SPAU315 Audiology Practicum I

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Essential reading I

- https://www.thebsa.org.uk/wp-content/uploads/2018/11/Recommended-Procedure-Pure-Tone-Audiometry-August-2018-FINAL.pdf

Essential reading II

- https://www.thebsa.org.uk/wp-content/uploads/2011/04/Uncomfortable-Loudness-Level-1.pdf

Calibration

- **Stage A**: routine checking and subjective tests
- **Stage B**: periodic objective tests
- **Stage C**: basic calibration tests

Stage A Calibration: Daily 1-8

Tests 1 to 8 should be carried out daily.

1. Clean and examine the audiometer and all accessories. Check earphone cushions, plugs, main leads and accessory leads for signs of wear or damage. Any badly worn or damaged parts should be replaced. If any transducers are replaced, then the audiometer must undergo a Stage B check.

2. Switch on equipment and leave for the recommended warm-up time. (If no warm-up period is quoted by the manufacturer, allow 5 minutes for circuits to stabilise.) Carry out any setting-up adjustments as specified by the manufacturer. On battery-powered equipment, check battery state using the specified method. Check that earphone and bone vibrator serial numbers tally with those on the instrument's calibration certificate. An instrument's transducers shall not be changed unless a full Stage B calibration is undertaken.

3. Check that the audiometer output is approximately correct on both air and bone conduction by sweeping through at a hearing level of just audible tones (e.g. 10 dB HL or 15 dB HL). This test should be performed at all appropriate frequencies and for both earphones and the bone vibrator.

4. Check that the masking noise is approximately correct at all frequencies through both earphones, at a level of 60 dB HL.

5. Perform a high-level listening check on air and bone conduction at all frequencies used, on all appropriate functions and on both earphones (e.g. 60 dB HL for air conduction, 40 dB HL for bone conduction). Listen for proper functioning, absence of distortion, freedom from clicks when presenting the tone etc.

6. Check all earphones and the bone vibrator for absence of distortion and intermittency; check plugs and leads for intermittency.

7. Check that all the switches are secure and that lights and indicators work correctly.

8. Check that the subject response button works correctly.

Stage A Calibration: Weekly 9-12

Tests 9 to 12 should be carried out weekly.

9. Listen at low levels for any sign of noise or hum, for unwanted sounds or for any change in tone quality as masking is introduced. Check that attenuators do attenuate the signals over their full range and that attenuators which are intended to be operated while a tone is being delivered are free from electrical or mechanical noise. Check that interrupter keys operate silently and that no noise radiated from the instrument is audible at the subject's position.

10. Check subject communication speech circuits.

11. Check tension of headset headband and bone vibrator headband. Ensure that swivel joints are free to return without being excessively slack. Check headbands and swivel joints for signs of wear strain or metal fatigue.

12. Perform an audiogram on a known subject, and check for significant deviation from previous audiograms (e.g. 10 dB or greater).

Instructions to patient

"I am going to test your hearing by measuring the quietest sounds that you can hear. As soon as you hear a sound (tone), press the button.

Keep it pressed for as long as you hear the sound (tone), no matter which ear you hear it in. Release the button as soon as you think you no longer hear the sound (tone). Whatever the sound and no matter how faint the sound, press the button as soon as you think you hear it, and release it as soon as you think it stops" *BSA (2017)*

- Alternative wording
- Printed version
- Verify understanding
- Other instructions: Sitting quietly, and interrupting if needed.

Test Order

- Start at **1000Hz** in the **better ear** : Why 1000 Hz? How do you know which one?
- **2000, 4000, 8000Hz, then 500, 250Hz**
- Fill in 750, 1500, 3000, 6000 if indicated by >20 dB difference in 2 frequencies or clinically indicated
- 3000, 6000Hz useful for tinnitus, high frequency loss and hearing aid fittings
- **Retest** 1000Hz on 1st ear.
- Retest further frequencies if threshold at 1kHz changes >5dB. No need to retest 1000Hz on 2nd side*.
- Record each point on audiogram, **RIGHT**, **LEFT**, **AC**, **BC**, **MASKED**
- Audiometry results less reliable at 250, 500 and 6000 and 8000 Hz. 6kHz depends on earphone placement

* unless tests in the first ear revealed significant variation

Test Stimuli Presentation

- **Duration of the Tone**: varied between 1 and 3 seconds
- **Interval between the tone presentations**: between 1 and 3 seconds
- Timing between presentations of tone must not be predictable: Why?
- Start at easily audible level, e.g. 40dBHL for normals, 30dB above estimated thresholds for others, but never more than 80dBHL
- If initial tone is not heard, then increase by 10dB until you get a response
- If no response up to 80dB, then increase in 5dB steps and watch patient for signs of discomfort

10 down up 5 method to find Threshold
Hughson-Westlake Procedure

BSA recommended procedure.

- Once a positive response is obtained, **decrease by 10dB** until no response given
- **Increase signal by 5dB** until response given
- Reduce by 10dB and repeat process until **2/2 or 3/4** responses at the same level
- Lowest intensity level heard in 2 out of 3 presentations on ascent (that is from below the hearing threshold)
- Move to the next frequency, repeat the process
- Takes approximately **20 minutes test time**
- Mark a **CIRCLE in RED** for right ear and a **CROSS in BLUE** for left ear on Audiogram

Bone Conduction Testing

- Tone will travel to both cochlea's and be perceived by the better cochlea– Therefore without masking, it is not possible to know which ear was responsible for the detection of the signal
- Need to place **Bone vibrator** on the mastoid of the **worse ear** (as per AC), close but not touching the pinna, avoiding the hairline

CORRECT TRANSDUCER PLACEMENT IS AN ESSENTIAL STEP TOWARDS ACCURATE RESULTS

Three routes of the signal via BC to cochlea

1. **Osseotympanic stimulation**: vibration of ear canals initiating AC (cartilaginous portion of EAM distorted-compresses air)
2. **Inertial stimulation**: inertia of the ossicular chain-lag relative to skull movement-causes stapes to move in the oval window similar to AC
3. **Distortional/compressional stimulation:** direct stimulation of cochlea due to compression of bone (skull) material

Criterion of Threshold, Test Stimuli, Subject Response, Instructions

- Identical to recommendations for AC audiometry
- Emphasis on the need to respond “regardless of which side of the head sound is heard”
- Measurements restricted from 500 to 4000Hz
- Order of Test: 1000Hz, 2000Hz, 4000Hz, 500Hz
- Procedure: As per AC test but no need to retest 1000Hz. Place vibrator on worse ear!
- Recording: The symbol for not-masked BC threshold is Δ and should be qualified by the side on which the bone vibrator is placed

Limitations

- **Air borne** sound generated by bone vibrator especially at **3000 and 4000Hz**, earplug will help with this
- But not at lower frequencies 2000Hz and below, occlusion effect may raise actual measured threshold
- Maximum output levels: 500Hz-50dB, 1000-4000 Hz around 70dB

BSA Descriptors for Pure-tone Audiograms

Four audiometric descriptors are given. These are based on the average of the pure-tone hearing threshold levels at **250, 500, 1000, 2000 and 4000** Hz. Averages do not imply any particular configuration of hearing loss and do not exclude additional terms (e.g. profound high-frequency hearing loss) being used.

Audiometric descriptor	***dB HL***
○ *Mild hearing loss*	*20-40*
○ *Moderate hearing loss*	*41-70*
○ *Severe hearing loss*	*71-95*
○ *Profound hearing loss*	*> 95*

J Am Acad Audiol. 2017 Jul/Aug;28(7):655-671. doi: 10.3766/jaaa.16061.

Perspectives on the Pure-Tone Audiogram.

Musiek FE[1], Shinn J[2], Chermak GD[3], Bamiou DE[4].

Author information

Abstract

BACKGROUND:

The pure-tone audiogram, though fundamental to audiology, presents limitations, especially in the case of central auditory involvement. Advances in auditory neuroscience underscore the considerably larger role of the central auditory nervous system (CANS) in hearing and related disorders. Given the availability of behavioral audiological tests and electrophysiological procedures that can provide better insights as to the function of the various components of the auditory system, this perspective piece reviews the limitations of the pure-tone audiogram and notes some of the advantages of other tests and procedures used in tandem with the pure-tone threshold measurement.

PURPOSE:

To review and synthesize the literature regarding the utility and limitations of the pure-tone audiogram in determining dysfunction of peripheral sensory and neural systems, as well as the CANS, and to identify other tests and procedures that can supplement pure-tone thresholds and provide enhanced diagnostic insight, especially regarding problems of the central auditory system.

RESEARCH DESIGN:

A systematic review and synthesis of the literature.

DATA COLLECTION AND ANALYSIS:

The authors independently searched and reviewed literature (journal articles, book chapters) pertaining to the limitations of the pure-tone audiogram.

RESULTS:

The pure-tone audiogram provides information as to hearing sensitivity across a selected frequency range. Normal or near-normal pure-tone thresholds sometimes are observed despite cochlear damage. There are a surprising number of patients with acoustic neuromas who have essentially normal pure-tone thresholds. In cases of central deafness, depressed pure-tone thresholds may not accurately reflect the status of the peripheral auditory system. Listening difficulties are seen in the presence of normal pure-tone thresholds. Suprathreshold procedures and a variety of other tests can provide information regarding other and often more central functions of the auditory system.

CONCLUSIONS:

The audiogram is a primary tool for determining type, degree, and configuration of hearing loss; however, it provides the clinician with information regarding only hearing sensitivity, and no information about central auditory processing or the auditory processing of real-world signals (i.e., speech, music). The pure-tone audiogram offers limited insight into functional hearing and should be viewed only as a test of hearing sensitivity. Given the limitations of the pure-tone audiogram, a brief overview is provided of available behavioral tests and electrophysiological procedures that are sensitive to the function and integrity of the central auditory system, which provide better diagnostic and rehabilitative information to the clinician and patient.