of sound/ pattern of hearing loss.
  - ▪ If fricative – High frequency loss
  - ▪ If Nasal – Low frequency loss
  - ▪ If Stop, Vowel – Mid frequency loss.
- ➤ It helps in hearing aid selection.
- ➤ Helps in counseling.

## NEED FOR SPEECH AUDIOMETRY

The PTA doesn't talk about the communication ability of the person. Communication ability of two persons are not same. Thus speech audiometry helps in different aspects such as :
- • To cross-check the pure tone threshold.
- • To find out the type of hearing loss
- • To find out the degree of hearing loss
- • Help in hearing aid selection
- • Help in identifying functional hearing loss
- • Helps in identifying the site of lesion.

### Advantages of speech audiometry :

- ▪ It require less time than PTA.
- ▪ More validity ( Sp.Stimulus > Non – Sp.Stimulus )
- ▪ It tells about the communication ability of the individual.

### <u>SPEECH DETECTION THRESHOLD ( SDT )</u>

**Materials Used for SDT :**
- ➤ Monosyllabic words (Can also use bi-syllabic spondaic words, very rarely sentences are used)

**Purpose of SDT :**
- ➤ To cross-check the pure tone threshold.
- ➤ To know the speech detection level.
- ➤ To know the severity of hearing loss.
- ➤ Helps in hearing aid selection.

**When to find SDT :**
- ➤ In case of DSL with hearing loss or when you can't find out SRT.

> ➤ In case with poor speech discrimination ( In cases of RCP, SN hearing loss, CAPD, Auditory neuropathy) we find SDT, not SRT, both for adult & child.

**Procedure to find out SDT :**

You can find out SDT under the head phone, or in free field condition. You will always get response from the better ear. This is the main disadvantage of caring out SDT in free field condition.

Input through the microphone and output through the headphone is used. Then we present monosyllabic words like *papa, mama, baba, nana,* at the intensity above threshold level.

When you are presenting the stimulus make sure that the microphone is " ON ", then follow "Up & Down" method like Pure Tone Audiometry. Make sure that you are getting responses twice at a time.

**SDT Vs PTA**

> ➤ SDT is always better than PTAvarage.
> ➤ SDT should be better in frequency range between 250Hz to 4KHz. of Pure Tone Threshold.

## SPEECH RECEPTION THRESHOLD

**Materials used :**

> ➤ Spondaic words
> ➤ Paired words
> ➤ Sentences
> ➤ Conversations
> ➤ Cold Running speech ( Speech which doesn't change intonation )

**Purpose of doing SRT :**

> ➤ To cross-check the PT threshold.
> ➤ To find out the level of speech recognition.
> ➤ Hearing aid selection.
> ➤ To detect functional hearing loss.
> ➤ To find out severity of hearing loss.

**SRT Vs SDT**
*(Difference between SRT & SDT is about 9 dB )*
> ➤ SDT is always better than SRT because in SDT they just have to identify or detect the speech signal which is present while in SRT they have to comprehend the speech signal & then have to repeat the speech stimulus.

**SRT Vs PTA**

➢ SRT correlates more with the Pure Tone Average rather than the individual pure tone threshold.
➢ In case of rising type of audiogram take the PTA at the two best frequencies and the SRT will correlate with the threshold of those frequency.
➢ In case of high frequency sloping we do the same thing.
➢ SRT & PTA should always correlate +/- 12dB, given by Ventry & Chaiktin – 1961. Again Olsen said that SRT & PTA correlate +/- 6dB. But for clinical measurement we take +/- 10dB.

**Conditions in which PTA will not correlate with PTA :**

➢ Due to instrumental problem. (calibration )
➢ Instruction to the patient.
➢ Functional hearing loss. ( PTA > SRT )
➢ Irregular shape of audiogram. ( This mainly with reference to the Pure tone threshold, one is normal and the other is higher )
➢ In case of auditory neuropathy. ( comprehension & Discrimination problem ). As these cases have poor discrimination in quite situation, so SRT will not correlate with PTA.
➢ In cases of CAPD. Usually the comprehension problem in CAPD is good but if certain noise is there, the SRT will reduce.
➢ Patient having language problem. ( If you are administering speech test of some other language to a person about which he is unknown, this will affect the SRT score.)
➢ The cases of children ( Speech material is not in the vocabulary of the child and so the child will not be able to understand. So it will affect SRT score.)

**BONE CONDUCTION SRT :**

You can present speech stimulus through bone vibrator using the speech audiometer using the same speech materials.

**Purpose of doing BC SRT :**

➢ To cross check the BC Pure Tone Threshold.
➢ To access the hearing ability of any individual through bone conduction mode.
➢ In case of difficult to test population. ( children with MR, Autism )

**Why SRT is not used with Bone vibrator :**

➢ It requires more energy.
➢ Range is limited.
➢ Usually speech through the bone vibrator is not calibrated.

## Procedure to find out SRT :

There are mainly 3 procedures to find out SRT. They are :
- ❑ *Ascending method* : Chakin – 1967
- ❑ *Descending method* : Tillman – 1973
- ❑ *Bracketing method*

## ASCENDING METHOD :

e.g.
PTA = 50dB ( Present intensity for below PTA )

30dB – 1 spondaic word – NR
      increase by 10dB
40dB – 1 spondaic word – NR
      increase by 10dB
**50dB – 1 spondaic word – R – *Initiation level***
      decrease by 15dB
35dB – 4 spondaic words – NR
      increase by 5dB
40dB – 4 spondaic words – NR
      increase by 5dB
**45dB – 4 spondaic words – R – *$1^{st}$ Trial***
      decrease by 10dB
35dB – 4 spondaic words – NR
      increase by 5dB
40dB – 4 spondaic words – NR
      increase by 5dB
**45dB – 4 spondaic words – R – *$2^{nd}$ Trial***

> $1^{st}$ = 50dB
> $2^{nd}$ = 45dB
> $3^{rd}$ = 45dB
>
> $2^{nd}$ & $3^{rd}$ trial are
> equal so **SRT = 45dB**

After matching the trials, which 2 trials have the same intensity, that will be SRT of the person. Hence in this case SRT is 45dB

## Procedure :

- ➢ Present the stimulus below the threshold level and increase the intensity and find the threshold.
- ➢ Set the intensity below the PTA threshold.
- ➢ Present one spondee – No Response
- ➢ Then increase the intensity by 10dB and present the stimulus (One spondee). You may get a response or may not get.
- ➢ If there is no response then increase the intensity by 10dB and present the stimulus. Keep increasing the intensity by 10dB until you get a response. If you

get a response at a particular intensity, at that intensity you decrease the intensity by 15dB and that reduced intensity will be *Initiation level.*

➢ Here you are presenting 4 spondees. You will not get any response at this level.

➢ Now increase the intensity by 5dB and see whether you got response or not. You have to increase the intensity by 5dB and present 4 spondees till you get the response of 2 out of 4 spondee. That is the end of the *1ˢᵗ Trial.*

➢ Then reduce the intensity by 10dB and this level will be initiation level for the 2ⁿᵈ ascending trial. Present 4 spondee. You may or may not get any response. Increase the intensity by 5dB and present 4 spondee. Check you get response or not.

➢ You have to increase the intensity by 5dB and 4 spondee till you get any response for 50% times and that's is the *2ⁿᵈ Trial.*

➢ Now reduce the intensity by 10dB, same process you put.

In all the three trials you check which 2 trials are same. The 2 trials which are same that will be the SRT. If all the 3 intensities are different then go for the 4ᵗʰ trial.


**DESCENDING METHOD :**

e.g.

PTA = 30dB ( Present intensity above the pure tone average )

50dB – 2 spondee – R
      decrease by 10dB
40dB – 2 spondee – R
      decrease by 10dB
30dB – 2 spondee – R
      decrease by 10dB
20dB – 2 spondee – NR
20dB – 2 spondee – NR
      increase by 10dB
30dB – 2 spondee – R – *initiation Level*
      decrease by 2dB
28dB – 2 spondee – R
      decrease by 2dB
26dB – 2 spondee – NR

> **SRT = IL – CR + ½ step**
>
> SRT   = 30-5+1
>         = 26dB
>
> IL = Initiation Level
> CR = Correct Responses(+ve)

Here SRT of the person is 26dB

**Procedure :**

➢ Present the stimulus or intensity for above the pure tone average and try to get 50% response. Here you are presenting 2 spondee.

➢ Take the intensity and present the stimulus. Here you will surely get the response. If you are getting the response then decrease by 10dB.

- ➢ Again you present the 2 spondee, you may or may not get a response.
- ➢ If you get the response then decrease by 10dB. If you are not getting the response then it is negative.
- ➢ At this level again you have to present 2 spondee to cross check., then increase by 10dB and you will get a response then this is called *initiation level.*
- ➢ From here decrease by 2dB and present the same 2 spondee and check whether you get a response or not.? Keep on decreasing by 2dB until you find there is a No Response. Stop where you don't get any response.

$$\boxed{\textbf{SRT = IL – CR +1/2 Steps}}$$

**BRACKETING METHOD : (*Combined Method*)**

Present the stimulus above the pure tone average. Probably at PTA+20dB. Present 3 spondee words. See for at least 50% responses.
SRT is that in which at least 2 intensities matches equally.
e.g.
PTA = 40dB
Start with PTA+20dB = 60dB

60dB – 3 spondee – R
      decrease by 10dB
50dB – 3 spondee – R
      decrease by 10dB
40dB – 3 spondee – R
      decrease by 10dB
30dB – 3 spondee – NR
      increase by 5dB
**35dB – 3 spondee – R ------------------------- ( 1 )**
      decrease by 10dB
25dB – 3 spondee – NR
      increase by 5dB
**30dB – 3 spondee – R ------------------------- ( 2 )**
      decrease by 10dB
20dB – 3 spondee – NR
      increase by 5dB
25dB – 3 spondee – NR
      increase by 5dB
**30dB – 3 spondee – R -------------------------  ( 3 )**

> 1st Trial = 35dB
> 2nd Trial = 30dB
> 3rd Trial = 30dB
>
> 2nd & 3rd Trials are equal Hence the SRT here is 30dB.

**Procedure :**

Initially you present the stimulus above the pure tone average. Probably at PTA+20dB. At this level you should present 3 spondee words. Present 3 spondee at this level and see

for the response. Some people may say that present the stimulus and see for the response. i.e. if you get response then reduce the intensity by 10dB and see for response again. If you are not getting the response by at least 50% then increase the intensity by 5dB and present 3 spondee. If you are getting the response the make the note of the intensity i.e. the *Initiation Level*. Then decrease the intensity by 10dB and present the stimulus. If you are not getting the response the again increase by 5dB and present the stimulus (3 spondee ). If you are getting response at this level then that will be the *2ⁿᵈ ascending trial*. Then decrease the intensity by 10dB and present 3 spondee. If you are not getting the response then increase the intensity by 5dB and see for the response. If you are getting the response at this level then this will be the end of *3ʳᵈ ascending trial*. And check for all the 3 trials and see which two values are same and they will be the threshold.

## SPEECH IDENTIFICATION SCORE/ SPEECH DISCRIMINATION SCORE

This is to find out speech discrimination ability of an individual. This score is doene at supra threshold level. This is calculated in terms of percentage.
i.e.

$$\frac{\text{Number of responses}}{\text{Total Number of speech stimulus presented}} \times 100$$

This should come 27 – 30dB above SRT in normal then it reaches a platue. If you will increase intensity more than this you will not get any variation.

**Materials Used :**
- PB words ( Phonetically Balanced Words )
- Simple words
- Simple sentences with key words

In normal = 100% normal response, 27 – 30dB above the SRT score.
Conductive hearing loss cases will have better graph than SN hearing loss cases. Because SN people have discrimination problem.



Normal 100%

SN hg.loss
70% – 80%
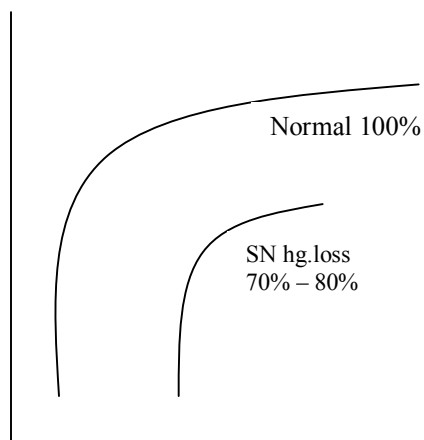
**SRT + 40dB = MCL**

**Roll Over Phenomena :**

As you keep on increasing the speech stimulus, the lower the score will be due to neural fatigue.

In SN hearing loss,

Better the hearing loss, more is the performance.

More is the hearing loss lesser is the performance.

*Sensory = Cochlear Pathology, Neural = Retro-Cochlear Pathology.*

*Jerger & Jerger (1977)* gave a speech test to differentiate between CP & RCP, i.e. PI–PB function ( Picture Identification – Phonetic Balance )

A different SL level i.e. SRT+SL. You have to find out the speech identification score. You need to use PB list and find out maximum & minimum score. If the difference is more than 0.45 then it is RCP and if the difference is less than 0.45 then it is CP.

Other test was Roll Over Index (Ro)

$$Ro = \frac{PBmax - PBmin}{PBmax}$$

e.g.

80% at 30dB SL

30% at 10dB SL

$$Ro = \frac{80 - 30}{80} = 0.6 \Rightarrow RCP$$

**Factors affecting Speech Audiometry / Speech Threshold**

- ❖ Familiarity of the word ( Educated persons will know the words and they will respond easily & quickly. If uneducated, then they may fail to respond. So educated people will have better performance than others )
- ❖ Practice Effect ( If a person comes regularly for the assessment then he may get familiar, which may show better response and that will affect SRT )
- ❖ Live Vs Recorded version ( Live when the clinician uses his own voice. Recorded when clinician records his voice and present the stimulus through tape recorder. In recorded voice the player produces some kind of mechanical noise. So, it's always better to go for live voice rather than recorded.
- ❖ Visual clues
- ❖ Close Vs Open set ( closed set is using head phone, Open set is free field situation. In open set patient respond through better ear. So closed set has better response than open set.)
- ❖ Carrier Phase ( means the instruction or phase which proceeds the stimulus words during speech audiometry. Designed to prepare the patient for the test)
- ❖ Types of hearing loss ( *Conductive* performs better than *Sensory*. *Sensory* performs better than *Neural*)

## HOW TO DEVELOP SPEECH MATERIALS :

- Select the language
- What type of speech material
- Develop a spondaic
- Which age group you are going to do. If doing with child you have to find out sub test.
- Materials should be within the vocabulary of the child.
- The list should be distributed to different professionals dealing with the particular group by the adults or children. Make a new word list and do a pilot study.
- Take out the word from the list which are made for that particular age group.
- If you are doing for PBmax it should be phonetically balanced or while doing SRT it should be emotional.
- You have to standardize the material. To standardize the material you have to select a subject.

    **Criteria for selecting subject :**
    - Age group of children
    - Mother tongue should be taken in to consideration.
    - Should have normal hearing
    - You have to rule out that they have not got CAPD.
    - Number of subjects you should have is minimum 30 numbers.
    - Administer the test and find out the results.

# HAPPY READING