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THE PHYSIOLOGY OF THE INTRA-TYMPANIC MUSCLES.

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"Self-preservation is the first law of Nature" is axiomatic, but the usual interpretation of the proverb is in its relation to volition. The true significance of the expression is much broader, for Nature acts according to this law regardless of the judgment, or aid, of the individual, though not always successfully in face of his opposition. More than this, Nature places a premium of the better development of power, or dexterity, and facility in action upon the proper and rational use of the means of protection which she affords. "Struggle for existence" presupposes that it is *difficult* to live; that there is opposition to continued existence with which all animals have to contend. Opposition indicates effort; effort suggests means, purpose, and development.

In a paper on "The Primary Physiological Purpose of the Membrana Tympani," read in September, 1888, at Washington, D. C., an *intention* for the drum-membrane other than the transmission of sound impulses was discussed. From it follows a *deduction* as to use of the intra-tympanic muscles, an addition to this function as ordinarily understood.

If the membrana tympani in purpose protects the aural tissues lying interior to it, these muscles being appendages to the membrane are designed to assist the purposes of the membrane, which they do in part by *protecting* it from injury by the impact upon it of sound impulses violent enough to rupture an inflexible membrane, firmly attached,

and having such a plane as to expose it to the fullest force of the concussion. The membrana tympani fulfills but one of these conditions; *it is firmly attached.* "I think it may be fairly inferred that the function of the tensor tympani muscle is to *protect*[1] the membrana tympani and the labyrinth from injury during loud sounds; while the stapedius muscle places these structures in a position to be impressed by the most delicate vibrations." (Toynbee, "On the Functions of the Muscles of the Tympanum in the Human Ear," British and Foreign Medico-Chirurgical Review, 1853.) Henle (Eingeweidelehre, p. 749) thinks the stapedius acts as a guard, when the stapes might, by undue force, be driven into the oval window. "A violent blow on the ear with the palm of the hand rarely produces mischief to the membrana tympani *when its reception is expected*;[1] whereas a comparatively gentle but *unexpected*[1] blow frequently produces, not merely concussion of the nervous labyrinth and serious derangement of the functions, but not uncommonly ruptures the membrana tympani itself." (Toynbee, Dis. of the Ear, 1860, Philadelphia, p. 206.) Toynbee refers to previous writers, Mons. F. Savart in 1822, Mr. C. Brooke in 1843, and later Professors Todd and Bowman, as taking the same view of the subject; that the membrana tympani with its appendages, the ossicles and muscles, is in function analagous to the iris. However much we might expect to find some conclusive statement upon so important a subject in the chapters devoted to physiology in later treatises upon the ear, I have not been so fortunate. The purpose of this part of the organ is indicated to be the transmission of sound, making reference to no other function, though that mucous membrane in other localities becomes dermoid in character when freely exposed abnormally is not questioned.

The external meatus, containing cerumen and hairs, ad-

[1] Italics are mine.

mits sound waves and affords protection to the drum-membrane: from insects, by the hairs and cerumen; from solid foreign bodies, by the hairs, cerumen, and the *shape* and *direction* of the canal; the curved course and the shape of the external meatus, flared at both extremities and narrowed in the middle, diminish the force of impact upon the drum-membrane of a column of compressed air: the oblique position of the membrane to the meatus, and its motility aiding this effect. The most obvious purpose of the intra-tympanic muscles is that of adjustment of the membrane, by their involuntary action, to the best condition of tension, or relaxation, and thus its relation to the column of air in the auditory meatus, to resist the *sudden* impact of air upon it.

Contraction of the palatal muscles, *and opening of the Eustachian tube*, is prompted by excitation of the trigeminus and the consequent contraction of the tensor muscle (Voltolini, Virchow's Archiv., band, 65, p. 467). The tensor tympani and the stapedius are supposed to be *involuntary* muscles;[1] the ligamentous bands act as supports.

Deduction.—Contraction of the tensor tympani causes motion of the malleus towards the inner tympanic wall, produces tension of the ligamentous bands supporting the ossicular articulations, contraction of the palatal muscles, and opening of the Eustachian tube, admitting a column of renewing air to support the membrane against the pressure of the air from the direction of the external meatus. This action is instinctive and involuntary, a shrinking from apprehension. The trigeminus governs this, as it does the same action of the eyelids.

The muscles are kept in a state of perfect action by their constant exercise in the performance of the other, and

[1] They are also somewhat subject to volition.

possibly more important function of adjusting the transmitting apparatus to sound waves of varying values.[1]

[1] It would be interesting to know, if possible, whether in cases of rupture of the membrana tympani by aerial concussion any impairment of the process above described previously existed.