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LETTER-WORD-& MIND-
BLINDNESS

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LETTER-. WORD- AND MIND-BLINDNESS



LETTER-, WORD- AND MIND- BLINDNESS



BY

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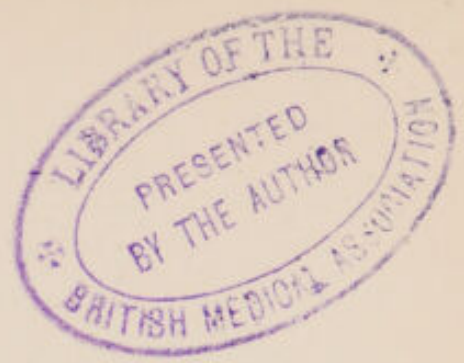
PREFACE.

OF the five chapters composing this little book, the last four were papers read before the Glasgow Medico-Chirurgical Society, and have been already published in the columns of the *Lancet*. These articles, embracing the results of extensive reading, as well as my own studies and observations, give a fairly comprehensive view of a subject, which has not received much attention in English medical literature. I have thought that the publication of these papers in book form would make them more accessible to those interested in the subject. For several reasons, it has been thought advisable to publish the papers in much the same form as they originally appeared in the columns of the *Lancet*, and therefore a certain amount of repetition, unavoidable in the circumstances, will be found in each of the chapters.

9 ELMBANK STREET, GLASGOW.

December, 1899.

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LETTER- WORD- AND MIND- BLINDNESS.

CHAPTER I.

THE VISUAL MEMORY.

FOR the successful performance of the function of vision, it is essential not only that the eyes should be healthy in structure and function, but also that the brain should co-operate harmoniously in interpreting the impressions made upon the sensory organ. The perfect performance of the visual act may therefore be regarded as the result of the combined and harmonious activity of eye and brain.

The eye is an optical instrument, so constructed that a picture of that part of the external world to which it is directed is thrown upon the retina or delicate nerve screen at the back of the eye. The rays of light striking upon the nerve tissue of the retina, set up chemical changes there, which are translated into nerve force through the medium of the special nerve terminals, the rods and cones. This nerve force is transmitted thence by the optic nerve to special regions of the brain, where these nerve changes are brought into the sphere of consciousness and appear as varieties of light form and colour. The optical aspect of vision has long been studied with great attention. The anatomy, physiology, pathology, and physics of the eye have been investigated with the greatest care. The cere-

bral or mental aspect of vision, however, has not received the same attention. Yet the brain contributes quite as much to each visual act as the eye itself, and there are many visual defects, where the eye is perfectly healthy and where the lesion lies in the cerebral centres of vision. We are apt to forget that we see with our brains as well as with our eyes.

The important contribution that the brain makes in the intelligent exercise of vision is most clearly demonstrated by the reports we possess of patients, who have been completely blind from birth with congenital cataract and who were operated on successfully after attaining maturity. We require to go to the early part of the century for records of such cases, as now these are operated on in infancy. Wilbrand in his monograph "*Die Seelenblindheit*"³⁵ gives an interesting series of them. From a study of these it is manifest that vision in our sense of the word was not possessed by these patients immediately after the removal of the opaque lens, which prevented the rays of light from reaching the retina. Even when the operation had been completely successful and clear images of the objects in the external world were thrown on the retina, such retinal images did not at first convey much information to these patients, who had been born blind. The brain had yet to learn to interpret the meaning of these retinal pictures. The patients had to learn by repeated experience and by the confirmation of the other senses, particularly of touch, to distinguish different objects in the field of vision from one another. At first they had no conception of the distance and size of the objects around them. It was only after a time, and by exercising their other senses, particularly touch, that they began to realize the relative size of objects and their relative distances. They gradually learned by repeated ex-

perience that the image of an object diminishes with distance and increases with proximity, and thus gradually acquired some idea of perspective. Nor could they at first recognise by sight alone the objects, which were presented for their inspection. They had yet to acquire a visual memory, which as we shall see gives us the power of visual recognition. Hence it was only after repeated experience, after they had acquired a sufficiently varied stock of visual memories, that they began to recognize objects by sight alone.

These patients, however, having come to years of maturity learned to interpret the meaning of their retinal pictures much more rapidly than the child does after birth. They started with fully developed brains, with all their other senses highly educated, and with a knowledge of the external world derived through the medium of their other senses. This sensory knowledge already possessed by them confirmed, corrected and deepened the impressions of the external world derived from their newly found visual sense.

The child after birth is much slower in building up his visual knowledge of the external world, because he has as yet no sensory knowledge of it whatever, and all his senses have to be trained simultaneously. It is some time before the infant learns even to fix his gaze on a given object. At first the eye is constantly wandering in restless fashion from object to object and the act of fixation, of directing the eye to a definite object and of keeping it in the field of vision for some length of time, is only gradually acquired by the child. It is only then that clear images of external objects will be fixed sufficiently long upon the retina to enable the higher visual centres in the brain to take cognisance of and register these visual impressions and thus lay the foundations of that visual memory, which as we shall see, plays such an important part in every

visual act. Amongst the first impressions stored in the child's visual memory are the faces of nurse, of parents, and those coming into daily contact with him, and very soon he learns to distinguish them from all others. But it is a considerable time before he acquires any exact knowledge of locality and distance, and if we watch an infant we can see how he gradually elaborates his knowledge of the external world by comparing his visual impressions with the information simultaneously derived through his other senses. The child looks at an object, moves about his hands until after several vain efforts he manages to grasp it, then he probably will feel it all over with his hands, may bring it to his mouth, suck it with his lips, or lick it with his tongue. If the movement causes any sound, we can see that the child is taking cognisance of it. The child is thus daily gathering information about the external world simultaneously through the medium of all his senses. The ideas of locality, of the relative size and distance of the various objects in our visual fields are thus gradually elaborated and built up by continuous observation and experience.

The picture of the external world thrown upon the retina is a picture upon a plane surface of two dimensions, and yet the brain has trained itself to translate this into a picture of three dimensions, imparting to it the conception of depth and arranging the different objects in the field at their relative distances from the eye of the observer. The action of the ocular muscles, the degree of contraction or relaxation of the muscle of accommodation, the apparent size of known objects in the field of vision, all these elements combine to enable us to form a correct judgment of the position, size and distance of the different objects in our fields of vision. Such knowledge is only acquired slowly and laboriously by the human being,

In every visual act, therefore, there are complex mental processes involved and a series of judgments arrived at, before we are able to interpret correctly the picture of the external world thrown upon the retina. But besides the perception of the position, size and distance of the various objects in our field of vision, the brain makes a further contribution by enabling us to recognise the different objects. This is accomplished through the medium of the visual memory, that is through the power of comparing present visual impressions, with the memories of past impressions, which have been preserved in the brain. This aspect of the visual act has met with comparatively little attention nor has it been studied with the care which the great importance of the subject fully merits.

Our senses are not only capable of being acted upon by stimuli from the external world, but the sensations thus produced, if sufficiently vivid and sufficiently prolonged or frequently repeated, leave in the brain permanent impressions, which are preserved and recalled into the sphere of consciousness at the will of the individual. This possibility of preserving and reproducing at will past sensory impressions, commonly called memory, is an essential condition for human progress, otherwise our knowledge of the external world would not increase by prolonged experience of it. But the facts of clinical experience and mental pathology have clearly demonstrated that memory does not exist as a special faculty or unity, but that there do exist individual or local memories, *e.g.*, memories of vision, of hearing, of touch, of taste, of smell, of muscular movements and so forth; that whilst all these forms of memory are intimately connected with each other, yet they are perfectly distinct and independent of each other, so that any single form may be enfeebled, entirely lost or developed to an abnormal extent without any of the other forms exhibiting any corres-

ponding modification. Pathology has further shown that each of these forms of memory occupies a distinct area of the cerebral cortex. Of these special forms of memory, the visual memory contributes a most important factor to every visual act by enabling us to recognise the various objects in our visual field as to their identity, character and qualities.

Schröder van der Kolk³⁵ has expressed with great clearness certain considerations, which of themselves suggest the improbability of the same sensory cells being the actual seat of visual perception and also of recording and storing up these impressions.

“If the visual perceptive centre in the brain” he says “is to be relied upon as giving us a true perception of the external world, then the sensory impressions produced in these cells must be pure and unmixed, *i.e.* must be produced, only by the stimuli conducted by the optic nerve-fibres from the retina. It is evident if this same centre and these same cells were employed both in receiving present impressions and in preserving them, that the actual perception would be modified or altered by the voluntary or involuntary activity of the past visual impressions. Further, the visual impressions must remain in this centre only so long as the external stimulus is present, and must disappear immediately after its withdrawal, and so render possible the perception of fresh visual impressions. It is thus a necessity that the visual mechanism in the brain must be twofold. It must be able to give us the pure perception of external objects and this perception must remain only so long as it is excited by the stimulus of the external object, but another mechanism must be present, wherein these visual impressions are retained but with diminished intensity, so that they can be readily distinguished from real visual impressions produced by external

stimuli, and these impressions or images must be stored up, so that at any future time they can be called into consciousness and compared or contrasted with present visual perceptions."

On purely theoretical grounds, therefore, the argument seems a strong one for the existence of two distinct centres in the brain, a visual perceptive centre, the cells of which are acted upon only by present external sensory stimuli and a visual memory centre, in which are retained the memories of past visual impressions. The facts of clinical experience, as will be seen by the study of the following pages, confirm in the strongest manner these theoretical views. As to the nature of the impressions received and preserved by the nerve cells in the visual memory centre, we can form no idea. Neither the microscope, nor chemical reagents, nor histology can reveal to us the modifications in the cerebral cells, which make possible the retention of past visual impressions, yet consideration of the mental processes involved in vision makes it clear that a visual memory, a storehouse of past visual impressions, has a real existence.

Although every human being endowed with the sense of sight possesses this visual memory, yet it is possessed in very different degrees by different individuals. Some people retain their visual impressions in such a peculiarly vivid way, that they can after long intervals of time recall and accurately describe the details of a landscape, or of a picture, or the peculiarities of a face, almost as if they had it before them. Others possess this power only in a much feebler degree. Francis Galton³⁶ in his interesting work "Inquiries into Human Faculty" made a careful investigation into the powers of visual memory possessed by one hundred different individuals, and found the most astounding differences.

Some people in committing a passage to memory do so by means of their visual memory, *i.e.*, when they recall it afterwards, they actually see the words, while others do so by means of their auditory memory and when recalling a quotation, they hear the words. The former have been called "visuels," and the latter "auditives." Galton gives a very good example of a powerful visual memory. He says, that he has met with many cases of persons mentally reading off their manuscript, when they were making speeches. One statesman assured him that a certain hesitation in utterance, which he had at times, was due to being plagued by the image of his manuscript speech with its original erasures and corrections. He could not lay the ghost and he puzzled in trying to decipher it.

A very remarkable example of vividness of visual memory for form and colour is reported in Dr. Edridge-Green's recent book on memory and its cultivation.³⁷ "The following," he says, "was related to Abercrombie by Dr. Duncan of Edinburgh, who heard it on the spot and saw both pictures. In the church of St. Peter at Cologne, the altar piece is a large and valuable picture by Rubens, representing the martyrdom of the Apostles. This picture having been carried away by the French in 1805, to the great regret of the inhabitants, a painter of that city undertook to make a copy of it from recollection and succeeded in doing so in such a manner, that the most delicate tints of the original are preserved with the most minute accuracy. The original painting has now been restored but the copy is preserved along with it and even when they are rigidly compared, it is scarcely possible to distinguish the one from the other."

Horace Vernet, the famous French Artist, was said, after looking attentively at an individual for a few minutes,

to be able to paint a good portrait of him without ever seeing him again.

These are examples of the great vividness and precision which the visual memory occasionally attains. But though there are very different degrees of retentiveness of visual memory, still every human being endowed with vision possesses it, and makes constant use of it in the recognition and interpretation of the objects which come within his field of vision.

When we recognise a friend in the street, we do so by comparing the present retinal impression with the visual memory of him, which exists preserved in a special area of the brain. When our friend is not present, we can call this visual memory at will into the sphere of consciousness and survey it just as we would an actual picture.

When we recognise a landscape, which we have not seen for years, we do so also by comparing the retinal picture of it with the picture in the brain produced by the visual impressions of years ago. When we recognize at a glance the character and uses of all the familiar articles around us, this is also done by comparing the retinal picture with the pictures stored in our visual memory and accumulated by our life experience. In short, whenever the act of recognition of an object falling within the field of vision takes place, this is accomplished by the exercise of the visual memory. It is thus evident, what an important part the visual memory plays in each visual act.

We are apt, however, to forget that the intelligent exercise of vision involves such complex cerebral processes, the easy and rapid accomplishment of which is the result of long years of incessant training. The most complicated cerebral processes through continuous practice are carried on with such ease and rapidity that they become transferred to the region of unconscious cerebration. Hence, it is only by a

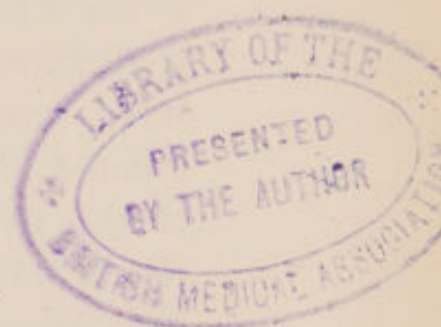
course of reasoning and analysis of the method in which our visual knowledge of the external world is gradually acquired that we arrive at some conception of the processes actually involved. But when disease disturbs the perfect adjustment of the complex cerebral mechanism, it often enables us to catch a glimpse of the processes which are constantly at work in this mysterious region of unconscious cerebration.

We have studied the visual memory by analysing the visual act and by observing the way in which our visual knowledge is slowly and laboriously acquired. In the following chapters we shall see how disease interfering with the harmonious working of the complex visual mechanism produces phenomena, at first sight startling and apparently inexplicable, but on more careful study found not only to be in harmony with our knowledge of the complex processes involved in vision, but throwing much additional light on the subject.

The phenomena of disease, as copiously illustrated in the following pages, clearly show that past visual impressions are arranged in definite groups within the visual memory area, so that one or more of these groups may disappear without any interference with the others. In this way are produced those disorders of the visual memory known as letter- word- and mind-blindness of which numerous and varied examples will be found in the following chapters. It has been the endeavour of the author to show that letter- word- and mind-blindness in all the varieties met with in clinical experience can be intelligibly explained by regarding them as disorders of the visual memory, produced by lesions affecting more or less completely a definite area of the cerebral cortex, in which are preserved these past visual impressions arranged in definite and ordered groups.

CHAPTER II.

LETTER- WORD- AND MIND-BLINDNESS.



THE case which forms the basis of this chapter, is one of singular purity and therefore affords an admirable opportunity for the study of the phenomena of letter- and word-blindness. Such pure cases rarely present themselves to the physician, but rather to the ophthalmologist, as the patient, in the absence of any other cerebral symptoms has no idea as to the true nature of his condition. Hence, this patient came under my notice in the Glasgow Eye Infirmary, whither he had come, under the impression that his inability to read was due to some affection of his eyes. The following is the history of the case.

A man aged fifty-eight years had always enjoyed good health with the exception of occasional attacks of bronchitis in winter. He was a teacher of French and German, and a man of intelligence and education. Of recent years he had a large amount of mental work, and before his present visual difficulties appeared he had considerable mental worry. He first came under my notice on Aug. 29th, 1894, and gave the following history. About one month previously he was greatly startled to find that one morning in his own house he could not read the French exercise which a pupil gave him to correct. On the previous day he had read and corrected the exercises just as usual. Greatly puzzled he went into an adjoining room, and having summoned his wife, he asked her if she could read the exercise. She read it without the slightest difficulty. He then took up a printed book

to see if he could read it, and found that he could not read a single word. He remained in that condition until I saw him. On examining his visual acuity with the test types I found that he was unable to read even the largest letters of the test types. He informed me that he could see all the letters plainly and distinctly, but could not say what they were. He made the most absurd mistakes, and only very rarely, after guessing several times, did he hit upon the proper name of the letter. What attracted my special attention was the fact that he read at once the number standing at the top of each paragraph of the test types. I found on examining him further with figures that he did not experience the slightest difficulty in reading any number of figures quite fluently and without making any mistakes whatever. He could read figures printed on the same scale as Jaeger No. 1, the smallest of the test types, and from other tests it was evident that there was no lowering of his visual acuity. His inability to read was thus manifestly not due to any failure of visual power, but to a loss of the visual memory for words and letters. The page of a printed book appeared to him exactly as it appears to a person who has never learnt to read. He sees each individual character distinctly enough, but the character is no longer a visual symbol, as he no longer remembers the special significance attached to it. His difficulty with written characters was equally well marked, and it was the same for Latin and Gothic characters. He was ignorant of music, and I therefore could not test his power of reading musical notes. To put it briefly, he had lost the visual memory of all the printed and written characters with which he was previously familiar. He could, however, write with perfect fluency and ease to dictation, although afterwards he could not read what he himself had written. No other mental defect could be ascertained on the most

careful examination. He spoke as fluently as ever, nor had he since the beginning of his attack ever experienced the slightest difficulty as regards speech. His mental powers were as vigorous as ever, nor was there any defect of memory apart from the loss of memory for the visual symbols of language. I was struck with the fact that in trying to read he always carried the book well to the left hand, and could not see it at all when carried to the right. On examining his visual fields with the perimeter there was found loss of the right half of each visual field—*i.e.*, he had right lateral homonymous hemianopsia. No other defect could be found, and the fundus of each eye was perfectly normal on ophthalmoscopic examination. His general health was good, and with the exception of atheromatous vessels there was no evidence of disease present on the most careful examination of all his organs. I have had this patient under constant observation during thirteen months and saw him last on Sept. 27, 1895. His general health has remained good during that period. No new mental symptoms have arisen. He informs me, however, that his memory is not quite as good as it used to be, and that this is particularly noticeable in the case of proper names. The right homonymous hemianopsia remains practically the same. With regard to his power of reading there has been a slow but steady improvement during the last six months. During the first six months his condition in this respect was stationary, but during this period I had advised mental rest, and he had made no attempts at reading unless when I examined him now and again. About six months ago, however, I advised him to begin to learn to read. He began by learning the alphabet and spelling through a child's primer. He practised daily, and at the present time he can read, but only slowly and laboriously, spelling out the words letter by letter like a child. In the

alphabet at the beginning of his primer he has underlined the letters which gave him difficulty, putting a double line below those which gave him most difficulty. On asking him to read he does so slowly, spelling out each word letter by letter. He makes many mistakes, particularly with the letters which he has underlined in the alphabet. His behaviour is exactly that of a child learning to read. Meeting with the letter F, for example, he hesitates, begins to run over the alphabet from A to F, and then he recognises the letter as F. Meeting with Y he hesitates for some time, although he says almost at once this is the last letter but one of the alphabet. However, giving him plenty of time and with occasional mistakes, he is now able slowly and laboriously to spell out printed matter. One point very observable in his reading is that he has no difficulty with some short, familiar words. *The*, for example, he always recognises at once without requiring to spell it out letter by letter. This point was also noticeable in a case recorded by Badal which I shall mention later, Badal's explanation seems a very reasonable one—viz., that such familiar words form, as a whole, a picture or graphic unity which is instantly recognised without it being necessary to analyse it into its constituent letters. With regard to written symbols, my patient has not made such marked progress. I tested him with very clear and distinct handwriting. He could only read a word here and there, and had great difficulty in recognising the letters. The explanation, I think, is very simple. During the last six months he has been reading printed characters every day, while he has not practised constantly the reading of written characters, but only tried it occasionally. This is a point of great interest—the comparative fluency with which he now reads printed, as compared with his difficulty with written characters, and the fact

that he has been practising constantly the reading of printed but not of written characters. His power of reading figures fluently remains as before. With regard to his power of writing to dictation, he writes as fluently and rapidly as he ever did. He does not spell quite so correctly as he did previously, and his handwriting, though quite legible, is not so good as it was previously to the onset of his word-blindness. The patient himself seeks to explain this by lack of practice in reading and writing during the last thirteen months, and no doubt this is an important factor; but another factor is to be found in the word-blindness, the patient being unable to read what he himself has written, and, therefore, gaining no help from vision in the spelling of the words and the formation of the letters. He is much in the same position as a man writing with his eyes shut.

It was Kussmaul¹ who firstly clearly pointed out that blindness for words is capable of being met with clinically as an isolated condition, and that it represents the pathological condition of a special faculty. Before the publication of Kussmaul's article, however, Sir William Broadbent³⁹ had already called attention to cases where the patients were unable to read printed and written words, but in these cases the inability to read was accompanied by speech disturbances, such as verbal aphasia or amnesia, in a greater or less degree. To Kussmaul, therefore, must be given the credit of first recognizing the possibility of this inability to read being met with as an isolated symptom. Kussmaul's exact words are "a complete text-blindness may exist, although the power of sight, the intellect and the powers of speech are intact." He invented the term "word-blindness" for this condition in which the patient, though not blind, is unable to read visible words. Since Kussmaul's treatise our knowledge

of the condition has been greatly increased by the numerous cases which have been reported. It is now evident that the terms "word-blindness," "*cécité verbale*," and "Wortblindheit" are not sufficiently precise without further definition.

There are different forms of word-blindness, which must be carefully distinguished from one another. The case reported is one of complete letter- and word-blindness. In the chapters which follow, additional varieties will be described. Cases where the patients can read the individual letters of the alphabet but cannot read words. Cases manifesting the converse condition, where the patient can read words but not the individual letters of the alphabet. Cases where there is a rapid exhaustion of the patient's ability to read. There are also partial cases, which do not belong to any of these categories, the patients being able to read only some letters and some words. In the case just reported, the inability to read embraced all the different forms of letters known to the patient, Gothic and Latin, written and printed. This is not always so. Michel² quotes a case where the patient could read the Gothic but not the Latin characters. Charcot³ records a case where a patient knowing French, German, Spanish, Latin and Greek, lost the memory of a few of the Greek and German characters only. Badal⁴ has reported a very peculiar case which merits more detailed description. The patient could see and name each individual letter, but could not combine these even into the simplest syllables or words. A few words she was able to recognise and pronounce, but these were such as were familiar to her from frequent repetition—for example, her own name. Badal's explanation is that such familiar words form a graphic unity, a form picture, which can be recognised at once without resolving it into the individual letters. Badal

traced her inability to read to a loss of the sense of space. Although in a given word she saw and could name the individual letters, she did not appreciate their relationship to one another. She could thus name any individual isolated letter, but when several letters were combined into a word she could not read it, because she could not perceive the relative order in which the letters were placed.

It is thus evident that the terms "word-blindness" and "alexia," whilst useful as general terms, do not convey a precise idea of the defect in any given case, which must be described in more precise terms. The case under consideration would be correctly described as one of complete letter- and word-blindness.

One feature of this case to which I wish to direct particular attention is the fact that this patient could read figures as fluently as ever; indeed, it was this feature which first made me suspect it was a case of word-blindness. On trying him with the test-types I was at once struck with the fact that although he could not read a single letter, he read without hesitation the number standing at the top of each paragraph of the test types. I then tested him further with large combinations of figures, and all these were read with the greatest fluency and without any hesitation whatever. This is a point in these cases which has not met with the attention it merits. In the vast majority of the recorded cases of word-blindness no mention whatever is made as to the ability to recognise figures. In the thesis of Mdle. Nadine Skwortzoff,⁵ amongst fourteen cases of word-blindness collected by her, only one occurs where it is stated that the power of recognising figures was preserved. On quoting this case she remarks that generally we find no difference in word-blindness as to the reading of figures and letters. Cases, however, do occur where the ability to recognise figures

remains intact, and that more frequently than was previously supposed. I have met with eight recorded cases in addition to my own. In the case of Mierzejewski,⁶ the patient, whilst unable to read words, could recognise and read figures even when these were combined in the most complicated manner. In a case very similar to my own, reported by Brandenburg,⁷ the patient suffering from word-blindness and right lateral hemianopsia could recognise and read figures. Brandenburg in his paper quotes a case reported by Joly where the patient suffering from agraphia and word-blindness could recognise figures and also write them. In a case reported by Dejerine⁸ the patient was totally word- and letter-blind with right homonymous hemianopsia, but he retained the power of reading figures and could do mental calculations as well as formerly. In Chapter IV. three other cases are quoted in full. Alfred Binet⁹ has presented us with a very interesting aspect of this same question from another point of view. In his interesting psychological study of MM. Inaudi and Diamandi, who have recently startled the scientific world by their great feats in mental arithmetic, Binet points out that whilst their memory for figures had acquired an abnormal extension, which excited astonishment and admiration, the other forms of memory—*e.g.*, that for words—presented nothing special, and, in fact, in some respects they were below normal. In the case of Diamandi, his extraordinary memory for figures was a purely visual memory. When he learned a series of figures by looking at them for a moment he could repeat them in any order. He explained the mental process by saying that he actually had a precise mental picture of the figures with all their peculiarities of printing and even of colour. His visual memory for figures was so exact as to resemble a mental photograph, which he could read off at leisure, as he would

from the page of a book. Yet his visual memory for words was by no means above normal. Experience thus clearly proves the complete independence of the visual memories of letters and figures, for, as we have seen, the one form of visual memory may be lost whilst the other remains intact, and the one form may be developed in excess whilst the other is even below the average.

Another very interesting form of loss of visual memory is that of loss of the visual memory for musical notes—note-blindness. This is a subject which until quite recently had scarcely met with any attention. Professor Edgren of Stockholm has published a striking paper,¹⁰ in which he gives fifty-two cases collected from various sources in which the power of musical expression was partially lost, and which he has designated by the term “amusia.” Professor Edgren regards the following conclusions as admissible from the study of the fifty-two cases:—(1) that a pathological process can cause partial or total loss of the power of musical expression—amusia; (2) that the various forms of amusia possess a certain degree of clinical independence in their relation to each other and to aphasia; (3) that the clinical forms of amusia appear to be analogous to the clinical forms of aphasia and are often, but not necessarily, accompanied by the analogous form of aphasia; (4) that amusia can exist without aphasia and aphasia without amusia; and (5) it is probable that certain forms of amusia possess an anatomical independence, the region affected being near to, but not identical with, that affected in the analogous form of aphasia. Of the different forms of amusia described in this paper one of the most interesting is note-blindness—*i.e.*, loss of the visual memory for musical notes. The patient can see the notes as usual, but has no longer the faintest idea of their significance. This is

very frequently associated with another form of amusia, tone-deafness, where the notes are heard, but simply as sounds, without the patient being able to assign them to their position in the musical scale. From the proximity of the visual and auditory centres it is easily understood how these forms are frequently associated together, just as the analogous conditions word-blindness and word-deafness. But note-blindness also occurs as an isolated symptom, there being no other impairment of the patient's powers of interpretation or expression of musical sounds, and the patient being able to read all other printed and written symbols. The patient can read the words of a song, but can no longer read the accompanying music. Word-blindness is very frequently accompanied by note-blindness, but not always, the patient sometimes retaining the power of reading musical notes. It is evident, then, that the visual memory for musical notes is quite distinct from the visual memory for words and letters, since the one form of visual memory may be entirely lost whilst the other is not changed or modified in any way. For illustrative cases I would refer to Professor Edgren's paper.

The following case, which has come under my observation, affords another excellent example of partial loss of visual memory. The loss of visual memory was also associated with right lateral homonymous hemianopsia, just as in my case of word-blindness.

The patient, a married woman aged thirty-eight years, consulted me on Nov. 23, 1888, at the out-patient department of the North Riding Infirmary, Middlesbrough, when I was acting there as resident surgeon. She gave me the following history. Twelve months previously she had fallen down in a fit, and for some time afterwards had some loss of power on her right side, and some slight difficulties in speech. During the last three months

she had suffered greatly from headaches, which were always worse at night. But it was her visual troubles about which she had come specially to consult me. She was constantly running up against people in the street and against objects such as chairs in her own house. What distressed her even more was that she could no longer find her way about the town. When she went out she could see the houses and streets quite plainly, but she no longer recognised them. She could no longer recognise her own street by sight. She only lived a short distance from the infirmary, but could not come to it alone. She was in the same position as a complete stranger, although she had lived in the town for many years. What was still more distressing to her was that she was quite helpless in her own house and could not do her own household work. She had completely forgotten where things were placed, and most of her time was occupied in looking for the various household articles. The history of running up against people and objects at once suggested an examination of her visual fields. It was found that there was a right lateral homonymous hemianopsia, loss of the right half of each visual field. Unfortunately she was illiterate, so that I could not test her visual acuity by reading the test types. By employing other tests, such as her power of picking up exceedingly minute objects and of recognising dots, &c., it was evident that the visual acuity in the left half of each field was exceedingly good. The hemianopsia, then, was quite insufficient to account for her visual difficulties. It was evidently a form of mind-blindness, a loss of the visual memory for places. There being a history of syphilis, she was put upon specific treatment. Her general condition greatly improved, her headaches and speech troubles disappeared, but when I last saw her, after three months

treatment, the hemianopsia persisted, and she had still the same difficulties as regards the visual memory for places.

Charcot⁸ relates a case in some respects similar to the preceeding, but in which the loss of visual memory was much more extensive. Charcot's patient was a highly educated and accomplished man in whom the visual memory had been very highly developed. After a time of great mental worry and anxiety, with loss of appetite and sleep, he was astonished to find that a sudden and profound change had come over him. At first everything was confusion, and the patient feared that he was threatened with some form of mental derangement. In every instance the memory of form and colour had completely disappeared, yet he could perceive them when present without difficulty. Like my patient, the monuments, houses, and streets of the town he dwelt in, seemed all strange and new to him. Every time he returned to it, after an absence, it seemed as though he had arrived there for the first time. He could not draw the simplest object from memory, although he used to draw fairly well. When he now tried to draw objects from memory he produced only a shapeless scrawl. He had also lost the visual memory of colours. He found the visual recollections of his wife and children impossible, and even when they were before him their faces seemed strange to him. There was only very partial letter-blindness, he having a difficulty in recognising a few letters of the Greek and German alphabets. His eyes were examined by Parinand and found to be normal.

A very interesting case of object-blindness associated with word-blindness, followed by post-mortem examination, has been recorded by Sérieux.¹¹

A female aged sixty-two years had a stroke in 1888, followed by paralysis, and had another attack in June, 1890,

with epileptiform convulsions and hallucinations of hearing. When examined on Dec. 16th, 1890, word-blindness and agraphia, and also word-deafness and paraphasia, were found to be present. She was also found to be suffering from marked object-blindness, which was exhibited by the inability of the patient to recognise her relatives and friends when they called upon her. Their faces and figures seemed to her to be quite changed, and, as she expressed it, all the people about her seemed to be wearing masks. This object-blindness, although best marked in relation to faces, was also manifested in relation to the familiar objects about her, although to a less extent. A few months afterwards she died from pneumonia. On examination of the brain a bilateral cortical lesion was found. On the left side there was a softening in the supra-marginal convolution, and also a limited patch of softening in the posterior extremity of the first temporal. On the right side there was a large patch of softening involving the angular and supra-marginal convolutions and also the posterior extremities of the first and second temporal convolutions.

I have quoted these additional cases in order to make the conception of the visual memory more complete. But what is meant by the terms "memory" and "visual memory"?

It is customary and correct to employ the term "memory" in a general sense to express the power, which all rational beings possess, of preserving and of reproducing impressions previously received. In psychology up till recent times memory was regarded as a special faculty and as an indivisible unity. But the new psychology, expounded with lucidity by Ribot¹² and by Binet,¹³ teaches that the word "memory" is simply a general term reducible to particular cases, that such a unity as memory

does not exist, but that individual memories do exist—*e g.*, memories of vision, of hearing, of taste, of smell, of movements, and so forth. The facts of mental physiology and pathology have clearly shown that we must not regard the memory as a single faculty having a definite location in the brain. The memory is really the sum total and result of a number of distinct mental processes. There exist partial, special, or local memories, each of which has its own special domain—all of which have intimate connections with one another, yet possess an independence of each other such that one of these special memories can be enfeebled, lost, or developed to an abnormal degree, without any of the other forms necessarily presenting any corresponding modifications. These special or local memories are both motor and sensory. Of these the sensory memories form a most important group. Each organ of sense has its cortical centre in the brain, where not only fresh sensory impressions are received, but also previous sensory impressions are stored up and linked with associated sense impressions stored in other centres. Our primary and most simple ideas of objects are formed by the revival in our minds of these sensory memories.

The member of this group which concerns us is the visual memory. There is in the cortical centre of vision situated in the angular and supra-marginal convolutions a storehouse of past visual impressions. These can be called into the sphere of consciousness at will when we form what we call a mental picture, or according to the French nomenclature, a visual image. To put it concisely, the visual memory means the power of preserving and of recalling to consciousness past visual impressions. It is only through the help of this visual memory, of this storehouse of past visual impressions, that we can interpret the fresh visual impressions that are constantly passing to the

brain. Sweep away the visual memories or images from the brain, and you have the condition commonly known by the term "mind-blindness." In this condition the object is seen, but there is no intelligent recognition of it. There are no past visual impressions to compare it with, and through the medium of the visual memory to arouse the other sensory and motor memories regarding it. Hence the object, though seen, has no significance whatever for the mentally blind. Mind-blindness, then, is simply loss of visual memory. We must carefully distinguish between simple perception of an object and an intelligent knowledge of it. If retina, optic tract, and percipient centre in the occipital lobe are intact, then we shall be conscious of the image of any object which falls upon the retina, and may assign it to its proper position in the external world. But we may have no intelligent knowledge of it. The visual memory centre must be communicated with, the present visual impressions must be compared with similar past visual impressions, and through the medium of the visual memory we arouse the other sensory memories regarding it, all of which are closely associated. The visual memory, then, plays a most important part in every conscious exercise of the vision. But it is evident from the study of the facts of mental pathology that this visual memory is not a unity. We have seen that the visual memories for words and letters, for numbers, and for musical notes have a functional independence of each other. Each group of visual memories may be entirely lost, whilst the others remain intact and unaffected in the slightest degree. Hence we are led to infer that they must possess an anatomical independence. We can as yet only localise the visual memory of words and letters, but from the frequency with which these three groups of visual images are simultaneously lost we can infer that the

regions affected, though not identical, are probably very close together. Further these three groups have this in common, that they are highly specialised visual memories, requiring for their retention in the brain a considerable amount of mental concentration and education.

There are other groups of visual memories which are not so highly specialised, and for the acquirement of which comparatively little mental concentration or special training is necessary. The visual memory of form and colour, of objects and places, furnishes us with a mental picture gallery which enables us to find our way with unerring accuracy through the intricate streets of a great city, which enables us to recognise a friend after the lapse of years, and which puts us in an intelligent relationship with the objects around us in our daily life. That this form of visual memory is distinct from the highly specialised visual memories of words, numbers, and musical notes is clearly shown by the clinical evidence. Word-blindness and note-blindness are but seldom accompanied by any impairment of this larger group of visual memories. We have seen, as in Charcot's case, that a great impairment of this group of memories may exist and yet the patient be able to read and write. Further, this form of mental blindness for form and colour, for objects and places, is of great rarity, whereas the loss of the highly specialised visual memories is comparatively common. I would thus divide the forms of visual memory into two main groups:—first, a group of highly specialised visual memories for the acquirement of which great mental concentration is necessary, and which are possessed only by those specially trained; and, secondly, a group of visual memories for form and colour, for objects and places, for the acquirement of which no great mental effort is required, and which are possessed by all men who have the sense of vision. We are led to infer

from the complete functional independence of these two groups of visual memories an anatomical independence, and a plausible suggestion has been offered as to why the loss of the first group should be comparatively common as compared with the loss of the second.

The organs of sense that are concerned in the reception and interpretation of speech are represented bilaterally in the cerebral cortex. Since each eye and each ear are connected with both hemispheres, destruction of the cortical centre in one hemisphere will not make the patient deaf in one ear or blind in one eye. Destruction of one occipital lobe causes, as we shall see, homonymous hemianopsia only. But with regard to language the education of these sensory centres is unilateral. In the auditory and visual centres of one hemisphere only are the sensory impressions of language, visual and auditory, retained and stored up. The hemisphere selected is always that in which are situated the motor centres for speech and writing. It is thus the left hemisphere in right-handed people and the right in left-handed people. A lesion on one side of the brain, in the vast majority of cases on the left side, may completely obliterate the visual word memories and make the individual word-blind. The visual memories of numbers and musical notes are also probably unilateral and in the immediate neighbourhood of the word centre, for, as already pointed out, all three groups of visual memories are frequently lost together. It has been suggested that the second group of visual memories—those of objects, of places, of form, and of colour, which do not require such an effort of attention and concentration—are efficiently imprinted and stored up in the higher visual centres of both hemispheres. Hence it would require a bilateral lesion to produce object-blindness, and hence, as can be readily understood, its much greater rarity. The case of

Sérieux, already quoted, supports this view, where the patient suffered from word- and object-blindness, and where, after death, was found a bilateral lesion in the brain involving the left supra-marginal convolution and the right angular and supra-marginal convolutions. This, however, is a subject which is by no means settled and which awaits further investigation.

A notable feature in both my cases of loss of visual memory was their association with right lateral homonymous hemianopsia. This condition also existed in Charcot's case of word-blindness, already referred to. According to Charcot, a similar hemianopsia associated with word-blindness was to be found only in one other observation, that of Westphal.¹⁴ Since then, however, many cases have been recorded, and I am able to quote nine additional cases. Two cases have been recorded by Samelsohn,¹⁵ two by Wyllie of Edinburgh,¹⁶ and two by Henschen of Upsala.¹⁷ One case has been reported by Brandenburg,⁷ one by Dejerine,⁸ and one by Bruns and Stoelting.¹⁸ In all these cases word-blindness was associated with right homonymous hemianopsia. As we have cases of word-blindness without right hemianopsia, and as we have right hemianopsia without word-blindness, it is evident that the cerebral centres for the right halves of both visual fields and for the visual memory of words must be distinct from one another. Yet these symptoms are associated with such frequency as to lead to the inference that the cerebral centres or the paths to them must lie in close proximity to one another. We shall see that pathological evidence confirms the inference drawn from clinical experience.

The question of the exact localisation of the visual centres in the brain has given rise to considerable controversy in the past. For a considerable time Ferrier and Munk carried on a discussion on this subject. Ferrier

originally held that the cerebral centre of vision was situated in the angular convolution, and Munk that it was in the convolutions in the posterior part of the occipital lobe. Recent clinical and pathological observations^{5, 8, 11, 17, 34} are reconciling these apparently antagonistic opinions by showing that both Ferrier's centre and Munk's centre have important parts to play in the function of vision. It has already been pointed out in this chapter that in the act of vision we must distinguish between the mere perception of an object, as occupying a certain position in our visual field, and the recognition of it, as to its exact nature and qualities. Although the boundaries of the visual centres cannot as yet be laid down with precision, yet the mass of pathological evidence tends to show that the occipital lobe, especially in the neighbourhood of the cuneus and the calcarine fissure, is the centre for primary visual impressions, the perceptive centre, and that in the angular convolution and its neighbourhood there is a centre of a higher nature, one of whose functions seems to be the storage of the visual memories of things and words, the visual memory centre. It is evident from what has already been said that the functional activity of both these centres must be called into play in every conscious and intelligent exercise of vision. It is now a matter of general agreement that the primary visual centre in the occipital lobe is connected with the half of the retina in each eye, the left occipital lobe with the two left halves and the right occipital lobe with the two right halves. But since the left half of each retina corresponds to the right half of each visual field a lesion in the left occipital lobe would produce blindness in the right halves of both visual fields, or, in other words, a right hemianopsia. The hemianopsia is termed homonymous because it is on the same side in relation to both

eyes. A lesion of the right occipital lobe would produce left homonymous hemianopsia. To put it concisely, destruction of the primary visual centre in the occipital lobe produces homonymous hemianopsia in the opposite halves of the fields of vision. It is also known that a lesion in any part of the optic tract from the cerebral cortex to the optic chiasm will produce homonymous hemianopsia.

In my case of word-blindness, however, there are two points which lead us to infer that the lesion causing the hemianopsia is in or near the cortex. 1. When a beam of light fell upon the blind half of each retina the pupils contracted actively, just as when it fell upon the seeing half. Wernicke first pointed out that if there be loss of the reflex movement of the pupil, when light is thrown upon the blinded portion of the retina, the break in the conduction must lie below the spot at which the fibres to the oculo-motor nucleus are given off—*i.e.*, it must lie in the optic tract itself. This valuable diagnostic symptom has been called Wernicke's hemiopic pupillary reaction. But when, as in my case, the pupillary light reflex is intact, the lesion is to be located higher up, in the internal capsule, the optic radiations, or in the cortex of the brain. 2. The association of the hemianopsia with word-blindness, which is known to be always dependent on a cortical or sub-cortical lesion, leads us to infer that the right homonymous hemianopsia is due to a lesion in the cortex of the left occipital lobe or of the optic radiations passing to it. The frequent association of right homonymous hemianopsia with word-blindness, already referred to, thus confirms the results of pathological experience, that the centre for the visual memory of words is in the neighbourhood of the left occipital lobe.

Although its boundaries have not yet been finally laid down, still a constantly increasing pathological experi-

ence^{5, 8, 11, 17, 34} tends to prove that the centre in which are stored the visual memories of letters and words includes the supra-marginal and angular convolutions, both of which belong to the inferior part of the parietal lobe. Pathological experience also shows that the more important part of the centre is situated in the angular convolution, which is bounded posteriorly by the occipital lobe. It has already been pointed out that the visual centre forms no exception to the law that with regard to language the education of the motor and sensory centres is unilateral. The hemisphere selected is always that in which are situated the motor centres for speech and writing, hence in right-handed people, forming the vast majority of cases, the visual memory centre for letters and words is situated on the left side of the brain in the region already described. This centre in the left angular gyrus and neighbourhood is connected with both occipital lobes, hence destruction of the left occipital lobe causes right homonymous hemianopsia, but not word-blindness, since the right occipital lobe is still connected with the visual word centre in the left angular gyrus. To have complete word-blindness the centre itself must be destroyed, or its connexions with both right and left occipital lobes must be cut off. The visual word centre is supplied with blood by the sylvian artery, and it is a significant fact that all the cerebral centres concerned either in the expression or in the interpretation of language are situated within an area supplied by the same vessel. The speech-motor centre, the graphic centre, the auditory word centre, and the visual word centre are all supplied by branches of this sylvian artery, hence it is easily understood how disturbances of all the centres or some combination of them are so frequently associated; further, in consideration of the immediate proximity of the visual and auditory word

centres, the auditory being in the posterior part of the first convolution of the temporo-sphenoidal lobe, it is manifest how the symptoms of word-blindness and word-deafness are associated with such great frequency. My case of word-blindness is a pure example of the rarer condition of isolated lesion of a single centre, all the other centres concerned in language being intact. The patient could speak, write, and understand spoken language as well as ever he did.

I have dwelt particularly on the fact that my word-blind patient could write fluently to dictation, although he could not read what he himself had written. The old explanation put forward to account for such cases was that by constant and prolonged practice the motor images of writing had become so deeply imprinted upon the graphic motor centre (in the second frontal) that without any aid from the visual centre the revival of these motor images was quite sufficient to guide the hand to form the letters correctly. It has been shown, however, by the recent observations of Dejerine⁸ and Sérieux¹¹ that when the visual word centre is destroyed the patient can neither read nor write. He is agraphic because he can no longer call up in his mind the visual memories of letters which are necessary to stimulate the graphic motor centre. How, then, are such cases as mine to be explained, where there is complete word-blindness without agraphia, and where the patient can write fluently, although he may not be able to read a single word of what he has written? It is now maintained that in such cases the visual word centre is intact, and also its connecting path with the graphic motor centre, but that the pathways connecting the primary visual or perceptive centres in both the occipital lobes with the visual word centre in the left angular convolution are cut across. Hence the visual memories of

words and letters can still be revived from within, and serve as a guide to the graphic motor centre; but impressions from without from the perceptive centres can no longer reach the visual word centre because of the interrupted pathways. Such an explanation is in perfect harmony with the facts observed in my case. I found that the patient, even when unable to read a single letter, still possessed the power of calling up at will the visual images of all the letters. He informed me that when I mentioned any letter he could mentally see it just as well as ever he could. Hence the patient could write because he had still the power of reviving the images of letters, and to accomplish this the centre itself must have been intact. How, then, could he no longer recognise these same letters which he had written? Because the visual word centre was cut off from the primary visual centres in the occipital lobes, and hence could not be reached by any visual stimulus from the external world. I would refer particularly to a case recorded by Dejerine⁸ in which the post-mortem examination supported in a very striking manner the view expressed above. This case is particularly interesting, as it presents almost the identical group of symptoms which were met with in my case of word-blindness.

Dejerine's patient was a man sixty-eight years of age who, after a number of attacks of tingling in the right arm and right leg, suddenly perceived that he was unable to read a single word. Although word-blind he could write as fluently as ever. He could copy correctly pages of manuscript, although he could not read a word he had written. He had also lost the power of reading musical notes (note blindness), but he could still sing well. He could read figures and do mental calculations just as well as ever. On examination with the perimeter he was found to be suffering from right homonymous hemianopsia. Ten

days before his death he was suddenly seized with paraphasia and total agraphia. There was no muscular paralysis, and his intelligence remained clear until his death, which occurred suddenly. On examination of the brain there was found (1) an old lesion, a softening which had destroyed the cuneus and some of the neighbouring convolutions of the left occipital lobe and had extended deeply into the white matter so as also to cut across the fibres passing from the right occipital lobe to the left angular convolution—this old lesion thus accounted satisfactorily for the hemianopsia and for the word-blindness without agraphia which had persisted for four years; and (2) a recent lesion—viz., a softening of the left angular and supra-marginal convolutions, which explained the recent appearance of total agraphia. The paraphasia was probably caused by disturbance of the auditory word centre, which is in the immediate neighbourhood. For other illustrative cases I would refer to the papers published by Dejerine and Sérioux, to which I have already called attention.

It is thus evident that in my case the word-blindness and the right lateral homonymous hemianopsia may be accounted for by a single lesion. We have seen that interruption of the optic radiations as they pass to the occipital cortex produces a lateral hemianopsia, just as when the occipital cortex is destroyed. A subcortical lesion in the white matter of the left occipital lobe, so situated as to cut across the fibres passing from both occipital lobes to the left angular gyrus, would render the patient word-blind but not agraphic. As such a lesion must involve the optic radiations passing to the left occipital cortex, the patient would have at the same time right homonymous hemianopsia. As to the probable nature of the lesion, the absence of all signs of disease, with the

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the hemianopsia, which is practically the same as at the outset of the attack; (2) the slow and gradual acquisition of the knowledge of printed letters, but only after persistent education and practice; and (3) the comparatively slight improvement in the knowledge of written letters, the study of which has not been carried out with the same steady perseverance.

CHAPTER III.

A CASE OF PARTIAL MIND-BLINDNESS WITH DYSLEXIA, A
PECULIAR FORM OF WORD-BLINDNESS.

THE following case, though different in many respects from that reported in the preceding chapter, yet belongs, in my opinion, to the same group. The patient was seen by me in Professor McCall Anderson's wards in the Western Infirmary, Glasgow, and with his kind permission I am enabled to report the case.

The patient, a tailor, aged forty-five years, was admitted into the Western Infirmary on March 4th, 1896. He stated that he had always enjoyed good health and had recollection of only one illness in his lifetime—an attack of influenza some years ago. He drank freely for many years, but during the last twelve months had been comparatively temperate in the use of alcohol. On admission he complained that he had been unable to follow his employment during the last six months because he became stupid, as he expressed it, when he attempted to do anything. The patient not being a very intelligent man it was exceedingly difficult to elicit any precise description from him as to the nature of this mental confusion. He always described himself as getting stupid and his head giving way when he attempted to work. He complained, also, of not being able to read, since his illness began, and it was a close analysis of this symptom which revealed the true character of the mental derangement from which he was suffering. On examination with the test-types it was evident that the visual disorder was a very peculiar one. On attempting

to read he read the first few words quite correctly and then suddenly came to a stop, saying he could not go on. After resting a little he would begin again with precisely the same result, always coming to a stop after reading a few words. On asking him how it was that he could not continue to read he said that although he could see the letters quite distinctly he became stupid—they seemed to lose all meaning for him. He particularly said, in answer to further inquiry, that there was no blurring of the letters and that they did not seem to run together. This difficulty had nothing to do with diminished visual acuity, as the result was precisely the same with the largest as with the smallest of the test-types. Further, on the application of other visual tests, it was evident that the visual acuity was unimpaired. The attempt to read seemed to cost him great mental effort and he frequently put his hands to his head during the trials. He experienced no pain, but simply a sense of great mental fatigue. His difficulty was the same with printing and writing. In order to get more exact information as to the way in which he had recently done his work inquiries were made of his employer, who furnished us with the following information. The patient used to be a very good workman, but for some time before his dismissal his work had been done very badly. Latterly he seemed to forget after he started to work how to proceed with it. On making a garment every successive step had to be pointed out to him, just as to a man who had never done the work before. He often made the most absurd mistakes in sewing the wrong pieces of garments together, and did not seem to recognise the shapes and relative positions of different pieces that were to be sewed together. Even when he did sew the correct pieces together his sewing was frequently so bad, like that of the merest beginner, that it had often to be ripped up. Some-

times his work would be torn up three or four times in the making of a single garment. These defects became so bad that he was dismissed, as he had been for some time practically of no use in the workshop. His fellow-workmen also observed that he spent a large portion of his time in looking for things which he had put away. Half of his time was latterly spent in looking for his needle and thread, his thimble, his glasses, or the parts of the garment he was working at and which he had put aside for a little while. He could not recollect even a few minutes afterwards where he had placed anything. The patient also informed me that of late he had frequently lost his way in parts of the city with which he was perfectly familiar, and only got home with great difficulty and by repeatedly asking information from passers-by. Two days before coming to the Infirmary he went into Glasgow Green for a walk. He was perfectly familiar for years with the Green, and though his house was close to it, he completely lost his way. He found his way home with the greatest difficulty after wandering about for some time and making numerous inquiries. At last a friend met him and led him home. This did not occur every day, but only occasionally, although of late more frequently. On asking him to explain this he said that he seemed suddenly to forget all about the directions of the different streets and that his whole surroundings seemed for the time quite new and strange. On examination of the patient no objective signs of disease could be discovered. A careful examination of the nervous system revealed no abnormality. His eyes were normal in every respect. There was a slight amount of presbyopia, for which he was wearing suitable glasses. The refraction, the visual acuity, the visual fields, and the fundus were all normal. The eye muscles, which were carefully examined, revealed no abnormality. There was

no general deterioration of the mental powers. The patient's mind in other respects seemed clear and active. His memory for past events did not seem to be at all impaired. There were no disturbances of speech. He was put upon arsenic and strychnine and during his residence in hospital there was great improvement in his condition. He was advised to practise reading for a short time every day. There was steady and continuous improvement. The time during which he could continue to read gradually increased until before he left the Infirmary he could read for any length of time. He was dismissed on April 24th, after seven weeks' stay. His general condition was improved and he gained a stone in weight during his residence in hospital. He went to the Lanark home for a few weeks and after leaving there resumed his employment. I saw him last in the beginning of August, three months after his dismissal from hospital. He was continuing well. He could read fluently and without effort. He never lost his way in the town. He was engaged at his employment of tailoring, although he said that he could not do his work as well or as smartly as before his illness, but he never made the absurd mistakes which he used to do. The main factor in contributing to the rapid improvement of the patient was in my opinion the complete withdrawal of the alcohol. Although for nearly a year preceding his admission into hospital the patient, becoming alarmed about his condition, had been comparatively temperate, yet he never became a total abstainer, and indulged daily in alcohol. But we know from experience that when a toxic condition has been established by excessive indulgence a comparatively small quantity may be sufficient to keep up the toxic condition. This is true, for example, of tobacco amblyopia, and was confirmed in this case by the rapid improvement after complete withdrawal of the toxic agent.

Such is the history of the case, of which the symptoms are entirely cerebral. At the first glance these seem to have no coherence or mutual relationship, but I will attempt to show that they have a very direct relationship to one another and point to an affection of a special area of the brain. On analysing the symptoms, which the patient described to the best of his ability as stupidity, there were three prominent facts:—(1) the peculiar difficulty in reading; (2) the inability to follow his employment of a tailor; and (3) the loss of memory for places. I will discuss each of these symptoms and finally see what relationship they have to one another.

The difficulty of reading complained of by the patient was a very peculiar one. He only read a few words and then came to an abrupt stop, saying that he could not go on. If he were allowed to rest a little he would again read a few words and stop just as before. I have already pointed out several features of this difficulty in reading which differentiated it from ordinary cases of asthenopia, due to muscular insufficiency or some optical defect. There was no blurring or running together of the letters. The patient saw them plainly, but, as he expressed it, after a little he became stupid and they lost all meaning for him. The difficulty was entirely independent of the size of the letters and therefore had no connexion with diminished visual acuity. There were four important features which distinguished this case clearly from an ordinary case of asthenopia. 1. The rapidity of the onset of the difficulty. He always broke down after reading a few words. 2. The intensity of the visual disturbance. After breaking down he could not read a single word by any effort of the will or any optical assistance, and still the words and letters were seen distinctly by the patient. 3. There was no pain or discomfort in or about the eyes,

but simply a sense of great mental effort. 4. No error of refraction, no affection of the fundus oculi, no muscular insufficiency or any ocular defect could be discovered on the most careful examination. It was therefore evident that this difficulty of reading was not due to any affection of the eye, but to some disorder of the visual centres in the brain. In the case recorded by me in the preceding chapter the patient with normal visual acuity was unable to read any printed or written characters with which he was previously familiar with the exception of Arabic numerals. Similar cases having been described ever since Kussmaul's article¹ by the term "word-blindness," I adopted it as the most convenient word for briefly indicating the character of the case. Sir William Broadbent, in a critical note in *The Lancet*²⁰ on my paper, has remarked that "in his judgment the employment of the term 'word-blindness' has been misleading and unfortunate." Now I quite agree with Sir William Broadbent that the word has frequently been used by writers loosely with different meanings attached to it, and therefore it has been frequently misleading. The fault, however, lies, not in the word, but in the fact that those who use it have not always a clear conception of what Kussmaul meant by it. By the term "word-blindness" is meant a condition in which with normal vision, and therefore seeing the letters and words distinctly, an individual is no longer able to interpret written or printed language. With a clear understanding of this definition there is nothing misleading about the term, which is a most convenient one for describing a group of cases, which, however, includes several different forms. All the varieties have this point in common, that the inability to interpret written and printed language is not dependent upon any ocular defect, but upon disorder of the cerebral visual centres. The case

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read further. After a short pause he again attempted to read, but came to a standstill after reading a few words. This experience was repeated in each successive experiment. He had precisely the same difficulty with types of all sizes. He could not state exactly the reason he could not continue reading. There was no pain or discomfort in the eyes or their neighbourhood; the letters did not become dim or confused—he could simply not read further. The attempt to do so appeared certainly to be unpleasant to him, as after having read quickly the first few words without mistake he at once put away the book as if to free himself of something unpleasant. Neither the eye nor its muscular apparatus showed any abnormality on the most careful examination. Aphasic disturbances were not present, nor was any other abnormality discovered. Professor Berlin wrote to the patient's medical attendant that as there was no disease of the eye and no muscular defect the difficulty of reading must be referred to a cerebral affection. The patient did not again come under his observation, but he learned through Professor Niemeyer that about six months later his opinion was confirmed by the development of further cerebral symptoms and the ultimate death of the patient with an apoplectic seizure.

The similarity of this case to my own as regards the peculiar character of the reading difficulty is very striking, and these cases may be regarded as presenting in its most typical form the characteristic features of this disorder. Professor Berlin in his monograph records six cases, and Niden,²² Bruns,²³ and Uhthoff²⁴ have reported others. The term "dyslexia" applied to these cases by Professor Berlin is a convenient one and I have adopted it as describing the prominent symptom in my case. Professor Berlin regards it as a special form of word-blindness due to an interruption in the conductivity of the connecting

fibres of the visual centre in the lower parietal lobe of the left hemisphere. This view has been borne out by post-mortem examination. On the whole, Professor Berlin says post-mortem evidence supports the statement that the anatomical seat of the lesion in dyslexia is to be found in the lower parietal lobe of the left hemisphere, which includes the supra-marginal and angular convolutions. Professor Berlin accounts for the phenomena observed, by the hypothesis that the interruption of the connecting fibres is only partial, that the capacity for conduction is reduced to a minimum, and that the slight power of conductivity remaining is rapidly exhausted. This seems a plausible and probable explanation of the rapid failure in the patient's power of reading. In the great majority of cases dyslexia has been found to appear as an early and sometimes as the first symptom of grave organic disease of the brain. Even in such cases frequently the dyslexia gradually improved whilst other grave cerebral symptoms subsequently appeared, such as right-sided hemiplegia, disturbances of sensation on the right side, right lateral homonymous hemianopsia, and sometimes aphasia. All these later cerebral symptoms pointed to a lesion on the left side of the brain within the area between Broca's convolution, the arm and leg motor centres and the visual centres, and such cases frequently went on to a fatal issue. There is another class of cases referred to by Professor Berlin where dyslexia sometimes appears—viz., in chronic alcoholics. In these cases he found that the disturbance gradually passed away when the alcohol was withheld. My case belongs to this category. The patient's habits, the continuous improvement when alcohol was withheld, and the non-appearance of any further symptoms of cerebral disease, all combine to confirm the opinion that the dyslexia was of *toxic* origin due to disturbed nutrition of

the cerebral centres or connecting fibres from excessive indulgence in alcohol. We are all familiar with many of the common forms of nervous disorder due to alcoholism, such as paresis and paralysis of the limbs, paresis and paralysis of the ocular muscles, and a peculiar form of amblyopia characterised by a central defect in the field of vision, very similar to the amblyopia produced by tobacco. That it also profoundly affects the cerebral visual centres we know from the frequency with which excessive indulgence in alcohol gives rise to a temporary mental affection in which visual hallucinations and illusions are prominent features. The opinion that the difficulty in reading was dependent upon a disorder of the visual memory centre, or of its connecting fibres, was strongly confirmed by consideration of the other peculiar symptoms present in the case.

The complete breakdown in the patient's capacity to follow his occupation of a tailor presents a striking analogy to the failure in his power of reading. He had been known for many years to his master and fellow-workmen as a good tradesman and a quick worker. Yet for a considerable time before his dismissal he did his work not only in an incompetent manner, but like a man who was in a tailor's workshop for the first time in his life; he seemed to have completely forgotten the relative shapes and positions of the different parts which make up a garment, so that he made the most absurd mistakes, often sewing pieces of different garments together. He was only able to continue at work for a little while through the kindness of his fellow-workmen, who had to direct him in every successive step what to do next. His sewing, too, was like that of a person who had never learned to sew, and was often so very bad that it had to be ripped up and finished by another workman. Finally, his employer dismissed

him, as he was practically useless in the work-room. This transition of a skilled workman to a condition of helplessness can only be intelligibly explained in my opinion by failure of visual memory. A moment's consideration will show what an important part visual memory plays in the exercise of this calling. The recognition of the different shapes of the various parts of a garment, and the relative positions in which they must be placed in order to complete the whole, is only possible through the exercise of visual memory, which has been gradually acquired by the previous experience of the workman. If this be lost then the individual is reduced to the condition of a man who has never learnt the trade. Even in simple stitching the visual memory comes into play and guides the complicated movements of hands and fingers. It is only by the failure of visual memory, in my opinion, that his conduct can be intelligibly explained. This view is strongly supported by a case reported by Dr. Hermann Wilbrand of Hamburg, in his interesting and able monograph, "*Die Seelenblindheit.*"³⁵ His patient was a woman suffering from mind-blindness, or, in other words, loss of visual memory. She was unable to recognise her friends, the familiar objects around her, or to remember places. The very rooms and furniture in her own house seemed all new and strange to her. She could not find her way about the town in which she lived, but required to be led about as if she had been in a strange town. Dr. Wilbrand particularly observes that she could no longer sew properly, an accomplishment in which she used to be proficient. When she tried it, the work she did was of the rudest description, like that of a child's first attempts. Fine sewing and stitching, Dr. Wilbrand remarks, are comparable to drawing, and even in the hands of the most expert cannot be properly done without the supervision of the visual memory.

The third peculiarity of the patient was the loss of memory for places. He could never remember where he put anything, and it was observed by his fellow-workmen that a large portion of his time was occupied in looking for things which he had mislaid. He also suffered occasionally from temporary loss of memory for familiar localities, so that he frequently lost his way in parts of the town with which he had been familiar for years. The recognition of places and localities can only be accomplished by a constant comparison of the present visual impression with the vast storehouse of mental pictures of places preserved in our visual memory. If the individual be deprived of this form of visual memory then he becomes like a complete stranger in his own house or in the streets of his own city. This form of visual memory supplies us with a kind of mental picture chart, which enables us to find our way with unerring precision amongst scenes and places with which we are familiar. In the case reported by Dr. Wilbrand, and already referred to, this loss of memory for places was a striking symptom, and in the preceding chapter some excellent examples of this form of failure of the visual memory were quoted.

Here, then, we have the history of a patient who could not read, who could no longer do his work as a tailor, and who occasionally lost his way in the midst of familiar surroundings. Yet the ocular part of the visual mechanism was perfectly normal, and as his visual fields were normal, we may also infer that the visual perceptive centres occupying the occipital lobes were also intact. I think it is clear from our analysis of the case that all the symptoms manifested have this very direct relationship to one another—that they are all dependent upon failure of the visual memory. The intelligent exercise of vision is a very complex act of which we have as yet only very imper-

fect knowledge. To the successful exercise of the function the brain contributes as largely as the eye. The ocular defects in all their multitudinous variety have been studied for many years with great industry and success, but the cerebral disorders, which interfere with intelligent vision, have until recent years not met with the attention they merit.

Increasing knowledge of the cerebral derangements of vision, based on clinical and pathological observation, makes it clear that we must carefully distinguish between the visual perceptive centre and the visual memory centre. The perceptive centres situated in the occipital lobes, chiefly in the neighbourhood of the cuneus and calcarine fissure, enable us to have conscious perception of objects as occupying a definite position in the visual fields. Derangements of this visual centre are evidenced by defects in the visual field, which have all been carefully studied. But the act of vision is infinitely more complex than the simple perception of an object as occupying a particular position in the visual field. It involves complex judgments and, above all, a constant comparison of present visual impressions with the vast series of past visual impressions, the accumulated riches of our life experience which are stored up in a special cerebral area, the visual memory centre, occupying the supra-marginal and angular gyri. Derangements of this centre are evidenced by the various forms of mind-blindness. The objects are distinctly seen, but they convey no information to the individual since they are no longer recognised by him. Word-blindness and loss of memory for places and objects are all simple varieties of mind-blindness. Clinical experience and pathology teach that word-blindness or loss of the visual memory of word symbols is due to a lesion in the visual memory centre on the left side of the brain. In most

cases of word-blindness there is no interference with the other forms of visual memory such as those of places, of objects, of form and colour. When there is complete mind-blindness involving the loss of all forms of visual memory, it is probable that there is a bilateral lesion involving the centres on both sides of the brain. In the present case there is nothing approaching to complete mind-blindness; but the loss of memory for places and the striking failure of that necessary for his employment, in addition to the peculiar derangement of the visual memory for letters, suggest the probability of some impairment of the functional activity of the right as well as the left centre. Nor is this supposition improbable when we consider that many of the nervous disorders due to alcoholism are bilateral, such as amblyopia and the ocular paralyses which are sometimes met with. It is a familiar fact that while alcoholism has a hurtful influence on the whole nervous system, its toxic influence may manifest itself by attacking specially some particular nerve or group of nerves or even some particular bundle of nerve fibres. That it also impairs the activity of the cerebral centres as a whole is frequently shown by a general failure of the mental powers, but here it also may exert its baneful influence on some special cerebral area and produce a temporary cessation of activity or derangement of that particular centre. M. Michel Delines in an interesting study²⁵ has called special attention to this fact. In the case under consideration the visual memory centres seem to have been specially attacked or, as suggested by Professor Berlin, their connecting fibres.

The derangements of these visual memory centres have met with comparatively little study and are not generally known, therefore the vast majority of such cases escape observation, and hence our comparatively scanty records

regarding them. The case just recorded forms an interesting sequel to that reported in the preceding chapter, and gives a clinical picture of another form of derangement of the visual memory. In this case the symptoms were only transient, being due to functional derangement caused by toxic influences; but in the vast majority of cases this form of visual derangement is a symptom of grave organic disease of the brain, and most important of all, it is a focal symptom pointing to disease of a particular area of the brain.

CHAPTER IV.

WORD- WITHOUT LETTER-BLINDNESS.

IN Chapter II., word-blindness was defined as "a condition in which with normal vision and therefore seeing the letters and words distinctly an individual is no longer able to interpret written or printed language." It was there pointed out that there are different forms which ought to be clearly distinguished from one another. In that chapter a case of letter- and word-blindness of singular purity was recorded, the patient having completely lost the power of recognising all the written and printed characters with which he was previously familiar with the exception of Arabic numerals. In Chapter III., a peculiar disorder was described in which the patient's power of interpreting written and printed language was rapidly exhausted and to which the name dyslexia has been given by Berlin. I have recently met with a third variety of word-blindness, where the patient, still able to recognise the individual letters of the alphabet, is yet wholly unable to recognise or interpret the words composed of combinations of these letters. As an excellent example of this distinct variety of word-blindness the following case is, I think, worthy of careful record and consideration.

CASE I.—A man, aged fifty-three years, on Sept. 7, 1897, came home from his business about 2 o'clock in the afternoon saying that he did not feel well and had to give up work in the morning as he could not see to read or

write. Shortly thereafter, whilst sitting on a chair, he became giddy, fell to the ground, and was unconscious, but only for a moment. He soon felt all right again and in the afternoon went out for a walk. In the evening about seven o'clock without warning he had a severe "epileptiform" fit with general convulsive movements and complete unconsciousness for about an hour thereafter. He remained in a dazed condition for about two days, but gradually recovered and since then had been able to go about. On the advice of his medical adviser he had kept away from business. Ever since the fit he had been unable to read and his medical attendant, Dr. Charles Whish, of Pollokshaws, brought him to me on Oct. 11, 1897, to ascertain the precise nature of the visual defect which prevented him from reading. On examining him with the ophthalmoscope, the only abnormal appearances to be found in his eyes were slight radiate lenticular opacities. These, however, were slight and situated at the periphery of the lens, so that they could not interfere to any great extent with the visual acuity. On testing him with the distance types composed of separate letters he could read the letters quite fluently, although his visual acuity was not quite up to the normal, being $\frac{6}{8}$. On testing him with the reading test types composed of words and sentences, I found he could not read when made to rely upon vision alone. If allowed to spell out aloud each word, letter by letter, he could read the words slowly and laboriously, just as a child spells them out when learning to read. When prevented from doing this he could not read words at all. The only exceptions were in the case of a few short familiar words such as "the," "of," "to," &c. These he sometimes picked out with a certain amount of pride. On asking him not to attempt any longer to read the words but to read the letters only, he read them off fluently line

after line. His difficulties in reading words were precisely the same with the largest as with the smallest test types. On the other hand, he read the letters of the smallest test types, Jaeger No. 1, without difficulty with suitable glasses. He had precisely the same difficulty in reading written as in reading printed words. On testing him with figures he could read them rapidly and fluently, not only the individual figures, but when combined into complicated groups of thousands, hundreds of thousands, and millions, and even in the form of very complex fractions. He could write to dictation and copy correctly although he could not read what he had written. The visual fields for white and colours were normal. I conversed with him on three different occasions for about an hour each time and there was not the slightest evidence of verbal aphasia or amnesia or of any speech difficulty whatever. His wife, however, informed me that since the fit he had occasionally forgotten the names of old friends and customers. He had also shown a disinclination to exert himself mentally, being disinclined to talk much even with his intimate friends. He was a man of the most regular habits, but before his fit he had considerable mental worry. His vessels were atheromatous. On the most careful examination no other symptoms were discoverable. The patient was seen by me on three different occasions. On the day preceding my last interview with the patient, there was a history of a transient attack of tingling and paresis of the right arm during a meal, so that he had for a short time to use his left instead of his right hand. This rapidly passed off and when seen on the following day there was no trace of it. I gave it as my opinion that the inability to read was not due to any ocular defect but to a lesion in the visual word-memory centre situated in the angular and supra-marginal gyri on the left side of the brain and

supplied by a branch of the Sylvian artery, that the lesion was either a small hæmorrhage or more probably thrombosis occluding that branch of the Sylvian artery supplying the centre. Whether the lesion would remain stationary or extend it was impossible to say. The patient was strongly urged to abstain entirely from business so as to secure absolute cerebral rest and iodide of potassium was recommended on the ground that there might be some specific affection of the cerebral vessels, although there was no history or traces of past specific disease.

For the after-history of the patient, which will be given very briefly, I am indebted to the kindness and courtesy of his medical attendant. About a week after consulting me, slight paresis of the right arm and leg and slight paraphasia began to manifest themselves. These symptoms rapidly developed and within another week there was considerable aphasia and well-marked right-sided paralysis, the face being now involved as well as the arm and leg. He complained greatly of pain on the left side of the head. When the aphasia was complete he was given block letters in order to see if he could not express his wants by means of these. He gave them to understand by signs that he recognised the letters, but could not combine them into words. The aphasia and right-sided paralysis became complete before his death, which occurred on Dec. 8, 1897, about nine weeks after I saw him. There was no post-mortem examination.

The feature of the case to which I wish to draw special attention is the inability to read, which when I saw the patient was the only symptom present, but which enabled us to give a positive diagnosis that he was suffering from organic disease of a special area of the brain. The diagnosis of the true nature of the patient's inability to read was not difficult. In the ordinary routine he was first

examined with the distance test types composed of individual letters and these he read without difficulty, showing that visual acuity for distance was nearly normal. When he was given the test types for near vision composed of words and sentences he was unable to read them. This inability to read was altogether independent of the size of the types, being the same with the largest as the smallest. For a moment this was somewhat puzzling. His ability to read the distance types composed of individual letters suggested the request that he should no longer attempt to read the words but simply to name each letter successively. This he did with fluency, running through line after line of the test types, beginning with the very smallest, Jaeger No. 1. It was then clearly evident that the inability to read printed or written words was not due to any ocular defect, but was a cerebral disorder of vision. This defect forms a very interesting contrast to the first case described by me, where the patient, having completely lost the power of recognising printed and written characters, was in the position of a child who has not yet learned the letters of the alphabet. The present patient, recognising the individual letters, but not being able to combine these into words, was in the position of a child who has learned the letters of the alphabet, but has made no further progress. His inability was with words alone and hence the case has been described as word- without letter-blindness. The patient was able to read if he was allowed to spell out aloud each word letter by letter. The explanation of this is simple. He could recognise by sight only the individual letters, but by spelling them out aloud he appealed to his auditory word-memory in the tempero-sphenoidal lobe, which enabled him to combine them into the corresponding word. An analogous condition was presented by my letter-blind patient, who, unable

by sight to recognise a single letter, could frequently do so if allowed to trace it out with his finger on the table. He was thus able to recognise the letter by reviving the graphic-motor images of the letters, which are probably stored in a special centre in the neighbourhood of Broca's convolution.

In many of the recorded cases of word-blindness the precise nature of the defect is not stated, the reporter contenting himself with the statement that the patient was unable to read. In others the inability to read is complicated with word-deafness, motor-aphasia, or verbal amnesia, and from the proximity of all the cerebral centres concerned in the expression or interpretation of language it is easily understood how these complications occur so frequently. In such cases the problem is obscured by the simultaneous involvement of a number of cerebral centres, so that the precise significance of the ability to read is not clearly seen. This peculiar form of word-blindness, however, does occur altogether apart from any other defects. In the present case the patient when seen by me presented on the most careful examination no other symptoms of any interference with his powers of expression or interpretation of language. On looking over the recorded cases of this variety of word-blindness I have met with two cases of singular purity which will be briefly quoted as affording further typical and uncomplicated examples of word- without letter-blindness. Swan Burnett, of Washington,²⁶ records the following case in a very graphic manner and with considerable detail.

CASE II.—The patient was a clergyman, eighty-two years of age. Three weeks before he was seen by Burnett the patient had an attack of giddiness followed by three general "epileptiform" seizures within two days. During

the intervals of these attacks he remained in a condition of stupor, but at the end of the third day became fully conscious and felt quite well with the exception of weakness. He found, however, that he could no longer read and therefore consulted Swan Burnett. On examination it was found that there was no ocular defect. It was also found that whilst he could read all the individual letters with ease he was wholly unable by means of visual impressions alone to interpret written or printed words. Numerals were read correctly and with ease. Burnett observed that he read at once the amount of a cheque but could not tell to whom it was drawn or by whom. He could write either spontaneously or to dictation but was unable to read what he had written. His mental faculties generally and memory in other respects were unimpaired. There were no other difficulties in the expression or interpretation of language. All other retinal impressions were correctly interpreted. The patient died from an attack of pneumonia about a year after he was seen by Burnett. In the interval no essential change had taken place in his condition. His general mental faculties and bodily health remained good until his fatal attack of pneumonia. His reading faculty, however, was never regained. There was no post-mortem examination. Burnett remarks: "This case seems to be one of alexia pure and simple. No other faculty, so far as the closest scrutiny and the most careful examination could determine, was affected except that of reading. This fact would seem to demonstrate quite conclusively the existence of a 'reading centre' separate and distinct from any and all other centres."

Mierzejewski⁶ communicated in 1890, at the September meeting of the St. Petersburg Psychiatric Society the following case of word-blindness.

CASE III.—A physician, aged fifty-six years, of delicate constitution, infected with syphilis in his youth, suffered for a long time from chronic nephritis. In January œdema appeared and he had an uræmic comatose attack which lasted four or five days. Two similar attacks, but of shorter duration, appeared thereafter. Some time after the third attack the patient observed that he had lost the power of reading, although he could easily recognise the letters. Mierzejewski on examination found that he could easily recognize every individual letter but could not unite these into syllables or words. He wrote to dictation fluently and correctly, but could not read what he had written. He wrote prescriptions correctly but could not read them again. He copied writing without mistakes, although he did not understand the meaning of the words he copied. He recognised and read figures even when they were combined in a complicated fashion. His visual acuity was normal and there were no abnormal appearances in the eye. There were no disturbances of speech whatever and his general intelligence was unaffected. No sensory or motor disturbances or any abnormality of the reflexes could be discovered.

Mierzejewski claimed after a perusal of the literature of word-blindness that his case was unique and that no case of word-blindness had been previously described in which the patient's power of recognising individual letters was preserved intact. He proposed to call this new form of word-blindness "*cæcitas syllabaris et verbalis sed non litteralis*." This form had been described, however, fourteen years before Mierzejewski's paper. Schweigger²⁷ in 1870 recorded the following case.

CASE IV.—A man, aged seventy-four years, had a slight apoplectic attack with loss of consciousness and clonic

spasms in the right arm but no paralysis. Shortly thereafter the patient lost the power of reading. Schweigger found he could recognise the individual letters but could not read the words composed of these letters. He read numbers with greater success but here also he made occasional mistakes. There were no speech disturbances. Fundus appearances were normal. There was right homonymous hemianopsia. A few days after Schweigger's interview the patient succumbed to a fresh apoplectic attack. There was no post-mortem examination. Schweigger remarks that he had previously seen a precisely similar defect in another patient.

These cases, then, afford typical examples of a special form of word-blindness which may sometimes appear as an isolated cerebral symptom uncomplicated by any other disorder in the expression or interpretation of language. On analysing their salient features it will be found that all present a striking agreement:—(1) they could read fluently the individual letters, printed and written, but could not interpret words composed of these letters; (2) they could read figures both individually and when combined in the most complex manner; and (3) they could write spontaneously and to dictation, but could not interpret the words which they themselves had written, although they could read the individual letters. How are these symptoms to be explained? This question will be answered most clearly by discussing in succession each of these groups of symptoms. In the second chapter it was pointed out that clinical observation and pathology prove the existence of two higher visual centres in the cortex of the brain, having distinct but closely allied functions. There is in the occipital lobe, especially in the neighbourhood of the cuneus

and calcarine fissure, the centre for primary visual impressions, the perceptive centre, the function of which is to bring into the sphere of consciousness a mental picture of the retinal impressions and through which we become conscious of objects as occupying certain positions in the visual field. Lesions of this centre are shown by defects in the visual fields. But there is in the angular convolution and its neighbourhood another centre, where these sensory impressions are received, retained and accumulated, the visual memory centre. The intelligent recognition of any object can only be accomplished by a comparison of the retinal impressions in the percipient centre with the visual memories of past impressions stored in the visual memory centre. Lesions of this centre are therefore evidenced by mind-blindness in its various forms, that is, the individual though seeing the object distinctly is no longer able to recognise it, having no visual memory or image with which to compare it. In the preceding chapters the different varieties of mind blindness have been discussed and it has been shown that word-blindness is simply a special form of mind-blindness. In right-handed people the visual memories of letters, words and figures seem to be stored in the left visual memory centre only. The lesions of this left centre are evidenced by disturbances affecting only these highly specialised visual memories or images, leaving in most cases quite unaffected the more general visual memories of form and colour, objects and places. The inability to read in the cases under consideration can only be intelligently explained by a lesion affecting this visual memory centre for words and letters. We are apt to forget that the power to read rapidly at sight has been acquired only by long and laborious effort. The complex cerebral processes involved in reading by prolonged practice are carried on with such ease and rapidity as to be

removed from the sphere of consciousness and transferred to the mysterious region of unconscious cerebration. When disease disturbs the perfect adjustment of the elaborate cerebral mechanism we may sometimes get a glimpse of the complex processes which are constantly at work in the great laboratory of the brain.

Let us analyse a little more precisely the cerebral visual processes concerned in the act of reading. A clearer conception of the processes involved will only be attained if we consider the manner in which an individual learns to read. The first stage is to store up in the visual memory the individual letters of the alphabet and to learn to associate these with their particular speech equivalent. When this has been attained there is no difficulty in attaching to any letter its particular speech equivalent as we have now stored in our memory centre a visual image of each letter which serves as a constant standard of comparison and recognition. This power is acquired with comparative rapidity, there being only twenty-six letters in our alphabet, or taking capital and small letters fifty-two visual images in all to be acquired. The next stage is to learn to interpret by sight words made up of different combinations of these letters and to associate them with their corresponding speech equivalents. This can only be accomplished by gradually storing up in the visual memory centre the visual images of the different words. This is a more formidable task and requires for its accomplishment a prolonged period of time. At first the child reads by spelling out each word aloud letter by letter, and thus by appealing to his auditory memory gets the proper word; or he may simply be seen to move his lips, spelling silently each letter and thus appealing to his memory of speech movements or glosso-kinæsthetic memory, as it has been called by Bastian. He has not yet acquired the visual

images of words and therefore cannot yet interpret written or printed words by sight alone. But by prolonged and persistent practice he gradually comes to interpret printed and written words simply by looking at them, or, to put it in another way, he has now accumulated in the storehouse of his visual memory the visual images of words. When he now looks at a printed or written word he can instantly interpret it by comparison with the word-image in his visual memory without having recourse to his auditory or glosso-kinæsthetic memory. In short, he has now learned to read by sight.

Now if by disease the visual word-centre is completely destroyed or if it is completely cut off from the primary perceptive centres in the occipital lobes, then the patient is both word- and letter-blind. But if the destruction is only partial and that part of the centre in which are stored the visual memories of letters remains intact, then the patient, though still able to recognise the individual letters by sight, will no longer be able to recognise and interpret words because he has lost the visual memories of words which he had acquired by years of laborious effort. He will be, so far as vision is concerned, in the same position as a child who has only mastered the letters of the alphabet but has not yet attempted to read words. He will be able to read only by spelling out aloud each letter of the word and thus appealing to his auditory memory. This was precisely the condition of the patients in the cases under consideration and this view of the condition renders intelligible the phenomena observed. This idea of the grouping together of definite classes of visual images within the visual word-memory centre may at the first glance seem somewhat fantastic, but certainly the study of clinical facts points strongly to this conclusion. How else is the fact to be explained that all the patients referred to

could read figures fluently, not only individually but when combined in the most complicated fashion? In Chapter II. a strong body of evidence was brought forward to prove the complete functional independence of the visual memories of words, letters and figures, for it was clearly shown by clinical facts that the visual memory for words and letters may be entirely lost whilst that for figures is preserved intact. The case at present under consideration with the others quoted affords further proofs. How can such complete functional independence be explained unless on the ground of anatomical independence? The visual memories of figures must be preserved in a different area of the cerebral cortex from the visual memories of words and letters. Both classes of visual memories, however, are lost simultaneously with such frequency as to make it highly probable that they are deposited in adjacent areas of the cerebral cortex. Similarly, since clinical facts clearly show that the visual memories of words may be entirely lost whilst the visual memories of letters remain intact, we are driven to the conclusion that these are deposited in different areas of the cerebral cortex, but from the greater frequency with which both are simultaneously lost it is evident that these areas are adjacent.

This view of the complexity of the visual word-centre and of the arrangement within its area of distinct groups of visual images not only explains such cases as we have been considering, but renders intelligible those peculiar cases recorded from time to time which, according to this view, would be regarded as cases of partial destruction of the centre. As examples of the curious partial forms of word-blindness sometimes observed the following are interesting. Bruns and Stolting²⁸ have recorded a case in which the patient's inability to read printed letters and words was complete, but only incomplete for written cha-

racters and for figures. Berkham²⁸ had a case in which the patient was word-blind but not completely letter-blind, being able to recognise some letters. Weissenburgh²⁹ had a case in which the patient was word-blind with the exception of a few words. Michel² quotes a case where the patient could read the Gothic but not the Latin characters. Charcot⁴ had a case where the patient knowing French, German, Spanish, Latin and Greek lost the visual memory of a few of the Greek and German characters only. In Burnett's case, in Mierzejewski's, and in my own, the patients could write spontaneously to dictation and copy although they could not read the words they had written. In their recent investigations Dejerine and Sérieux^{8, 11} have shown that when the visual word-centre is destroyed the patient can neither read nor write. He is agraphic because he can no longer call up in his mind the visual memories of letters which are necessary to stimulate the graphic motor centre. In these three cases there was only partial destruction of the visual word-centre, and the visual memory of letters was still preserved intact. Hence these patients could all write. I observed in my patient, however, that he wrote very slowly and spelt out each word as he wrote it. He could revive only the visual image of each letter and not the visual image of the whole word. Hence his slowness in writing and his necessity for spelling it out letter by letter.

With regard to the position of the visual word-centre, this has been discussed in a previous chapter. It was there stated that although its boundaries have not been finally laid down, still a constantly increasing pathological experience tends to prove that the centre in which are stored the visual memories of letters and words includes the supra-marginal and angular convolutions both of which belong to the inferior part of the parietal lobe. The

visual word-centre like the speech-centre is unilateral and in right-handed people is situated on the left side of the brain. This view is confirmed by a valuable collection of cases at the end of an article by Starr on the pathology of sensory aphasia.³⁴ In twenty cases where the patients were completely unable to read, the angular or supra-marginal gyri were found to be affected in fifteen, and in the others the lesions were in the neighbourhood of this area and therefore isolated the centre.

There can be little doubt that this was the situation of the lesion causing the inability to read in the case which forms the subject of this chapter. The history of the case is one of gradually extending thrombosis of the left Sylvian artery with consequent softening of the brain, and this was the opinion of the consulting physician who saw the patient after the appearance of the right hemiplegia and aphasia. The branch of the Sylvian artery supplying the visual word-centre is distinct from that supplying Broca's convolution and the motor areas for face, arm, and leg. At the outset there probably was a partial blocking of the main trunk of the left Sylvian artery, and hence the preliminary symptoms. But the thrombosis had first blocked completely that branch of the artery supplying the angular gyrus and its neighbourhood, and hence the purity of the symptoms when the case was seen by me. Shortly afterwards the thrombosis extended to the branches of the vessel supplying Broca's convolution and the motor areas, and hence the aphasia and right hemiplegia. If part of this visual word-centre received its blood from a different source that part would escape destruction and this is probably what has happened in the case under consideration. Nor is this supposition improbable, as the posterior cerebral artery supplies a large part of the cortical area of the occipital and temporo-sphenoidal lobes which are in the

immediate neighbourhood of the word-centre. It will be observed that in Burnett's case, in Mierzejewski's, and in my own case the visual fields were normal. This is strongly in favour of the lesion being a cortical one. In sub-cortical lesions where the word-centre is simply cut off from the percipient centres in the occipital lobes, the word-blindness is nearly always accompanied by right homonymous hemianopsia. This is due to the fact that a subcortical lesion in the white matter of the left occipital lobe, so situated as to cut across the fibres passing from both occipital lobes to the left angular gyrus, must also involve the optic radiations passing to the left occipital cortex, and the patient will then be not only letter- and word-blind but also exhibit right homonymous hemianopsia. This is clearly exemplified and fully discussed in Chapter II., where the patient was completely letter- and word-blind and had right homonymous hemianopsia. The complete absence in the present case of any defect in the visual fields is thus in favour of the lesion being a cortical one, an affection of the centre itself, as I have regarded it.

CHAPTER V.

LETTER- WITHOUT WORD-BLINDNESS.

IN the preceding chapters on word-blindness and its varieties certain views have been expressed which, in my opinion, afford the only reasonable explanation of all the varieties of this condition which are met with. My attention has been recently drawn to a rare form where the patient is able to read words but not the individual letters of which the words are composed—*i.e.*, letter- without word-blindness. Recorded cases of this variety are excessively rare and my attention was specially drawn to it by the occurrence of two cases in the Western Infirmary of Glasgow. Since the occurrence of such cases forms powerful clinical evidence in support of the views maintained in the preceding chapters, I have thought that a critical examination of the visual phenomena manifested in this little known variety—letter- without word-blindness—would prove both interesting and instructive. I have to thank Professor Sir William T. Gairdner and Dr. James Finlayson for their kind permission to quote their as yet unpublished cases and also to express my great obligations to their assistants, Dr. James Carslaw and Dr. John Love, who supplied me with every facility for studying them. These cases were somewhat complex and the following must not be regarded as in any sense a complete report of them, but simply as very brief records of the chief visual phenomena, that being the only aspect of these cases which concerns us in the present paper.

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letters both written and printed. On testing him with words, however, in a large number of trials it was quite evident that he could read almost every word presented to him, even words of three or four syllables and very unfamiliar ones, while at the same time he was quite unable to name or point out a single letter of the word he had just read. Such words as "stethoscope," "telescope," "electricity," "infirmary," &c., were read at once. The word "JOB" was read at once, but when the letters were arranged "OBJ" and he was asked to read them he could not name a single one. The contrast between the fluency with which he read the words and his inability to make anything out of the individual letters was very striking. Substantives he could make out much better than verbs and could read them with the greatest fluency. Slight intentional mistakes in spelling and even reversing letters were not observed by the patient, who read the words just as if no alteration had been made and did not seem conscious of anything peculiar about the word. Numerals he recognised and named as far as "nine," but not beyond that, and only the Arabic numerals and not the Roman. There was no amusia; the patient could name and intone correctly the signs of the new notation but could not name them as letters of the alphabet. During his residence in hospital the patient's power of reading words improved so that when he was shown to the Glasgow Medico-Chirurgical Society on May 6, 1898, he could interpret correctly any request in printing or writing and was able to read a letter written by himself. He had been instructed to educate himself by learning the letters of the alphabet again. This was done but only with partial success. When he left the hospital about three months after admission he was able to recognise some letters but only occasionally and with many failures. He could write a few

letters to dictation but he made many mistakes. On May 2, he wrote the following letter which he was able to read afterwards :—

DEAR MOTHER.—Please send my clothes to-morrow and my boots as I am getting on the grounds. I am keeping better ; hoping you are well.

He addressed the letter quite correctly. On attempting to write the alphabet from memory he wrote as follows :—
“a, b, c, d, e, i, j, h, m, n, s, u, w, v, y, z,” and the following letters being dictated he wrote as follows :—

Dictated b, wrote b.	Dictated c, wrote c.
„ y, „ l.	„ f (failed).
„ p (failed).	„ d, wrote a.
„ r (failed).	„ n (failed).

Numerous trials as to his power of writing and reading individual letters were made, but the above may be taken as a fair sample of the measure of success attending these trials. While he failed with many of the letters, he wrote readily words beginning with the same letters. In the above trial he failed to write “p,” “r,” or “n,” but wrote quite readily “pot,” “Robert,” “nail,” and so on. He left hospital at the end of May and has not been seen since the above examination was made, so that nothing can be said as to his further progress.

As a parallel to this case I will briefly quote a case reported by Dr. Byrom Bramwell³⁰ selecting only those features of it which specially interest us in the present chapter.

CASE II.—A man, aged sixty years, was suddenly seized with loss of power of the right hand and arm and with aphasia on Dec. 22nd, 1886. On March 9th, 1887, he came under

observation with paralysis of the right hand and arm, considerable motor aphasia but no word-deafness. There was partial right homonymous hemianopsia. "The patient," says Dr. Bramwell, "is unable to recognise a single letter of the alphabet; he can neither spontaneously name the letter when it is shown to him nor can he when the names of the different letters are repeated aloud to him indicate when the particular letter which he is asked to recognise is named. He is unable to recognise figures either spontaneously or when they are named to him. Soon after the patient first came under my observation his wife, who always accompanied him when he came to see me stated that he was able to read and make out some things which interested him in the newspapers. I paid very little attention to this statement, for it is well known that aphasic patients who are utterly unable to read a single word not unfrequently occupy themselves with a book or a paper, and appear to their friends to be intelligently interested. Knowing that this patient was unable to read a single letter of the alphabet I paid no attention to this statement. When, however, his wife stated on a subsequent occasion that he had when walking in the cemetery read to her the names (with which, be it observed, he had not been previously acquainted) on some of the tombstones correctly, and also that he had on another occasion turned up and pointed out in a guide-book the name of a landlord about whose property they were talking, my attention was aroused and I found on investigation that the patient could read many words the individual letters of which he was totally ignorant of, even when they were named to him. Thus on June 1st he read correctly the words which I had written to him on a piece of paper, but he was totally ignorant of the individual letters composing the words which he was able to read and did not know them when they were named."

CASE III.—A case of somewhat similar character to the two preceding ones but in which the letter-blindness was not so complete has been recorded by Broca. Not having been able to see the original report of this case I quote it from Brissaud's article on Aphasia.³¹ "A patient may suffer from letter-blindness and not from word-blindness proper or he may be blind to words and not to letters. While this is true, letter-blindness is, as a rule, accompanied by word-blindness. That letter-blindness may exist without word-blindness is illustrated by a case reported by Broca. This patient was attacked by partial letter-blindness—that is to say, he had lost the visual memories of some letters. He could read words, however, in which were letters he did not know and one could change the place of letters in a word or even suppress some without his perceiving it."

CASE IV.—(Abbreviated from notes supplied by Dr. James Carslaw).—On Jan. 18th, 1898, a young married woman, aged thirty years, had a sudden attack of right hemiplegia with aphasia. She was admitted to Professor Sir W. T. Gairdner's wards in the Western Infirmary on Feb. 1st. She was found to be seven months pregnant; she had a previous history of rheumatism and the physical signs of mitral obstruction. She had right hemiplegia, the leg, arm, and face being involved. There was complete motor aphasia which remained persistent during her whole stay in hospital, the patient only being able to say two or three words on dismissal. There was no word-deafness. There was complete word- and letter-blindness on admission, the patient being unable to recognise any word, letter, or figure, printed or written. From this word-blindness there was a gradual recovery and when tested on June 8th, a month before her dismissal, she recognised

all the words submitted to her and all the letters of the alphabet and figures in any combination. From the period of her admission the power of recognising words, letters, and figures was very carefully tested from time to time. These successive examinations elicited the remarkable fact that there was not a simultaneous improvement in her power of recognising the various forms of printed and written characters, but that she first acquired the power of recognising numerals, then words, and last of all the individual letters of the alphabet. This progress will be most vividly seen by briefly quoting extracts from the ward journals bearing on this point. "Feb. 1st: The patient was unable to recognise any printed or written words, letters, or figures." "Feb. 22nd: If the page of a book is read aloud to the patient she can follow with her finger and point to the last word when a stop is made. She fails, however, to detect intentional mistakes made when reading. She can pick out with her finger a word here and there. She cannot point out a single letter of the alphabet except 'a' which she generally recognises correctly. She now recognises the Arabic numerals." "March 7th: The patient can now apparently understand printed matter though some words seem to puzzle her. She can follow with her finger as the page is read and detect intentional mistakes fairly well. She can now pick out a few letters of the alphabet but with very variable accuracy. Arabic numerals are recognised at once both individually and in combination up to 100, but beyond this she has difficulty." The patient was now dismissed owing to her approaching confinement and was readmitted in May. The next examination was made therefore after an interval of about two months. "May 16th: The patient recognises words correctly and easily. She often indicates the recognition of the word by pointing to

the corresponding object. She can with greater accuracy than before correct mistakes intentionally made in reading. She does not, however, readily detect slight mistakes in spelling—*e.g.*, ‘chiar’ for chair—though she at once points to the object indicated. The individual letters composing the words are not, however, easily recognised, and when asked to point out individual letters of the alphabet she makes very many mistakes. She makes fewer mistakes with the small letters than with the capitals. She recognises Arabic numerals correctly and quickly, and to higher figures than formerly, but not Roman figures.” “June 8th: The patient now recognises printed and written words rapidly and correctly. She quickly indicates with her finger any intentional mistakes made in reading aloud to her. She at once points to any word named. She can now pick out all the individual letters of the alphabet, both small and capital. She recognises Arabic numerals in any combination and now also recognises Roman figures. In short she has now regained the power of recognition of all the printed and written characters with which she was previously familiar.” The patient was dismissed on July 9th.

CASE V.—As a parallel to this case where the patient, completely word- and letter-blind, recovered the power of reading words before letters I can quote briefly a case reported by Dr. MacVicar at a meeting of the Forfarshire Medical Association on Feb. 4, 1898.³² The patient was a young man, a painter by trade, who had received a fair education. His head was struck forcibly against the edge of a dresser on Dec. 27, 1897, the injury being over the right parietal eminence. He suffered from symptoms of concussion, and after recovery from this was unable to read. He gradually improved and was able to read aloud, and wrote to dictation short words before he could recognise letters. He understood “written speech” subse-

quently to being able to read aloud. He could read simple sentences in fourteen days and numerals in nineteen days after the injury. The lesion was supposed to be of the nature of a hæmorrhage due to *contre-coup* over the left angular gyrus and possibly affecting the supra-marginal and posterior part of the third temporo-sphenoidal convolutions.

These five cases make it quite clear that there is a distinct variety of "letter-blindness" where the individual though able to read words cannot read the individual letters of which the words are composed. Recorded cases of this kind are rare and Dr. Bramwell in narrating his case remarks that he is not aware that such a condition has been previously described. The rarity of such cases, however, is, I think, chiefly owing to the circumstance that when they do occur they are not recognised. The fact of there being two in the Western Infirmary at the same time forms a strong presumption that such cases are by no means so rare as is commonly supposed. Such cases escape observation because the patients are not accurately tested as to their power of reading not only words but also individual letters. If the patient can read words the examiner may not know the necessity of also testing his power of reading letters and, conversely, if he finds the patient unable to read letters he will probably take it for granted that he is also unable to read words. If all patients were carefully tested as a matter of routine, both with words and individual letters, the number of recorded cases belonging to this category would be rapidly increased.

How are we to explain the, at first sight, startling fact that these patients whilst able to interpret words could no longer interpret the individual letters of which the words

were composed? In the preceding chapter I discussed at length a class of cases exactly the converse of those at present under consideration—viz., cases in which the patients could read the individual letters but could not recognise by sight the words composed of aggregations of these letters. Both classes of cases are explained in precisely the same way. The fact of the existence of these two definite classes of cases, the one being the complement of the other, is the strongest possible proof of the correctness of the views set forth in detail in the preceding chapter where it was maintained that clinical evidence demonstrated the complete independence of the visual memories of letters and of words, and that this complete functional independence could only be reasonably explained on the assumption that these distinct groups of visual memories are stored and preserved in different but probably contiguous areas of the cerebral cortex.

The ability to recognise by sight the individual letters of the alphabet is acquired by the individual in a comparatively short space of time, there being only twenty-six letters in our alphabet, or double that number taking small letters and capitals. At first we read words by spelling them out letter by letter, and by thus analysing the word into its constituents of letters and syllables. Individuals who have not progressed beyond this stage—*i.e.*, who read all words by analysing them into their individual letters—would necessarily become blind to words if they became blind to letters. But by years of persistent labour and practice we gradually acquire and store up the visual memories of words. When this stage has been reached the individual reads not by analysing each word into its individual letters but by recognising each word as a separate picture. The words cease to be for such an individual simply a congeries of letters; each word is

regarded rather as an ideogram, picture, or symbol which suggests a particular idea. That this is the true explanation is confirmed by the facts observed in three of the preceding cases.

In cases 1, 3, and 4 slight mistakes in spelling, changing the place of some of the letters, and even suppressing a letter, were not noticed by the patient. In Case I., even when one or two letters in a word were reversed—such as “LOVƎ” instead of LOVE—the patient did not seem to notice anything amiss but read the word correctly without making any remark. From these observations it is clear that these patients recognised the words by their general form alone. A slight alteration in one or two letters was therefore not observable so long as the general form and appearance of the word were preserved. In fact, these individuals recognised a word just as they recognised a landscape or a familiar face, by their general outline and form, without resolving them into their constituent details. It is, therefore, easily conceivable how such individuals who have thus acquired by long and constant education the power of reading words by sight, not phonetically but ideographically, can lose the visual memory of the individual letters and yet retain the visual memory of words or, to put it briefly, such individuals may be letter-blind without being word-blind.

In previous chapters it has been pointed out that in the visual memory centres the visual images or memories are arranged in definite groups having a certain independence of each other. The visual memories of objects, of places, of forms, and of colours are deposited in different brain areas from the visual memories of words, letters, and figures. Hence we have word- and letter-blindness occurring without the loss of these other forms of visual memory. Further, it was argued from the clinical evi-

dence that the visual word-centre (generally regarded as occupying the left angular and supra-marginal gyri) is itself complex and that within it are stored different groups of visual symbols—numbers, words, and letters—in quite distinct but probably adjacent cerebral areas. In Chapter II., the complete independence of the visual memory of numbers from that of words and letters was proved from the clinical evidence and the conclusion was drawn that these must be deposited in separate cerebral areas. Bastian,³³ in his recent admirable work on Aphasia, has evidently adopted this view. He adds an important piece of confirmatory evidence. “Destruction of the visual word-centre,” he says, “is the common cause of word-blindness. If there should be a separate seat for the registration of numerals it is suggested that its escape from damage would account in all probability for the preservation of the ability to read and the ability to write numerals. That this is the true explanation seems all the more probable because on rare occasions it has been found that loss of ability to read and comprehend numerals exists in the absence of word-blindness. One such case has been recorded by Trousseau and another by de Capdeville in which there was a transitory defect of this kind.” Now precisely the same clinical evidence can be brought forward to show the complete independence of the visual memories of words and letters. In the preceding chapter four cases of great purity were quoted and discussed in which the patients could read fluently individual letters but not words. In the present chapter five cases are adduced in which the patients could read words but not letters. The clinical evidence therefore clearly indicates the complete independence of these two groups of visual memories and hence justifies the inference that these are deposited in distinct areas of the cerebral cortex. This is precisely the

chain of reasoning which led to the inference that the numerals were stored in a separate cerebral area, and if the reasoning is sound in the case of the numerals it is equally valid in the case of the words and letters. Since the visual memories of letters and words are usually lost together it is highly probable that the areas in which they are stored are contiguous. When there is only partial destruction of the centre and that part of the centre in which are stored the visual memories of letters remains intact, then the patient can read individual letters but not words; on the other hand, when the letter area is destroyed and the part in which are deposited the word memories is still functionally active, then the patient, though he cannot recognise an individual letter, can recognise words, just as in the cases under consideration in the present chapter. When the destruction of the centre is partial and irregular, part of each area being destroyed, then the patient will be able to read some words and some letters, the extent of the ability to read being dependent upon the extent of cerebral cortex within the centre which is still functionally active. The cerebral area destroyed may be very irregular and hence arise those very peculiar cases of which several examples are quoted in the second and fourth chapters. In fact, the varieties are endless, but the view here expounded is the only one which renders all these varieties intelligible.

Case IV. affords a very striking confirmation of this view that the visual memories of numerals, of letters, and of words are stored in perfectly distinct though adjacent cerebral areas. The lesion in this case was almost certainly an embolism, blocking up the left middle cerebral artery, cutting off the blood-supply to the left motor area, to Broca's convolution, to the visual word-centre in the left angular gyrus, and hence the symptoms, right hemiplegia,

aphasia, and word-blindness. At the outset this patient had lost the visual memories of all the symbols printed and written—numerals, words, and letters—with which she was previously familiar. That this is the condition most commonly met with is easily understood, when we consider that all these visual memories are deposited in areas which though distinct are certainly close together and probably contiguous. It is only when a part of the area escapes, that these cases are met with where the patient retains some special group of visual memories. The vascular supply of the cerebral cortex is liable to considerable variation. As a rule the visual word-centre is supplied by a branch of the middle cerebral artery, and here evidently this branch supplied the centre in its whole extent. Hence the complete blotting out of the visual memories of numbers, words, and letters. In the case narrated in the preceding chapter, the patient lost only the word-memories and retained those of figures and letters. Here part of the word-centre was probably supplied by a branch of the posterior cerebral and hence escaped destruction. This variation of vascular supply no doubt explains many of the clinical varieties of this defect which are met with. In the case under consideration the visual word-centre gradually recovered its functional activity, probably by a gradual restoration of the blood-supply through anastomosing channels. In the gradual restoration to functional activity of the centre the outstanding feature is that the patient first gained the power of recognising Arabic numerals, then words, and, last of all, individual letters. I do not know of any more convincing proof which could be brought forward to demonstrate that these different groups of visual memories are deposited in distinct cerebral areas. If the centre was simply the general repository of these visual memories

without any definite grouping or arrangement of them, then there would have been a gradual simultaneous recovery of numbers, words, and letters, which was not the case. On the other hand, if these three distinct groups of visual memories are deposited in definite and distinct areas within this centre, then as the blood-supply is gradually restored, enabling the successive areas to resume their functional activity, it is to be expected that the patient would regain the different groups of visual memories in successive order, as actually took place in the case under consideration. It is to be observed that the order of recovery is not from the simple to the complex, but that the power of recognising words was recovered before the power of recognising letters. This order of recovery was also observed in Case V. already briefly quoted.

The order of events cannot therefore be explained simply by a gradually increasing functional activity of the centre as a whole, nor do I see any other way in which the phenomena observed can be intelligibly explained, than on the ground of distinct areas within the centre being occupied with these different groups of visual memories—numbers, words, and letters.

In these pages an attempt has been made to give some reasonable explanation of the phenomena observed in the various forms of letter-, word-, and mind-blindness. The views set forth therein have been arrived at by a minute analysis of cases observed, and by a critical study of the clinical observations of others. They have the merit of simplicity and of rendering more intelligible the varied and manifold phenomena met with in these conditions.

Although there were no post-mortem examinations in the cases coming under my own observation, which have been recorded in the preceding pages, yet I think the

careful analysis of the visual symptoms is of considerable clinical value. The cases recorded are for the most part of great purity, that is, unaccompanied by derangements of other centres such as the auditory and speech-motor centres, which so frequently complicate the symptoms and hence obscure to some extent the significance of the visual derangement. It is particularly from a study of these pure cases, that we can hope to attain a more precise knowledge of the nature of the different disorders embraced in the term word-blindness. Pathology can teach us little apart from careful, thorough and correct clinical observation. In a large proportion of the hitherto recorded cases of word-blindness with pathological examination, the nature of the visual defect is recorded so vaguely that the pathological examination loses much of its value. An increased and more widely diffused knowledge of the nature and varieties of the cerebral disorders of vision would lead to a more precise, rigorous and comprehensive examination of the symptoms during life, and consequently would give any subsequent pathological examination a greatly increased value.

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