

General notes

RECOMMENDED PROCEDURES FOR PURE-TONE AUDIOMETRY USING A MANUALLY OPERATED INSTRUMENT

A few years ago the British Society of Audiology commissioned its Education Sub-Committee to consider the various methods of audiometry for clinical purposes, for hearing-aid dispensing and in connection with hearing conservation in industry.

Full circulation of drafts and discussion of the comments received led to their approval and general acceptance by the Society, and subsequently, with minor editorial changes only, by the British Association of Otolaryngologists. The Society and Association then asked this Journal, and the *British Journal of Audiology*, to publish these BSA–BAOL recommended procedures in order to encourage standardization of manual audiometric methods throughout British practice. To help this, abbreviated versions of these recommendations are provided—for ‘ready use’ in the clinic.

It is also recommended that the results of these tests should be plotted on audiograms having the format and symbols recommended by the Society and Association, as published previously in this Journal (‘Standard forms for results of audiometry’, Vol. 89, pp. 1069–1074, 1975) and elsewhere.

The air-conduction tests are applicable to the majority of adult patients and children over the age of about 6 years. For the remainder of very young, aged or sick patients, some modification of the recommended procedure is likely to be required according to the age of the patient, his condition and the experience of the tester, but this will usually result in a less accurate measurement of the hearing loss.

A number of common features of various published methods (see Bibliography) have been retained in the selected procedures which are widely used and taught in the United Kingdom.

The selected methods have been chosen on the following grounds:

- (i) They are known to yield thresholds in close agreement with those obtained from most other accepted methods.
- (ii) The test can be performed with reasonable economy of time.
- (iii) Thresholds are measured with an effective size of attenuator step that reflects the accuracy of pure-tone threshold audiometry and which can be plotted easily and reliably on the BSA–BAOL recommended format for audiograms. Specifically, threshold measurement is obtained only in steps of 5 db. and estimation to a smaller step is not recommended.
- (iv) The method can be taught without difficulty to all grades of students required to perform audiometry, including those with minimum academic attainments.

Criterion of threshold

The threshold of hearing for a pure tone is the level at which the tone is heard for 50 per cent of the number of times it is presented at that level. In clinical

practice, the threshold is taken as the minimum level at which a response is obtained for at least 50 per cent of a limited number of individual presentations. With the recommended procedures this means, in effect, the minimum level for which a response is obtained on at least 2 presentations out of possible three or four.

Test stimuli

The signal presentation key must be in the 'off' position during each change of setting of the hearing level control. The minimum duration of an individual presentation of the tone should not be less than 0.5 seconds. Due to the effect of temporal integration, shorter duration bursts of tone would be required to be at greater levels in order to be heard. Durations of about 1 to 3 seconds are recommended.

It is important to avoid a rhythmic presentation of the tone, both in the interval between tones and in their duration. Otherwise this may lead to the patient anticipating near-threshold presentations in the 'descending' direction, and in consequence, being judged to have erroneously-acute thresholds. For this reason, use of the regular automatic switching available on some audiometers is deprecated for these purposes. It is also important to avoid unduly long intervals with no audible stimuli which lead to erroneously-poor measured thresholds.

Patient's response

All possible auditory, visual and tactile clues should be eliminated from the tester and the apparatus, and it is essential for the tester to see the patient. The patient's response must not generate any audible sound and must involve minimal movement; acknowledgment of the tone by signalling with a bell push or by raising and lowering the finger are satisfactory. Arm raising, a vocal 'yes', or a tap on the table are to be avoided. The patient's signals should indicate the entire duration of hearing the tone; this aids the tester's precision in identifying valid responses.

Instructions for most adult patients and children over the age of about 10 years

'I am now going to test your hearing by measuring the faintest sounds that you can just hear. *As soon as* you hear a sound, press the switch button (or raise your finger). Keep it pressed (or raised) as long as you hear the sound, no matter which ear you hear it in. Release the button (or lower your finger) *as soon as* you think you no longer hear the sound. No matter how faint the sound, press the button (or raise your finger) when you think you hear it, and release it (or lower it) when you think you do not hear it'.

Alternative wording is acceptable, providing the same points of instruction are included. The provision of an abbreviated printed version of these instructions may be advantageous.

Instructions for young children, and some difficult-to-test adults

For these patients, the above instructions will need considerable abbreviation and simplification, often with further instructions during the course of testing according to how the patient actually responds to the test signals.

Order of test

Start with the better-hearing ear (according to the patient's account). Start with 1,000 Hz. Next proceed to test 2,000, 4,000, 8,000, 500 and 250 Hz. For the first ear only, retest at 1,000 Hz. If the retest value is more than 5 db. more acute than the original value, retest the next frequency and so on. Take the more acute threshold as the final value. Where needed and practicable, test also at intermediate frequencies 750, 1,500, 3,000, 6,000 Hz. (e.g. 3,000 and 6,000 Hz. in all cases of high-tone hearing loss, especially 3,000 Hz. for compensation assessment). Then test the opposite ear in the same order without the retest at 1,000 Hz.

Symbols: Air conduction: 0 right, X left
 Bone conduction: [right,] left
 Δ not masked (but specify where the bone vibrator was placed)

Recommended procedures

Two variations of a basic procedure for determination of a patient's threshold are in use and have been shown to give results in such close agreement that they are recommended as direct alternatives. The two methods are identified below as Method A and Method B, the first two stages to familiarise the patient with the test being common to both methods.

Familiarization

Present a tone of about 3 seconds' duration at a level that is expected to be clearly audible to the patient, which will commonly be about 30 db. above the roughly estimated threshold. Check that the patient responds correctly, i.e. indicates the entire duration of the tone burst presented.

If there is no response, raise the level in 20 db. steps until a response is obtained.

Note: In both test methods, to follow, present tone bursts of random duration varying between 1 and 3 seconds, with intervals varying between 1 and 3 seconds (and occasionally much longer, if the patient's responses do not correspond well with the interruption of the tone).

Test Method A

1. Reduce the levels in 10 db. steps until the patient no longer responds.
2. The tone level of succeeding presentations is determined by the preceding response. After reaching no response from the patient in Stage 1, and after each subsequent failure to respond to a signal, the level is increased in 5 db. steps until a response occurs. After the response, the intensity is decreased 10 db. and another ascending 5 db. series is begun, and so on until the threshold becomes evident. Threshold is defined arbitrarily as the lowest level at which responses occur in at least half of a series of ascending trials, with a minimum of two responses required at that level.

Test Method B

1. Reduce the levels in 10 db. steps until the patient no longer responds.
2. Confirm that the last level presented without acknowledgement was truly

below threshold by presenting two or three further tone bursts at that level. If none of these individual presentations, or only one of four, was acknowledged that level is taken as being 'not heard'.

3. If the level tested at Stage 2 was 'heard', i.e. two satisfactory responses were obtained in three or four individual presentations, test one or more levels 5 db. lower until the tone is 'not heard' (i.e. no responses to three presentations, or only one response to four presentations).
4. Raise the level 5 db. above the 'not heard' level measured at Stages 2 or 3, and present as many tones up to four in number as may be necessary (two, three or four in fact) to decide whether at least two satisfactory responses in up to four presentations had been obtained. If this level was 'heard', this is the threshold for that tone.
5. If at Stage 4, that level was 'not heard' (i.e. only one or none of the presentations was acknowledged), raise the level by 5 db. and repeat Stage 4. Continue in this way until two out of four presentations are satisfactorily acknowledged.

REFERENCES

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ABBREVIATED VERSION OF BSA-BAOL RECOMMENDATIONS
ON METHODS FOR AUDIOMETRY:

GENERAL POINTS

Test Signal: On for 1–3 seconds bursts.
Randomly vary durations of both tones and intervals.

Patient's Response: Silent.
For whole duration of signal.

Instructions to Patient: Indicate as soon as you hear the tone and for as long as you continue to hear it.
No matter how faint the tones or in which ear they are heard, respond when you hear them.

Order of Test: (I) Test the better-hearing ear first.
(II) 1, 2, (3), 4, (6), 8, 0.5, 0.25 kHz., and then retest 1 kHz.
(III) 1, 2, (3), 4, (6), 8, 0.5, 0.25 kHz., in the other ear.

Symbols: 0 = R, a-c X = L, a-c
{ = R, b-c } = L, b-c
Δ = Not-masked, b-c

ABBREVIATED VERSION OF BSA-BAOL RECOMMENDATIONS
ON METHODS FOR PURE-TONE AUDIOMETRY:

METHOD A

- Familiarization:*
1. 3-seconds tone at estimated threshold +30 db.
 2. If not heard, increase in 20 db. steps until heard.
 3. Check correct manner of response.
- Test (Method A):*
4. Drop in 10 db. steps until not heard.
 5. Raise in 5 db. steps until heard.
 6. Repeat as required, down in 10 db. steps, up in 5 db. steps.
 7. Threshold is lowest level at which 50 per cent or more of ascending signals are heard, with minimum of 2 responses at that level.

ABBREVIATED VERSION OF BSA-BAOL RECOMMENDATIONS ON
METHODS FOR PURE-TONE AUDIOMETRY:

METHOD B

- Familiarization:*
1. 3-seconds tone at estimated threshold +30 db.
 2. If not heard, increase in 20 db. steps until heard.
 3. Check correct manner of response.
- Test (Method B):*
4. Drop in 10 db. steps until not heard.
 5. When not heard, present 2 or 3 more tones at that level.
 6. (a) If 'heard' (at least 2 responses out of 4), lower level by 5 db.
or
(b) If 'not heard' (1 or 0 responses out of 4), raise level by 5 db.
 7. Repeat stages 6(a) or 6(b), as far as necessary.
 8. Threshold is lowest level 'heard'.