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Binaural minimum audition in a subject with ranges of deficient acuity.

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While working on the problem of the bone transmission of sound, the writers found several peculiar effects. At certain pitches, pulsating ringing tones were heard synchronous with the heart beat. Other frequency ranges showed evidences of diplacousis. In determining in which ear a sound was apparently being heard, when the sound was being applied to both ears, "cross-over" effects from one ear to the other occurred as the pitch was changed without referable cause in so far as the acuity curves for the two ears was concerned. Inasmuch as bone transmission is necessarily conveyed to both ears, it was thought essential that binaural acuity for air transmitted sounds be tested as well as monaural. It was also considered important to find out whether or not any reinforcing effect due to the use of the two ears which might be shown in the ranges of normal hearing, would similarly be found in abnormal ranges.

The type of apparatus used has been described elsewhere.[1] Alternating electrical currents were generated by means of a vacuum-tube oscillator and sounds were produced from these currents by the use of the thermophone. The frequencies and intensities were regulated by electrical means. For binaural tests, two exactly similar thermophones were used in series, so that the measured current ran through both of them and the same intensity of sound was applied to the two ears. The absolute intensities were calculated from the currents and from the characteristics of the thermophones.

The results obtained are shown graphically in the accompanying sketches where the sensitivities are given for each ear and also both together. The difference between any two adjacent horizontal lines, as 8 and 9, represents a factor of 10 in the intensity of the applied sounds. The matter of attention introduces a certain factor of variability in the results, perhaps amounting

[1] Kranz, F. W., Minimum intensity for audition, *Phys. Rev.*, 1923, xxi, 573.

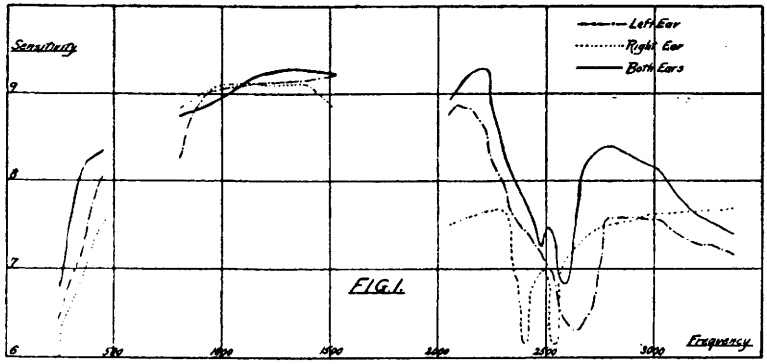

FIG. 1.

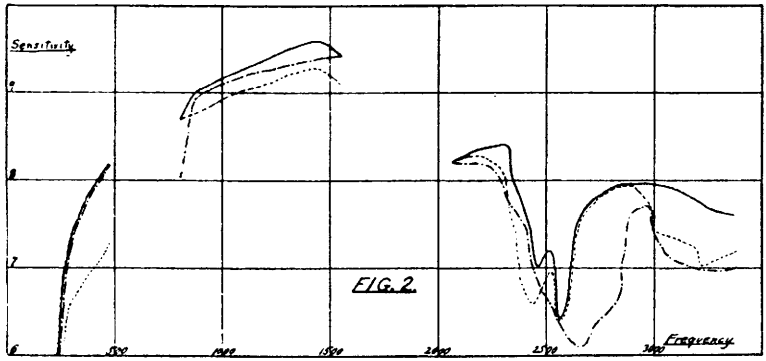

FIG. 2.

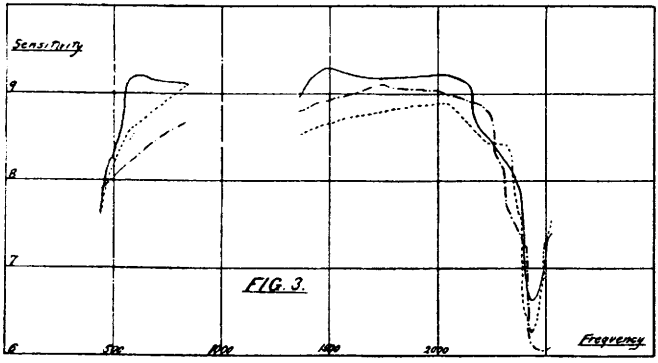

FIG. 3.

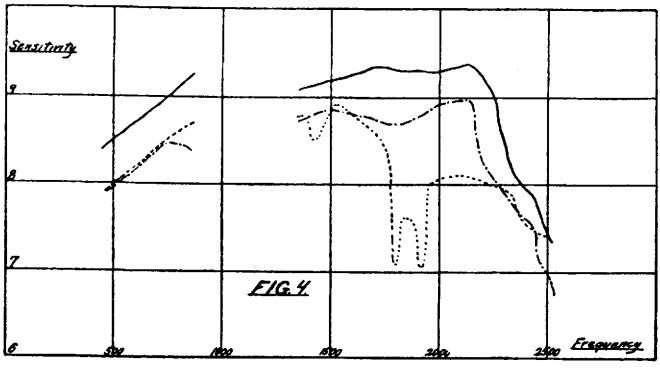

FIG. 4.

to 0.2 or 0.3 on the scale of sensitivity shown. The frequency is given in double vibrations per second. It is seen that binaural sensitivity is in general not much different from the sensitivity of the better ear but it is also, with few exceptions, slightly higher. It may be concluded that the binaural sensitivity at minimum audibility is but slightly better than the sensitivity of either ear alone, and this is also true in the ranges of depressed sensitivity as well as in the ranges of normal hearing.

It was found that while the region of decreased acuity was very noticeable for air transmitted sound near minimum audibility, the depression was not nearly so evident in the case of bone transmitted sound. The question came to mind—in passing over a frequency range, will a portion of this range which shows a low value of acuity when at or very close to the low limit of audibility, continue to be noticeably low in comparison with the remainder of the range as the intensity of stimulus for the whole range is increased? It was found by trial that when the intensity of the stimulus was about 10 times that required to hear the weakest part of the range, this low sensitivity portion was no longer noticeable as the frequency was varied to pass through it.

The conclusions in this paper may be summed up in two statements:

1. The sensitivity for binaural minimum audition is consistently slightly higher than for either ear alone. The amount, however, is not large, and in fact, does not lie far beyond the limits of a reasonable error in attention.

2. Decreased acuity of hearing for certain limited portions of the tone scale as determined by minimum audible sounds, is not a criterion of deafness with respect to ordinary intensities. Once the threshold of such a range of decreased acuity is attained, it takes comparatively little additional energy to cause the deficiency to seemingly disappear quite completely.