abdominal reflexes on one or both sides, exaggeration of the knee-jerks, patellar clonus, ankle clonus, and—most important—plantar extensor response of the big toe, with fanning of the other toes, paresis, loss of sense of position, and diminution of bone sensibility show that there is a lesion involving the pyramidal tracts and the posterior column. The superficial sensibility is usually unaffected.

THE IMPORTANCE OF ANATOMICAL DIAGNOSIS IN PROGNOSIS AND IN CASES WHERE SURGICAL INTERFERENCE MAY BE CONTEMPLATED.

The diagnosis of the exact localization of disease of the spinal cord is of great importance from two points of view—namely, in prognosis and in the rare cases where surgical interference is contemplated.

The prognosis is always most grave where there is clinical evidence of extensive diffuse myelitis and where the lesion affects certain regions of the spinal cord owing to dangerous symptoms and complications arising. These lesions in the upper cervical region may affect the phrenic neurones. Again, a lesion in which the symptoms point to a complete transverse myelitis is evident by an absolute loss of sensibility below the lesion paraplegia and loss of control over the sphincters. In such cases cystitis and secondary infective nephritis are liable to occur; also large sacral bedsores, unless great care be taken by the doctor and nurse.

When the lesion affects the lumbo-sacral region and the lower motor neurones are destroyed there is, in addition, atrophy with reaction of degeneration of the muscles of the lower extremities; the sphincter troubles are more serious and bedsores are almost sure to occur in spite of careful treatment and nursing.

Anatomical Diagnosis in Relation to Surgical Interference.

A precise anatomical diagnosis in cases of extra-medullary tumour of the spinal cord and meningitis circumscripta is essential before operative interference can even be contemplated. Extradural tumour is really a more hopeful surgical operation than cerebral tumour. The difficulty of diagnosis lies, however, in the fact that we cannot always be sure that the tumour is outside the cord. It may be intramedullary. The existence of definite symptoms of root irritation prior to pressure symptoms serves as a means of localization of the situation of the tumour and affords evidence of its extradural situation.

The earliest symptom noticed by the patient in extradural tumour is pain or paraesthesia, generally on one side and only in the area of distribution of a root and associated with hyperaesthesia of the corresponding skin area. As the tumour increases in size it produces sooner or later a unilateral compression of the spinal cord of the same side, and this causes an interruption of sensory and motor tracts.

Now it frequently happens in these cases that a sensory dissociation known as the Brown-Séquard phenomenon is found—namely, there is loss of sensibility to pain, heat, and cold of the side opposite to the lesion and paralysis and loss of tactile kinaesthetic sense on the same side as the lesion. This can be explained on anatomical grounds. The fibres conveying sensations of heat and cold and pain decussate to the opposite side almost immediately in the grey matter, whereas the fibres conveying tactile kinaesthetic impressions do not decussate until they reach the medulla. The existence of compression in the pyramidal tract fibres is shown by weakness or loss of voluntary power in the limb, dragging of the foot, increase of deep reflexes, ankle clonus, and plantar extensor response. If unrelieved the pressure increases as the tumour grows and a complete paraplegia results.

These cases of slow-growing benign extradural tumour may be easily missed in the early stages and the case regarded as functional, unless a very careful and methodical examination is made, and that leads me to say a few words in conclusion regarding the differential diagnosis of spinal cord disease and hysteria in its multiform simulations.

Diagnosis of Functional Diseases.

The experiences of the great war have given us innumerable instances in support of Babinski's view that these

functional disabilities are the result of auto- or hetero-suggestion, and can be cured by suggestion or persuasion.

I do not, however, hold with those authorities who think it unnecessary or undesirable carefully to examine a case to enable them to exclude organic disease. Certainly there is a danger of suggesting to the patient symptoms, especially in respect of sensory disturbances, but after you have made a careful and methodical examination of the superficial and deep reflexes and found them all normal, you are justified in arriving at the conclusion that the contracture, paralysis, or inability to stand or walk (astasia abasia), which may have even existed for months or years, is the result of auto- or hetero-suggestion, and you can then with confidence assure your patient that he can be cured. In these functional cases, moreover, even after prolonged disuse of the limbs, there is little or no wasting, and the muscles all respond normally to electrical stimulation. I would remind you that in long-standing functional cases there is acrocyanosis and coldness of the feet, so that no response occurs to stimulus of the sole. If the foot be warmed the response can be obtained.

The recognition of functional sensory disabilities simulating spinal cord disease is easy: the superficial sensibility to pain, heat and cold, and touch is lost completely; there is no dissociation, neither the anaesthesia nor the pains complained of conform to the anatomical distribution of spinal roots or peripheral nerves. In the limbs the superficial anaesthesia takes the form of a stocking or gauntlet, and can easily be removed by suggestion, the restoration of sensibility being from above downwards. The secret of success in the treatment of these functional cases is faith; consequently, in the first treatment you must not leave the patient until you have established that by bettering or curing the disability. It may take minutes; it may take hours.

However, among the very numerous cases of functional disability there are many cases of organic disease of the spinal cord with a large halo of functional disturbance, which can be removed by various methods of suggestion, by re-education and various other forms of encouragement. But the fact must not therefore be overlooked that such a patient, in spite of the satisfactory results of such treatment, is suffering with a permanent disability, which may progress in spite of improvement by the treatment.

From what I have said it is clearly necessary to decide by examination: First, whether the case is functional or organic. Secondly, if organic, in order to form a correct judgement regarding prognosis and treatment, it is essential to diagnose the pathological nature of the lesion and its anatomical situation.

In conclusion, I would ask you to bear in mind that more mistakes are made from not looking than from not knowing.

THE LABYRINTHINE REACTIONS OF EXPERIENCED AVIATORS.

BY

DAVID RANKEN, M.S.LOND., F.R.C.S.ENG.,
SQUADRON LEADER R.A.F. MEDICAL SERVICE.

This investigation was undertaken in order to ascertain the difference, if any, between the labyrinthine reactions of experienced pilots and those of the average individual of the same age who has done no flying. In the American Air Force the Bárány rotation tests have played a much more important part in the acceptance or rejection of aviation candidates than in our own, and it is stated by Colonel Isaac Jones of the American Air Force, in his book entitled *Equilibrium and Vertigo*, that in addition to the majority of aviation candidates, all experienced pilots so far examined by them have without exception shown normal responses to their routine standards in the turning chair.

As the Aviation Candidates Medical Board, Hampstead, has during the last eighteen months examined several hundreds of experienced pilots for civilian aviation, the present seemed a suitable time for such an investigation. All tests employed have been performed as closely as possible in conformity with the rules laid down for the

American Air Force in order that the results obtained might be strictly comparable.

The points investigated were:

1. (a) The average amount of nystagmus, past-pointing, and vertigo in pilots who have from 100 to 1,000 hours to their credit. (b) As (a), but in pilots who have flown more than 1,000 hours.
2. The difference, if any, between the reaction sensibility of the right and left labyrinths.
3. The reasons for unduly high or low periods or errors.
4. The relation, if any, between these tests and others in use at the Aviation Candidates Medical Board.
5. The value of these tests from the point of view of the medical selection of pilots.

1. Average Nystagmus Periods.

(a) The average nystagmus periods of 100 pilots with from 100 to 1,000 hours in the air to their credit were:

(i) After turning to the right ten times	... 22.6 secs.
(ii) After turning to the left ten times	... 23 secs.

(b) The average nystagmus periods of 50 pilots with over 1,000 hours to their credit were:

(i) After turning to the right ten times	... 20.6 secs.
(ii) After turning to the left ten times	... 21.82 secs.

On comparing these two sets of figures it will be noticed that the first pair is a trifle higher than the second pair, both also being slightly lower than those laid down by the American Air Force—that is, 26 seconds after turning to either the right or the left, as the normal average. It will also be noted that the response in both cases is slightly higher after turning to the left than to the right—that is, after stimulating the right than the left labyrinth, as rotation to the left stimulates and produces impulses mainly from the labyrinth of the opposite side, and vice versa.

Past-Pointing.

The average past-pointing in 50 pilots with 100 to 1,000 hours to their credit was:

(i) After turning to the right ten times	... 2.5 errors
(ii) After turning to the left ten times	... 2 errors

In the case of 50 pilots with over 1,000 hours to their credit the figures were:

(i) After turning to the right ten times	... 2.25 errors
(ii) After turning to the left ten times	... 1.8 errors

It will again be noticed that the first pair of figures is slightly higher than the second pair. It would seem at first sight also that stimulation of the left labyrinth causes more reaction and consequent error than that of the right. A more probable explanation, however, is that in routine testing all pilots were turned to the right first, and a preliminary education thus gained in pointing errors caused them, consciously or subconsciously, to expect, allow for, and compensate the tendency to such errors on being turned in the opposite direction—that is, to the left. Of all three tests, this would seem the one where erroneous results are most easily obtained, for the above reason.

Vertigo.

It is in the case of the vertigo periods, however, that the most striking results were obtained. The vertigo periods are considered by some to be identical with the nystagmus periods—that is, 26 seconds after turning to the right and 26 seconds after turning to the left.

In the case of 50 pilots with 100 to 1,000 hours to their credit the average vertigo periods were:

After turning to the right ten times	... 13.5 secs.
After turning to the left ten times	... 11.7 secs.

In the case of 20 pilots with over 1,000 hours to their credit the average vertigo periods were:

After turning to the right ten times	... 13.1 secs.
After turning to the left ten times	... 12.4 secs.

The outstanding feature in these pairs of figures is that they only amount to about half as much as those assumed to be the average for the normal individual. If this assumption were correct one might be justified in believing that the majority of aviators acquire a diminished vertigo period consonant with their flying experience. At a recent examination of cadets for the Air Force, however—youths of about 18 years of age who had never been up in the air—the writer found that the average

vertigo period after turning ten times to the right was 15.4 seconds, and after turning to the left 15.3 seconds. One can only say therefore that in the case of the nystagmus and past-pointing—the average number of errors in the last named is taken to be three after turning to either right or left—there appears to be a very slight gradation of reaction sensibility of the labyrinths, greatest in those who have done no flying and gradually diminishing according to the number of hours done in the air, and that the statement cannot be corroborated that 26 seconds is the average vertigo time of the normal individual or of the experienced pilot.

2. The Relative Reaction Sensibility of the Right and Left Labyrinths.

Bearing in mind that turning to the right chiefly stimulates the left labyrinth and vice versa, it is interesting to compare the above nystagmus, past-pointing, and vertigo figures. From them it would seem that stimulation of the right labyrinth produces less past-pointing and vertigo, but a longer nystagmus period than stimulation of the left labyrinth.

The number and extent of the difference are too small for dogma, but it may be stated that a series of cases was taken with the idea of discovering whether there is a guiding labyrinth, and whether it differs in right- and left-handed people.

Out of 71 right-handed pilots it was found on interrogation and after trying to eliminate such influences as training, talk of the machines, etc., that 29 preferred to turn in the air to the left, 12 to the right, and 30 were indifferent whether they turned to the right or left—in other words, the preponderance of right-handed pilots prefer to turn to the left, which act stimulates principally their right labyrinth. Only six genuine left-handed pilots were examined, and it was considered that this number was too small to form any just idea of the preferences of naturally left-handed individuals.

3. Reasons for Excess or Diminution in the Extent of Labyrinthine Reaction.

In order to discover whether all experienced pilots satisfy the labyrinthine reactions laid down as standards, the nystagmus times and past-pointing errors of 100 pilots were investigated and compared. In all, therefore, four tests were employed, namely:

1. Nystagmus after turning to the right.
2. Nystagmus after turning to the left.
3. Past-pointing after turning to the right.
4. Past-pointing after turning to the left.

Of 100 experienced pilots three failed to satisfy the standards in all four tests; two failed to satisfy in three tests; seven failed to satisfy in two tests.

A certain number of others failed in one result only. This was always the second past-pointing test and possibly due to previous experience of error as explained above.

Of the seven who did not satisfy in two tests, these were always nystagmus results, and furthermore all were below and none above the time limits save one where the periods were thirty-seven and thirty-nine seconds respectively. It may here be noted that American standards allow anything between sixteen seconds and thirty-six seconds.

Of the two who did not satisfy in three findings—that is, both nystagmus and one past-pointing test—one had suffered during the previous year from nervous debility, and showed signs of it in the other tests performed at the examination. His vision also was defective—right eye $\frac{1}{2}$, left eye $\frac{1}{4}$ —and although no heterophoria was present, the nystagmus periods were not easy to take owing to a seeming difficulty of the eyes to fixate after rotation. He had previously done 3,500 hours in the air, and a recent report from his squadron stated that in practice his vision and flying were satisfactory. He did not wear glasses.

The other, with 800 flying hours to his credit, had normal vision and muscle balance. Four years previously he had spent six weeks in bed with diphtheria. There were apparently no complications, but he was advised by his doctor not to fly for some time. He had consequently flown only once in three years, so that his experience in the air could hardly be called recent; still on rigid standards he would have been rejected as an aviation candidate.

Of the three who failed to satisfy in all four tests, one had done 480 hours between April, 1918, and January, 1919. He had recently suffered from influenza and malaria and was only two weeks out of hospital. He still suffered from headaches. His vision and muscle balance were normal.

The second, who had 5,000 hours in the air to his credit, had just recovered from an attack of jaundice—cause unknown—at the time of examination. He had had a previous attack in 1915. His vision and muscle balance were normal.

The third had suffered from a nervous breakdown one year before, and influenza and pneumonia six months previously. He had recently done 750 hours in the air. His vision and muscle balance were normal and no nervous symptoms were present at the time of examination.

It would seem, therefore, that although definite failure in one or more of these tests is not enough, *per se*, on which to reject a candidate, still a combination of three or four failures is often accompanied by evidence of actual or recent impairment of one or other of the various systems of the body. It is noteworthy also that, in practically every case that could not be said to satisfy rigid standards, failure was due to inability to reach the minimum rather than to exceed the maximum limit, there evidently being a decided tendency towards diminished rather than increased labyrinthine reaction sensibility.

4. Relationship between these Tests and others Used by the Aviation Candidates Medical Board, Hampstead.

In order to see if there is any relationship between the results of these tests and those employed routinely by the Aviation Candidates Medical Board a series of 100 cases was taken and a comparison made. The tests selected for comparison were three in number—namely, tremor of eyelids or hands, self-balancing, and the rod and board test. It was found, however, that a pilot might have what are accepted as normal labyrinthine reactions and yet at the same time perform only moderately or badly one, two, or all three of the above-mentioned tests. Of the pilots discussed under (3), only one of the three with all four labyrinthine reactions unsatisfactory was poor in two tests—namely, self-balancing and the rod and board test; the other two performed all the tests satisfactorily. In addition, in the case of the other pilots discussed under (3), abnormal labyrinthine reactions seemed to bear no relationship at all to the successful execution or otherwise of these three tests. This is perhaps not surprising, as the turning reactions only test the integrity and tone of the cerebro-cerebellar-vestibular tracts, whereas it is well known that many factors may enter into the successful execution of the other tests cited.

5. Value of these Tests from the Point of View of the Medical Selection of Pilots.

At present, and until other and perhaps surer standards are laid down, one is inclined to view the utility of these rotation tests, at all events from the point of view of routine examination, as being problematical. It is true that they may draw attention in certain instances to particular defects which might or might not have been otherwise noted, but, on the other hand, their rigid observance might easily exclude men whose past histories and recent performances are those of perfectly successful pilots. Their value, however, and the data they give to anyone capable of interpreting such information is undoubtedly great in certain instances, as the following two cases recently seen by myself will show:

CASE I.

Lieutenant L. complained of deafness in the left ear incurred in May, 1918. The history was that whilst descending, and about 700 feet from the ground, he felt a tightness in the head and a mist before his eyes. He made a bad landing—"pancake"—was so dizzy on attempting to alight that he could not keep his feet, and had to be taken to his quarters on an ambulance and put to bed. He did not vomit, but things seemed to go round him to the right and he slept badly. During the next few days he was very shaky on his feet when attempting to walk. About two weeks later he was permitted to start flying again. He is now unable to stay long in the air and is always sick should he remain up as long as an hour. Before his accident he was a good stunter, but now either cannot or dare not stunt. On examination he was found to be totally deaf in the left ear, and his nystagmus and past-pointing indicated impairment of the left labyrinth; he was actually sick whilst being tested. The caloric test confirmed the view that his left labyrinth was not functioning, so that here was a pilot with a completely destroyed left labyrinth whose defect had unfortunately not been recognized, and who, being allowed to fly was a constant danger to himself and anyone else who happened to be his observer.

CASE II.

Lieutenant G. was, in May, 1917, in a balloon which was struck by lightning; the telephone receivers were in his ears at the time. The balloon was immediately hauled down, but he felt "overpowered by dizziness," which was accentuated when attempting to walk to his hut after reaching the ground. He also noticed that he was quite deaf in the left ear. After a week's leave he was again put on balloon duty and managed to continue for three months. During this time he always felt uncomfortable and dizzy in the air, though never troubled similarly before the accident. At the end of these three months he was, fortunately for himself, transferred to ground duties. On recent examination for assessment of gratuity,

I found him to be completely deaf in the left ear, and the rotation and caloric tests showed a functionless left labyrinth. Like Case I, this was an undiagnosed case of a destroyed labyrinth, which only careful rotation and caloric tests could demonstrate.

CONCLUSIONS.

1. Experienced pilots have, if anything, a slight tendency towards diminished labyrinthine reactions.
2. Disturbance, present or past, of some other system of the body may affect labyrinthine reactions.
3. Where deafness is present no medical examination of a candidate or pilot is complete without a careful investigation of the functions and reactions of the semicircular canals of both sides.
4. In the absence of a discovery of present or past signs or symptoms pointing to an aural affection, routine examination by means of the Bárány tests is superfluous, provided that a thorough general medical examination is made.

THE EFFECTS OF RADIUM TREATMENT ON WAR INJURIES IN THE NEIGHBOURHOOD OF NERVES.*

BY

WALTER C. STEVENSON, M.D.DUB.,

CAPTAIN R.A.M.C., HOME HOSPITALS RESERVE,
SURGEON TO DR. STEVENSON'S HOSPITAL AND TO THE INCORPORATED
ORTHOPAEDIC (CHILDREN'S) HOSPITAL OF IRELAND, DUBLIN.

THAT radium in suitable doses does not injure nerve tissue is shown by the work of Mme. Fabre and Dr. Paul Touchard on five cases of syringomyelia, all of which improved, showing increased mobility of the limbs with diminution of stiffness. One patient's hand had been quite helpless in a *main en griffe* position, but after radium treatment she was able to flex, extend, and separate her fingers. A second was able to resume his work as a draughtsman after six months' disuse of pencil and compasses. Another remarkable fact was the disappearance, in one case, of the trophic disturbances characteristic of Morvan's disease.¹

The conclusion that the powerful physical agent (the gamma rays from radium C) has some effect on injured nerve areas was forced on me, more or less by accident, in the following case:

CASE I.

Pte. S. fell off a transport wagon on March 15th, 1917, fractured the anatomical neck of his left humerus and injured his brachial plexus. When admitted to the Special Military Surgical Hospital, Blackrock, over eight months later, he had limited movement of the shoulder and little power to move his wrist; he was unable to flex his thumb and fingers, especially at the distal joints. Sensation in the hand and wrist, except over the ulnar distribution, was impaired. His first three fingers were discoloured, and there were trophic changes of the nails of the second and third fingers. On December 31st, 1917, graphs of the movements of the wrist and fingers were made with the aid of a strip of lead, as is the routine in this massage department. On January 18th, 1918, with the purpose of increasing the movement in the shoulder-joint, 100 millicuries of radium emanation screened by 2 mm. of lead in a flat applicator, kindly sent me by Dr. Lynham of the London Radium Institute, was applied for two hours in the axilla, and for two hours each on the front and back of the joint. Two days later the masseuse brought the patient to me and asked why he could flex and extend his wrist better and flex his fingers better, and why the discoloration of his fingers was less when radium was only applied to the shoulder. The graphs, which I have before me, taken on January 3rd, 1918, are conclusive evidence of an increase of voluntary movement, which cannot be explained by any change of weather or treatment, nor by suggestion, for it was not expected. The movement in the shoulder was practically unaltered except that voluntary abduction was temporarily reduced from 63 degrees to 59 degrees.

It is difficult to explain the effect of radium in the foregoing and following cases. I can only report the results of careful observations and accurate records in which I have eliminated as far as possible the many sources of error, especially suggestion. The sudden improvement in movements cannot be explained by greater personal attention to a patient, muscle re-education, the recent removal of a splint, or any change of environment or treatment that I am aware of. That radium will within six hours

* Paper read before the Section of Surgery, Royal Academy of Medicine in Ireland, November 21st, 1919.