OUTLINES OF A NEW THEORY OF MUSCULAR ACTION: BEING A THESIS READ FOR THE DEGREE OF DOCTOR IN MEDICINE, BEFORE THE UNIVERSITY OF DUBLIN, DEC. 17, 1862

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SAMUEL HAUGHTON

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Trieste

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A NEW THEORY OF MUSCULAR ACTION:

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BY THE

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1863.

TO

WILLIAM STOKES, M. D.,

REGIUS PROFESSOR OF PHYSIC IN THE UNIVERSITY OF DUBLIN,

Whose readiness to devote his valuable time in aid of investigations tending to promote Medical Science is well known to all who have had occasion to seek his co-operation, this attempt to determine some of the numerical laws of Muscular Action is gratefully dedicated by

His obliged pupil and friend,

SAMUEL HAUGHTON.

TRINITY COLLEGE, DUBLIN,
March 31, 1863.

OUTLINES

OF

A NEW THEORY OF MUSCULAR ACTION,

&c. &c.

PART I.

ON THE RATE OF MUSCULAR ACTION.

In the Croonian Lecture, read before the Royal Society, on November 16th, 1809, Dr. Wollaston called attention to the sound, or susurrus, produced by the muscles when in a state of contraction. He states correctly that this sound is best produced by inserting gently the extremity of the finger into the ear, bringing at the same the muscles of the hand and forearm into strong contraction. The muscular susurrus may also be heard easily by using a stethoscope upon a contracted muscle, either of the observer's or of any other person's body.

Having described the mode of obtaining the sound, Dr. Wollaston correctly adds that it "resembles most

nearly that of carriages at a great distance passing rapidly over a pavement;" to which admirable description of the sound I would add, that it bears the most striking resemblance to the deep hum produced by the blowing fan of a large foundry.

Dr. Wollaston attempted to estimate the frequency of the elementary muscular contraction that produces the susurrus by allowing his ear to rest on the ball of his thumb, while his elbow was supported by a horizontal board, in which he had cut a number of equal notches, about one-eighth of an inch asunder. Against these notches he rubbed a pencil with a regular motion, until he made the sound so produced to coincide roughly with that of the muscular contraction; and he attempted to estimate the number of notches passed over in a second. His conclusion from these comparative experiments is the following:—

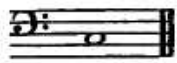
"The greatest frequency that I think I have observed was about 35 or 36 in a second, and the least was as low as 14 or 15 . . . .; they appeared to be in general between 20 and 30 in a second; but it is possible that the method I employed may be found defective, and it is to be hoped that my estimate may be corrected by some means better adapted to the determination of intervals that cannot actually be measured."

An accidental observation made upon myself a few months ago has enabled me, I believe, to fix

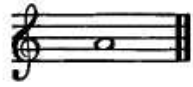
with the precision desired by Wollaston the rate of the muscular contraction that causes the susurrus. About three years ago, on recovering from a slight access of fever, which was fortunately cut short, I found that it left the following trace of its visit in my system:—Occasionally, since that period, when overworked by mental exertion, I have been subject to a singing in both ears, which is relieved by a drink of warm milk, and by sleep; sometimes, however, I have found the tinnitus aurium so great as to prevent sleep.

In June last (1862), while kept awake by this disagreeable noise, I amused myself with producing, by the contraction of the masseter muscles, their well-known susurrus. To my great surprise and pleasure, I observed that the tinnitus and susurrus were in unison, differing from each other by several octaves.

I followed up the clue thus found, and consulted my musical friends, whom I instructed in the mode of making Wollaston's experiment, without, however, informing them of the note that I myself believed to be the true sound of the susurrus and tinnitus. My friends have arranged themselves into two groups, which have fixed upon CCC and DDD, respectively, as the note of their susurrus—that is to say, two octaves below bass C and D



These notes are found on the new pianos only, and several of my friends informed me that the C or D, the lowest on their piano, was an octave above the susurrus; but, on inquiry, there was no difficulty in ascertaining what note was really indicated. The tuning of the pianos was carefully tested with a standard CC diapason, of 64 double vibrations per second, used for acoustical experiments, and corresponding with 426⅔ vibrations in the second for the note, treble A.



Four of the observers, of whom two were ladies, found CCC, and five, of whom three were ladies, found DDD, which notes correspond, respectively, to thirty-two and thirty-six vibrations in the second.

To my own ear, the susurrus has constantly the sound of CCC; and the tinnitus had, on the morning of 30th June, 1862, the sound of the octave above treble C, that is to say, it was  ;* five octaves above the susurrus, and therefore corresponding to a rate of vibration thirty-two times faster than that of the muscle, or 1024 times in the second.

* This is the note given out by a well-formed hand bell, of 4 inches diameter.

The tinnitus is altogether independent of muscular or voluntary action of any kind, and is, I believe, a sign of the rate at which nervous action takes place in the brain. This conjecture I hope at some future time either to verify or disprove. The sound of the muscular susurrus, when fully heard, is ridiculously like the sound of the cab-wheels of London heard in the silence of the night, when the absence of thoroughfare in the streets enables the cabmen to drive fast. I have measured the intervals of the Guernsey granite pavement, and found them to be about four inches, making therefore three impulses in a foot traversed by the cab-wheels. If the cabs be supposed to drive eight miles an hour, the number of impulses per second will be

$$\frac{5280 \times 3 \times 8}{3600} = 35{\cdot}2.$$

Considering that the standard DDD of the susurrus is thirty-six vibrations per second, its resemblance to the sound of cab-wheels ceases to be a matter of surprise. In order to determine the sound of the susurrus precisely, I procured a long wooden tube, 3 inches by 2½ inches inside, like an organ-pipe, fitted with a moveable piston, so that on applying it to an acoustical bellows, on moving* the piston in or out, I could

* The piston is moved in the acoustical tube by means of an endless chain movement, made for me by Mr. Spencer, of Aungier-street.