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Reprinted from the Archives of Otology, Vol. xxxi., No. 4, 1902.

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THESE experiments, of which a concise but necessarily incomplete summary is here attempted, were made during the visit of Dr. Haddon's expedition to Murray Island. They seem to be the first that have been conducted with a view to determining the auditory acuity, the highest audible tone, and the minimum perceptible difference of pitch among a primitive people. They will be published at full length in a forthcoming number (vol. ii., part 2), of the *Reports of the Cambridge Anthropological Expedition to Torres Strait* (University Press, Cambridge, England).

I.—*Acuity of Hearing.*

This is an exceedingly difficult subject of investigation anywhere, but in Murray Island the constant rustle of the palm-leaves and the beating of the surf on the shore aggravated the difficulty. After futile attempts with Politzer's hœrmesser, I had to lay it aside in favor of a stop-watch. A neighboring island, which I did not visit, proved quiet enough for my colleague, Dr. Rivers, to use the hœrmesser. He tells me that hardly any native there could hear as well as another member of the expedition, who was tested along with the islanders, and was found to have, for a European, only moderately acute hearing. My own inquiry was for the most part confined to children. Otorrhœa did not appear to be at all common during our stay on the island; moreover, I was anxious to avoid the possible interference of past sea-diving on adult auditory acuity. Either Dr. Rivers or I was always tested along with the islanders, the

other of us holding the watch (a Runne's clock). External noises varied so much from day to day that I found it impossible to compare the results obtained from islanders on one day with those obtained from others on the next. Unless some fixed person was tested simultaneously with the natives, the experiments proved useless. In all, thirty natives were examined.

I cannot here quote the data on which my conclusions rest. The evidence appears to show that a considerable number of the islanders has slightly subnormal hearing, that in a small proportion (chiefly in those who have had otorrhœa after deep sea-diving) hearing is very decidedly defective, and that it is exceedingly rare to find an islander whose hearing equals the hyperacute hearing of many Europeans.

II.—*The Upper Limit of Pitch.*

In these experiments I used a Galton-whistle made by Hawksley, of Oxford Street, London. The diameter of the bore is 1 *mm*, and it is graduated according to the formula $n = \frac{v}{4l}$, where n is the number of vibrations, v the velocity of sound, l the variable length of the whistle. Reliance cannot, however, be placed on the accuracy of such estimations. From this cause, also from variations in tone-intensity and from the employment of different methods of tone-production, have arisen the surprisingly different results, varying from 18,432 vibr. (Zwaardemaker), to 40,960 vibr. (Preyer), which even recent observers have adduced from experiments on European ears.

Fortunately my own work is free from such sources of fallacy, as I used the same Galton-whistle under precisely the same conditions (save for negligeable differences of temperature), first among the Murray Islanders in the Torres Straits, and later among a number of country-folk in north-east Scotland. My results, therefore, are independent of an accurate determination of the note emitted by the whistle, and I am consequently able to compare the upper limit of hearing among a primitive and a civilized community, simply

by observing the length of the whistle on each occasion when that limit was reached.

I hope shortly to estimate the pitch of my whistle by aid of a modified form of Kundt's dust figure-apparatus, but for the present it must suffice merely to state the whistle-length in millimetres. The figures in brackets give the number of subjects investigated within each age-group.

Age.	Whistle-Length at Upper Limit.	
	in Murray Isl. (44)	in Scotland. (29)
- 9	2.23 (2)	1.97 (4)
10–19	2.26 (17)	1.99 (9)
20–29	2.91 (6)	2.23 (3)
30–39	3.16 (7)	2.70 (5)
40–49	3.72 (6)	2.79 (5)
50–59	4.60 (6)	3.98 (3)

Those whose hearing in both ears was defective, or in whom otoscopical examination revealed obvious signs of disease, are here excluded. The whistle was held at a metre's distance from the subject's ear. After a little practice, the india-rubber bulb, which I attached to the whistle, could be compressed so as to give time after time a blast of sufficiently constant force. Five determinations were made for each ear. Finally the average for the two ears (except in the rare cases of unilateral deafness) was taken. The interest shown by the Murray Islanders in these experiments was astonishingly great. The children, indeed, were considerably more attentive than their fellows in Scotland.

The results show that from childhood onwards a higher tone is heard by the European than by the Papuan ear. They also show, as Zwaardemaker has before found, that the range of hearing varies according to the age of the subjects investigated. It might be thought that sea-diving would have produced intra-aural changes unfavorable for a high upper limit of pitch. But Murray Island children showed the same inferiority as the adults: nor could islanders who had never dived hear a higher tone than the majority of those who had dived.

III.—*The Least Perceptible Difference of Pitch.*

Here again I am able to present a series of experiments, performed under strictly comparable conditions upon the children and adults of Murray Island and later on village school-children and people in northeast Scotland. I used two forks of the same pitch, $c' = 256$. An arm of one of the forks was graduated and carried a sliding metal clamp which could be screwed fast to the arm at any desired position; by this means its pitch could be made to differ by relatively small or great amounts from that of the other fork. Before applying the forks successively to the ear of the subject (who sat with his back towards me), I took care always to listen to them first myself, so as to be sure that the intensity of the sounds did not materially vary. Each fork was applied to the ear for about two seconds. The interval between the withdrawal of the first and the presentation of the second fork was likewise about two seconds, during which the second fork was being struck. The subject was then asked which of the two forks was the higher, or whether he thought they were of the same pitch. After a short preliminary explanation of the general procedure, I began the experiment by presenting an interval so large that the subject could not fail to appreciate it. Next I rapidly and roughly arrived at an interval which was too small for his correct appreciation. I then worked gradually towards the threshold from a point which was clearly above it. Having reached and passed below this threshold, I gradually increased the interval between the forks again, until once more I arrived at the point of just perceptible pitch-difference. I applied the two forks five times for each position of the clamp, and was not satisfied that the subject had correctly appreciated the given interval unless he had given at least four successively correct judgments at the corresponding position of the clamp.

When later I came to determine the vibration-frequencies of the tones of the variable fork, Mr. G. T. Bennett, of Emmanuel College, Cambridge, kindly gave me the benefit of his considerable practice in beat-counting. From a mathe-

matical study of our results, he has no doubt that they are to a sufficient approximation correct.

The general education of the Murray Island children was not very different from that in a British village school. They were all taught to sing European airs in class-time, and they did so with remarkably exact intonation. The table shows that of the eleven children examined five could

Correctly appreciating a difference of.	11 Papuan children.	15 European children.	20 Papuan adults.	18 European adults.
1 vibr. per sec.	0	0	0	0 (2 *m*)
2 " "	0	0	0	2 (1 *m*)
3 " "	1	2	0	0
4 " "	0	0	1	2 (2 *m*)
6 " "	1	1	0	1
7 " "	0	3	1	2 (1 *m*)
9 " "	2	2	2	0
12 " "	0	2	0	0
14 " "	2	1	2	0
16 " "	2	1	9	3
19 " "	3	3	4	2
22 " "	0	0	1	0

not discriminate between two successive tones less than sixteen vibrations per seconds apart; in other words, five could not appreciate an interval less than an untempered semi-tone. Of the fifteen European children, on the other hand, only four required so large a pitch-difference. The results given by the adult islanders are not so comparable with those obtained in Scotland. They had received no European musical education in childhood. While the school-children were wont to sing European rather than Papuan airs, the adults were limited almost wholly to native music, save for the hymns they had learned to sing (!) in church. Now if third- and quarter-tone music is so widely spread among primitive people, as has sometimes been stated, we might expect them to show a highly refined ability of distinguishing tone-differences. Instead, we find that no less than fourteen of the twenty adult islanders examined fail with intervals less than the semi-tone. The eighteen European adults include six who played a musical instrument; of these three had had valuable practice in tuning the violin,

and one the violoncello. They are separately accounted for in brackets accompanied by the letter *m*, but at most only one or two of them could be termed "highly musical." In Murray Island there were neither stringed nor wind instruments. Several of the islanders examined, however, claimed to be composers of native songs.

Both in Murray Island and in Scotland I have interesting records of the different and often considerable effects of practice, obtained by experimenting on the same subject on two, three, or even four separate occasions. I thus obtained over twenty-five hundred judgments in Murray Island alone. Sometimes the constant, sometimes the variable fork was first sounded, in order to determine the possible influence of the order of presentation. I hope that these results will have special interest when compared with the work of Martin and Müller (*Zur Analyse der Unterschiedsempfindlichkeit*, Leipzig, 1899), who investigated the subject so far as the judgment of different weights was concerned. I do not, however, propose to publish further data here. They will appear later in the above-mentioned volume of the Expedition Reports.

The Knickerbocker Press, New York