A Ripple Effect in the Audiogram

IN the course of some psycho-acoustic experiments it was found that one observer's thresholds of acuity at two frequencies separated by only a few tens of cycles differed by nearly 10 decibels. Dips in an audiogram are not uncommon ; but the difference observed pointed to an uncommonly sharp change of sensitivity. Further tests revealed other equally sharp fluctuations in this observer's audiogram. Eventually a systematic exploration of the right-ear thresholds of this and one other observer was undertaken. Thresholds were measured at 10-cycle intervals over the range 400–3,000 c./s.
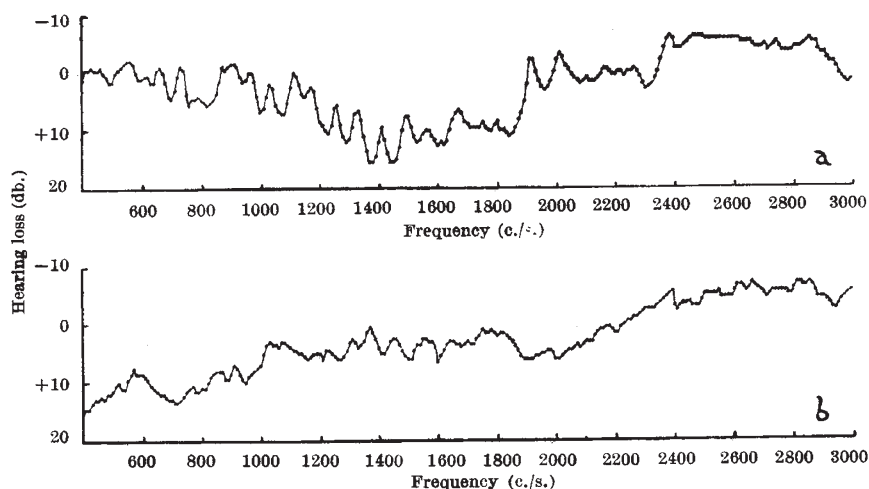

Fig. 1. Audiograms (a) for subject A, aged 21, and (b) for subject B, aged 28 years

The remarkable feature of these audiograms (Fig. 1) is the appearance of distinct ripples covering the range of frequencies up to about 2,000 c./s. Further experiments showed (1) that the ripples were stable over a period of at least two months, (2) that the left-ear audiograms also showed ripples, but the periods and amplitudes differed, and (3) that the ripple effect must be a very common, if not a universal phenomenon, since three additional observers also had the same sort of rippling audiograms in the narrower band from 1,000 to 1,400 c./s. This ripple phenomenon seems to have been unnoticed hitherto.

Threshold sensitivity fluctuates quite widely from one test session to another, and even within a single session if it is at all prolonged. To demonstrate the ripple effect it was necessary, therefore, to keep the test sessions short ; but each session included measurements of threshold at frequency intervals which were small compared with the period of the ripple, and the frequency band covered was more than twice the period.

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Magnitude of Discomfort caused by High Brightness

HITHERTO the greatest care has been taken here in the studies of building efficiency to avoid methods of subjective judgment which depend on assessment of sensation magnitude in terms of numbers. For certain reasons, however, a numerical assessment of the magnitude of the sensation of discomfort due to glare was required.

An experiment was designed in which subjects, so far as possible naïve in the context, were asked to adjust conditions in a room with glaring light sources until the sensation of discomfort was 'twice', 'ten times', 'one-half' and 'one-tenth' of the original level of discomfort. Eight out of twelve subjects were able to make judgments without trouble, the other four being either unco-operative or unable to follow what was required of them. The results were consistent and showed less variance than expected. The precise relations, which will be reported elsewhere, are not of importance in the present context because they depend on the experimental conditions.

It is of interest, however, that discomfort magnitude was found not to be correlated linearly with (apparent) brightness of the glaring sources. Whereas, under the given conditions of adaptation, apparent brightness was known from previous work[1] to be related to photometric brightness (luminance) by a power law of the form :

$$M = k L^{0.5}$$

where M is apparent brightness magnitude and L is luminance, the magnitude G assigned to the glare discomfort was found, under essentially the same conditions, to follow a law

$$G = k L^{1.23}$$

In other words, whereas the luminance of the sources must be raised four times $\left(\text{antilog} \dfrac{\log_{10}2}{0.5} \right)$ to appear twice as bright, the sources will appear twice as uncomfortable (for glare) if their luminance is raised only 1·8 times $\left(\text{antilog} \dfrac{\log_{10}2}{1.23} \right)$.

If these data are valid, it raises an important principle in practical engineering matters involving subjective judgments of magnitude, especially if this principle is applicable in other modalities, such as noise. This is, that if a stimulus gives rise to both a primary sensation (loudness or brightness) and also an associated secondary sensation (pain or discomfort), it does not follow that the magnitude of the secondary sensation is directly or simply linked to the magnitude of the primary sensation. Hence, if we wish to find out about discomfort or pain, we must assess discomfort or pain directly in relation to stimulus energy, and must not make implications from brightness or loudness magnitude assessments.

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[1] Hopkinson, R. G., Nature, 178, 1065 (1956).