

NARROW BAND MASKING IN BONE CONDUCTION AUDIOMETRY

J. D. Hood

The sound from a bone conductor placed anywhere upon the head will be heard with equal loudness at each ear. An essential requirement, therefore, with all bone conduction tests is the exclusion of the untested ear by means of an efficient masking sound, so that all threshold readings can be validly related to the tested ear.

The criterion of masking efficiency has been expressed very concisely by Denes & Naunton (1952) as good masking ability but minimal loudness and, from a knowledge of Fletcher's so-called critical frequency bands, Hood (1957), it can be shown that this is best achieved by the use of selected narrow bands of noise. This means that with the greatest economy in loudness it is possible to obtain a one to one relationship between the sensation level of the noise and the pure tone threshold elevation it induces. This is an important attribute of these narrow noise bands which enables us to determine with simplicity and accuracy the bone conduction threshold of almost any variety of hearing loss.

The test procedure which we have termed for convenience the shadowing technique, is shown in Fig. 1. Let us suppose that there is a pure nerve deafness of 40 db. of the subject's right ear to be tested and no loss of hearing of the left ear; the columns at each side are taken to represent the available hearing, and are calibrated in decibels.

The solid portion of the left column represents the nerve deafness of the right ear. A bone conducted sound at normal threshold intensity applied to the right mastoid is heard in the subject's left ear. This provides us with the first point on the graph, in which the masking intensity at the left ear is plotted on the horizontal scale and the bone-conduction threshold responses on the vertical scale.

Now, as shown in Fig. 1, the masking noise at a level of 10 db applied to the left ear raises its threshold for the bone conducted test tone by 10 db. In the same way, increases in masking noise intensity of 20 or 30 db. will bring about increases of identical magnitude in the threshold values for the test tone. Reference to the graph shows, up to this point, this step by step correlation, the 'shadowing' effect between the intensities of masking noise and test tone threshold. When, however, the masking noise reaches the 40 db. level it will be seen that the bone conducted test tone will be heard at threshold by the right as well as the left ear. A further intensity increase of the masking noise to 50 or 60 db. will further raise the threshold of the

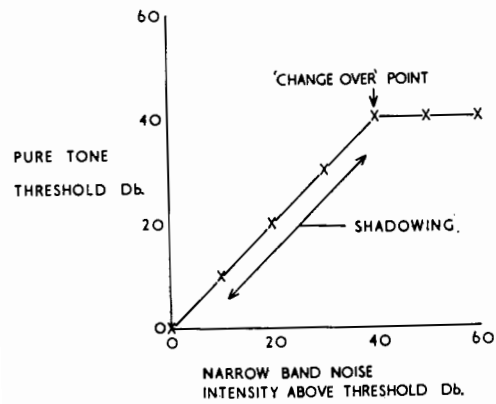
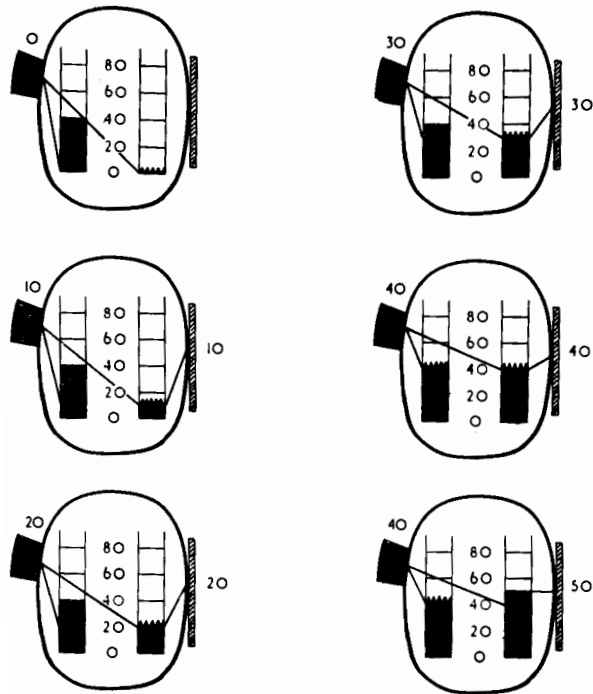


Figure 1

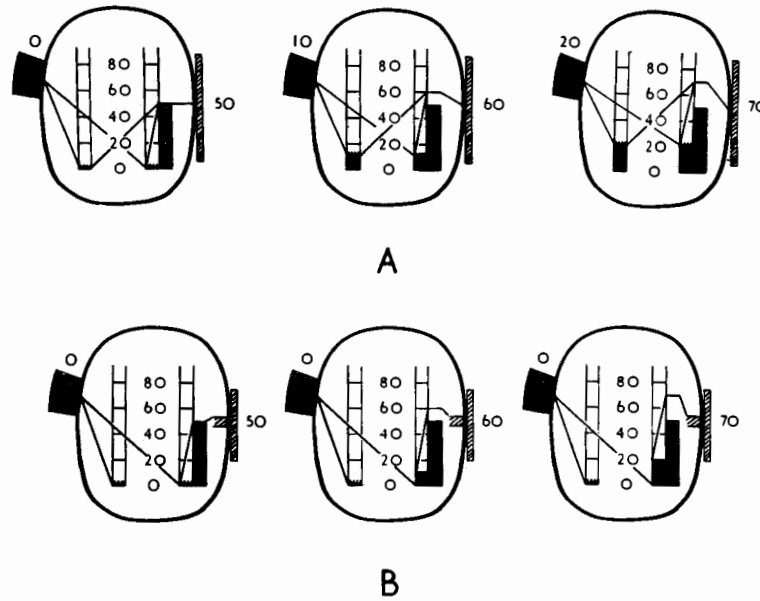


Figure 2

left ear alone, leaving the test tone to be heard by the right ear alone without further elevation above its true threshold value, 40 db.

The true threshold for the right ear will thus be shown at a point on the graph, referred to as the 'change-over' point, at which the slope of the curve changes from 45 degrees and becomes horizontal. In the case being considered, the change-over point occurs at 40 db. If, extending the argument, the deafness of the tested ear had been 50, 60 or 80 db. identical values of masking noise intensity would have been required to reach the 'change-over' points. In all cases, true threshold readings would be obtained.

This case is one of comparative simplicity. When we come to consider conductive elements, certain difficulties arise as illustrated in Fig. 2A. Here the subject has normal hearing of the right or tested ear, and a pure conductive deafness of 50 db, of the left ear indicated by the solid area adjoining the calibrated column which represents the inner ear hearing capacity of the left ear. If, now, we apply the shadowing technique as shown, an initial masking intensity of 50 db. above normal threshold must be applied to overcome the conductive deafness. At this intensity the sound will pass by bone conduction to the opposite or tested ear, and further increases of 10 db. and 20 db. will result in the right ear being masked.

This difficulty can easily be overcome, as shown in Fig. 2B, by the use of an insert receiver. With this it is possible to apply a tone of 80 or 90 db. intensity, without it being transmitted by cross conduction to the opposite

ear. In this way the masking tone may be confined exclusively to the untested ear. As a result, at any intensity between 50 db. the air conduction threshold of the left ear, and 90 db., the masking noise will be effective in the left ear alone.

If we now apply the 'shadowing' procedure and make step by step changes of masking intensity within this range, they will be found to leave unaltered the bone conduction threshold readings.

This technique brings within the resolving power of air and bone conduction audiometry a considerable range of cases that cannot be attained with conventional masking techniques.

Careful attention to the fundamental features of the test procedure is, however, essential. These are outlined as follows:

1. Establish the air-conduction audiogram of both ears in the normal way with masking, if necessary, of the untested ear, i.e., if the hearing loss of the tested ear exceeds 50 db.
2. Find the bone-conduction threshold with the bone-conductor applied to the mastoid of the tested ear without masking of the untested ear.
3. Apply the masking noise of the appropriate band to the untested ear by means of an insert receiver and establish the threshold of the noise.
4. Apply the 'shadowing' procedure thus: Increase the level of the masking noise by 10 db. above threshold and re-test the bone-conduction threshold. If the bone-conduction threshold is raised by 10 db., increase the masking intensity by another 10 db. and repeat.

Continue this procedure until the point is reached at which the bone conduction remains constant with further additional incremental steps of 10 db. of the masking noise. This is the 'change-over' point and gives the true bone-conduction threshold of the tested ear.

L'ASSOURDISSEMENT AVEC DES BANDES ETROITES DE BRUIT EN AUDIOMETRIE PAR CONDUCTION OSSEUSE

Le son venant d'un conducteur osseux placé n'importe où sur la tête peut en général être perçu avec une intensité égale par chaque oreille. A cause de cela il est essentiel, qu'avec tous les testes de conduction osseuse, l'oreille non testée est excluee par un bruit masquant efficace, de façon que toutes les mesures de seuil peuvent être validement rattachées à l'oreille testée.

L'efficacité d'un bruit masquant nécessite une bonne abilité masquante mais une intensité minimum et les bandes de fréquence de Fletcher nous apprennent que cela peut être achevé le mieux par l'emploi d'étroites bandes sélectionnées de bruit. L'attribut important de ces bandes est qu'il existe une relation d'une à une entre le niveau de perception du bruit et le seuil masqué du ton pur.

L'épreuve suivante est recommandée: Etablir le seuil de conduction osseuse non masqué. Appliquer la bande étroite de bruit à l'oreille non testée par écouteur miniature et accroître son intensité jusqu'à 10 db. au-dessus du seuil. Si le seuil de conduction osseuse est élevé, accroître le bruit encore de 10 db. et continuer de cette façon jusqu'à ce que le seuil de conduction osseuse reste inchangé en présence du bruit. Cela procure le seuil de conduction osseuse vrai de l'oreille testée.

J. D. Hood, Ph. D., D.Sc.
Otological Research Unit,
Medical Research Council,
The National Hospital,
Queen Square,
London, W.C. 1, England.

REFERENCES

- Denes, P., Naunton, R.F.
Proc. Roy. Soc. Med. 45, 790, 1952.
- Hood, J. D.
Proc. Roy. Soc. Med. 50, 689, 1957.
Laryngoscope, 70, 1211, 1960.