SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY AND SECTION OF LARYNGOLOGY

COMBINED MEETING held at OXFORD

July 17th, 1942

OTOLOGICAL SESSION

Chairman—F. W. WATKYN-THOMAS, F.R.C.S. (President of the Section of Otology)

The Effect of Certain Cerebral Lesions upon the Caloric Responses*

By GERALD FITZGERALD AND C. S. HALLPIKE (London)†

ACCORDING to Bauer and Leidler (1911) the removal of one cerebral hemisphere in the rabbit results in the exaggeration of the nystagmic response to a cessation of rotation towards the opposite side. For example, removal of the left hemisphere causes an exaggeration of the nystagmic response to a cessation of rotation to the right.

According to Ewald's law, the horizontal canals which are chiefly involved respond preponderantly to ampullo-petal flow of endolymph. Now cessation of rotation to the right causes an ampullo-petal flow of endolymph in the left horizontal canal, and Bauer and Leidler, accepting Ewald's law, argued that the enhancement of the nystagmic response to this stimulus was due to an increased sensitivity of the left labyrinth; and from this were led to the general conclusion that ablation of a cerebral hemisphere gives rise to an increase in sensitivity of the homolateral labyrinth.

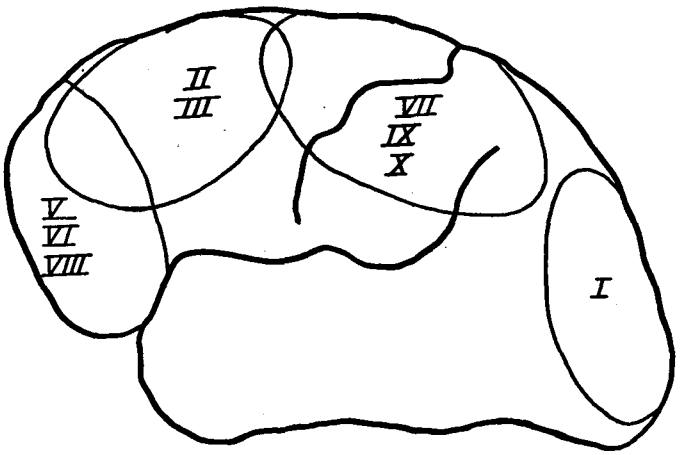
These observations were repeated in 1923 by Dusser de Barenne and de Kleyn. Following removal of one hemisphere (e.g. the left) there was observed as before an exaggeration of the nystagmic response to cessation of rotation to the right, so confirming the finding of Bauer and Leidler. The effect was then tried of caloric stimulation. With hot caloric stimulation there was found an exaggeration of the response from the left labyrinth, a result which seemed to confirm Bauer and Leidler's notion of an increased sensitivity of the labyrinth on the side of the missing cerebral hemisphere. This was surprisingly contradicted, however, by the results obtained with cold water, which revealed an exaggeration in the response of the *right* labyrinth. These findings were explained in the following way: The three stimuli of which the effect was observed to be enhanced were (1) Cessation of rotation

* Abridged version. For a full account of this work see *Brain*, 1942, **65**, 115. Studies in Human Vestibular Function: I. Observations on the Directional Preponderance ("Nystagmusbereitschaft") of Caloric Nystagmus Resulting from Cerebral Lesions. The figures are reproduced by permission of Dr. F. M. R. Walshe, Editor of *Brain*, published by Macmillan & Co. Ltd.

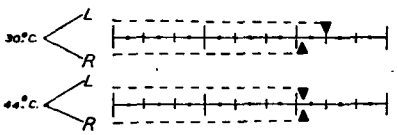
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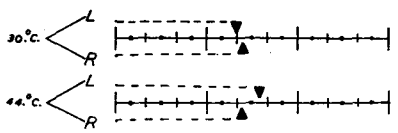
TABLE I.



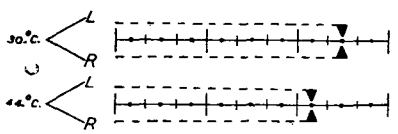
Temporal lobes not involved. Caloric reactions normal.



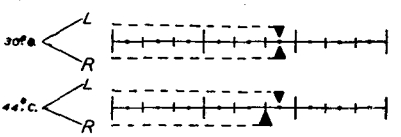
Case 1.—M.G.



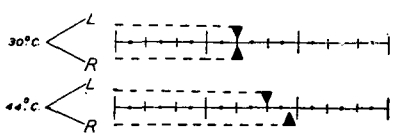
Case 2.—D.F.



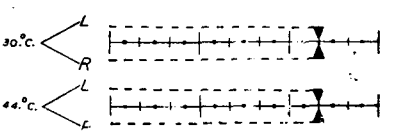
Case 3.—F.F.



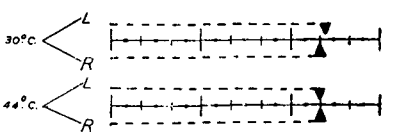
Case 4.—K.A.



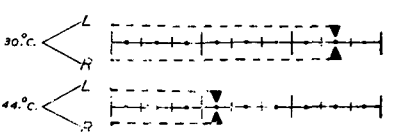
Case 5.—T.H.



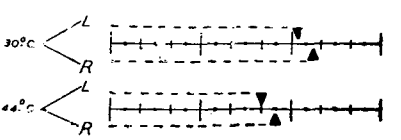
Case 6.—F.L.



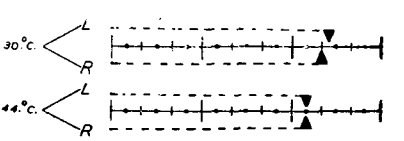
Case 7.—A.L.



Case 8.—G.P.



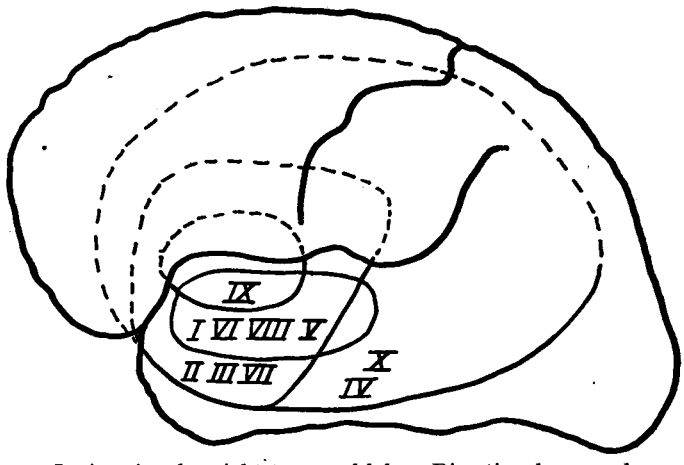
Case 9.—A.S.



Case 10.—S.T.

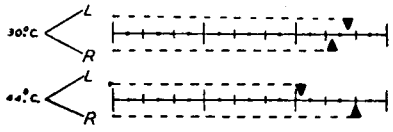
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TABLE II.

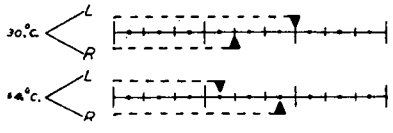


Cases 1-5. Lesions involve right temporal lobe. Directional preponderance of caloric nystagmus to the right.

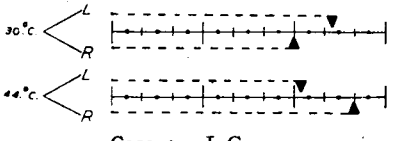
Cases 6-10. Lesions involve left temporal lobe. Directional preponderance of caloric nystagmus to the left.



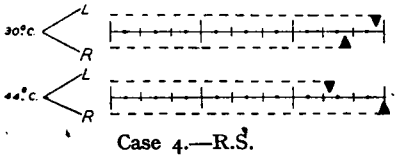
Case 1.—E.D.



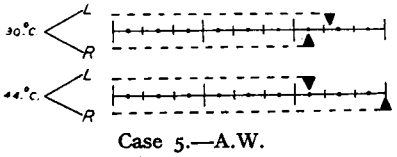
Case 2.—A.E.



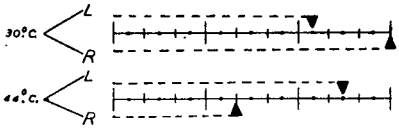
Case 3.—L.G.



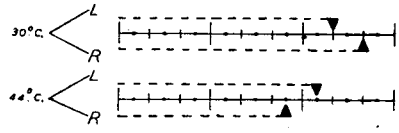
Case 4.—R.S.



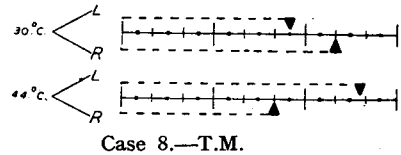
Case 5.—A.W.



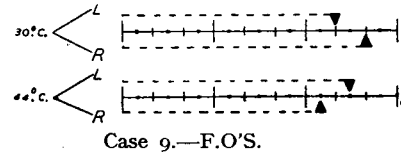
Case 6.—A.F.



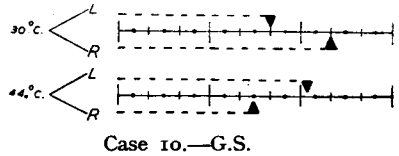
Case 7.—F.M.



Case 8.—T.M.



Case 9.—F.O'S.



Case 10.—G.S.

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to the right. (2) Hot caloric stimulation of the left labyrinth. (3) Cold caloric stimulation of the right labyrinth. All of these have it in common that they give rise to nystagmus to the left, and Dusser de Barenne and de Kleyn therefore concluded that the effect of removing one cerebral hemisphere, in this case the left, was a central facilitation of all and any labyrinthine impulses which would normally result in nystagmus to the same side. According to the terminology then adopted, the phenomenon was described as " nystagmusbereitschaft " to the side of the ablated cerebral hemisphere. These findings had an obvious application to the clinical problem of localization of cerebral lesions in man and were so applied by de Kleyn and Versteegh, who reported some results in 1927. Hot and cold caloric tests were carried out according to the threshold method of Kobrak (1918) in thirty-six subjects with cerebral lesions and a nystagmusbereitschaft was found in eleven. No information was, however, given as to the nature or position of the lesions shown by clinical examination, operative or post-mortem findings except in one instance in which a large abscess of the frontal lobe was correlated with a nystagmusbereitschaft to the same side.

In the present work further evidence has been obtained of the occurrence in the human subject of nystagmusbereitschaft attributable to cerebral lesions and it has further been possible to identify the area of the cortex, disease of which determines the appearance of this phenomenon. As an English translation of nystagmusbereitschaft, the term directional preponderance of induced vestibular nystagmus has been devised and will be adhered to. It has the particular advantage of describing the essentially directional character of the disturbance.

MATERIAL.

This was provided from the wards of the National Hospital and consisted in all of some fifty subjects in whom there was clinical and often other evidence of supratentorial lesions of the central nervous system. In none of these was there any evidence of aural disease or any spontaneous nystagmus. Hearing was normal in all. Hot and cold caloric tests were carried out with certain modifications of the usual procedure. In some cases the responses revealed directional preponderance, in others it was absent, and it soon became apparent that its occurrence was dependent upon the localization of the lesion. Final conclusions were based upon twenty subjects in whom the existence and localization of the lesions could be considered as securely established by the clinical, operative or post-mortem findings. For the most part the lesions were actively growing tumours, but some long-standing vascular lesions were also included.

METHODS.

To obtain maximum efficiency of the caloric tests certain technical modifications were found necessary. For the details and rationale of these modifications reference should be made to *Brain*, 1942, ii, 115, wherein are also discussed the limits of variation in the results obtained in normal subjects. The form adopted for expressing the results is shown in Fig. 1, which gives the average result obtained in normal individuals. Each continuous line represents a three-minute period, subdivided into intervals of minutes, 20 seconds and 10 seconds.

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L. and R. denote the reactions of the left and right labyrinths at 30° C., and 44° C. The stimulus extends in all four over the first forty seconds and the dotted lines indicate the duration of the responses. For reasons given elsewhere this is measured from the application of the stimulus.

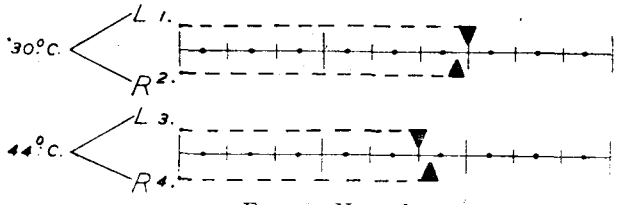


FIG. 1.—Normal.

Fig. 2 shows the response pattern characteristic of directional preponderance to the right (the effect obtained by Bauer and Leidler in the rabbit by removal of the right cerebral hemisphere). There is an exaggeration of the left cold and right hot responses, both of which consist of nystagmus to the right. The right cold and left hot responses, both of which consist of nystagmus to the left, are diminished.

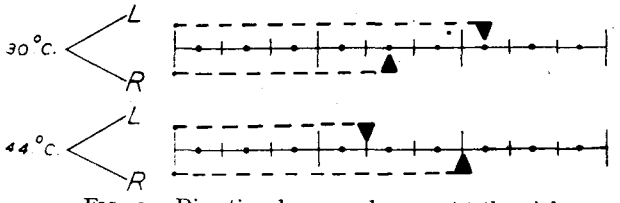


FIG. 2.—Directional preponderance to the right.

Fig. 3 shows the response pattern characteristic of directional preponderance to the left (the effect obtained by Bauer and Leidler in the rabbit by removal of the left cerebral hemisphere). There is an exaggeration of the right cold and left hot responses, both of which consist of nystagmus to the left. The left cold and right hot responses, both of which consist of nystagmus to the right, are diminished.

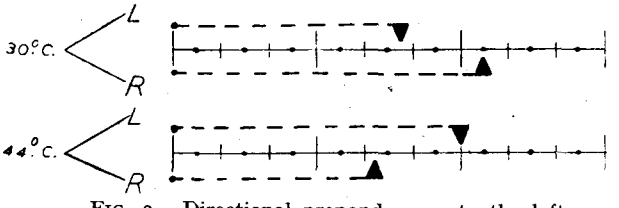


FIG. 3.—Directional preponderance to the left.

RESULTS.

Table I shows the localization of the lesions and the caloric responses in ten cases in which the responses were normal. In some of these the lesions involved the left hemisphere and in some the right. For the purpose of illustration they are all shown as being projected upon the lateral surface of the left hemisphere. The

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lesions are scattered throughout the hemisphere from the frontal to the occipital poles, with the exception of the temporal lobe. The caloric responses vary in their general magnitude but there is no alteration of their normal pattern.

Table II shows the localization of the lesions and the caloric responses in ten cases in which the latter showed directional preponderance. In Cases I—V the lesions involved the right temporal lobe with directional preponderance of the caloric responses to the right. In Cases VI—X the lesions involved the left temporal lobe with directional preponderance of the caloric responses to the left.

CONCLUSIONS.

(1) The findings of Dusser de Barenne and de Kleyn are confirmed that directional preponderance of induced vestibular nystagmus (caloric) does occur in association with some lesions of the human cerebrum.

(2) The matter has been carried a stage further by the identification of the temporal lobe as the site of the nervous mechanism the involvement of which determines the occurrence of this phenomenon.

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