curve from which you read off the average time at which cleavage of a large number of eggs occurred.

The advantages of this method are: a permanent record is left on paper; the counting is done with ease after the process has passed; each egg is counted only once, the mark across the image of the egg on the paper indicating the eggs already counted in the preceding period.

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SPECIAL ARTICLES

THE EFFECT OF A SECONDARY SOUND UPON HEARING

THE problem of hearing in the presence of a secondary sound has of late received considerable attention from correspondents of this journal. The ancient belief that certain persons suffering from paracusia, in the form of a partial deafness of the conduction-type, are able to hear more acutely in noisy surroundings than under conditions of quiet has been brought to question and debated on various sides.[1]

The matter seems at last to be decided by the excellent experiments of Knudsen and Jones, reported recently.[2] The threshold of hearing was ascertained for speech-sounds and for a faint tone both in silence and with a constant noise, and it was shown that for all subjects, normals and defectives alike, acuity is reduced in the presence of a noise. This finding is not incompatible, it must be noted, with the well-attested fact that under particular conditions the paracusic can carry on conversation more easily in the presence of a secondary sound. The phenomenon is a consequence not of an increased sensitivity of the acoustic mechanism, but rather of a relative advantage which the situation affords the paracusic over his normal companion.

The explanation is plain. The commonest auditory defects involve a considerably greater reduction of low tones than of high tones, and since most extraneous noises are made up predominantly of low-pitched tones, it follows that the person of impaired hearing is deaf to the secondary sound relatively more than he is to the essential tones of speech (which are of higher pitch) and thus in conversation is disturbed by the sound relatively less than is a person of normal hearing. Now since the loudness of one's voice is adjusted by reference to the background as he hears it, the normal person, being greatly disturbed by a sound, speaks much louder than usual, but the defective, selectively deaf to the sound, raises his voice but little. The net result of the background, in this situation, is a favoring of the person of impaired hearing, though actually the acuity of both persons is reduced as compared with silence. This explanation is supported by the fact that the illusion of improved hearing in the presence of a noise occurs only in conversation between a normal and a defective, and never between two normals or two defectives.[3]

All this seems clean-cut enough. The writer has merely to add some remarks upon an experiment which in a measure confirms, and further extends, the findings of Knudsen and Jones and which brings forth an additional problem for settlement. The experiment, conducted at the University of California last year in collaboration with Mr. Stanley R. Truman, was concerned with the effect of a background of tone upon the acuity of the normal ear.[4] Various frequencies and intensities of tone were used for the background and for the testing-tone, and we found, as Knudsen and Jones did, that at the introduction of a tonal background hearing is always reduced.

However, we came upon the further discovery that the threshold does not remain constant under such conditions. At the entrance of the secondary tone the acuity is considerably diminished, but recovery of sensitivity begins immediately and proceeds at a rapid rate until, under a given set of conditions, it may become three or four times as great as it was at first. Sensitivity does not, however, reach the level shown under conditions of silence; after about two minutes it has attained its highest extent and from then on we found no indication of further significant change.

Just what is the cause of this change in threshold-sensitivity we are thus far unable to state with conviction, but experiments are in progress which it is hoped will afford a clue. It would be interesting as well as significant in this relation to know whether paracusics would show the same type of curve of threshold-recovery as do normal persons under the conditions stated, and whether with prolonged stimulation by a secondary tone the relative advantage which, as has been pointed out, circumstances may afford the paracusic would continue to be maintained. Unfortunately, Knudsen and Jones do not tell us the temporal conditions of their tests, and the presumption is that they took no pains to control them—though it is plain on the basis of our results that the temporal factor is of first importance. It is to be hoped that some investigator with the necessary clinical facilities will extend the work of Knudsen and

[1] See, *e.g.*, 60 (1924), 360; 61 (1925), 260 ff.; 62 (1925), 109–111 and 182; and esp. Kranz, 60 (1924), 549.

[2] V. O. Knudsen and I. H. Jones, *Laryngoscope*, 36 (1926), 623–663.

[3] See Knudsen and Jones, *ibid.*, and *cf.* H. Fletcher, *Volta Rev.*, 26 (1924), 443 f., 447 f.

[4] See *J. Exper. Psychol.*, 11, 1928, 98–112.

Jones, and trace the sensitivity of the paracusic ear in the presence of a tonal background throughout its course of change; the result might lead us to a better understanding of this phenomenon not only in paracusia but in normal hearing as well.

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REMARKABLE MUSICAL TECHNIQUE OF THE LARGER ANGULAR-WINGED KATYDID

IT is evident that there has been marvelous specialization in the vocal music of the birds, the flute-toned thrushes, including the marvelous hermit, probably leading them all with their tonal embellishments. There has been a parallel specialization among the musical insects of the world. The insects have turned especially to instrumental music, adopting microscopic teeth to be operated upon by a scraping edge as the more common type for their frictional music, in the majority of instances. A mere file-vein and scraper or plectrum to rasp across its teeth seem simple enough as a musical instrument, but even this primitive chitin xylophone offers many possibilities of specialization. It may have teeth of different sizes and spacing, to produce different notes as in the case of certain sound-making ants and beetles, or more than one file-vein may be present on an insect. For the present these specializations of the physical structures of the instrument itself need not be considered. There is a further possibility, and that concerns the technique, the manner of handling the instrument to produce the greatest variety of tones and notes. In the music of man, technique has become the big factor, and marvelous progress has been made in this direction alone by the modern masters over the ancients. In spite of the fact that the crickets have somehow hit upon tonality in their music, and the katydids have not, the latter have nevertheless shown a marvelous specialization in the direction of technique far excelling the crickets. The larger angular-winged katydid has proven himself a master-artist with his xylophone. He has specialized in a manner that makes him a pioneer in his art, at least in our own country. Unfortunately we know too little of the musical behavior of insects elsewhere in the world. This fine katydid, as veritably leaf-adorned as the trees themselves, has somehow learned of the full potentialities of his microscopic file-vein and is making good use of his acquirement. The file-vein is a mere thickened ridge or vein bearing parallel chitin bars or teeth, like the teeth of a comb, these being set practically at right angles to the vein and perpendicular to the surface from which they arise. An almost universal technique among the crickets and katydids is to draw the scraper entirely across this music-file one or more times to produce a note. In the single chirp of a cricket or the intermittent rasp of many katydids, an extremely rapid back-and-forth movement several times delivered produces the sound. The quaver of the cricket-chirp is due to these alternate wing-strokes. In this manipulation all the teeth of the file-vein are used practically simultaneously. The larger angular-winged katydid has somehow gone far beyond this and has learned to produce a long, slow crepitation of thirty to forty or more clicks, making use of the individual teeth, or perhaps sometimes slipping over two or more teeth. The wing-covers along their upper edge are opened nearly three sixteenths of an inch, and set at an angle that will bring the file-vein of the under side of the upper tegmen against the scraper of the upper side of the under tegmen. The scraper is now slowly moved with nice adjustment and precision over the individual teeth, in a gradual closing movement of the wings to produce the long series of individual clicks characteristic of the more typical "song" of this species.

A count of the teeth of the file-vein, including poorly-developed ones at each end of the file, reveals only from fifty-five to sixty teeth, in a length of about three mm. It is probable that not many more than forty to fifty well-developed teeth are present on this file, which would allow not more than an average of one tooth per click in a series of thirty to forty clicks. This is a remarkable specialization in technique and shows the nice control of the katydid in this behavior. It would appear that no other katydid or cricket in our own country has progressed this far in the matter of technique, and we know as yet too little to speak with any authority covering the technique of any foreign species. This katydid not only makes use of this specialized technique, but it has in addition an intermittent zip, produced by striking all the teeth with one quick draw of the scraper across the teeth.

One wonders how this fine katydid sensed this new technique of tapping the chitin-bars of its dorsal, organic xylophone very slowly, to make each tooth emit a note or tone. The most marvelous thing about life, however, is the way it always seems to sense possibilities in every detail of form and function. Once the chitinous xylophone came into being on its wing-covers, once the scraper began to touch the bars to produce a rasp, potentialities were ahead. In the case of the intermittent rasp or zip of this katydid, one quick closing draw produced the note. Slowing down this closing draw of the scraper upon the file-vein was the next step, and some weird prescience of life has in some manner taught the katydid to do just this.