COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF HEALTH

# COMMONWEALTH ACOUSTIC LABORATORIES

SYDNEY

# THE EFFECT OF DISTANCE OF EARPHONE FROM EAR ON AUDIOMETER READINGS OF THRESHOLD INTENSITY LEVELS FOR PURE TONES

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# THE EFFECT OF DISTANCE OF EARPHONE FROM EAR ON AUDIOMETER READINGS OF THRESHOLD INTENSITY LEVELS FOR PURE TONES.

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The purpose of this investigation was to discover the effect of raising an earphone certain distances from the ear on audiometer readings of threshold intensity levels for pure tones within the audiometric frequency range. This information was required because an audiometric screening test for the detection of hearing loss in new-born babies which was under consideration involved holding the earphone sound source certain distances from the ear to avoid causing arousal by a tactile stimulus.

## METHOD:

Measurements of the intensity levels necessary to obtain threshold were made with four frequencies (500, 1000, 2000 and 4000 cps) at fixed distances of the earphone from the ear (0, ½, 1, 1½ and 2 inches). In the original design only four distances were used (0, 1, 1½ and 2 inches), but subsequent measurements were made at the distance of ½ inch. Both ears of each of 12 normal hearing subjects were tested (24 normal hearing ears). The testing was done in an anechoic room, using a 2 dB-step descending technique to obtain thresholds.

The earphone used was a Telephonics TDH39 (in an MX 41/AR cushion) to which were attached, in an adjustable manner, three rods used in determining and maintaining the distance of the earphone from the ear. The earphone was raised from the ear in such a way that it remained parallel to its orientation when on the ear. The earphone was driven by a Bruel and Kjaer Beat Frequency Oscillator Type 1014, the intensity levels being controlled by a Danbridge Decade Attenuator Type DA3T. The output sound intensity levels at the earphone were calibrated using a Bruel and Kjaer Artificial Ear Type 4151 and Frequency Analyser Type 2107.

In order to eliminate systematic practice, fatigue, etc. effects from the mean results, the orders in which the distances were presented to the ears were completely counterbalanced, and the particular orders were assigned to individual ears at random. At each distance, the frequencies were tested in the following order:

4000, 2000, 1000 and 500 cps.

## RESULTS:

The mean increase in intensity necessary to reach threshold at a particular distance of the earphone from the ear was calculated by subtracting the mean audiometer reading of threshold intensity level of the ears at 0 inches (earphone on the ear) from the mean audiometer reading of threshold intensity level at the particular distance for each frequency. Thus, taking the mean threshold intensity level at 0 inches to be zero at each frequency, the mean amount (in decibels) that the intensity of sound has to be raised to reach threshold at the five distances and four frequencies is given in Figure 1 and Table 1a.

<u>Figure 1:</u> The effect of distance of earphone from ear on audiometer reading of threshold intensity level for four frequencies.

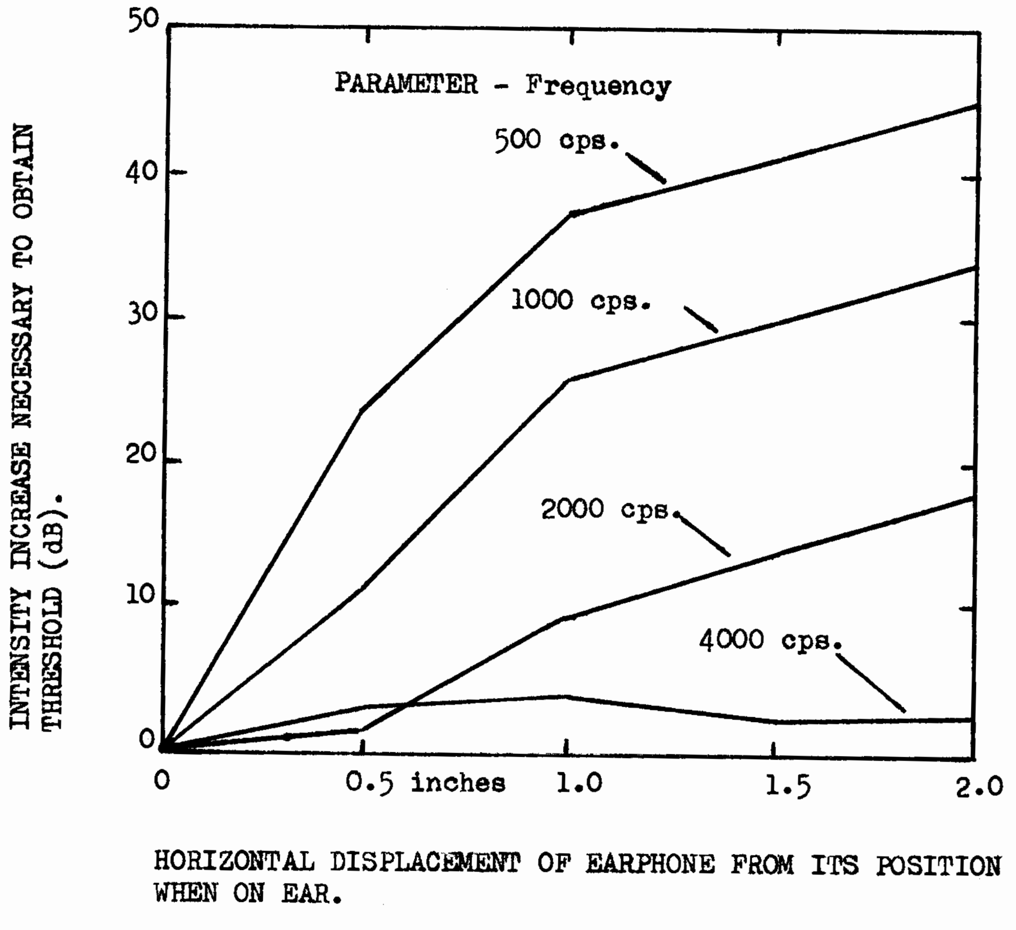

TABLE 1a: MEAN DIFFERENCES IN AUDIOMETER READINGS. (dB)

| DISTANCE / FREQUENCY | 0" | ½" | 1" | 1½" | 2" |
|---|---|---|---|---|---|
| 500 | 0 | 23.5 | 37.4 | 41.2 | 44.8 |
| 1000 | 0 | 10.8 | 25.7 | 29.8 | 33.5 |
| 2000 | 0 | 1.3 | 9.3 | 13.7 | 17.4 |
| 4000 | 0 | 2.5 | 3.3 | 1.6 | 1.8 |

TABLE 1b: STANDARD DEVIATIONS OF AUDIOMETER READINGS. (dB)

| DISTANCE / FREQUENCY | ½" | 1" | 1½" | 2" |
|---|---|---|---|---|
| 500 | 3.7 | 4.8 | 3.4 | 4.6 |
| 1000 | 4.4 | 3.9 | 2.7 | 3.3 |
| 2000 | 1.7 | 4.03 | 3.7 | 4.6 |
| 4000 | 1.8 | 3.6 | 2.5 | 2.2 |

It was considered necessary to test the statistical significance of the differences between the mean threshold intensity levels for the distances at 4000 cps only. Consequently, at this frequency an analysis of variance was carried out, in which the differences were found to be highly significant.

TABLE 2: TABLE OF ANALYSIS OF VARIANCE.

| SOURCE | S. of S. | df. | VAR. EST. |
|---|---|---|---|
| Ears | 2,286 | 23 | 99 |
| Distances | 134 | 3 | 44.7 |
| Residual | 305 | 69 | 4.4 |
| TOTAL | 2,725 | 95 | |

$F$ distances = 10.16 $p < .1$
$F$ ears = 22.5 $p < .1$

Both F ratios are highly significant.

CONCLUSIONS:

Figure 1 shows that raising the earphone from the ear has its greatest effect at the lower frequencies. From 1" to 2" at the frequencies 500to 2000 cps, the change in threshold intensity level as a function of distance conforms with the inverse square law governing the attenuation of sound over distances in air. At the distance ½ inch and the frequency 4000 cps other factors such as the baffle effect of the head, semi-open cavity, etc. must be in operation.

Since the threshold intensity level of the frequency 4000 cps is not affected to any great degree by raising the earphone up to 2 inches from the ear, it would be the most reliable frequency to use in an audiometric test which involves holding the earphone close to, but not on, the ear. However, in such an audiometric test the information in Figure 1 can be used in calculating the approximate intensity of the frequencies 500, 1000 and 2000 cps at the subject's ear, if the distance of the earphone from the ear is close to one of the investigated distances (½, 1, 1½ and 2 inches) and the output sound intensity levels at the earphone for these frequencies are known.

SUMMARY.

The effect of distance of earphone from ear on the threshold intensity levels of the pure tones 500, 1000, 2000 and 4000 cps was investigated, the distances used being 0, 1, ½, 1½ and 2 inches. The largest effects of distance occurred at the lower frequencies. Thus, 4000 cps would be the most reliable frequency to use in an audiometric test, involving the earphone being held close to, but not on, the ear, as the threshold intensity level of this frequency is not affected to any great extent by distances up to 2 inches from the ear.