Basal-celled Carcinoma of the Palate.—W. A. MILL.

Male, aged 49.

History.—Admitted to the Royal Cancer Hospital in the summer of 1936 complaining of a swelling of the roof of the mouth, involving practically the whole of the hard palate, but more marked on the right side, expanding the right alveolus and causing some swelling in the right side of the cheek. A skiagram showed irregularity and bone absorption of the right maxilla. The first section taken was reported as a mixed salivary tumour. It was hoped that the tumour might be shelled out, but, owing to infiltration, this proved impossible. Examination of a further microscopical section resulted in the diagnosis of adenocystic basal-celled carcinoma. It was decided to see the effect of radium bomb treatment and 91 gm. hours were given. The tumour was very much reduced in size but did not by any means disappear. In *November* the right hard palate and tumour were removed and the walls treated with diathermy. An obturator was made and radium inserted into it, the dose given being 1,150 mgm. hours.

J. F. SIMPSON said that he had had a similar case in a woman with a " parotid tumour " in the palate. In 1935 she was treated by radium, and the growth appeared to subside. Later she suffered from deafness ; it was a catarrhal deafness, because the nasal septum had become involved and was splayed out, as the palatal tumour took on a malignant change. He had removed the tumour, and at present the patient was well.

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY

March 5th, 1937

President—DOUGLAS GUTHRIE, M.D.

Labyrinthine Reactions and their Relation to the Clinical Tests

By W. J. McNALLY (Montreal)

OUR present knowledge of labyrinthine function began with the contribution of Purkinge in 1825. The rotation test was introduced to the clinic about fifty years ago through the work of Kreidl, of James, and of Jansen. The caloric test is little more than twenty-five years old and was introduced by Bárány and brought to its present form by Kobrak. The rapid tilt test, first introduced as a clinical test by Tait and McNally in 1926, has not yet received the general recognition that it deserves.

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Royal Society of Medicine

The Rapid Tilt Test

The idea of tilting an animal out of the horizontal plane about a horizontal axis has been recognized for some time as a means of testing labyrinthine function. The slow tilt is the common form, both in the laboratory and the clinic, and it is used as a test of otolithic function (Jones and Fisher, 1918, and Grahe, 1927).

Ewald (1892) and André Thomas (1898) found that, following the removal of one labyrinth, an animal could be upset to the operated side if the table upon which it stood was suddenly tilted towards the side of the operation. The quicker the tilt, the more easy it was to upset the animal. The test was introduced for use in patients by us in 1926 (see Tait, 1926). Following a loss of one or both labyrinths, if the patient is placed upon a tilt table, it is very easy to upset him by a quick tilt to the side of the absent labyrinth. If the lesion is bilateral a tilt in any direction will upset him. We showed conclusively that the absence of a protective reaction to a quick tilt is due to a lesion of the semicircular canals.

In 1931 and in subsequent publications we have given a full description of the parts of the labyrinth concerned in the response to a slow tilt, on the one hand, and to a quick tilt on the other. A slow tilt stimulates the utricles but does not stimulate the semicircular canals, and in response to a slow tilt the utricles elicit a compensatory reaction. A quick tilt stimulates the vertical semicircular canals to bring about a prompt compensatory reaction of the body musculature. This reaction still takes place in the absence of the utricles, but in the frog it tends to be slightly overdone. De Kleijn and Versteegh (1935) found the reaction still present after the removal of one utricle in the rabbit.

The utricles are also stimulated ("second mode") by a quick tilt, but they tend to throw the body in the direction of the tilt—an anti-compensatory reaction. This "second mode" reaction of the utricles tends to check and to tone down the reaction from the vertical semicircular canals.

The rapid tilt test proved to be an excellent method for demonstrating lesions of the individual vertical canals. Both Breuer and de Cyon had noted that, following an experimental injury to a semicircular canal, an abnormality was noticeable in the animal's movements, chiefly when the movement occurred in the plane of the injured canal. In spite of this, however, previous to our introduction of the quick tilt test, the eye reflexes were the only ones generally used, either in the clinic or in the laboratory, as an indication of semicircular canal function, but now the whole system of body musculature has been brought into connection with the semicircular canals. The tonic labyrinthine and neck reflexes so completely described by Magnus and de Kleijn were never associated with the semicircular canals.

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Since our work was published, Rademaker and Garcin (1932) and de Kleijn and Versteegh (1935) have used the quick tilt test in the laboratory and the clinic as a means of diagnosing a loss of one or both labyrinths. These authors report that if the lesion is unilateral and of long standing, it may be compensated for, so that the patient may respond equally well to a tilt to either side. We also have found this to be true. They confirm our conclusion that the reaction to a quick tilt is chiefly from the canals.

Elimination of Individual Labyrinthine End-organs

By 1930 we had developed our operative technique to such a point that it has since been possible in the frog to sever the nerves to any or all of the semicircular canals, the utricles, or the saccules without causing any complications. This has made it possible for us to push the analysis of labyrinthine function to a point not hitherto possible.

Mechanism of Semicircular Canal Stimulation

It has been proved conclusively by Maxwell and by Steinhausen in certain fishes, and by McNally and Tait in the frog, that a semicircular canal responds to rotation in only one sense. Ewald found in birds (and presumably it is the case in man) that a semicircular canal responds to movement in either of two opposite senses. The reasons for applying this supposition to man are that, following a unilateral destruction of the labyrinth, it is still possible to elicit nystagmus by turning the patient to either side. Furthermore, the hot or cold caloric test elicits in each case its own form of nystagmus, presumably from stimulating the same canal in opposite directions. Since the explanation of the caloric and rotation tests is based upon the theory of two-way response of each semicircular canal, we must for the present accept this, but it is well to keep in mind that there is experimental evidence to show that this rule does not apply throughout all the vertebrates. Since Steinhausen's experiments demonstrating the movements of the cupula in the live pike, it is generally admitted that endolymphatic flow is the adequate stimulus of a semicircular canal.

The horizontal canal is stimulated by rotation about a vertical axis. This does not alter the animal's relation to the gravitational field. The animal's head must be held level during the rotation, and to accomplish this the vertical semicircular canals and the utricles must be intact. A lesion of any of these structures immediately shows itself in some slight unsteadiness of the head, which results in vertical canal reactions being superimposed upon the counter-circling reactions.

Rotation about a horizontal axis, which is in most cases a simple tilt, is the adequate stimulus for the vertical semicircular canals.

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Movement about this axis does change the animal's relation to the field of gravity, so that the animal must readjust itself in order to bring its centre of gravity back within the base of support.

Characteristic Reaction Patterns of Body Musculature

When a semicircular canal is stimulated, the response of the body musculature is always so directed as to return the body, head, and eyes to their original positions—the movement is compensatory. If a horizontal canal is stimulated, the reaction involves the musculature of both sides of the body in such a way that the animal tends to circle in the direction opposite to the turning. Stimulation of a vertical canal also involves the musculature of both sides in such a way that the body tends to be shoved towards the corner diagonally opposite to the one in which the stimulated canal is located, e.g. the right anterior vertical canal reaction tends to shove the body, head, and eyes, backwards and to the left. We have found that the musculature which participates in any one of these complex reactions is invariably the same. The flexors and extensors, the abductors and adductors, of both sides of the body are innervated in such a manner each time as to bring about the same pattern of movements characteristic of each individual canal. As soon as one learns to recognize the reaction pattern characteristic for each canal, it is very easy to tell which canal is being stimulated. Frequently more than one canal is being stimulated simultaneously and, of course, the resulting reaction pattern of the body musculature is a combination of the canal effects, but it is still possible to analyse the resulting reaction and to determine which canals have played a part. It is this consistent and characteristic involvement of the body musculature following stimulation of any particular semicircular canal that must, we feel, eventually be recognized as having great clinical importance. When they have been studied in man and the differences which result from the erect posture and from superimposed reflexes (neck reflexes, etc.) have been analysed and recognized, the presence or absence of any one pattern in response to a rapid tilt, will serve as an indication of the condition of its initiating canal.

The Two "Modes" of Utricular Stimulation

It was suggested at the beginning of this address that we had found the utricle in the frog to be affected by two kinds of stimulation, and that a different reaction is elicited to each. I should like to explain this a little more fully.

"*First Mode*" *of stimulation.*—In response to a slow tilt the utricle sets up a compensatory reaction of the body, head, and eyes. It is best shown in a frog from which all the canals have been eliminated, the two utricles remaining intact. If the tilting is slowly

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and smoothly carried out, the animal shifts its position so as to keep the head level and its centre of gravity well within the base of support.

"Second Mode" of stimulation.—If the frog with only utricles intact is given a quick tilt, there is a prompt movement of the head and body in the direction of the tilt—an anti-compensatory reaction which tends to upset the frog. This reaction is not present in a delabyrinthized frog, so it must arise from the utricular maculae. Because of the frog's natural squat position, the animal is particularly well adapted to bring out the unsteadying effect of the second mode of utricular action. An animal which stands high on its four legs like a dog is more readily upset on a tilt table, because its centre of gravity is more easily displaced outside the base of support. Because of this a delabyrinthized dog is very easily upset by a quick tilt in contradistinction to a delabyrinthized frog. How a dog with only two utricles would behave in response to a quick tilt would be a very interesting problem to investigate.

The difficulty of carrying out ablation operations on the individual end-organs of the mammalian labyrinth, together with the difference in posture as compared with the frog, are sufficient to account for the fact that the two modes of utricular action which we discovered in the frog have not been identified as yet in the mammal.

Mechanism of Utricular Stimulation

If a frog from which one labyrinth has been removed is very carefully manipulated, it can be made to assume a symmetrical pose for a considerable period of time. It requires a definite head movement, as from a jar of the table, before the characteristic asymmetrical pose is resumed. From this and other experiments it is quite obvious that the utricle is not constantly signalling and that it requires some slight movement or accentuation of otolithic stimulation to initiate utricular action. The mere holding of a position is a property of the muscular system with its receptors. When the utricle is stimulated it may break up the existing posture and dictate a new muscular set-up.

A downhill slip of the otolith is not the adequate stimulus of the utricle. This is shown in the first two of the following experiments.

When a frog is tilted through a certain angle on the tilt table, its head describes an arc of a circle. The farther the head is distant from the axis of rotation, the longer is this arc. Theoretically, a rapid arc displacement of the head gives a possibility of relative translatory movement of the otolith upon its macula, which might conceivably constitute the effective stimulus. So far as ready elicitation of this reflex goes, one finds, however, that it is a matter

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of indifference whether the rapidly tilted animal is near or far away from the axis. Moreover, whether the frog (with a certain compass direction) sits on this side or on that side of the axis, it always responds in the same way. These facts, of themselves, practically dispose of the supposition that effective stimulation involves a translatory displacement of the otoliths.

Maxwell's (1923) direct experiment on the actual utricular otolith should also be kept in mind. Having freely exposed, in the dogfish, a utricular otolith from above, he gently displaced it, backwards, forwards, or laterally, with the help of a light pledget of cotton-wool held in a forceps. To his surprise the effect of this displacement was exactly contrary to what might have been predicted on the Kreidl gravity hypothesis. For example, a forward displacement of the otolith, instead of making the eyes roll upwards, caused them to roll downwards, and so on.

Ulrich (1935) has also carried out experiments on the exposed utricular otolith. As a means of applying pressure, having exposed the utricular otolith in the live pike, he used a human hair held in a micro-manipulator. He also noted eye movements as an indication of utricular reaction. He found that the only effective pressures or movements of the otolith were those directed outwards and forwards, or directly outwards. Pressure inwards, or backwards, elicited no reaction of the eyes. Furthermore, when the eye on the side of the stimulated utricle reacted, it always moved upwards, and the opposite eye moved downwards. He could not make the eye on the same side move downwards by any manipulation of the utricle. Since his results are quite different from Maxwell's, he suggests that the pressure applied to the otolith in Maxwell's experiments was not so carefully measured as in his own. In view of Ulrich's findings, our experiments should be recalled, in which only one utricle is left intact in the frog, the remaining end-organs having been eliminated.

A solitary utricle is able to elicit normal reactions in response to a slow tilt backwards, forwards, or to either side. It is, however, more responsive to a lateral than to a medial tilt.

Ulrich's findings lessen the value of those of Maxwell as a support for any theory of utricular mechanism but they do not exclude any particular theory, since obviously both sets of experiments are technically extremely involved, and must be repeated before either can be accepted as an indication of what happens within the utricular chamber.

Our experiments have shown that there are not two different mechanisms of utricular stimulation. The utricular process corresponding to the "first mode" and to the "second mode" of stimulation is one and the same thing. We have made the tentative suggestion that if the otolith would tend to preserve, under the

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influence of gravity, a vertical orientation like that of a buoy floating in water, it would fulfil the conditions necessary to explain the two modes of utricular stimulation (see Tait and McNally, 1934).

The utricles have connections with the same muscle groups as have the vertical semicircular canals. They are able to elicit the same reaction patterns of the body musculature. It is necessary, however, to distinguish between the two modes of utricular stimulation. In response to a quick tilt backwards the utricles (second mode) elicit the same reaction pattern of the musculature as results from a quick forward tilt of the vertical semicircular canals, and *vice versa*. On the other hand, a slow forward tilt of the utricles (first mode) elicits the same reaction pattern as a quick forward tilt of the vertical semicircular canals.

The reactions from the vertical semicircular canals and from the second mode of utricular stimulation are mutually opposed. The utricles tend to thrust the head and body in the wrong direction, while the canals tend to over-compensate for the stimulus. The two, acting together, neutralize each other sufficiently to bring about promptly the exact amount of compensatory reaction necessary to overcome the exciting stimulus.

Saccule

Ablation experiments carried out upon the saccular otolith and nerve have not been able to demonstrate any equilibrating function for the saccule. This has been shown by Laudenbach, Maxwell, McNally and Tait, and Huddleston in the frog ; by Parker, Maxwell, von Frisch, and Ulrich in fish ; by McNally and Tait in the rattlesnake ; and by Versteegh in the mammal. These results have been confirmed by the study of action currents from the saccular nerves in fish by Ross and in the frog by Ashcroft and Hallpike and by Ross and McNally. These latter experiments have afforded evidence that the saccule is concerned with the reception of sound vibrations and therefore may be part of the hearing mechanism. Since its connection as part of the equilibrating mechanism has not been established we do not take it into consideration in analysing any of the reactions which follow vestibular stimulation.

Intracranial Connections from the Labyrinth

It has been difficult to demonstrate labyrinthine representation in the cerebral cortex. Penfield and Gage have reported that only rarely does stimulation of the temporal-lobe cortex during operation cause a sensation of movement or dizziness in the patient.

Spiegel carried out labyrinthine stimulation on animals. In one set he strychninized various parts of the cerebral cortex after the method of Dusser de Barenne, and in another he recorded the electrencephalogram during the stimulation of the labyrinth. He

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felt that the results pointed to labyrinthine representation in the ecto- and supra-sylvian gyri, which would, in man, correspond to the posterior part of the temporal lobe.

The value of the equilibrating tests in localizing intracranial lesions is lessened for the four following reasons:

(*a*) The complexity of the internal wiring: The great number of connecting paths from the vestibular nuclei to the other parts of the central nervous system are still not known in detail. In view of this scant knowledge, some harm has been done in the past by otologists attempting a too-ambitious localization of intracranial lesions based upon insufficient or misleading evidence derived from the vestibular tests.

(*b*) The difficulty of carrying out ablation operations on the individual end-organs in the labyrinth: This has been partly overcome by our development of a special operative technique in the frog, and by Versteegh's operations upon the utricle and saccule in the rabbit.

(*c*) Lack of knowledge of the reaction-patterns of the body musculature characteristic of stimulation of the individual labyrinthine end-organs: Now that these have been definitely established by us in the frog, it is a matter of determining how they have become modified in man. Once this is established, their recognition by neurologists and otologists, coupled with carefully controlled correlation studies with operative and *post mortem* findings, may serve to fill in some of the gaps in our knowledge concerning the intracranial pathways from the individual labyrinthine receptors.

(*d*) Inadequate tests for canal and otolith function have hampered progress: It is hoped that judicious use of the quick tilt test as a means of diagnosing lesions of the individual canals and their association with the utricle, will eventually add to the value of the vestibular tests in intracranial localization. Grahe's slow tilt method is well adapted to the study of "first mode" utricular stimulation.

Reactions Following the Vestibular Tests

The labyrinth is so designed as to be stimulated by any movement of the head in space. The resulting reactions are compensatory and are intended to return the body, head, and eyes to their original positions. To bring about this result the necessary muscle-groups are stimulated and the sympathetic and parasympathetic nervous systems are notified to make the necessary preparations in the way of extra blood-supply for the muscles, nerves, etc., that will take part in the readjustment. In addition there is a message sent through to consciousness that the head has been moved.

If the labyrinth is stimulated by anything other than active movement of the head—as, for instance, when the fluid in the

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semicircular canals is artificially moved during the caloric test—the central nervous system does not discriminate between this and a true head movement, with the result that the stereotyped set of reactions are called forth to meet an emergency which has not arisen. It is like a false alarm to the fire department ; the engines arrive, there is no fire, and the engines only obstruct the traffic, because they were not really needed. A message goes through to the central nervous system that the head has moved, but the eyes and bodily sensations inform the central nervous system that the head has not moved, and it is these contradictory messages which result in the sensation of dizziness. The sympathetic and parasympathetic readjustments result in excessive flushing, perspiration, and nausea. The compensatory muscular readjustment of the body and limbs occurs to counteract a movement which has not taken place, with the result that they set up movements in the opposite direction. These movements are the fall of the body, the turning of the head, and the past-pointing of the limbs.

The sensation of movement (the vertigo or dizziness) is always in the same direction as the quick phase of the nystagmus and in the direction of the supposed stimulating movement. The slow phase of nystagmus, the fall, the turning of the head, and the past-pointing of the limbs, all being compensatory, are in the opposite direction.

When considered in this light, it becomes clear that past-pointing, falling, and head turning are really compensatory movements just as much as are the protective movements which resist a sudden tilt and they also have the characteristic reaction patterns of the musculature, depending upon which end-organ is stimulated. The reaction patterns are slightly modified because of the erect posture of the patient. When a patient on all fours is quickly tilted, the arms resist by buttressing, just as the forelimbs of a frog do. When, however, man assumes the erect posture and is subjected to a quick tilt his arms can now no longer act as a buttress and they are used in the same way as the tight-rope walker uses his pole. They are moved about in the air to alter the centre of gravity and bring it over the base of support. This explains why the arms, which have been held out straight in front of the patient after a caloric or rotation test, are both moved to the same side and opposite to the direction in which the patient feels that he is falling, but in the same direction as the other compensatory reactions, such as the turning of the head, etc. The so-called " disc-thrower's position " is this same reaction modified because of the patient's erect posture. It is a characteristic pattern of response of the body musculature resulting from special stimulation of the labyrinth.

Rademaker and Garcin (1933), and de Kleijn and Versteegh (1935) have noted that in the presence of certain intracranial lesions,

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the protective reactions to a quick tilt, together with the past-pointing and falling after the caloric or rotation tests, may be present or absent independently of the eye nystagmus which follows the caloric or rotation tests. This is another indication of the close association which exists between these compensatory reactions which follow labyrinthine stimulation. It would also suggest that their paths are separate from the vestibulo-ocular paths for nystagmus.

The experiments upon which these remarks are based have been carried out in association with Professor John Tait, Head of the Department of Physiology, McGill University, Montreal.

BIBLIOGRAPHY

EWALD, J. R. (1892), "Physiologische Untersuchungen über das Endorgan des Nervus octavus," Wiesbaden.

GRAHE, K. (1927), *Ztschr. f. Hals- Nasen- u. Ohrenh.*, xviii, 411-22.

JONES, I. H., and FISHER, L. (1918), "Equilibrium and Vertigo," J. B. Lippincott, Philadelphia, 444.

KLEIJN, A. DE, and VERSTEEGH, C. (1935), *Acta Oto-laryng.*, xxiv, Fasc. 1, 34-52.

MAXWELL, S. S. (1923), "Labyrinth and Equilibrium." Philadelphia and London.

MCNALLY, W. J., and TAIT, J. (1925), *Am. J. Physiol.*, lxxv, 155-79.

Id. (1933), *Quart. J. Exper. Physiol.*, xxiii, 147-96.

MCNALLY, W. J. (1931), *Tr. Am. Acad. Ophth.*, xxxvi, 282-305.

RADEMAKER, G. G. J., and GARCIN, R. (1932), *Rev. Neurol*, Tome I, No. 4, 637-53.

Id. (1933), *Ibid.*, Tome II, No. 5, 566-79.

TAIT, J. (1926), *Laryngoscope*, xxxvi, 713, also *Tr. Am. Otol. Soc.*, 1926.

TAIT, J., and MCNALLY, W. J. (1934), *Phil. Tr. Roy. Soc.*, Series B, Biological Sciences, No. 513, ccxxiv, 241-86.

THOMAS, ANDRÉ (1898), *Compt. rend. Soc. de biol.*, Paris, Series 10, Tome V, 594-6.

ULRICH, H. (1935), *Pflüger's Arch. f. d. ges. Physiol.*, ccxxxv, 545-53.

DISCUSSION.

Mr. SYDNEY SCOTT said that he had not made observations on frogs but only on fishes and pigeons. One conclusion arrived at was that the retina of the trout was maintained in the same position in water relative to space, by the integrity of the labyrinthine reflexes, which kept the trout's window constant, whether the trunk or head were moved by water currents (with certain limits of course) either upwards, downwards, or sideways.

When the labyrinth of the trout was destroyed the reflex control movements of the eyeball were lost, and the retina could no longer be maintained in the same constant relative position in space.

When the pigeon's labyrinths were destroyed, it failed in its attempts to pick up a grain of Indian corn from the ground, because the neck muscles over-acted, as in Dr. McNally's frog's when deprived of the

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utricle, and the pigeon, though it could see, pecked too far and missed separate grains of corn scattered on the ground. It had to feed from a cupful of corn. He had never succeeded in differentiating whether this form of inco-ordination was due to utricular or to canalicular defunction. Probably it was due to utricular loss. Human beings seemed capable of adaptation to destruction of one and of both labyrinths, but even after four years the pigeon failed to compensate sufficiently to enable it to feed naturally.

Apparently the slow and fast tilting tests could be applied with advantage in clinical investigation; he had long considered that the rotation tests could be overdone. In neurological cases, what was often desired was to ascertain the minimal stimulus necessary to prove the efficiency of the vestibular nerves. When rotated very slowly in a chair, only a few degrees, the normal person would know definitely whether he were being turned, say to the left or to the right. In certain lesions of the vestibular nerve one could slowly turn the patient round to an extent of 45° to 90° or more, without his knowing the direction or whether he was being moved. He had been wondering whether Dr. McNally had ever tested cases of Friedreich's ataxy by strong rotation stimuli. Some years ago, he, Mr. Scott, had examined two cases of that disease and strong rotation produced convulsive seizures. However, a few weeks previously, he had applied the test to another reputed case of Friedreich's ataxy, but this patient did not over-respond.

Mr. C. S. HALLPIKE said that his first question concerned the effect of caloric stimulation of the utricle. There seemed good reason to believe that in the case of the canals the end-organs reacted rapidly, but they also adapted rapidly: i.e. if a constant stimulus was steadily applied, responses ceased. But in the utricle the adaptation was relatively slow, and continued stimulation of the utricle would give a continued response. He therefore thought that the caloric stimulus in its later stages would tend to stimulate the utricle more than the canals. With regard to the canal end-organs he would have thought that their response would be more especially confined to the onset of the stimulus.

With regard to the planes of the utricular macula: in the case of the rabbit, de Bourlet had shown that it lay on the floor of the vestibule. He (the speaker) had looked at many sections of the human temporal bone, and his impression was that the utricular macula lay more towards the roof, at the front upper corner.

He asked how it was possible to assess the degree of a nystagmic reaction. In the nystagmic reaction the eyeballs oscillated with a certain amplitude and for a certain time, but he thought these factors were not necessarily associated; in one case the eyeballs executed movements of small amplitude over a long time; in another, the amplitude was larger and the time short. What was the factor which should be chiefly considered in determining the degree of the reaction?

Dr. DE KLEIJN (Utrecht) said that if one wished to know something about the functions of different parts of the labyrinth, it was necessary to cut through the nerve connections to the different parts, and

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Dr. McNally had so far been the only person to do that. The result was a realization that the functions of the different parts of the labyrinth were much more complicated than had previously been supposed. Versteegh had been able to show that after extirpation of the saccule no static disturbances appeared in mammals, and that after section of the utricular nerve the reflex resulting from position disappeared, and the reflexes corresponding to movement were present. Up to the present time there was no knowledge about the reaction of the utricle on movements because one could not cut through the nerves going to the different canals. He wondered whether Dr. McNally had made experiments on mammals, or intended to do in the future, because he was the only worker, so far, who had the capacity for carrying out these very difficult experiments.

Mr. F. J. CLEMINSON said that he would like to ask Dr. McNally about one small clinical point. When a patient presented himself complaining of vertigo he was asked to try to describe his sensations during the attack. When pressed to be exact he might say that he felt that he was being whirled round in spite of himself. Or he might describe his sensations as not those of rotation. He might feel a little "swimmy" when he righted himself from a stooping posture, on account of changes in the blood-pressure following the change of position. But in the cases of which he (the speaker) was thinking, the chief complaint of the patient was not feeling at all sure of his equilibrium; he had a general feeling of insecurity, as if the floor on which he was standing was moving or changing its level, and he feared he might fall. If asked in what direction, he replied that it might be to the right, or to the left, or anywhere. Since first reading the work in which Tait and McNally differentiated the various parts of the labyrinth, he (Mr. Cleminson) had always wondered whether this form of vertigo might not be due to utricular disturbance, as the patient experienced just the kind of vague uncertainty which the frog seemed to show on the film. Did Dr. McNally regard this as a reasonable suggestion ?

Dr. PHYLLIS M. KERRIDGE asked whether Dr. McNally had carried out experiments on frogs which were unable to see. Dr. Bogue and she were planning to make a film showing disturbances of equilibrium in blind children, not for research reasons, but for the instruction of medical students. The maintenance of a normal posture and the regaining of equilibrium after it had been disturbed were very difficult for blind children. Their physical instruction in the special schools was much on the lines of balance exercises for children who could see, and they were encouraged in the playground to follow pursuits involving balance-sense, such as roller-skating, skipping, and walking on stilts. She would like to know whether Dr. McNally could suggest exercises or motions calculated to indicate the use of muscle groups, such as he had described in his lecture.

Mr. H. V. FORSTER said that he would like to have information concerning the value of the labyrinth as an end-organ assisting in the maintenance of muscle tone, but more especially with regard to the cristae of the semicircular canals. He had understood from recent experiments that, after division of the canals in pigeons, the dynamic

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function was permanently lost but the tonic function returned after the cristae had recovered from the shock of operation.

With regard to Dr. McNally's observations on intracranial tumours, he was reminded, when asked, as an otologist, to assist a physician in the localization of cerebral tumours, that in clinical cases, as well as in experimental animals, tumours at a considerable distance from the pons and medulla might give rise to vestibular symptoms.

Mr. F. C. ORMEROD said he wished to raise two points. The first concerned the slow-tilting experiments. The reaction due to the macula of the utricle only came into play after the frog had been tilted to the extent of 45° by the slow method. He wondered what was the explanation of that ; apparently there was a threshold of appreciation by the utricle.

The other point concerned the relative strength of the response to the ampullifugal and ampullipetal currents in the canals. In any pair of canals the movement of the fluid in a particular direction in either canal would give the same result, and it was said that in the horizontal canals the ampullipetal result was stronger than the ampullifugal. Could Dr. McNally confirm that ? or was he able to estimate the difference in the results from the two kinds of currents ? It was important, when performing rotatory tests on patients, to know from which labyrinth one was obtaining results, or what was the proportionate result from the two.

Dr. MCNALLY (in reply to Mr. Sydney Scott) said that he had not investigated cases of Friedreich's ataxy. If a test was evolved whereby the site of intracranial lesions in the vestibular pathways could be determined, investigation of such cases would be more enlightening.

With regard to the simultaneous occurrence of diplopia and nystagmus in some types of lesion, he had observed some cases of it.

In reply to Mr. Hallpike with reference to the adaptability of the canals as compared with that of the utricles, and the possibility of calorific effects on the utricles, he was prepared to accept Mr. Hallpike's explanation. The caloric was a splendid clinical test, but not much was known as to how it operated. Until the point was reached at which individual end-organ lesions could be produced in animals and caloric tests then carried out, one would not be able to say what was the labyrinthine effect of the caloric test.

He was unable to answer Mr. Hallpike's question as to the planes of the utricles ; he had not had the pathological experience with the human subject that Mr. Hallpike had had.

Concerning measurement of the degree of nystagmus : In experimenting on frogs, not much time was spent in looking for nystagmus, and he had never been much impressed by the large amount of work which had been expended on attempts to differentiate fine degrees of it. So little was known about the tests that not much could yet be done in interpreting results. He had only done a little clinically in this matter, by observations on patients ; frankly, he did not see that much could be gained in that way at present.

He much appreciated what Dr. de Kleijn had said about the second mode of testing in mammals. He (the speaker) had worked entirely

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with frogs in these researches. If the labyrinth of the frog was removed and it was placed on the tilt table, its body was wet, and hence it had a fairly firm setting, and when it was tilted, nothing happened, because the equilibrium was fairly well established; it was difficult to dislodge its centre of gravity from its basis of support. But mammals would be standing on four legs and their centre of gravity was high, so that in their case it was a simple matter to displace the centre of gravity. A de-labyrinthized man might be much more easily upset than was a frog after the same operation, therefore the second mode of stimulation was not so obvious, and that was why it was more difficult to detect. He was hoping that Dr. de Kleijn would himself carry out the investigations which would afford an explanation on these points; no one was better qualified.

He had been interested in Mr. Cleminson's idea and in the type of vertigo he mentioned. If only the utricles were attacked the patient was very wavy, and possibly he had an intracranial tumour or some type of lesion which picked out the utricular fibres and stimulated them. The floating sensation might be interpreted as an irritation of vestibular fibres in the brain stem.

In answer to Dr. Kerridge: All the frogs used in the experiments were first blinded by cutting both optic nerves; before this method was adopted the frogs were lively at the first touch, and reactions occurred because of the use of the eyes. With regard to blind children, he thought that, from the scientific standpoint, the inclusion of some children who were blind and deaf would be valuable, because some of those who were blind with perfect labyrinths, would show certain reactions, while if both blindness and deafness were present, some other interesting reactions might be observed.

In reply to Mr. Forster: The cristae probably had something to do with posture. It was believed that following some lesions the posture was normal, but this was not quite the case; there was a decannulated posture. What had been said about implanting tumours was not confirmed by his experience. It was amazing how little disability followed removal of large cerebral and cerebellar areas; one would not expect equilibrium to be affected unless the lesions were in the posterior fossa.

In answer to Mr. Ormerod: He had analysed carefully the slow-tilting test, and there was no rule which he could lay down. In the rotation tests he had found that in the lower animals only the maximum held. He hoped that some day more would be known about the caloric test and the rotation test, and what part was played by the factor of intracranial adaptation, so that maxima and minima could be discarded.

The following case was shown:

Massive Involvement of Skull, Temporal and Occipital Regions by Carcinoma derived from a Rodent Ulcer.

—JOHN F. SIMPSON.

Male, aged 65.

A "sore place"—probably a rodent ulcer—appeared in the region of the lower end of the right post-auricular groove in 1908

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and in 1914 was treated by surface application of radium. The condition healed, and remained healed until early in 1934, when there was a small ulceration on the lower part of the pinna and adjoining the mastoid area. Deafness and aural discharge were noticed at this time. X-ray examination showed the mastoid to be largely eroded.

June, 1934: Patient referred to Mr. Stanford Cade who irradiated the involved area as follows: 25.6.34: Interstitial needling, 2,034 mgm.-hrs.; 7.7.34: Surface application, 2,080 mgm.-hrs.

August, 1934: All ulceration healed; no discharge from ear.

December, 1936: Patient complained of pain in neck and shoulders (rheumatism) and very slight occasional serous discharge from ear. No ulceration behind the ear and no glands palpable. The introduction of a speculum into the contracted meatus caused bleeding.

January, 1937: Intrameatal biopsy revealed "squamous-celled carcinoma, probably derived from a rodent ulcer" (Dr. W. Newcomb).

X-ray examination shows erosion of the posterior part of the petrous, the entire mastoid and part of the squama, also portions of the occipital and parietal bones.

There are no nerve palsies and the patient is still playing golf, quite unaware of the true condition.

The patient is now undergoing a course of tele-radiation given by Mr. Stanford Cade, who is employing the 4 gramme radium bomb.

ABSTRACTS

EAR

Labyrinthine Deafness with Sigmatism in a family in which several generations of marriage with blood relations had taken place. DR. RYO TAKAHASHI. (*Oto-Rhino-Laryngologia*, X, 1, 7, 1937).

The writer followed up a very complicated list of relations among whom repeated inter-marriage between uncles and nieces had taken place through four generations. In the father and three of his five children there was sigmatism combined with dullness of hearing; the two other children died of profuse nasal hæmorrhage. More thorough examination showed that the dullness of hearing was exclusively labyrinthine and combined with sigmatism. The "s" sounds were replaced by "t" sounds, but the speech disturbance steadily improved as the patients grew up. This labyrinthine deafness is without doubt the result of the inter-marriage of the blood relations in which the deafness with sigmatism appeared to be unquestionably the consequence. The writer was of the opinion, along with Köhler, that sigmatism is to be attributed to the loss of

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