CLINICAL NOTE

THE BINAURAL BEAT PHENOMENON

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It is well known that when two pure tones differing slightly in pitch are heard simultaneously, a beat is perceived equal in frequency to that by which the two tones differ. The explanation is a simple interference phenomenon and obtains equally with sound waves or oscillating electric currents.

This beat can easily be observed if the ear-piece of an audiometer is applied to one ear and a pure tone of frequency 250 produced. If now the base of a vibrating tuning fork of 256 frequency is touched on the outside of the ear-piece, a beat of 6 c.p.s. is at once heard.

If the fork is held near the meatus of the opposite ear, the beat is again heard. The attenuator of the audiometer is now adjusted until the intensity at the ear-piece is 10 db. above threshold, and the intensity of the fork made of a similar value. The beat is still clearly audible. It is just detectable when the two tones are only 5 db. above threshold.

This experiment can be repeated using the audiometer set at 125 and a 128 fork, or at 500 and the 512 fork, when beats are again audible. At 1000 and 1024 the rate of beat is too rapid to be detected.

Consideration of this observation at once raises the question of the place where the interference can take place. The very low intensity used negatives the possibility of the two air waves mixing in either ear, but to give extra confirmation of this the experiment was repeated using an observer who had total unilateral nerve deafness. The fork applied to the case of the receiver at the good ear produced the beat in the usual way, but no beat was heard when it was held near the deaf ear. This conclusively rules out air conduction to the opposite ear at the intensities used in the experiment.

It would appear that the only possible place where the two tones perceived through opposite ears could mix is in the central nervous system. While it is not at present proposed to suggest exactly how this occurs, the phenomenon would seem to be of some importance in a discussion on the mechanism of hearing.

If the cochlea acts as a simple microphone and transmits to the brain electrical currents varying in frequency and intensity in direct correspondence to the sound waves falling on the ear, then mixing of these electric currents in the brain could easily explain the phenomenon. The cochlea microphonic potentials described by Wever and Bray are usually considered, however, to be an epiphenomenon and not the mechanism of transmission of hearing from ear to brain. Even if this is true, it is conceivable that interaction between these currents, although only an epiphenomenon, could produce the beat. It would,

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however, appear that at the low intensities used an epiphenomenon could hardly reach sufficient strength to produce such a result.

The usually accepted Helmholtz resonance theory of hearing is that the cochlea acts as an analyser of sound, and that the type of nervous impulse in an auditory nerve fibre has no relation to the frequency of the incoming sound. It produces the sensation of pitch by virtue of the particular region of the basilar membrane with which it is connected. Under these conditions it is difficult to see where the interference beat observed in this experiment could be produced.

Might it be that in the brain the impulse is reconverted into some nervous or electrical response which possesses at least an aspect which has a frequency character identical to that of the original sound?

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