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DISTURBANCES OF VISUAL ORIENTATION

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DISTURBANCES of visual orientation, meaning thereby an affection of the power of localizing the position in space and the distance of objects by sight alone, are among the rarer conditions due to cerebral lesions met with in civil practice. Only a relatively small number of cases in which it was a prominent symptom have been recorded, and in several of these it was complicated by serious mental degradation or by grave disturbances of speech, which made it difficult or impossible to analyse or investigate its exact nature minutely. Since in many of these cases, too, it was associated with diffuse or multiple cerebral lesions, severe arterio-sclerosis, or with senilé atrophy of the brain, it was scarcely possible to determine the exact site of the lesions on which it might depend.

In the six cases recorded here this condition was due to perforating gunshot injuries of the head which, as a rule, produce relatively local and circumscribed lesions; and, as all the patients were young men, extensive vascular, nutritional, and other diffuse pathological disturbances of the brain can be excluded. Further, the general mental state of all the patients except one was excellent, and in one other only was speech so seriously affected as to interfere in any way with examination. The symptoms were very much alike in all, although more pronounced and persistent in some cases than in others, but, unfortunately, their earlier stages only could be

observed except in one instance; since in this man they were practically identical, eight months after his wound was inflicted, with those of the other patients, it is evident that the condition can be more or less permanent, and may not alter materially with time. As the patients were examined under different circumstances—two, for instance, were seen on one occasion only, while others remained under constant observation—the completeness of the clinical description varies.

Case 1 has been already published in conjunction with Captain S. Smith, but is recorded here more fully, since later observations emphasized the importance and significance of symptoms which were not then recognized.

I am glad of this opportunity of expressing my thanks to the colleagues and medical officers with whom I saw these patients.

CASE 1.—Pte. M., aged 27, was admitted to a Base Hospital on November 2, 1915, with the history of having been wounded in the head by a shrapnel bullet some days previously. On admission he was in a dull and confused state; he was unable to remember his number or regiment, how he was wounded, and what happened to him during the several days that elapsed between the infliction of the wound and his arrival at the base. There was no paralysis, and the range and the power of the movements of all his limbs were normal; there was no obvious ataxia. The right knee jerk was, however, brisker than the left, and the plantar response on this side was extensor. Tactile and painful stimuli were appreciated naturally and localized correctly everywhere, and there was apparently no loss in his sense of position; Weber's compass points could be also discriminated at the same distance apart on his two hands. There was no optic neuritis.

The *wound of entry* was a small puncture 23 cm. behind the nasion (nasion to inion-34 cm.) and 7 cm. to the right of the middle line; there was no exit wound, but a round shrapnel bullet could be felt under the scalp 4 cm. above and 4 cm. behind the upper margin of the attachment of the left pinna. An X-ray examination revealed a small gap in the skull under the wound of entry, and several fragments of bone deep in the brain along a track leading from it. The bullet had broken through the skull in the left temporal region, and was removed, together with fragments of bone, by Lt.-Col. Sargent a few days later. It was a spherical lead ball, 12 mm. in diameter. It was dropped into sterile broth, but produced no growth. A clean circular opening, only slightly larger than the missile, was found in the squamous bone. The entrance wound was not touched till several weeks later, when a few fragments of bone, which had probably been extruded from the brain, were removed from dense fibrous tissue at the bottom of a shallow sinus.

His condition improved rapidly, no weakness or paralysis developed, the reflexes became normal, and all forms of sensation remained unaffected. His hearing was also normal, but there was a complicated disturbance of vision which will be described in detail. He rapidly regained almost the entire use of his intellectual faculties; he was an intelligent man, had been educated at a first-class school and trained as an engineer; before enlistment he was employed as a technical draughtsman. His memory for the past was evidently fair, but there was a blank, which gradually diminished, for events that occurred during a considerable period before the infliction of the wound. His general attention was always fair, though at first he tended to tire easily. At no time, however, during the three months he was under observation could his behaviour and conduct be described as normal; it rather resembled that of an intelligent child, and he was in fact always treated by his fellow patients and by the nurses as an interesting child would be. He was always too facile, laughed unnecessarily and often inappropriately, and on one occasion when a patient in a bed near him died, he burst into tears and asked to be moved into another ward. He was always extremely good tempered and never moodish.

There was some disturbance of speech when he was first admitted, but it became gradually less. In the first place he stuttered, but, according to his own statement, he

stammered in childhood, and, apart from this, he had no obvious difficulty in uttering words. He could understand speech and even complicated orders fully, or failed to do so only when his power of retaining the whole sentence was at fault. He had, however, some difficulty in recalling words, especially names, but even then succeeded in expressing himself fully by the substitution of a word or an explanatory phrase. He never used wrong words.

He was from the first able to read and comprehend short sentences, but had great difficulty in following consecutive words and lines owing to his visual trouble. He was quite unable to write even single letters, and on attempting, only made an unintelligible scrawl—most often a rough circle—but as he was equally incapable of drawing a line or any simple object, although he was a draughtsman by profession, this inability was obviously due to apraxia of his arms rather than to a specific agraphia. Between two and three months after the infliction of the wound, when most of the following observations were recorded, his speech defect was almost negligible. During the whole time he was under observation he presented signs of bilateral ideomotor apraxia, that is, he was unable to perform certain even simple purposive actions and to use objects and instruments which were quite familiar to him and which he recognized correctly, despite the fact that there was no weakness, ataxia, or sensory disturbance in any of his limbs.

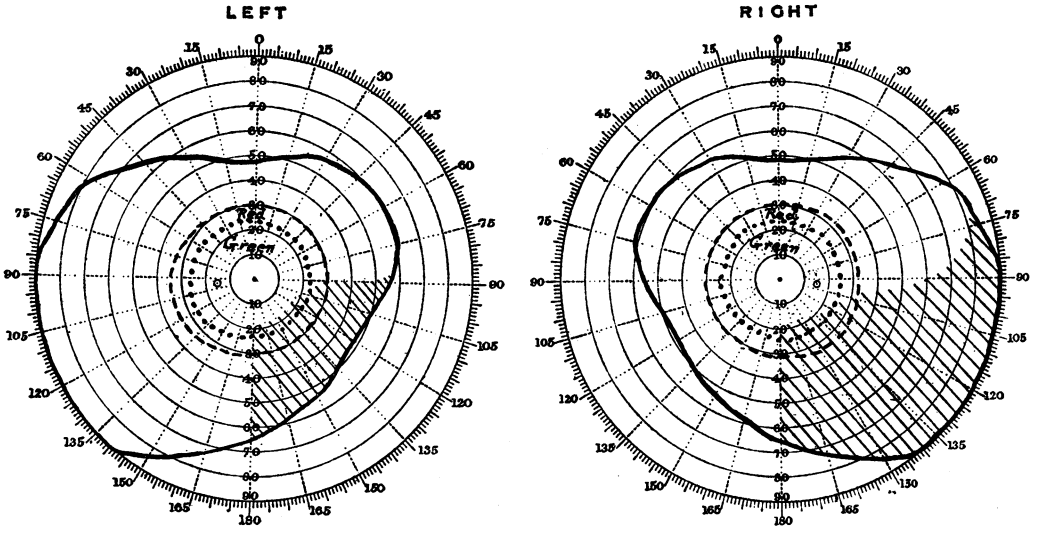

FIG. 1.

When the patient was first seen a disturbance of vision was noticed, but its nature could not be properly investigated till his general condition had improved. The most striking features were his inability to seize or touch directly any object presented to him, and even to extend his hand in the proper direction towards it, though he could perceive and recognize it; and his difficulty in fixing with his eyes anything held in front of him. When asked to look at the observer's face, for instance, he generally stared open-eyed in a wrong direction and then moved his eyes about in an irregular manner, most commonly towards the ceiling, saying, "Sometimes I can see it quite well, but often I cannot see what I want to look at." On the whole, he seemed to see better the less effort he made.

Three months after the infliction of the wound these troubles were less pronounced. His optic discs were normal; his central vision was 6/6 in each eye, and he could recognize movements of fingers in all parts of each half of his visual fields. Perimetric examination was not easy owing to his difficulty in keeping his eye directed on the fixation point; but repeated observations proved that he could recognize a white object, 10 mm. square, to the normal peripheral limits in both eyes. There was, however, some amblyopia in both lower right quadrants, which reached to within 20 degrees of the fixation point (Fig. 1). When the test object was in this amblyopic area he

frequently said, "There is something moving, but it is not plain, and I don't know where it actually is." No defect in visual acuity was discovered in the left halves of the visual fields, and the fields for red and green were normal in extent to both sides of the fixation point.

Although there was no ocular palsy, for several weeks after his injury he was frequently unable to move his eyes to order in any direction, though he understood fully what was required of him, and even after three months he often made mistakes or succeeded only after several attempts. When on one occasion he was asked to look upwards toward the ceiling, he pointed correctly to it with his hand, but moved his eyes first to the right, then to the left, and finally downwards. His eyes were, however, always turned accurately towards an unexpected noise made to one side of him, and he generally succeeded in obeying the military command of "Eyes right," or "Eyes left" when either was suddenly given to him.

He was also unable to follow accurately with his eyes a finger or other object moved in any direction; the eyes generally remained for a moment directed towards the position in which he originally fixed it, and either failed to follow it, or they were later suddenly jerked towards the direction in which it moved. Similarly, he failed to keep his eyes fixed on a spot, as on the observer's eyes, when his head was passively rotated to either side.

There was also a considerable tendency for his eyes to deviate quickly from even a stationary object which he had succeeded in fixing. This difficulty in fixing and in bringing into central vision objects within his range of vision diminished, but as long as he was under observation he frequently failed to look directly at the observer's eyes, or at anything else when asked to do so. Even when there could be no doubt that he knew the position of the object in space at which he should look, as his own hand, he often failed to bring his eyes directly to it.

Further, there was frequently no reflex blinking, withdrawal of the head, or any general reaction when a hand or other object was suddenly swung towards his eyes, either from in front or from either side, or to any other threatening action on the part of the observer. If an object was moved slowly towards his eyes these rarely converged upon it, and the pupils did not contract, though they reacted well to light. When a light was suddenly turned on to one side he did not, as a rule, turn his eyes to it with the accuracy and promptitude of a normal person.

He presented no trace of visual agnosia—that is, inability to recognize and distinguish by their visible characters objects he could see. From the first, too, he recognized ordinary symbols, as the plus, subtraction, and the multiplication signs, an arrow pointing direction, etc. He was also able to recognize letters, and to read.

His visual memory was not seriously affected; he could from memory describe the form of familiar objects—as a pipe, give a minute description of his father, and tell how he would reach his bedroom at home. He was evidently a strong visualist, and spoke of having "a good picture" of incidents which occurred while he was in the trenches, as of a German attack by fire. His colour memory was apparently also intact; he could remember the colours of the football shirts worn by a local team, and describe the sky as "blue, as a rule, with clouds of a different colour, and it is often red at sunset, especially in stormy weather."

On the other hand, his visual retentiveness was very defective; when he was shown in succession four objects which he could recognize and name, he was, as a rule, unable to name them again, or describe them in correct order after an interval of thirty seconds; and after the same period he could not recollect the number or arrangement of four or five dots which he had seen on a piece of paper. He was also unable to sketch any simple object which was shown to him, though this was to be expected owing to the apraxia of his right arm; he explained it himself by the statement, "I cannot remember long enough what it is like in order to draw it." He was much more retentive to auditory impressions, such as words or sentences repeated to him.

Throughout the whole time he was in hospital his most striking symptom was his inability to take hold of or touch any object with accuracy, even when it was placed in the line of vision. When a pencil was held up in front of him he would often project his arm in a totally wrong direction, as though by chance rather than by deliberate decision, or more frequently he would bring his hand to one or other side of it, above or below it, or he would attempt to seize the pencil before he had reached it, or after his hand had passed it. When he failed to touch the object at once he continued groping for it until his hand or arm came into contact with it, in a manner more or less like a man searching for a small object in the dark.

Several records were taken by asking him to bring his finger to a black dot on a sheet of paper held in various planes of space in front of him, and it was found that the errors were equally great in all directions. This defect cannot be attributed to ataxia of his limbs—that is, to disharmony in the range and time of the components of the movement, as there was no evidence of this when he handled or attempted to use objects; nor can it be wholly due to apraxia, as his errors in direction had none of the characters of the movements of an apraxic limb. Further, there was no demonstrable loss in the sense of position or of movement to which "sensory ataxia" could be due. Despite the inaccuracy of his movements, he could, however, always succeed in reaching any object which was at the moment in central vision. On one occasion, when he was not aware he was under observation, he wished to get a box of matches from his locker in order to light a cigarette; he sat up in bed, turned his head and eyes towards the locker, stared vacantly at one spot for a moment, then slowly and deliberately moved his eyes into other directions, until, after several seconds, the match-box, as if by chance, came into his central vision; then he put his hand out to take hold of it, but succeeded in reaching it only after repeated gropings.

This difficulty in localizing correctly in space objects that were accurately seen was greater when the object lay outside his present line of vision; then he always failed to seize it directly, and generally made gross errors in pointing to its direction. When, for instance, the observer's arms were outstretched from his sides, and the patient was asked to point to the moving fingers of one or other hand, he usually only brought his own hand to the observer's face or shoulder. In fact, he stated not infrequently that though he could see the object he was not sure where it was. This was clearly demonstrated during examination with the perimeter; then he frequently said he was aware only that "something white was moving somewhere" as the test object was brought towards the fixation point, and frequently made gross errors when he attempted to point to or describe its position; on one occasion, for instance, he described it in the left lower quadrant when the object was in the right upper quadrant.

He frequently failed to recognize moving objects by extra-central vision in portions of the visual fields in which he was certainly not blind, especially when two were presented simultaneously to him, one to each side of the fixation point, as the observer's fingers for instance. The proportion of such stimuli which he missed was variable, and increased as he tired or when his attention flagged.

Another prominent symptom was his inability to determine, or at least recognize correctly, the relative positions of objects within his field of vision. He was much confused as to which side was right and which left, and even after daily testing he remained uncertain which was his right, and which his left hand. This difficulty in describing the lateral position of one object in relation to another was overcome by making him state which was the nearer to a man who lay for weeks beside him, with whom he had become very friendly, and by asking him whether two objects which he had seen were in the same relative positions as two similar objects which were immediately uncovered. It was found that to these tests his replies were frequently incorrect when the objects were not widely separated. This held whether the test objects were side by side, one above the other, or one nearer to him. (These tests were carried out by silver and copper coins of the same size, and by squares of green and white paper.) The most remarkable errors were made when he was asked to say which of the two objects was the nearer to him; even when they were separated by 10 to 15 cm., at a distance of half a metre from his eyes he made many mistakes; the explanation he offered spontaneously was: "I can only look at one at the time." When he was asked to explain why he could not say which of the two objects was the nearer to him he, on one occasion, replied: "When I look at one it seems to go further away, when I try to see which is the nearer they seem to change in position every now and then; that one at which I look directly seems to move away." When his finger was moved from one to the other, he could, however, recognize their relative positions at once.

Similarly, he often failed to distinguish the difference in the length of two lines, even when it was considerable, and frequently called the longer the shorter, or vice versâ, though their lengths were in the proportion of two to three. This was especially so when they were not drawn parallel and close to one another, so that their retinal images could be successively superimposed. He was also unable to judge with certainty the relative sizes of similar objects, as circles, squares, and coins, which were placed in front of him. But though he could not estimate the relative length of two lines he could always recognize accurately and without delay whether a rectangular quadrilateral figure was

a square or not. This was apparently due to the fact that he perceived the figure as a whole and recognized its shape at once, as he could a drawing or an illustration. He was at first unable to indicate the length of a yard, a foot, or an inch, and never became able to do so with approximate accuracy.

His stereoscopic vision was unaffected, at least he always appreciated the depth and thickness of objects, and did not see them merely as flat bidimensional forms. He even recognized at once the well-known visual illusion of the truncated pyramid, saying "That's a box; it changes according as your eyes catch it, sometimes I can see it open, sometimes the other way."

He made very poor attempts at exploring with his eyes any large surface presented to him; when he was shown the page of a journal on which there were a few widely separated illustrations he often noticed that one only on which his eyes first fell, and rarely succeeded in discovering them all. Similarly, when he was asked to count or to point to four or five coins placed irregularly and at some distance apart on a board in front of him, he was generally satisfied with indicating one or two. Those which lay beyond his central vision obviously did not attract his attention; but it was also remarkable that he rarely attempted spontaneously to run his eyes over the whole surface to make sure that those only were present which he had seen at the first glance. On the other hand, he generally brought his eyes to them immediately when the remaining illustrations or coins were tapped by a pencil.

The failure to perceive the several objects in front of him was obviously not due to the right-sided hemi-amblyopia, as he missed as frequently the objects to the left as to the right of the point on which his eyes were directed. It seemed, in fact, that his attention to visual impressions tended to be arrested or occupied exclusively by any object that was at the moment in central vision. When he was asked to count coins or other objects arranged in close series in front of him he usually commenced at any part of the series to count to right or left, but soon became confused, and began to enumerate again those which he had already included in his count; he could, however, count them accurately if he was allowed to take each in succession in his hand. Similarly, though he often failed to count by vision alone fingers held at some distance apart in front of him, he succeeded at once when he moved his hand over them. The failure in these simple tasks when he relied on vision only was evidently due to defective localization in space of the individual objects which he attempted to enumerate, and to defective recognition of their spatial relations to each other.

These disturbances explain partly his difficulty in reading; at first he picked out only a few individual words from a page, and he had always difficulty in following the lines in the normal manner. Later, he became able to read a letter or sentences from a daily paper, but only slowly and with difficulty, due, he explained, to the fact that "I start to read a column, but soon skip some lines, or I may get on to another column; I lose the place." But here his inability to fix correctly and bring the letters and words immediately into central vision was a contributing factor to his difficulty. The succeeding words from left to right in a line, however, often excited the appropriate and customary movements of his eyes on to them; at one time when he was unable to fix one of a row of letters which was separately exposed to him, explaining, "I'm not looking at it now; I have lost it," he immediately afterwards read correctly and with scarcely any hesitation, the following phrase which contained words unfamiliar to him, "Histological and Experimental Observations on the Destruction of Tumour Cells in the Blood Vessels."

Although his lower limbs were apraxic in imitating movements, in attempting movements to order, and especially in more complex actions such as putting on his trousers, he was eventually able to walk easily, but proceeded only in short, shuffling steps, as though not confident of himself. His gait was not ataxic. If left alone, he quickly deviated from the direction in which he wished to go, and ran into objects even though he was aware they were present. When, for instance, he was asked to walk between two rows of beds, he frequently turned to the right or to the left and stumbled up against one; it is noteworthy that he more commonly deviated to the left, though the left halves of his visual fields were certainly unrestricted. Even when urged to keep his eyes to the ground and avoid obstacles, he often did not succeed; he repeatedly ran with considerable force against a wall or into a large red screen which stood in the ward. When he was brought into a large room in which a few chairs had been placed and ordered to walk to any part of it, he almost invariably walked into a chair and then pulled up suddenly as if surprised at its presence, even though he had seen it and pointed to it before he started. After hesitating for a moment, as though

uncertain how to get round it, he usually shuffled towards one side with side-steps, very much as a crab does when it meets a stone, frequently retraced his steps when almost around it, and after he had evaded it often set out in a wrong direction towards his goal. He explained his difficulty by saying, "I don't look where I am going and I can't always go where I want to." When his movements were carefully observed, it was obvious that it was chiefly due to the fact that visual impressions of the obstacles did not readily excite his attention, and that he could not recognize correctly their spatial relation to himself, and especially their distance from him. When, for instance, he walked up against a screen or wall he was evidently surprised, and once, in fact, explained that though he could see it he did not realize he was so near it.

His difficulty in extricating himself and in finding his way round an obstacle in his path was extraordinary; in this respect he was, though he possessed good vision, much inferior to a blind person or a blindfolded man. An equally striking phenomenon was his inability, or at least his great difficulty, in finding his way about. When he was taken some distance from his bed he was unable to make his way to it again, even though he could see it and point correctly to it. On one occasion he was brought about five yards from his bed, to reach which he had only to take a single right-angle turn, but though he indicated it correctly and recognized the patient in the adjoining bed, he commenced to walk in a wrong direction when told to go to it. This happened even after the correct route had been pointed out to him. On another occasion, when taken into the next ward, he failed to return through the open door when asked to do so. Even after several tests, and after he had been led along the correct route to his bed he often failed to find it again; in this respect, too, his symptoms contrasted strongly with the condition of a blind person, who can learn by experience the spatial relations of his surroundings and the topography of his room. He could localize sounds fairly accurately, and when his eyes were closed walk in a correct direct direction towards them.

The extent and position of the anatomical lesion in this case can only be approximately determined by craniometric measurements. If it be assumed that the shrapnel ball took a direct course between its entrance and its exit, the brain was entered in the posterior and upper part of the right supramarginal gyrus, and the track probably passed through the dorsal part of this hemisphere, perforated the falx dorsal to and n front of the posterior margin of the splenium of the corpus callosum, entered the left hemisphere in this position, passed just dorsal to Wernicke's field in front of the knee of the optic radiations, and made its exit in the inferior part of the left supramarginal gyrus in front of the posterior end of the Sylvian fissure.

Experience has shown that the area of destruction and secondary change produced by such a missile is generally of considerable extent. The track would probably admit a finger.

The symptoms of visual disturbance presented by this patient can be summarized now, but as they resemble closely those found in the succeeding cases, a discussion of their nature and significance can be best delayed till the final part of this article.

Central vision was intact, and apart from some amblyopia in the lower right quadrants, the fields of vision were uncontracted; but owing to a disturbance of visual attention he frequently failed to perceive objects moving within his range of vision.

His remaining symptoms may be grouped into two classes, though those placed in each class are certainly not unrelated to one another. In the first group come the disturbances of the ocular movements, the difficulty in fixing objects and in maintaining fixation on moving objects, the imperfect or incorrect movement of the eyes to order, and the absence of accurate convergence and accommodation, and of the visual blinking reflex. The second group includes the disturbances in visual localization and orientation in space; he was unable to touch or otherwise indicate correctly the positions of objects he

saw distinctly, whether they were in central or extracentral vision. He made errors in all directions though they were most prominent in the estimation of the distance of the object from him; he was also unable to recognize immediately and correctly the relative positions of two objects in space, and to determine the relative length of two lines or the relative sizes of two objects.

As a result of all these disturbances he had much difficulty in exploring surfaces with his eyes and picking out objects on them, in counting similar objects whether they were placed in series or scattered irregularly in his field of vision, and in reading. His difficulty in reading was partly due to imperfect fixation, and partly to failure to appreciate the relative positions of the words on the page in front of him. In walking, he ran into obstacles as their retinal images did not readily excite his attention and especially since he failed to appreciate their relation in space to himself, and particularly their distance from him. He had also difficulty in finding his way about, though he could see the path he should follow, and in learning the topography of the room in which he was.

CASE II.—Sergt. K., aged 33 years, who was seen with Captain Wagstaffe, was an intelligent and fairly educated man; he had been a cloth designer. He was wounded, probably by a rifle bullet, in July, 1917, and was unconscious, or, at least, dull and confused, for two or three days. The entrance wound was not at first recognized, but the wound of exit had been excised and fragments of bone removed from it in a casualty clearing station. He had at first a slight affection of speech, which consisted chiefly in an inability to recall names, and slight numbness of his right hand, but both these symptoms diminished quickly. He had no paralysis or difficulty in using his limbs. From the time he regained consciousness he found his sight much affected.

The *entrance wound* was a small puncture situated 7 cm. above the inion and 5 cm. to the right of the middle line; while the *exit*, which was represented by a healed scar, was 10 cm. vertically above the tip of the left mastoid.

He was first seen in a Base Hospital four weeks after the infliction of the wound, and remained under observation till he died suddenly from other causes about three weeks later. During this time there were no paresis, ataxia, or other disturbance in the movements of his limbs, and all his reflexes were normal. There were, however, slight sensory disturbance of the cortical type in his right hand. The functions of all his cranial nerves were unaffected, apart from slight deafness of the left ear, due to old middle ear disease.

At this period he spoke fairly well, though he hesitated occasionally to find the proper word, and sometimes did not comprehend fully a long and complex sentence unless it was repeated to him. Reading was much affected by the disturbances of vision to be described, and he could not write even his own name, owing, he explained, to the fact that he "had to stop to think out the individual letters": but even when the letters were pronounced to him he could rarely write them. He had also much difficulty in spelling even simple words which he used spontaneously and could repeat.

He described his vision as "misty," and recognized that he could not be certain of the position in space of objects which he could see. Owing to his inability to fix the test-type accurately it was difficult to estimate the acuity of central vision, but he repeatedly read some of the letters on the 6/12 line at the usual distance, and could pick out words in Jaeger I. His visual fields were taken on three separate occasions with the perimeter; there was complete bilateral inferior hemianopia, with some peripheral contraction in the upper right quadrants (Fig. 2); the borders of this blind portion were indefinite, but the fields for colour were unaltered above the horizontal line through the fixation point. He frequently failed to recognize the presence of moving objects, such as the observer's fingers, in the right halves of his seeing field, especially when objects were presented simultaneously to him to the right and left of his fixation point, though vision

n this region was fairly good. After repeated testing it was obvious that this was due to defective visual attention in the right half of his field.

All his ocular movements were unaffected, except convergence and accommodation: when any object was brought close to his eyes from a distance of one metre or more the eyes did not converge nor the pupils contract. If, however, he was asked to keep his eyes fixed on his own finger, or on an object in his own hand as he approached it

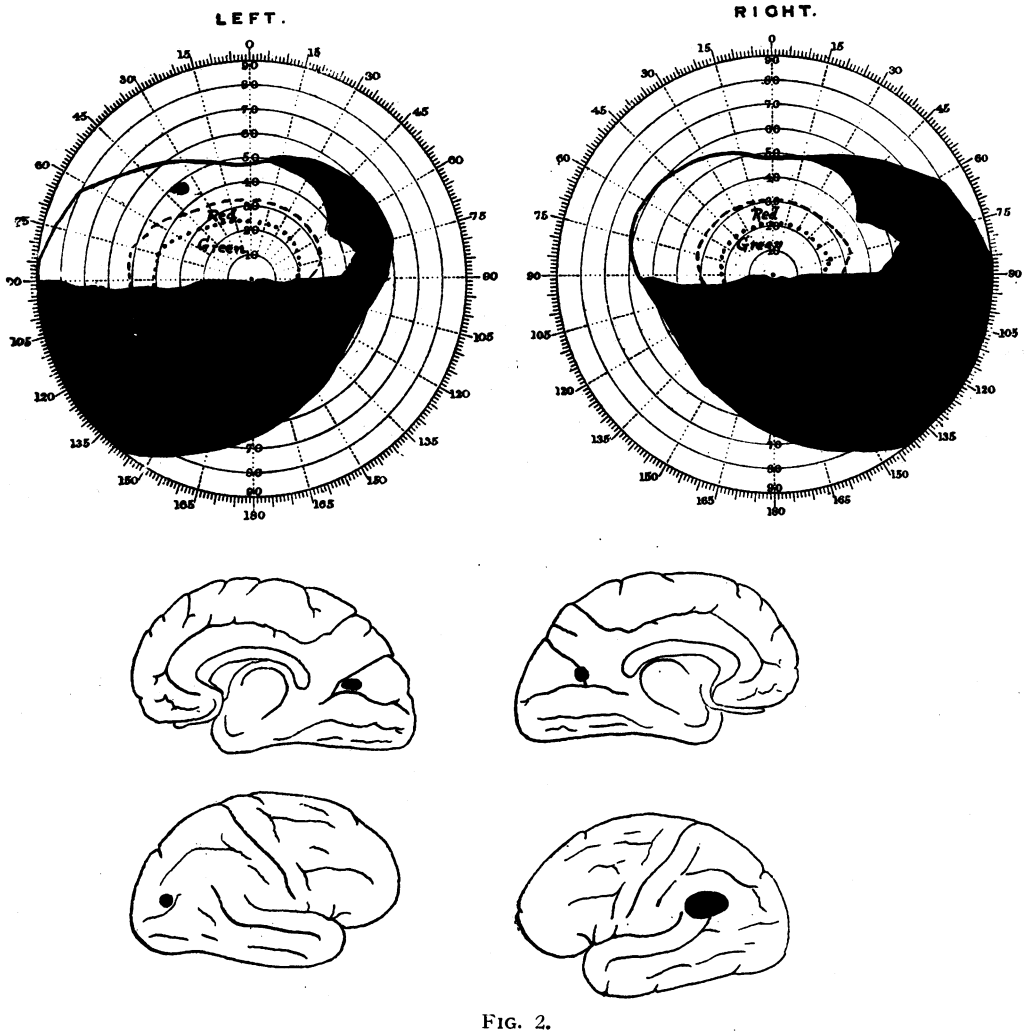

FIG. 2.

L. and R. 6/12 and J. 1.

to his eyes, convergence and contraction of the pupils occurred, but not constantly. Further, he never blinked, withdrew his head, or re-acted in any way when a hand was suddenly swung towards his face, or to any other threatening action; he always blinked, however, when his own hand was passively jerked towards his eyes. Though he could move his eyes normally in every direction he had considerable difficulty in fixing objects and in bringing objects which he saw into central vision; he rarely succeeded at once in looking anyone who spoke to him directly in the face; at first he stared

open-eyed, and then searched slowly and awkwardly for the point he wished to find. He could not, as a rule, bring his eyes directly to a spot on his own body which was touched.

He showed no trace of agnosia, or inability to recognize objects familiar to him by vision, and his visual memory was not seriously affected.

But the most striking symptom in this case, too, was the patient's inability to localize correctly in space objects which he could see and recognize perfectly well. When, for instance, he was asked to touch a piece of paper attached to the end of a metal rod, he rarely reached it directly, but brought his hand to one or other side of it, or above it or below, and continued to grope till his hand came in contact with it. But the greatest errors were in the estimation of its distance; he generally projected his hand beyond the object if it were within the range of his arm; when on one occasion his accommodation was being tested and the object was within a few centimetres of his nose, he searched for it at full arm's length, though he brought his hand to it immediately if it was allowed to touch his nose. When, however, the object was beyond his reach he often attempted to seize it with his outstretched arm, and seemed confused and perplexed at his failure. Similarly, he was unable to bring his finger directly to a word he had read or an illustration he had seen in a magazine. In judging the position in space of any object which he saw, he made errors in all directions, but they were greatest in the estimation of its distance. They occurred, too, regardless of the portion of the visual field in which the object lay, but were considerably greater when he saw it by extracentral than by macular vision.

As he ate his dinner with a knife and fork it was seen that, though he could bring the food accurately to his mouth, he had considerable difficulty in seizing it with his fork, and he often brought both knife and fork too heavily on to his plate, as though he believed this were further from him than it actually was. On one occasion, when an opaque screen was placed between his hand and the object he wished to touch, he brought his hand forcibly against it as though it were not there; similarly, when a large plate of glass was placed in front of him, and he was asked to touch a silver coin which was sometimes held in front of it, sometimes behind it, he generally brought his hand into the glass as though it were not there, and after he had learned by experience that he must avoid it, he occasionally brought his hand round it, though the object was the nearer to him. It was also remarkable that when he attempted to touch or seize any object he frequently brought his hand into his line of vision, and yet continued to move it forwards as though he could still see the object.

When two objects of the same size were placed on a table in front of him he occasionally made mistakes in describing their relative positions; this was particularly so when one was nearer to him than the other, and when they were not separated by a great distance. He was also unable to count accurately four to six coins placed in front of him; some did not attract his attention even though they lay in the seeing portion of his visual fields, and as he could not acquire an accurate idea of their spatial relations he was liable to return his eyes to, and count again, coins which he had already included. He even failed to count correctly the pips on playing cards which were given to him. He made no systematic efforts to explore fully with his eyes the whole surface on which the coins or other objects lay.

He rarely made even approximately correct attempts at dividing a line or at finding the centre of a circle, and he was usually satisfied with the gross errors which he made. On one occasion, when he was given a piece of bread and a knife, and asked to divide the bread equally between two men, he cut it into two pieces, one of which was about six times as large as the other, and was apparently satisfied until it was pointed out to him that the division was unfair.

During examination he never gave any indication that he did not see individual objects stereoscopically and in proper perspective, and when questioned he stated that he always perceived them in their proper form. He was also tested by a hand stereoscope, with which he stated that he could formerly recognize stereoscopic pictures in perspective. Several stereoscopic photographs and drawings, which when seen by the unaided eyes appeared flat, but by stereoscopic vision assumed unexpected forms, were shown to him in it, and in every instance he described them correctly as tridimensional objects. When, however, the stereoscope showed separate objects at different distances from his eyes, as two statuettes on a table, he could not recognize with constancy and certainty which was the nearer.

During the time he was under observation he had much difficulty in reading. This difficulty was investigated by handing him Jaeger's types; when he was asked to read

the largest type, J.15, he at first said he could not distinguish any words, but almost immediately read the word "circumstances" in J.14; later, he succeeded in reading a few isolated words, but very slowly and uncertainly, and he could not follow the words or the lines in proper order. And yet immediately afterwards he picked out certain words of the smallest type, J.1. If, however, only individual words of any size were presented to him through a slit in a sheet of paper, he always read them promptly and without any hesitation, or the apparent confusion which he showed when a whole paragraph was visible to him. His difficulty in this case seemed to be due to inability to keep both his attention and his vision fixed on the individual words, and to follow the letter and words in their proper sequence.

About six weeks after the infliction of his injury he could walk securely, but in moving about he ran into and collided with such objects as beds and other patients standing in the wards, as though these were not there. This occurred even when there could be no doubt that their images fell in the seeing portions of his retinae; in fact, in moving about he showed none of that hesitation or tendency to groping his way with the hands which occurs in a blind person. He was also unable to find his way back to his bed if there was any obstacle in the path. When he was asked to grasp a piece of paper suspended by a thread a few yards away from him he walked towards it and attempted to seize it when it was still far beyond his reach, and continued searching for it with his hand until it had actually touched his face; then he grasped it at once.

A post-mortem examination was obtained a few hours after death. On examination of the brain, the entrance wound was found in the middle of the lateral surface of the right occipital lobe, some distance behind the level of the parieto-occipital notch. From here the missile passed through the dorsal parts of the optic radiations and emerged on the mesial surface of the hemisphere in the angle between the calcarine and the parieto-occipital fissures. The track of the missile was small, and it had produced relatively little softening around it. The missile then entered the mesial surface of the left hemisphere in the parieto-occipital fissure, the destruction it produced reaching to 0·5 cm. of the calcarine fissure, passed through the dorsal portion of the optic radiations, and made its exit in the anterior portion of the gyrus angularis. On this side there was a considerable area of destruction, especially under the operation wound. A microscopical examination of the brain has not yet been possible.

In this case an intelligent and well educated man, without any signs of paralysis and only a very slight affection of speech, presented symptoms very similar to those observed in Case I. His visual acuity was at least 6/12 and J.1 in each eye, but he had a complete inferior horizontal hemianopia, and objects in the right upper quadrants of his visual fields did not excite attention readily or in a normal manner.

He moved his eyes accurately in all directions to order, but he generally failed to accommodate on an external object that was slowly approached to his eyes, and his pupils did not then contract. The blinking reflex was abolished. He had much difficulty in bringing objects into central vision and in fixing them accurately, and his eyes could not be directed immediately to any part of his own body. He was unable to localize in space objects which were in either central or extracentral vision, and to determine the relative positions of two objects which he saw; he made errors in all directions, but they were most pronounced in the estimation of distance. He had also difficulty in recognizing the relative lengths of lines and the sizes of objects when the difference was relatively small, in counting objects of similar size and appearance which were visible to him, and in reading. His stereoscopic vision was unaffected. When he walked in the ward he ran into large

obstacles, and had a difficulty in finding his way about, which could not be attributed wholly to the blindness of the inferior quadrants of his visual fields.

CASE III.—Private C. was wounded in October, 1916, by a fragment of shell-casing. He was unconscious for a day, and was admitted to the Base Hospital, where he was seen with Captain Burrows four days later. He remained under observation for more than two months, but a satisfactory investigation of his condition was difficult as he had almost complete motor aphasia as well as a slight right-sided hemiplegia and a partial bilateral ideomotor apraxia.

The *entrance wound* was 8 cm. vertically above the tip of his right mastoid process; several fragments of depressed bone were removed, and some softened brain tissue and blood clots were evacuated from it by operation. Radiographic examinations revealed a large piece of metal near the surface of his left hemisphere, about 2 cm. behind the lower end of the Rolandic fissure; its removal had been attempted, but the trephine opening had been made too far forwards, approximately over Broca's convolution. It was probably to this operation that his aphasia was due.

His condition was repeatedly investigated from 18 days after the infliction of the wound. He was then bright and intelligent, and remained so, though for some weeks he suffered with occasional attacks of severe headache. He was at first unable to utter a single word, and he could use but very few up to the time he was transferred to England. He expressed himself and made his wants known readily by gestures, and understood simple sentences and orders. Owing to his visual disturbances his ability to read could not be tested properly, but when shown a paper in which the words "bomb," "Russia," "German," etc., appeared, he showed by gestures that he recognized them. The weakness and apraxia of his right arm made writing impossible.

The strength of the left limbs was unaffected, but the right sides of the tongue and face were weak and the movements of the right arm, though unrestricted in range, were feebler than those of the left; this feebleness seemed to be largely due to the considerable disturbance of sensation of the cortical type that was present in this limb. The right tendon-jerks were brisker than the left, but the abdominal and plantar reflexes were equal and normal.

He presented all the symptoms of bilateral ideomotor apraxia, similar, though less severe in degree, to those of Case I. It was most pronounced in the employment of simple instruments and tools, the use and nature of which he recognized, and in showing how tools which he had not in his hand should be employed.

It was impossible to determine accurately the acuity of his central vision, but he could certainly see and distinguish objects 15 or 20 yards distant from him. He had at first a left-sided hemianopia, but eight weeks after being wounded he could recognize a small piece of white paper to the normal peripheral limits, and in all parts of his visual fields; even earlier than this he had apparently perception of moving objects to the left of the fixation point, but it was difficult to direct his attention to them by vision. His optic discs were normal.

No evidence of any ocular palsy could be detected, but a very striking feature during the whole period he was under observation was his difficulty in looking directly at, or fixing immediately, any object to which his attention was drawn; when suddenly spoken to, for instance, he rarely succeeded in bringing his eyes at once to my face, but stared for a moment in one direction, and then rolled his eyes round till they fell, as if by chance, on me. He also failed to follow accurately any object at which he was looking when it was moved, and to converge correctly on to it when it was approached close to his eyes. Further, when a hand was suddenly jerked towards his eyes he never blinked or responded to it by the usual reactions.

He repeatedly showed by gestures that he could recognize the nature and use of all objects that he could perceive. It was impossible, owing to his speech defect, to determine the state of the visual memory and visual retentiveness.

He suffered with an extremely gross disturbance of localization in space by vision, but this diminished after some weeks. When asked to touch or grasp my hand or a pencil held in front of his eyes, he groped wildly for it, and, as a rule, brought his hand beyond it when it was within his reach, but he made errors in every direction in the judgment of its position. If his hand, however, came in contact with my arm, he moved his fingers promptly along this until they reached my hand or the object it held. In all these attempts he used the left hand in preference to the right, but the errors

were equally great with both. That these symptoms cannot be attributed to disturbances in the movements of his arms was shewn by the fact that he could always bring his finger accurately and promptly to any point on his own body that was touched. He was extremely slow and awkward in taking food with a spoon; often striking it too heavily on the plate, or searching portions of this on which there was no food, but he always brought the spoon quickly and correctly to his mouth.

When he attempted to touch any object he generally stared at it with widely open eyes, then brought his hand slowly forward from the neighbourhood of his mouth or chest, and continued groping and searching for it with his fingers till he reached it, or even after he had passed it; he has even hit my face with his hand when attempting to seize a pencil I held a considerable distance to one side of it. Sometimes he leaned forward in bed and searched for the object at full arm's length when it was quite close to his eyes, but often underestimated its distance, too, and tried to seize it before his hand had reached it. His errors were always much greater when the object he wished to touch lay outside central vision, but when vision to the left of the fixation point had recovered, it was observed that he could localize the position of objects in space better to this side, which had been blind, than to his right.

Similarly when requested to pick up coins placed on a board in front of him, he searched for them with his hand, employing touch rather than vision, though he could obviously see them, and he generally failed to bring his fingers down to any one directly. Several observations made it probable that he frequently did not recognize accurately the relative positions of two similar objects in space, especially when they were at different distances from him and not widely separated; but here, too, his aphasia made definite conclusions impossible. When asked to count a row of coins he became hopelessly confused, went from one to the other and back again and often passed over some of the series; but he succeeded in enumerating them correctly when he was allowed to run his left fingers over them.

The power of localizing sounds in space was repeatedly tested, and seemed to be equal to that of normal persons.

Owing to his inability to express himself intelligibly by speech, it was impossible to ascertain with certainty if stereoscopic vision was intact, but while he was under observation he presented no evidence that it was affected.

In this patient the co-existence of motor aphasia made it impossible to investigate the condition as easily and as fully as in the other cases, and the presence of apraxia and a left-sided homonymous hemianopia increased the difficulty in examining his visual disturbances. The hemianopia disappeared, however, while he was under observation. The acuity of central vision was apparently good.

Although there was no ocular palsy, he was unable to bring objects into central vision or fix them promptly, or to keep his eyes directed on an object when it was moved. If the point which he was at the moment fixing was approached to his eyes he rarely accommodated on to it, and reflex blinking did not occur when a hand was suddenly jerked towards his face. He had, in addition, a serious disturbance of orientation in space by sight, which was greater when the objects lay outside macular vision; there was probably associated with this an inability to recognize the relative positions of two objects in space. He could not count a number of similar objects correctly by vision, though he always succeeded by touch alone. His stereoscopic vision was probably intact.

CASE IV.—Pte. P., was seen, through the kindness of Captain E. F. Buzzard, in King George's Hospital, London. He had been wounded by fragments of an aerial bomb while sleeping three months previously. When he wakened he found his left limbs in clonic spasms, and after the spasms ceased these limbs were paralyzed, but they

improved rapidly, though his left arm remained weak and numb. His sight became immediately affected.

WOUNDS.—The scars of two wounds were visible in the left parietal region; both had been operated upon in a casualty clearing station. One lay 9 cm. above the inion, measured along the middle line of the skull (nasion to inion 35 cm.) and 6.5 cm. to the left; the other 14 cm. above the inion and 2.5 cm. to the left. Radiographs showed two fragments of metal close to the right side of the skull, one about the middle of the first temporal or the lower part of the supramarginal gyrus, and the second in the region of the right precentral gyrus.

He was an intelligent and fairly educated man; his memory and attention were good. He had no speech defect. When he was examined the range of the movements of his left arm were unrestricted, but it was considerably weaker than the right, and there was some loss of sensation in it, chiefly distally and on the ulnar side. The knee and other tendon jerks were exaggerated on this side, and the left plantar response was of the doubtful extensor type.

His optic discs were normal and vision was 6/5 in each eye. There was, however, a peripheral contraction in the lower right quadrants of the visual fields, the exact limits

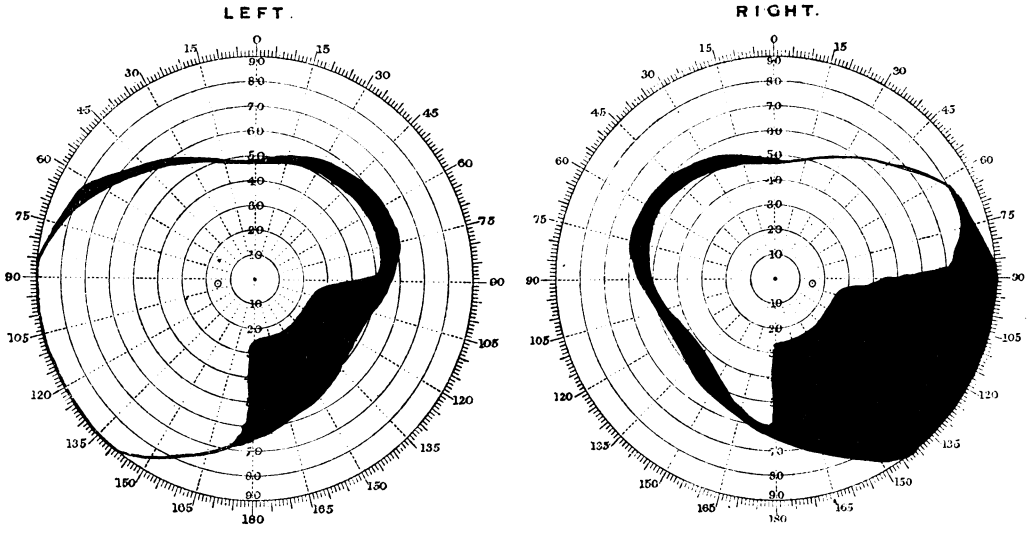

FIG. 3.

of which were difficult to mark out, as central to the blind area his attention to visual stimuli was poor (Fig. 3). There was also a considerable disturbance of visual attention to the left of the fixation point, especially noticeable when two objects, one held to his right and the other to his left, were moved simultaneously.

His ocular movements were unrestricted, but he had great difficulty in accommodating and converging his eyes upon any object which was approached close to his face, and the pupils did not, as a rule, then contract, but he succeeded in accommodating when his own finger was moved close up to his eyes. When spoken to he rarely brought his eyes promptly and directly to my face, and he was slow and uncertain in fixing any object to which his attention was drawn—he failed to bring it quickly and accurately into central vision. He never blinked or reacted in the normal manner when an object was suddenly swung towards his eyes.

He gave a very clear history of his visual disturbances. His sight was at first misty, but he could see and recognize large objects. It improved quickly. Then he became aware that he could not be certain of the position in space of objects which he saw. "When in hospital in France I had a bed-table for my cup and plate, but when I wished to take up the cup I would miss it with my hand, and would have to search the table till I touched it. It was just the same with my food; when I wished to pick up something from my plate I even put my hand into the cup or under the

bed-table instead of on to the plate. I could see the things quite well, but when I tried to take hold of them my hand would miss them." He could, however, bring both hands correctly to his mouth. These symptoms diminished, but he complained that he still failed to reach directly objects which he wished to seize. Similarly, when he attempted to read, "I lose the place and get on to another line and get totally mixed up." He still lost words in the line, and especially the succeeding line in the page, and, consequently, he now read much more slowly than formerly.

When he began to walk, about two months after being wounded, he discovered he had difficulty in finding his way in the room. "I was liable to run into things; I had not the proper judgment of their position, I could not tell exactly when I was near an obstacle." He stated that when walking he had at first to grope with his hands in front of him lest he should collide with obstacles. His description made it evident that his chief difficulty was in estimating distance. "I could see things and judge their position better when they were far away; the chief trouble was that when I got near them I did not know how near they were." He required special care in going up and down stairs "as I did not know the height of the steps till I got my feet actually on them." He said he was not surprised at the length of the ward when he first travelled it, as he had judged its distance approximately.

When he was examined three months after he was wounded all these symptoms were, from his description, less obvious than they had been. When he was asked to touch anything within his reach, he often failed, however, to bring his hand correctly to it; but his movements were, as a rule, well orientated, and his errors were chiefly in distance; when the object was placed close to him his hand usually went beyond it, but in other tests he occasionally attempted to grasp it before he had reached it. He was now prompt and accurate in deciding on the relative positions of two similar objects placed in front of him. He was not so accurate in dividing a line or in finding the centre of a circle as a man of his intelligence should have been. When asked to count coins on a table in front of him he was remarkably slow and made many mistakes; these he explained by saying, "I can't get my eyes on to them," and his difficulty in fixing objects promptly appeared to be the chief cause. He stated that he had always seen men and other tridimensional objects in perspective, and not merely as flat bidimensional figures.

In reading he occasionally missed words, and often failed to bring his central vision promptly to the left of the succeeding line, or even commenced to read a wrong line. He complained that in writing letters, "I often write one line across another, I cannot keep straight," and this actually occurred when he was tested. When asked to walk about the ward, in which chairs and tables were scattered irregularly, he did not run into any of them, but he moved slowly and carefully. On attempting to go to the lavatory, he reached the door correctly, but had then to grope about to find its conspicuous white handle.

In this patient the symptoms were less pronounced when he was examined three months after the infliction of the wound than they had previously been. Central vision was normal and only the right lower quadrants of the visual fields were restricted.

The ocular movements were intact, but when an object was approached close to his eyes, he failed to accommodate and his pupils did not contract. He had also difficulty in fixing objects accurately and promptly, and he never blinked or withdrew his head from a threatening movement or gesture. He described graphically his inability to localize objects in space; previously he evidently made errors in all directions, but when examined it was chiefly in the estimation of distance. At this period he could recognize the relative positions in space of objects which he saw. In reading, he frequently failed to follow the words properly, and the fact that he could not divide a line accurately or find the centre of a circle showed that he still had difficulty in appreciating relative

lengths and sizes. In walking, he was liable to run into obstacles, and had difficulty in finding his way. His stereoscopic vision was intact.

CASE V.—Pte. M. was seen at the National Hospital, London, through the kindness of Dr. James Collier. He had been a maltster, and was a well educated man. In September, 1915, he was wounded by a rifle bullet, and was probably unconscious for a considerable time. The wounds of entrance and exit were both operated upon in a Base Hospital.

The *entrance wound* was represented by a healed scar, under which a defect in the skull, 1 by 2 cm., could be felt; it lay 6.5 cm. above the inion, and 6 cm. to the left of the middle line, at the posterior angle of the parieto-squamous suture. A considerable area of bone had been removed at the site of the *exit wound*, which measured 6 cm. across; its centre was 6 cm. above the inion and 4 cm. to the right of the sagittal suture. The scalp pulsated over it. No foreign bodies were retained in the brain.

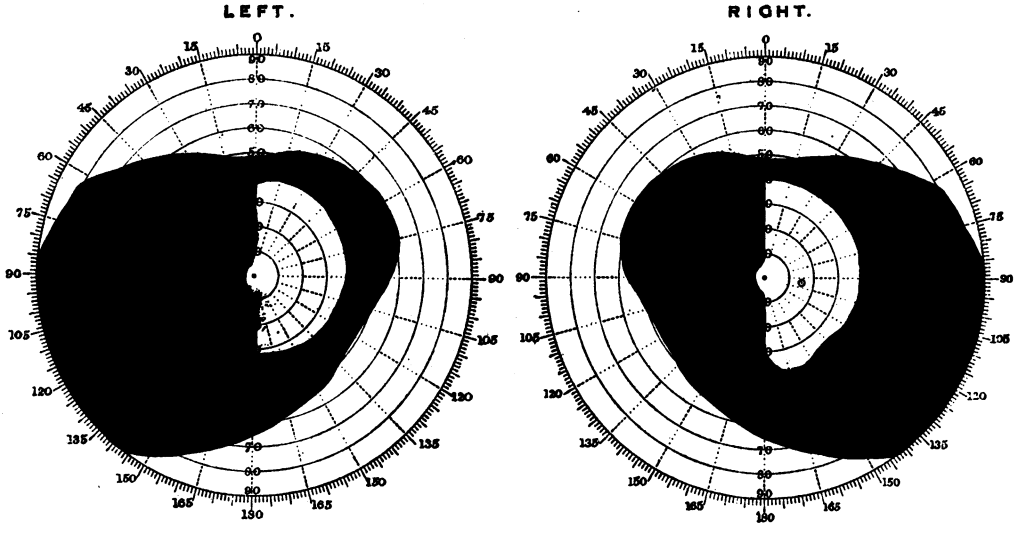

FIG. 4.

He was examined eight months after the infliction of the injury. His mental state was dull; he was slow in replying to questions and reacting to orders; his memory was unreliable and his attention poor. There was slight weakness of the right side of the face, but the tongue was unaffected. His right limbs were feebler than his left, though all movements were possible, and their range was unrestricted. Sensation on the right side of his body was much affected, the disturbances involving chiefly the sense of position, the appreciation of movement, the recognition of shape, the discrimination of compass points, and the localization of tactile stimuli. He walked easily, and his gait presented scarcely any abnormal features. The tendon-jerks were brisker in his right than his left limbs, but the plantar responses were flexor and the abdominal reflexes were normal. He understood speech, and expressed his ideas readily in words, but he was unable to read, largely if not wholly owing to his visual disturbances. Hearing was unaffected in both ears.

It was impossible to determine accurately the acuity of central vision, as he could not fix the test-types, but he was able to recognize small objects 6 metres distant. There was a complete left homonymous hemianopia which extended to 5° from the fixation point, and a considerable contraction of the periphery of the right visual fields (Fig. 4). He recognized readily all objects that he could perceive. His eyes were moved normally in all directions to order, or when he was told to look at his left hand as this was passively moved about, and the pupils were equal and reacted well to light.

He had, however, great difficulty in bringing the eyes to, or fixing, any object that was within his range of vision; when requested to look at my finger he generally stared with open eyes in a wrong direction and then rolled his eyes about in search of it. Even when his eyes fell on my arm, he often failed to follow this up to my finger, or they occasionally swung off to another object. He often appeared to be satisfied with imperfect fixation; he continued, for instance, to stare at my wrist on which his eyes had converged, when asked to look at my finger. The object he sought seemed often to come into central vision more by chance than by a purposeful effort dependent on its localization in space by peripheral vision. He also failed to follow with his eyes an object which he had succeeded in fixing when this was moved. He could, however, bring his eyes promptly and correctly to any object he held in his left hand.

He also failed to accommodate accurately when an object was approached towards his eyes, and he rarely blinked or reacted appropriately when a hand was jerked abruptly towards his face in a threatening manner.

When asked to touch with his left hand any object held in front of him, he had, in the first place, difficulty in directing his eyes to it; when he succeeded in this he made, as a rule, gross errors in estimating both its direction and its distance. He generally brought his hand too low and beyond the object, and then often continued to search for it until some part of his arm came into contact with it, when he could seize it immediately. When asked to walk to and seize a large white card which was suspended by a thread some distance in front of him, he generally approached it in an approximately correct direction, but almost invariably passed it and continued to grope for it, evidently perplexed by its disappearance from vision. When, in another test, he was told to sit down on a chair in the centre of the room he either walked abruptly into it, or mistaking its direction passed it, but if his hand or any part of his body touched it he could seat himself immediately. Here contact with the chair gave him the necessary information on its position in relation to himself which he could not obtain from vision only.

His ability to recognize the relative positions of two objects in space was tested by placing green and white cards on a table. He constantly made errors in estimating which was the nearer to him, and he frequently failed also to appreciate accurately their relative lateral positions. Similarly, when they were placed on a vertical surface he often made mistakes in describing which was the higher and which the lower. He was also unable to count correctly a few coins on a small table in front of him; his eyes wandered irregularly over the surface of the table, but he made no systematic attempt to explore it with his eyes. He consequently failed to perceive certain coins and re-enumerated others. The impression received was that his failure in this task was largely due to his inability to appreciate the mutual spatial relations of the several objects. He counted them correctly when they were dropped one by one into his hand.

In one test, when he was sitting on the floor, coins were dropped on to it so that they made sufficient noise to attract his attention; when his eyes were closed he made many errors in searching for them and in pointing to their direction. His eyes, however, generally turned immediately in the direction of the sound, though probably not as accurately as they do in a normal person.

When he was brought into a large room he was able to identify various objects that were in it as his eyes fell upon them in succession, though he could not point to them accurately, but in walking across the room he almost invariably collided with one or other obstacle which he had previously seen and recognized; he even ran forcibly into a screen, the upper end of which was as high as his eyes, and he hurt himself on one occasion by running into the wall. He was too dull to permit reliable introspection, but his explanation was always "I didn't see it, I didn't notice it." His surprise when he collided with the screen suggested that he misjudged its position in space, not that he did not perceive it. He occasionally proceeded in a wrong direction towards the object he was told to approach, and frequently passed beyond it. He had also difficulty in finding his way about the ward and back to his own bed.

Unfortunately, investigations were not made to determine if he saw objects in proper perspective, and if he had intact stereoscopic vision.

Autopsy.—He died about six weeks after the occasion on which I examined him. I am indebted to Dr. Yealland for the following notes on the condition of the brain.

In the left hemisphere the entrance wound was represented by an area of traumatic softening with the meninges adherent around it, which destroyed the supramarginal gyrus and extended forwards to the fissure of Rolando; the gyrus angularis and the temporal gyri escaped. The bullet emerged on the mesial surface of this hemisphere

immediately above the splenium, and here the two hemispheres were bound together by scar tissue. The direct injury to the mesial surface of the right hemisphere also lay immediately above the splenium, while the exit wound was represented by a small hernia which involved the upper part of the gyrus angularis and the gyri immediately dorsal to it; the gyrus supramarginalis escaped. The cortex above the right calcarine fissure was softened, and a section through this hemisphere showed that the greater part of the projection fibres to the calcarine area was probably interrupted by the lesion.

Death was due to a large abscess which developed in the white matter of the left hemisphere below and anterior to the track of the missile, and had burst into the lateral ventricle. As the symptoms of this abscess appeared late it was probably not a factor in the production of the visual disturbances described above, as these were observed six weeks before death and had persisted from the time the wound was inflicted.

In this case the symptoms were observed about eight months after the infliction of the wound; they had probably existed during the whole of this period, but owing to his dull mental state, a complete and reliable history was not obtainable.

His macular vision was at least moderately good, but he had a left-sided homonymous hemianopia which came to within 5° of the fixation point, and a considerable peripheral contraction of the right halves of his visual fields. There was no ocular palsy, but he generally failed to accommodate or converge on near objects, and had great difficulty in bringing objects, the images of which fell on the seeing portions of his retinae, into central vision and in following them with his eyes when they were moved. The visual blinking reflex was also absent. He could not locate objects correctly in space even when they were in central vision, mistaking, as a rule, their lateral and vertical positions in relation to himself as well as their distance, though his errors were predominantly beyond and below the point he wished to touch. He was also unable to recognize the relative positions of two objects within his fields of vision, and he usually failed to explore a surface in front of him and count easily visible coins upon it. In walking, he ran into large and conspicuous obstacles, and had difficulty in finding his way about. His localization in space by sound was probably also defective.

CASE VI.—Pte. W. was seen with Captain S. Smith. He had been previously a railway fireman, and was unintelligent and poorly educated. He was wounded, probably by a rifle bullet, in May, 1915, and remained under observation till four weeks from this date. He had no paralysis or disturbance of sensation, but on regaining consciousness he found that his sight was seriously affected; he noticed this chiefly in an unsuccessful attempt to read.

The *entrance wound* was 9 cm. above the tip of the left mastoid, and 2·5 cm. behind a vertical line through it; it was a small puncture surrounded by an operative flap. The *wound of exit* was 9 cm. above the tip of his right mastoid and 2 cm. behind its plane. Both wounds had heen operated upon in a casualty clearing station; the entrance wound was not enlarged, but some depressed bone was removed from it; softened brain tissue had escaped from the exit, which was considerably larger.

When he was examined three weeks after the infliction of the injury his wounds were almost healed, and there was no trace of paralysis, sensory disturbance, or alteration in his reflexes. His speech was also unaffected. He had difficulty in reading owing to his visual disturbances, but he could comprehend fully sentences which he could follow. He could write correctly.

His central vision was 6/6 and Jaeger I in each eye, and the optic discs were normal;

but there was a lower left quadrantic hemianopia which came to 7° from the fixation point, and a slight peripheral contraction of the upper left temporal quadrant. [Fig. 5.] His ocular movements and pupillary reflexes were normal. When he was asked to look at any object he fixed it slowly and uncertainly, and in doing so generally rotated his head so that his eyes were deviated to the right and slightly downwards; there was no strabismus or diplopia to account for this posture. He also followed objects that were moved in front of him imperfectly with his eyes, and did not converge properly upon them when they were brought close to his face. He recognized all objects which he saw.

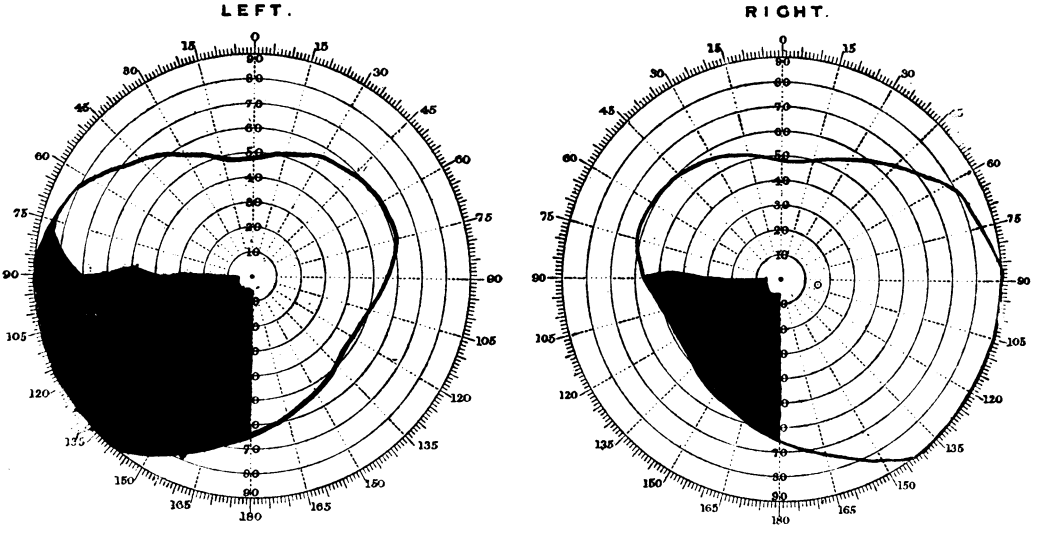

FIG. 5.

When he first came under observation he made slow and inaccurate attempts to touch anything that was presented to him, failing chiefly in estimating its distance. He also made mistakes in estimating the relative distances of two objects which were placed in front of him; when tested with silver and copper coins of the same size he often failed to recognize which was the nearer to him, but this symptom disappeared before he was transferred. Even four weeks after he received his wound he often failed to count correctly five or six similar coins which were within his range of vision; he moved his eyes slowly to each, and often included one or more twice in his count, or missed some of them. He had evidently not a correct perception of their spatial relations to one another.

His most persistent trouble was in reading: he usually succeeded in following any line which he started, but at its end stared blankly at the page, or moved his eyes from spot to spot, saying, "I can't find it; I don't know where the next line is." He frequently commenced to read again at a wrong place, generally two or three lines too low.

Four weeks after the wound was inflicted he was placed on his feet, and though he could walk quite well he repeatedly failed to find his way about the small ward in which he had lain for three weeks. He frequently ran into large obstacles which he could certainly see, but, unlike Case I., he succeeded in finding his way around them the moment he touched them.

In this case the disturbances of visual orientation were slighter than in the others, and they diminished considerably while he was under observation. His central vision was intact, but there was an inferior left quadrantic hemianopia which did not, however, involve

the macular region. His ocular movements were unaffected, though he could not, as a rule, direct his eyes promptly on any object to which his attention was drawn, or keep them on it accurately when it was moved, and he failed to converge on it when it was approached to his eyes.

As in the other cases, the impairment of the orientation by vision was shown in his inability to touch accurately anything within his reach, though the movements of his arms were unaffected, his errors being chiefly in the estimation of distance, and in his failure to recognize the relative distances of two objects in space. In reading, too, he was frequently unable to bring his eyes at once to the words in the proper sequence. When he walked he ran into obstacles which were certainly in vision, and could not find his way about readily.

A survey of these cases shows that the functional disturbances were very similar in all, or differed only in degree; in some of the patients the symptoms persisted practically unaltered for months, but in others they were more or less temporary, and, as in Cases IV and VI, diminished or disappeared within a few weeks.

In discussing the condition which is illustrated by these cases it will be most convenient to deal with the main symptoms separately. These fall naturally into two groups; the first includes the disturbance of orientation and localization in space by sight, the inability to estimate absolute and relative distances, and the failure to recognize relative lengths and sizes; while in the second group we may place together the disturbances of the movements of the eyes and ocular reflexes, that is, the difficulty in fixing objects seen and in keeping the eyes fixed on them when they are moved, the failure to converge on and accommodate for near objects, and the absence of the blinking reflex.

(To be concluded.)