Papers and Originals

Modern Tests of Vestibular Function, with Special Reference to their Value in Clinical Practice

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Summary: The many vestibular tests now available provide the means of accurate localization of lesions at all levels of the vestibular pathways. The value of the test procedures described has been well established in the examination of very many patients over the past twenty years, and though other forms of tests are available only those have been included which have proved to give consistently useful information.

Most of these tests can be undertaken by the clinician without the use of any costly equipment, and together with a careful history and examination the diagnosis can in most cases be arrived at. Recognition of the highly important role of optic fixation and ocular deviations on vestibular nystagmus, together with recent facilities to demonstrate this electronystagmographically, may provide additional valuable and more precise information.

Introduction

The writer of a recent leading article in the *British Medical Journal* (1969) has drawn attention to the "slight decline in spirits" experienced by the majority of physicians on hearing their patient's complaint is of giddiness (Matthews, 1963). The many new diagnostic methods now available for the assessment of vestibular function should provide a basis for considerable optimism. A brief review of these modern tests, with particular regard to their value to the practising clinician, would seem opportune at the present time.

Vestibular Tonus

Modern tests of vestibular function are based on the concept of vestibular tonus. According to this the vestibular system operates in two halves, left and right, each with its centre in the brain stem. The arrangement is shown in Fig. 1. Within each centre are two kinds of vestibular elements, the phasic, or canal, elements and the tonus elements. With regard to the canal elements the two nuclear centres are connected peripherally to the semicircular canals and centrally to the eye muscles. This system evokes nystagmus chiefly in response to canal stimulation. The tonus elements, which are closely related, influence the canal centres, each tending to cause nystagmus to its own side. In normal circumstances the left and right centres are balanced and there is no nystagmus. If, however, there is a unilateral lesion this balance will be upset and nystagmus towards the normal side will be the result. With severe or acute lesions this will be a spontaneous nystagmus. With

resolving or less severe lesions the imbalance may be demonstrable only by inducing vestibular nystagmus; for example, by caloric stimulation, when the exaggerated nystagmus towards the normal side is known as directional preponderance.

FIG. 1.—Schematic representation of neurological mechanism of vestibular system showing interaction of canal and tonus elements.

As will be seen from Fig. 1 the tonus elements are connected with the labyrinths, in particular the utricle; they are also connected with higher centres, in particular a cortical component in the posterior part of the temporal lobe. A lesion anywhere in the vestibular pathways may lead to vertigo, the clinical characteristics varying with the site in question.

Vestibular Tests

Before embarking on any tests of vestibular function the importance of a careful history and examination of the ears cannot be overemphasized. Of 106 consecutive cases of vertigo examined by Sir William Gowers (1893) 76 years ago he wrote that in no fewer than 94 ear symptoms had been present.

The following tests may be considered in turn as they are commonly carried out on a patient. (1) Tests of stance and gait, (2) observation for spontaneous nystagmus, (3) observation of optokinetic nystagmus, (4) tests for positional nystagmus, (5) caloric tests of vestibular function, (6) electronystagmographic investigation, and (7) rotational tests.

1. Tests of Stance and Gait

Observations of the patient standing and walking with his eyes closed may give useful information about the side of a

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unilateral vestibular lesion. Owing to unilateral decrease in vestibular tonus the patient tends to stagger or drift to the side in question. In cases of streptomycin intoxication imbalance is often extreme. Cases of hysterical imbalance can often be recognized by bizarre abnormalities of stance and gait. In our experience, however, some underlying vestibular abnormality is usually found in such patients and they are often helped by a course of vestibular exercises (Cawthorne, 1946; Cooksey, 1946).

2. Examination for Spontaneous Nystagmus

The eyes should be examined with the patient's head erect and with good illumination. The patient is asked to look up and down and to follow the examiner's finger to points some 30° to left and right of the midline. A rough guide to this is when the limbus and caruncle meet in the adducting eye. Any nystagmus present within these limits is pathological. Nystagmus present at the extreme limits of gaze is often present in normal persons.

(a) Spontaneous Vestibular Nystagmus

Spontaneous vestibular nystagmus is distinguished from other types of nystagmus by its so-called saw-tooth character—that is to say, it consists of a slow deviation of the eyes to the affected side followed by a rapid recovery. Since the latter movement is the more striking, vestibular nystagmus is always described as being in this direction. Vestibular nystagmus is, furthermore, exaggerated on looking in the direction of the quick component. Nystagmus to the right is described as being of first degree when present only on right lateral gaze, of second degree if present also in the straight-ahead position, and of third degree if present, in addition, on left lateral gaze.

These characteristics are important in the diagnosis of a case of acute labyrinthine vertigo. The patient lies with the affected ear uppermost. The reason for this would appear to be to avoid looking towards the normal side because of the exaggeration of spontaneous nystagmus in this direction.

Spontaneous vestibular nystagmus may be due to either peripheral or central vestibular lesions. The differential diagnosis of the two types is summarized in Table I.

TABLE I.—Spontaneous Vestibular Nystagmus

	Peripheral Type	Central Type
Duration	Temporary, not more than 3 weeks	Permanent
Direction	One only	May be multidirectional
Character	Always conjugate	May be dissociated or deranged
Effect of removing fixation ..	Enhanced	Unchanged or inhibited

When vestibular nystagmus is dissociated in the absence of any peripheral ocular disorder the commonest cause is a brain-stem lesion involving the posterior longitudinal bundle between the third and sixth nerve nuclei, a so-called internuclear ophthalmoplegia. This is recognized by vestibular nystagmus confined to or more pronounced in the abducting eye on lateral gaze, nystagmus in the adducting eye being absent or less evident and adduction also typically defective.

If internuclear ophthalmoplegia is bilateral multiple sclerosis is almost certainly the diagnosis. Acute vertigo is not infrequently a presenting symptom in such cases. Unilateral internuclear ophthalmoplegia is a not uncommon sequel of vascular lesions.

(b) Other Varieties of Spontaneous Nystagmus

Certain other types of nystagmus have to be distinguished from spontaneous vestibular nystagmus. The commonest

varieties are of pendular type—that is to say, characterized by oscillations that are about equal for the two directions. The most frequently encountered type is so-called congenital nystagmus. It usually occurs in young persons and may have a jelly-like character. It often takes on the character of vestibular nystagmus on lateral gaze. The aetiology is obscure and the morbidity is localized to the upper brain stem, presumably due to a lesion involving the efferent pathway for optic fixation, since vision is unaffected. It is always associated with defective optokinetic nystagmus. Congenital nystagmus usually persists throughout life and causes little disability. Other types of pendular nystagmus include spasmus mutans of infants. It may also be associated with various visual defects.

3. Optokinetic Nystagmus

Observations of optokinetic nystagmus are of great importance in the assessment of vestibular function in view of its similarity to vestibular nystagmus. Both types of nystagmus are identical in character, having alternating slow and rapid components, and through both vestibular and optokinetic pathways tonic influences are exerted on the eye muscles by the labyrinths and retinae respectively which may summate or be opposed.

In Fig. 2 are shown the cerebral pathways for optokinetic nystagmus. From the right halves of the retinae fibres pass via the right external geniculate body, optic radiation, and visual cortex to an optomotor centre situated in the peristriate cortex corresponding to Brodman's area 18 or, according to other authors, in the angular gyrus. This centre receives fibres not only from the homolateral but also from the contralateral cortex by the corpus callosum. The efferent pathway passes forward deep to the optic radiation in its posterior two-thirds, when it parts company and joins the cerebral peduncle converging towards the midline in the region of the fields of Forel.

FIG. 2.—Schematic reconstruction of the cerebral mechanism of optokinetic nystagmus in man.

In the midbrain the left and right pathways converge lying ventrolateral to the medial longitudinal bundle and cross the midline at the level of the third and fourth nerve nuclei, continuing through the pontine tegmentum to join the opposite sixth nerve nucleus. The mesencephalic and pontine pathways occupy the general region of the excitatory or activating reticular formation. The tonic influence exerted through the right hemisphere is to drive the eyes to the left, and vice versa.

In clinical practice optokinetic nystagmus is conveniently elicited by using a small rotating drum with mechanically regulated drum speeds as described by Cawthorne *et al.* (1956) (Fig. 3). The drum can be rapidly reversed and the speed control operated by the examiner without relaxing his scrutiny of the subject's eyes. The axis of rotation of the drum is variable, so that it is possible to investigate nystagmus in any desired direction. Comparisons are made, firstly, of amplitude and symmetry of nystagmus to left and right, up and down, and, secondly, any abnormalities in character of the responses themselves are noted.

FIG. 3.—Bárány drum used to test optokinetic nystagmus.

The first abnormality, directional preponderance or, in other words, nystagmus of greater amplitude to left or right, is due to a unilateral lesion. If the lesion in question is at a high level in the optomotor pathway in the cortex or diencephalon the directional preponderance will be towards the affected side. If, on the other hand, there is a unilateral lesion of the labyrinth, eighth nerve, or vestibular nuclei below the level of entry of the eighth nerve, optokinetic nystagmus summates with vestibular nystagmus and there will be a directional preponderance towards the normal side.

The second type of abnormality is more often encountered in lesions of the midbrain or pons, where both pathways, being close together anatomically, tend to be bilaterally involved. Responses are absent, sluggish, broken up, or even apparently reversed in direction. The diagnosis of a lesion of the brain stem can often be made in a matter of a few seconds from observation of optokinetic nystagmus alone in such cases.

4. Positional Nystagmus

Tests for positional nystagmus are carried out to assess the function of the otolith apparatus which regulates the position of the head in space. The test procedure is illustrated in Fig. 4.

The patient is seated on a couch and asked to fix his gaze on the examiner's forehead. The head, turned to one side, is then carried back briskly into the position shown and any resulting nystagmus observed. There are two main types of positional nystagmus.

(a) Benign Paroxysmal Type

In this condition a bout of severe vertigo and nystagmus accompanied by distress is the result of putting the head in the position shown. The nystagmus is typically rotatory in

character, is directed towards the undermost ear, occurs only after a latent period of a few seconds, and then disappears. It may occur in the reverse direction on sitting up but is less severe or absent if the test is repeated. The condition is a

FIG. 4.—Procedure used to elicit positional nystagmus.

common sequel of head injury but may also be associated with vascular occlusion or infection. Clinicopathological studies have shown the lesion to involve the otolith apparatus placed undermost in the test position (Dix and Hallpike, 1952 ; Cawthorne and Hallpike, 1957). The phenomenon may be totally and permanently abolished by surgical exenteration of the defective labyrinth or division of the eighth nerve (Citron and Hallpike, 1956, 1962).

(b) Central Type

By contrast with the benign paroxysmal type, positional nystagmus of central type is always of sinister significance and is often associated with other neurological abnormalities indicating a posterior fossa neoplasm or demyelinating process. Occasionally, however, it occurs as the only abnormal physical sign. In this event more detailed investigation is called for, which may include air studies and radiological examination of the chest, which sometimes shows evidence of a primary lung carcinoma (Cawthorne and Hinchcliffe, 1961).

In its typical form positional nystagmus of central type occurs in the test position without latent period. Vertigo is absent or slight, and the direction of the nystagmus varies. It may be upwards or downwards or often horizontal towards the uppermost ear. It does not adapt with time and reappears unchanged on repeating the test. The main distinguishing features between positional nystagmus of benign paroxysmal and central type are summarized in Table II.

TABLE II.—Positional Nystagmus

	Benign Paroxysmal Type	Central Type
Latent period	2-20 seconds	None
Adaptation	Disappears in 50 seconds	Persists
Fatigability	Disappears on repetition	Persists
Vertigo	Always present	Typically absent
Direction of nystagmus ..	To undermost ear	Variable
Incidence	Relatively common	Relatively uncommon

A difficult situation may sometimes arise in the case of positional nystagmus apparently of benign type in which the characteristics are not entirely clear-cut. Although the associated vertigo may be severe and nystagmus paroxysmal, its direction may be atypical. In such cases, though the essential stimulus which initiates the nystagmus is within the undermost labyrinth, the actual lesion occurs in the central part of a reflex through the cerebellar nodulus (Riesco MacLure, 1957 ; Fernandez *et al.*, 1959). Any qualitative deviation of the nystagmus from the typical pattern should thus provide a warning against the possibility of a serious intracranial lesion.

5. Caloric Tests

The caloric test depends on the fact that when the external auditory meatus is warmed or cooled the thermal change is transmitted to the lateral semicircular canal and a movement

of the cupulas results which induces vestibular nystagmus. The test was first established on a quantitative basis by Fitzgerald and Hallpike (1942), who used it to demonstrate directional preponderance or, in other words, prolonged nystagmus to left or right, to which I have already referred.

In Fig. 5 is shown the test procedure. The patient's head is raised 30° above the horizontal to bring the lateral semicircular canal into the vertical plane, the position of maximum sensitivity to thermal stimuli. The stimuli, water at 30° C. and 44° C., are 7° below and above body temperature, and with these the external meatuses are irrigated in succession for periods of 40 seconds. In this position thermal stimuli give rise to cupular displacements resulting from changes in specific gravity of the endolymph in the proximal and distal parts of the canal. Thus a cold stimulus gives rise to an ampullo-fugal displacement resulting in a decrease in the resting discharge potentials, and the hot stimulus gives rise to an ampullo-petal displacement with increase in the resting discharge. The former initiates nystagmus to the opposite side and the latter to the same side.

FIG. 5.—Caloric test procedure.

Observations of nystagmus are carried out with good illumination, the patient fixing his gaze on a point in the straight-ahead position. The responses measured are the time intervals from the beginning of the irrigation to the end of the nystagmus. The results are graphically recorded.

In Fig. 6 is shown the result in a normal subject. The continuous lines represent time, three minutes divided into 10-second intervals. Above are shown the two responses, left and right, to the cold stimulus, 30° C. Below are shown the two responses, left and right, to the hot stimulus, 44° C. It is convenient to number the responses 1 to 4 from above downwards. Responses 1 and 4 consist of nystagmus to the right, responses 2 and 3 consist of nystagmus to the left.

FIG. 6.—Caloric test results obtained in an average normal subject.

In Fig. 7 are shown the three abnormalities which may occur as a result of a right-sided vestibular lesion. Patterns 1 and 2 are the two primary abnormalities which occur as a result of organic lesions of the right canal and tonus vestibular elements respectively. Pattern 1 is the commonest abnor-

malinity, a so-called canal paresis, and represents loss of sensitivity of the right phasic vestibular elements with both cold and hot stimulation. Pattern 2 is a directional preponderance to the left resulting from a lesion of the right tonus elements. Responses 2 and 3, representing nystagmus to the left, are enhanced with respect to responses 1 and 4, nystagmus to the right. In pattern 3 is shown the caloric abnormality elicited when both right canal and tonus elements are involved by an organic lesion. This pattern can be recognized on analysis as an algebraic summation of patterns 1 and 2. Thus the open triangles show the shortening of responses 2 and 4 resulting from the canal paresis. It is easy to understand from patterns 2 and 3 that the diagnosis of a right vestibular lesion could not be made by carrying out only the cold or hot responses alone. If only the cold responses were carried out the lesion in pattern 2 would appear to be on the left and the pattern in 3 normal. If only the hot responses were carried out then the lesion would appear right-sided. It is only when all four responses are known, however, that the directional nature of the abnormality is apparent. Other abnormalities in pattern of the caloric responses, though at first confusing, may be interpreted as with pattern 3 as algebraic summations of the primary patterns.

FIG. 7.—Caloric test abnormalities occurring as a result of a right-sided vestibular lesion.

Directional preponderance may occur as the sole abnormality in a significant proportion of unilateral lesions involving the labyrinth, eighth nerve, or their central connexions in the brain stem and cerebellum. It may finally occur in lesions of the cerebral hemispheres involving the posterior part of the temporal lobe and thus be a useful localizing sign in cases of epilepsy and cerebral tumour. In a similar way canal paresis may occur in a lesion of the labyrinth, vestibular nerve, or the vestibular nuclei within the brain stem.

In the case of brain-stem lesions the tonus elements have been shown to be located in the vestibular nuclei below the level of entry of the eighth nerve (Carmichael *et al.*, 1965).

Abnormalities of the caloric responses as carried out and interpreted in the above way may thus constitute a physical sign of wide diagnostic significance in practical neuro-otology.

6. Electronystagmographic Investigation

During recent years the recording of a subject's eye movements has been found of ever-increasing value in the localization of the lesion responsible for any spontaneous nystagmus or abnormalities of induced nystagmus. Electronystagmography is a relatively time-consuming procedure, however, and its results can only be interpreted in association with those of a previous neuro-otological investigation such as that already described.

The method of recording is based on the fact that a positive potential exists between the cornea and fundus. Within certain limits of eye deviation a linear change occurs in this potential difference which can be recorded between skin electrodes placed on either side of the eye in the plane of its movement. The great advantage of this technique is that

recordings can be carried out with the eyes open or closed in total darkness.

FIG. 8.—Arrangements of electrodes for electronystagmographic recording.

FIG. 9.—Technique for recording spontaneous nystagmus

This facility is of vital importance in diagnosis, since nystagmus, as we have shown, may be greatly affected by fixation. One further essential in technique is that the position of the eyes should be known. If this were not the case an enhancement of vestibular nystagmus on removal of fixation might merely be the result of an eye deviation in the direction of its quick component, and serious errors in interpretation of the records could ensue. For this reason, then, D.C. amplification must be used.

The manner of application of the electrodes is shown in Fig. 8. A convenient technique for recording is shown in Fig. 9. The patient sits in a chair, the seat

of which can be raised or lowered by a hydraulic jack so as to adjust the chin level to a rigidly mounted rest. The patient fixes his gaze on a mark on the vertical bar in front of him. The bar can be deviated to his left or right by means of a handle controlled by the examiner behind him.

Fig. 10 shows the arrangement of the recording pens. Their rotational axes are actually and their writing points virtually coincident. The outer pen records the angular deviation of the fixation mark. The inner, or eye, pen records conjugate eye movements in the horizontal plane.

FIG. 10.—Arrangement of pens for recording spontaneous nystagmus.

The record demonstrates third-degree vestibular nystagmus to the left. In the upper tracing the patient's gaze is deviated 30° to the right. It is seen that the amplitude of the nystagmus becomes progressively enhanced as the patient looks straight ahead and to the left as shown in the lower two tracings respectively. By convention, any upward movement of the pens represents an eye movement to the right, and vice versa.

In Figs. 11 and 12 are shown the effect of removing optic fixation by eye closure in two patients with left vestibular lesions.

In Fig. 11 the left eighth nerve had been divided for Ménière's disease. Spontaneous nystagmus to the right following operation had subsided, and, as can be seen, no nystagmic movements are apparent on the recordings in any direction of gaze. Between the arrows the patient's eyes are closed while endeavouring to maintain the same gaze deviations. A brisk vestibular nystagmus to the right is seen which disappears immediately visual fixation is restored.

FIG. 11

FIG. 12

FIG. 11.—Appearance of spontaneous nystagmus as a result of removal of optic fixation by eye closure in a patient aged 35 with Ménière's disease affecting the left ear eight days after intracranial division of the eighth nerve. FIG. 12.—Effect of eye closure on nystagmus in a patient aged 58 with left acoustic neurofibroma.

In Fig. 12, by contrast, the patient suffered from an advanced left acoustic neuroma involving the brain stem. With gaze to left or right, first-degree vestibular nystagmus to left or right respectively can be seen. On eye closure, while endeavouring to maintain the same gaze deviation between the points shown by the arrows, nystagmus disappears. On opening the eyes it reappears immediately.

In clinical practice elimination of fixation by eye closure is not of the same significance as total darkness, and comparison of recordings of spontaneous vestibular nystagmus with both methods has proved of important value in localizing lesions of the vestibular pathways at different levels in the central nervous system.

In Table III are summarized the results in brain stem lesions.

TABLE III.—Effects of Eye Closure and Darkness Upon Spontaneous Nystagmus Resulting from Lesions at Different Levels of the Central Nervous System

Lesion	Darkness	Eye Closure
Labyrinthine or peripheral to vestibular nuclei	Nystagmus enhanced if present or made manifest if not	Nystagmus enhanced if present or made manifest if not
At or about the level of the vestibular nuclei	Nystagmus enhanced in amplitude but decreased in respect of slow component velocity	Nystagmus abolished
Above the level of the vestibular nuclei	Nystagmus abolished	Nystagmus abolished

Important information can be provided by electro-nystagmography in lesions in other situations in the nervous system as illustrated by Fig. 13. This shows a record made in the straight-ahead position of gaze from a man with a long-standing history of unsteadiness and attacks of vertigo. The recording demonstrates irregular saccadic movements but no definite vestibular nystagmus. These so-called square waves are characteristic of cerebellar lesions. Subsequent neurological examination demonstrated bilateral cerebellar signs. The diagnosis was multiple sclerosis.

FIG. 13.—Saccadic movements in straight-ahead position of gaze in a patient with cerebellar disease. Eyes open. Optic fixation.

7. Rotational Tests

Whereas the clinical value of the caloric tests depends on the relative sensitivity of the labyrinths and their central connexions, these tests provide little information on the absolute sensitivity of the semicircular canal mechanisms. With rotational tests, on the other hand, both labyrinths are stimulated simultaneously, and though they have little localizing value there is the great advantage that the physical forces engendered within the semicircular canals can be calculated with considerable precision. The rotation test is thus of particular value for determining semicircular canal sensitivity.

In Fig. 14 is shown a suitable type of rotating chair. It is servomechanically controlled, and by means of it angular accelerations from 0.1 to 10° per second per second can be applied at will. The deflection of the cupula of the horizontal semicircular canal which results from such stimulation is accompanied by vestibular nystagmus towards the direction of turning and a sensation of rotation.

A spot of light in front of the subject's eyes is attached to and rotates with the chair. The nystagmus can then be recorded electronystagmographically with or without optic fixation. In the normal subject the threshold for nystagmus is of the order of 0.1° per second per second in the absence of fixation. With the inhibitory effect of fixation the threshold is much higher, in the range of 1.5° per second per second.

FIG. 14.—Rotating chair.

Rotational tests carried out with a chair of this type can give much useful information to supplement that given by the caloric tests. These tests are of two main types.

(a) Impulsive Rotational Stimuli

By this is meant the sudden attainment from rest of a constant angular velocity or the sudden arrest of the chair from a constant angular velocity. Such stimuli give rise to post-rotational nystagmus and are useful in certain circumstances in the demonstration of directional preponderance.

FIG. 15.—Nystagmic responses to impulsive rotational stimuli (60° per second) in a patient after right hemispherectomy. Eyes open. Optic fixation.

Such stimuli have had practical application in the case of cerebral lesions when carried out with and without optic fixation. This is illustrated by the following case.

In Fig. 15 is shown a record of induced vestibular nystagmus to impulsive rotational acceleration and deceleration stimuli up to and from velocities of 60° per second to right and left, from a patient on whom a right hemispherectomy had been performed. Active optic fixation was maintained on a light source rotating with the subject in the straight-ahead line of gaze.

Responses 1 and 4, consisting of nystagmus to the right, are much greater than responses 2 and 3 consisting of nystagmus to the left. In other words, there is a well-marked directional preponderance to the right, the side of the lesion. This confirmed the results of previous caloric tests and is in accord with the findings of Carmichael *et al.* (1954) that directional preponderance is consistently towards the affected hemisphere in patients with unilateral cerebral lesions involving the temporal lobe.

The records shown in Fig. 16 were obtained from the same patient with the eyes open in darkness—that is, without optic fixation. The nystagmographic findings now show striking alterations. Firstly, the amplitude of the nystagmus is greatly increased. This is not surprising, since vestibular nystagmus, as has been described, is inhibited by optic fixation, and we would expect its enhancement when optic fixation is removed. A second and more important difference is the effect on the directional preponderance. Thus the directional preponderance to the right, the side of the lesion, so evident with optic fixation, is absent or reversed without it. There is, in other words, a pronounced directional preponderance to the left.

FIG. 16.—Nystagmic responses to impulsive rotational stimuli (60° per second) in a patient after right hemispherectomy. Eyes open in darkness. No optic fixation.

This reversal of directional preponderance in cerebral lesions has been confirmed in numerous other cases with unilateral temporal lobe lesions.

(b) Estimation of Threshold

A more recent use of rotational tests has been to determine the absolute sensitivity of the semicircular canal system. If caloric tests, carried out by the technique described in the presence of optic fixation, have shown severely reduced or

absent responses then two possibilities have to be considered. Either semicircular canal function may be bilaterally deranged or the induced nystagmic response may be inhibited by abnormally strong optic fixation.

The rotational thresholds are genuinely raised both with and without optic fixation in the first instance, as, for example, with streptomycin intoxication and other labyrinthine disorders. In the second instance, though little or no nystagmus is obtained by vestibular stimulation in the presence of optic fixation, if this is eliminated by darkness or eye closure, then the threshold to angular acceleration is normal. This condition is akin to that of so-called vestibular habituation encountered physiologically in ballet dancers, ice skaters, and other persons who, in the course of their occupations, are subjected to repeated angular accelerations.

Rotational tests carried out on certain patients with vertigo have shown that a similar condition may be present. Thus, though no nystagmus may have been elicited by caloric tests carried out with optic fixation maintained, yet thresholds of angular acceleration in darkness are within normal limits. There is, in other words, an enhanced power of optic fixation. The condition has been encountered not infrequently in patients with vertigo in association with anxiety states and other psychiatric disorders. The cause of the phenomenon is difficult to explain, but is believed to result from some central process involving the presynaptic inhibitory mechanisms within the brain stem reticular pathways (Dix and Hood, 1968).

In the absence of facilities for rotation tests the phenomenon can often be made manifest in the caloric test by removing optic fixation by the use of Frenzel's (1928) glasses.

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