Comments and Communications

Traveling Waves in the Brain[1]

In an earlier paper (GOLDMAN, S., VIVIAN, W. E., CHIEN, C. K., and BOWES, H. N., *Science*, 1948, **108**, 720) equipment for electronic mapping of the electrical potential at the surface of the skull has been described. In this paper it was stated that area displays of the instantaneous skull potentials could not readily be interpreted because of the speed of the activity. Subsequent work in cleaning up residual artifacts has clarified these pictures. The taking of motion pictures of the activity and their display at slow motion (by a 4: 1 ratio) has added further information, so that it is now possible to give a first report of the results.

In the observed area displays, there is some activity of rise and fall in potentials, which apparently occurs at irregular times at isolated electrodes. Less frequently the activity of a large part of one of the hemispheres of the brain seems correlated. The most striking activity, however, is that of traveling waves across the skull. Some traveling waves cross the entire skull, often crossing the central fissure. If all sixteen electrodes are placed above the general outline of a single occipital or temporal lobe of the brain, it may be seen that there are traveling waves within the single lobe. In a single lobe the traveling waves often show a rotational (or circular) path which has never been noticed in the case of waves crossing larger areas of the brain. Within the same lobe there are successively clockwise and counterclockwise rotations, interspersed with straight motions at various angles. The frequency of rotation of the rotatory motion is approximately 9 per sec.

The traveling wave phenomena are much more pronounced when the eyes are closed than when they are open. It was therefore thought at first that the single lobe effects, such as rotational motion, might be characteristic only of the occipital lobes, where they were first observed. This, however, turned out not to be true, since the same type of single lobe phenomena, including rotational motion (but of reduced voltage), occurs also in the temporal lobes. Surprisingly enough, the traveling wave activity in the temporal lobes also becomes much more pronounced when the eyes are closed. This would appear to indicate that when the eyes are closed in a wide-awake individual (holding the hands in front of the open eyes to keep out light has the same effect as closing the eyes), the entire brain changes its type of activity, becoming more active internally. If the individual becomes drowsy, the amplitude of the traveling wave activity is greatly decreased. No characteristic individual activity was observable in the frontal lobes.

[1] This research has been supported in part by the Signal Corps, the Air Materiel Command, and the Office of Naval Research.

Tests were made with visual and auditory stimuli to see whether they gave rise to traveling waves. In the case of an auditory stimulus, an effect could be observed in the pattern, but it was stationary and localized. No effect whatever could be observed in the pattern when a visual stimulus was brought into the field of vision. This was undoubtedly due in part to the crudeness of the test.

The major part, at least, of the traveling waves may be identified with the alpha rhythm. This is indicated by their frequency and their variation of intensity with time, and with opening and closing of the eyes. The suggestion, often made, that the alpha rhythm represents a scanning operation in the brain appears, as a gross interpretation, to be borne out by the observed pictures. This is particularly true for the single lobe pictures, as might be expected. We have, however, no experimental information as to the physiological nature of this operation, nor do we yet really know that the fundamental nature of these traveling waves is that of a scanning process.

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Louisiana Oyster Production

In a recent article (*Science*, 1948, **108**, 484) the writer made the following points: the Fish and Wildlife Service has not collected annual fishery statistics on the Gulf Coast every year due to lack of funds; the federal oyster statistics prior to 1930 are about 35% exaggerated when given in pounds; state and federal statistics show no evidence of decline in Louisiana oyster production; oyster production of other Gulf states combined has declined 78% since the 1920's; and the misgivings expressed by Walter A. Chipman, Jr. (Oyster Institute of North America Trade Report No. 91, June, 1948; mimeographed) over the threatened "existence of the large oyster industry of that state" (Louisiana) were unfounded.

In a rather curious reply, which avoids mention of the points I made, Chipman (*Science*, 1949, **109**, 210) says, "Even though the total production remains stable or actually increases, it must be realized that this situation results from expansion of the industry through use of undeveloped grounds, of which Louisiana has an abundance, and of better utilization of producing grounds. It does not negate the fact that a continuing unexplained mortality may prevent the production from reaching even higher levels. Furthermore, once the expansion is completed, this mortality may then result in decline as the adverse factors causing this mortality continue and spread to other areas. This latter possibility has been in the minds of Louisiana oyster conservationists for some time. Because they are progressive and look into the future, they have good reason for alarm."

This contradicts none of the facts I previously presented. Alarm over the failure of the Louisiana oyster

industry to increase is interesting, but not contradictory to the statement that it has not declined in total production. The fact that an industry does not increase its production can scarcely be advanced as evidence of its endangered existence. If Louisiana oystermen are making better utilization of producing grounds and expanding onto abundant undeveloped grounds, as Dr. Chipman states, then it would seem that fears for the future are needless. Since he has this view, objections to my less sanguine statement that there is no evidence of production decline are inconsistent and contradictory.

It is quite true, as Chipman points out, that serious mortalities have occurred from time to time. Mortalities of oysters and other animals, catastrophic and otherwise, are well known phenomena on the Gulf Coast and such information has been published 45 years and more, but it is an exaggeration to say that mortality "threatens the very existence" of Louisiana's oyster industry. There is no evidence of decline in production of the Louisiana oyster industry. Unfortunately, however, the condition of the oyster industry in Texas is more serious, and Chipman's fears would be more appropriate there. In 1904 Texas produced 199,000 barrels of oysters. In the fiscal year 1947–48 only 23,000 barrels were produced, a decline of 88%, which has not yet been stemmed. Louisiana is the only Gulf state in which oyster production has not declined.

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Thiamin or Thiamine?

Periodically I am asked whether vitamin B_1 should be referred to as "thiamin" or "thiamine." The following history may be of interest to some readers.

I suggested "thiamin" in 1937 in response to a request from the Council on Pharmacy and Chemistry of the American Medical Association. This was adopted (see *J. Amer. med. Ass.* 1937, 109, 952). The name so appeared in this journal and in other publications of the AMA for two or three years, including the 1940 edition of "New and Non-Official Remedies."

Under date of July 3, 1939, E. Fullerton Cook, chairman of the Committee of Revision of the Pharmacopoeia of the United States, wrote me a letter which included the following paragraph:

> You may wonder why the Pharmacopoeia has suggested the use of this title, when "Thiamin Chloride" had already been widely used. The Pharmacopoeial group recognized that Thiamine Hydrochloride had, essentially, the characteristics of an alkaloid, and the use of the final "e" and "Hydrochloride" rather than "chloride" when the hydrochloride radical is attached, is in strict accordance with our rules for nomenclature. Of course we would add "Thiamin Chloride" as a synonym, at Dr. Nelson's suggestion.

The spelling "thiamine" was adopted for the second U. S. Pharmacopoeia XI Supplement and has since been accepted by *Chemical Abstracts, Journal of Biological Chemistry, Journal of the American Medical Association* (including the 1948 edition of "New and Non-Official Remedies"), and other publications.

"Thiamine" must now be accepted as the approved spelling.

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Freezing Laboratory Materials for Plant Science

The routine practices of drying plant materials for taxonomic and morphological studies, or preserving them in various chemical solutions, have many disadvantages. Neither method is adequate for color preservation. The formaldehyde vapor method, which preserves well, has a disadvantage in that some people are sensitive to formaldehyde. When an early frost line threatened in the fall of 1947 I collected flowers, packaged them in lined paper bags of the type sold for food processing, and placed them in a commercial deep freeze locker. This procedure proved so successful that I made extensive collections the following summer. By merely packaging specimens while they are fresh, and transferring them to the deep freeze, one can readily provide a wide range of material for subsequent classroom needs.

Some flowers and plant materials lend themselves more successfully than others to this treatment but even the most delicate, such as *Impatiens pallida* Nutt., retain enough color and form to be useful for the duration of a two-hour laboratory period. Even if the color alters upon prolonged exposure to room temperature, the form of the flower remains intact. Keeping such material covered in culture chambers until it is needed helps maintain the natural form. Other plants emerge in a remarkably fresh condition, with scarcely any alteration, even after several hours. Some of the flowers which have given especially good results are: *Phleum pratense* L. and other species of grass, *Eriocaulon septangulare* L., *Phytolacca decandra* L., *Polygonum pennsylvanicum* L., *Chenopodium album* L., *Potentilla fruticosa* L., *Cassia marilandica* L., *Sambucus canadensis* L., *Plantago major* L. and *P. lanceolata* L., *Ligustrum vulgare* L., *Asclepias syriaca* L., *Clethra alnifolia* L., *Kalmia latifolia* L. and cultivated species of *Azalea* and *Rhododendron*, *Euonymus japonica* L., *Daucus carota* L., *Tilia americana* L., *Achillea millefolium* L. and other species of Compositae.

Other plant materials that have been particularly useful for subsequent studies during the year include the hips of *Rosa rugosa* Thunb. These have been successfully used for lycopene extraction, structural studies of the chromoplasts, and for vitamin C analysis using the method recommended by Tuba *et al.* (TUBA, JULES, HUNTER, G., and OSBORNE, J. A., *Canad. J. Res.*, 1946, 24, 182). Even after many months of storage, an excellent reaction for ascorbic acid granules in the cells may be obtained.

The freezing method seems to offer a valuable means for having available a wide range of seasonal materials at all times.

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