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Effect of labyrinthine stimulation on the vagus control of the heart.

By RALPH ALMOUR and MORRIS H. KAHN.

[*From the Oto-laryngological and Cardiovascular Departments, Beth Israel Hospital, New York City.*]

The work presented in this paper is the first of a series of studies which were undertaken with the view of determining the existence of a reflex path between the vestibular nerve and the autonomic or visceral nervous system. This investigation was prompted by a two-fold purpose: to establish, if possible, the existence of a tonic influence of the kineto-static labyrinth on the visceral nervous system, and to determine the physiological relationship between the two; and to establish the presence of a phenomenon which would be applicable to practical use from a clinical standpoint.

The labyrinth exerts a tonic influence on the general body musculature through its intercommunications with the somatic nervous system. The effects of the labyrinth on the visceral nervous system are not nearly as obvious nor as easily demonstrable as its effects on the somatic nervous system. For example, the stimulation of the vomiting center which occurs during the performance of the labyrinthine tests, or during an attack of seasickness, may be the result of cerebral impulses produced by the cumulative nausea, or as some authorities believe, may be produced by a direct reflex action of the hyperactivated labyrinth upon the center in the dorsal nucleus of the vagus.

That an interrelation exists between the visceral nervous system and the labyrinth is apparent when one considers that tinnitus is a common symptom accompanying disturbances of the viscera in other parts of the body. Woakes[1] considers that impulses from the stomach pass by way of the vagus nerve to the inferior cervical ganglion, where a communication is established with the nerves which regulate the amount of blood supply to the inner ear through the internal auditory artery. The vascular changes thus produced, cause the tinnitus. This, of course,

[1] Woakes, *Deafness, Giddiness and Noises*, p. 135; quoted by Kerrison, *Diseases of the Ear*, Lippincott, 1913.

is only a reflex involving the sensory portion of the vagus. That a like reflex might possibly exist wherein the labyrinth and the vestibular nerve compromise the receptor and afferent arc, and the visceral nervous system and the efferent arc, has led us to investigate the effects of labyrinthine stimulation on the various components of the autonomic nervous system.

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The ramifications of the vagus nerve and its association with the various nerve tracts are so complex that they embrace practically all the vital functions. The oculo-cardiac reflex evidences such a pronounced physiological relationship between the eye and the heart through the vagus, that it might theoretically be conceived that the other special senses have a corresponding intimacy with it.

In a study of the psycho-galvanic reflex,[2] it has been shown that stimulation of the special senses will register a reaction in the pulse and respiration. This has been done by means of the string galvonometer. The cause of the deflections produced in the string of the galvonometer was an external stimulus resulting in a muscular effect.

By this method, Albrecht[3] was able to distinguish organic from inorganic disturbances in hearing. He allowed a current of a given strength to pass through the subject, and connected him to a coil galvanometer. Then, upon applying sound stimuli, there were observed vibrations of the string which depended upon endosomatic processes. These vibrations can be distinguished from those produced by other causes (for instance, muscular contractions) by the latent period of one or two seconds which intervenes between the time of stimulation and the appearance of the vibrations.

Van Iterson[4] suggested the importance of these examinations in the testing of the auditory apparatus. He showed that by applying sound stimuli, in a person with a functionating auditory apparatus, a deflection of the galvanometer could be observed every time a sound was heard. This appeared after a short

[2] Wiersma, E. D., *Verslagen Koninklijka Academie van Wetenschappen*, 1915.

[3] Albrecht, D. W., *Arch. f. Ohren, Nasen u. Kehlekopfheilkunde*, 1917, ci. 1.

[4] Van Iterson, C. J., *Acta Oto-laryngologica*, 1920-21, ii, 174.

latent period. In a deaf person, this psychic effect was not produced. The reaction, in each case examined, occurred absolutely independently of the patient's will.

We have endeavored, by means of the electrocardiogram, to observe what effect the stimulation of the kineto-static labyrinth produced upon the vagus control of the heart. The method of procedure was as follows: The patient was attached in the electrocardiographic circuit, and a normal record in all three leads was taken after the resistance of the body in the circuit had been estimated. The labyrinth was stimulated by the caloric method, using water at 68° C.

After the normal records were taken, irrigation of the ear, either right or left as indicated in the chart, was then begun simultaneously with the taking of an electrocardiographic record in Lead II. In the first several patients, the record was continued throughout the entire test. We later found it equally satisfactory to take a short strip at the beginning of the douching, another as soon as nystagmus was noted, a third strip at the first evidence of vertigo, and a fourth at the onset of nausea. Although careful notation was made at the time when these phenomena appeared clinically, the electrocardiogram in most of the cases, showed more exactly the time of occurrence.

In analyzing the tracings, it is necessarily desirable to establish and briefly review what may be the possible effects of vagus stimulation upon the electrocardiographic record. One of the most conspicuous effects of vagus stimulation is upon the sinus node, causing a slowing of the heart rate. An equally common effect is an increase in the conduction time, *i. e.*, a relative blocking between the P (auricular) and R (ventricular) waves. The occurrence of nodal rhythm is perhaps next frequent in occurrence. The other forms of irregularities and abnormalities in the heart mechanism caused by vagus stimulation are not so common, and need not be considered in this study.

Analyzing the electrocardiographic films, we find no evidence of any changes in the character or rate of the heart. No cases, wherein the ears were either normal or abnormal, evinced any changes that could be attributed to vagus action, even where there was reason to believe that vagotonia existed. Two of the cases were asthmatics with signs of a vagotonic condition. One of the cases tested was a patient in whom one labyrinth was shown to be

non-functioning, both in its cochlear and kineto-static portions. Records were taken of the effect of the caloric test on the electrocardiographic picture, each ear being subjected to the douching while the patient was in the electric circuit. The same findings occurred for the testing of both the active and destroyed labyrinth.

We therefore conclude from our experiments, that no reflex nerve path exists from the ear to the heart by way of the vagus nerve. That portion of the dorsal nucleus of the vagus which ccmprises the cardiac center of the vagus is not influenced by stimulation of the labyrinth by the caloric method, either during the period of reflex activity (nystagmus) or after consciousness reacts to the stimulation in the form of vertigo and nausea.

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The viability of hemolytic streptococcus in certain solutions containing gelatin.

By FRANK L. MELENEY and ZUNG-DAU ZAU.

[*From the Department of Surgery, Peking Union Medical College, Peking, China.*]

For certain quantitative biologic tests it is necessary to use a suspending medium in which the streptococcus will survive without increase or diminution in numbers for a considerable length of time.

Falk has recently reviewed the extensive literature on the subject of the inhibitory effect of the cations of various salts on the biologic activities of bacteria and other cells. He concludes that balanced solutions containing two or more salts in the proper proportions preserve the life of bacteria better than either distilled water or solutions containing single salts unless they are very dilute.