nator, responds at a given place to a given tone, thereby stimulating certain of the auditory end-organs and consequently causing the perception of the tone corresponding to the given vibration.

The writer of this article is not alone in his contention that the basilar membrane is not a vibrating structure. In 1892, Howard Ayres, writing in the *American Journal of Morphology*, holds to this position, because he finds that the basilar membrane is composed of several sheets of fibers and cell masses and that its phylogenetic history shows it to be a modified portion of the skin which always serves as a floor on which the sense organs rest. He claims that the tectorial membrane is simply a waving field of long hairs springing from the top of the hair cell and floating freely in the endolymph. Dr. K. Kishi, in the article in *Pflüger's Archives* reviewed below, also agrees in many respects with the writer.

C. E. MOFFITT.

UNIVERSITY OF IOWA.

Corti'sche Membran und Tonempfindungstheorie. K. KISHI.
Archiv f. d. ges. Physiologie (Pflüger), 1907, CXVI., 112-123.

Kishi begins by deploring the present vacillation and uncertainty regarding the theory of tone sensation, and surmises that the obscure problem will be solved only when the anatomical structure of the inner ear is rightly understood. His studies of the labyrinth first led him to doubt the wide-spread view that the membrana basilaris is a vibrating structure; for the layer of basilar fibers is protected from the vibrations of the labyrinthine fluid by two thicker layers above it and two below. And even if the basilar fibers could be set in vibration, they are not in an advantageous position for actuating the hair cells and so stimulating the auditory nerve. The properties of a system of selective resonators, which Helmholtz assigned to the membrana basilaris, Kishi attributes to the little understood membrana tectoria. This conclusion is based upon investigations of the position, the physical constitution and the finer structure of this membrane. He shows that the membrana tectoria, which grows out from the labium vestibulare and extends over the organ of Corti, does not float free above the hair cells as has often been thought, but is always attached to the edge of the reticular membrane. As to its physical condition, he decides that it is very delicate but highly elastic, which accounts in part for the distortions and the bulging form usually observed in microscopic preparations. As to its finer structure, the membrana tectoria is found to consist of two layers of fibers which in the normal condition Kishi

believes to be stretched above the organ of Corti in such a manner that, when set into sympathetic vibration by sound-waves in the endolymph, they act directly upon the protruding hairs of the hair cells.

In the opinion of the reviewer, this paper taken together with Shambaugh's presents a strong case against the basilar membrane theory of audition. But Kishi's hypothesis that the membrana tectoria is made up of stretched fibers which serve as selective resonators is rendered extremely improbable by the admirable work of Shambaugh. The theory which the latter writer substitutes is, however, from the standpoint of the physicist, untenable. One feels that the anatomists have as yet failed to discover in the cochlea any structure which is physically capable of satisfying the requirements of the Helmholtz resonance theory of audition.

W. V. D. BINGHAM.

HARVARD UNIVERSITY.

PERCEPTION OF THE VERTICAL.

Influence de la force centrifuge sur la perception de la verticale.

B. BOURDON. *Année psychologique*, 1906, XII., 84-94.

This investigation is, as its title implies, an experimental study of the effect of centrifugal force on judgments of the vertical during rotation.

With apparatus so arranged that the speed of rotation could be regulated with accuracy and so that his results could be automatically recorded, M. Bourdon made five different sets of experiments on the perception of the vertical and a sixth set on the torsion of the eyes during rotation. The first three of the sets of experiments were with the tactual perception of the vertical and consisted of: (1) Placing a rod vertical—the body being vertical and the head movable. (2) Placing a rod vertical—the body being vertical and the head immovable. (3) Placing a rod vertical—the body being vertical and the head inclined 10 degrees (that is, an amount equal to the angle formed with the vertical by the resultant of gravity and the centrifugal force). The fourth set of experiments consisted in placing the head itself in such a position that it seemed vertical; and the fifth set consisted in determining the apparent visual vertical.

M. Bourdon interprets his results as according perfectly with the hypothesis that when we turn in a circle we take for the vertical the direction of the resultant of gravity and the centrifugal force. That the figures given in the five series of experiments do not accord with