

MEMORY DEFECTS AFTER HEAD INJURY

BY

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The phenomenon of retrograde amnesia following head injury has attracted considerable interest in recent years. Retrograde amnesia, usually of short duration, is almost invariably present in cases of closed head injury of sufficient intensity to produce some period of post-traumatic amnesia. Although the duration of retrograde amnesia seldom exceeds a few minutes, it may in more severe cases embrace a period of hours or even days. In general, the duration of permanent retrograde amnesia tends to be greater in the more severe cases and to be roughly proportional to the length of post-traumatic amnesia (Russell, 1948b). There are, however, exceptions to this rule (Symonds, 1949). Other features of retrograde amnesia which have been studied in recent years include its manifest "shrinkage" during recovery from the post-traumatic confusional state (Symonds, 1949; Paterson and Zangwill, 1944); the occasional presence of "visions" or islands of memory within the period of amnesia (Russell, 1932, 1948a); and its reduction, in some cases at least, by investigation under barbiturate hypnosis (Russell and Nathan, 1946). These various features of traumatic amnesia have been well described by Russell and Nathan (1946) and do not call for further comment.

In addition to the residual retrograde amnesia, even where this is extremely brief, there may be a further weakness in the memory for events which have occurred before the injury. Although such defects have often been recognized, little attention appears to have been given to their systematic study. Our intention in the present paper is to analyse the incidence and character of these memory defects in a group of patients who appeared to have made a complete recovery from head injuries, and to indicate that in some cases, despite lack of residual impairment on tests of memorizing and intelligence, faulty recall of pre-traumatic events may be serious enough to constitute a minor residual disability.

Cases

The nature of memory impairment for events shortly preceding concussion head injury is well illustrated in the following cases.

Case 1.—J. H., aged 17, a laboratory assistant (R.I. No. 104025), fell from his motor-cycle on November 24, 1950, sustaining a mild concussion head injury. On admission to hospital an hour later he appeared fully conscious and orientated in all spheres. Recovery was uneventful, and the patient was discharged 19 days later free from symptoms. Retrograde amnesia was of a few seconds and post-traumatic amnesia a matter of minutes. There was no evidence of post-traumatic intellectual loss nor any defect on tests of memorizing.

The patient was interviewed by one of us (M. W.) on several occasions during his stay in hospital and after his return home. It was found that he was able at all times to give a clear account of the greater part of the course of his journey before the accident. His last memory was of his machine skidding, though he did not recollect his actual fall. At the same time, it was found that there were amnesic gaps in his memory for parts of the journey before this episode. Thus, he could not remember driving along a stretch of some five miles of road to the spot where the accident occurred, and no amount of effort enabled him to recover this memory. If retrograde amnesia is assessed as "seconds", therefore, it is important to bear in mind that before his last memory there is an amnesic gap covering several minutes, and that his memory for the journey as a whole was patchy.

This case is of interest in so far as the brief permanent retrograde amnesia bounded by the patient's memory of his skid was associated with a further amnesic gap covering a longer period. In the following case, likewise a comparatively slight injury, the residual amnesic defects were both more complex and more severe.

Case 2.—R. H., a motor mechanic aged 20 (R.I. No. 132125), fell from his bicycle on October 18, 1950, hitting the left side of his head and sustaining a concussion head injury. On admission, he was conscious and orientated, though drowsy, and had a confused recollection of the preceding half-hour. Recovery was

uneventful, and the patient was discharged after 12 days with residual retrograde amnesia of "seconds" and post-traumatic amnesia of under one hour.

He was interviewed several times during his stay in hospital, and after discharge. On the morning after his accident he had recovered a vivid recollection of the moments immediately before the accident. He had a clear memory of rounding a corner into a main road, of seeing a bus drawn up just ahead, of hitting the kerb and flying over the handlebars. He could not, however, recollect where he had been going at the time, nor for what reason. Nor, on further examination, could he describe any incidents during the previous seven days. Three days later he was able to recall that some time during the week before the accident he had been moved to a different job. He also recovered some vague recollections of events which had occurred on the day of the accident itself, but apart from these isolated recollections his memory for the week before the accident up till the few moments just preceding it was very defective.

Case 2 provides a good example of a patient who, despite typically brief retrograde amnesia, presented quite marked residual memory defects for events preceding the accident by some days. This patchy amnesia had not recovered when the patient was seen three weeks after the accident.

In the following case the residual memory defects were considerably more severe and gave rise to a genuine minor disability.

Case 3.—P. H., an agricultural labourer aged 23 (R.I. No. 134424), ran into a telegraph pole on his motor-cycle when returning home from work. On admission (December 4, 1950) he was unconscious, with a skull fracture in the right parietal region. His condition deteriorated after a few hours, and at operation a right extradural haematoma was evacuated. Following a number of epileptic attacks, further extradural and subdural clots were removed at operation eight days after admission. Apart from a left hemiplegia, which improved steadily, his neurological condition was satisfactory. On discharge, four and a half months after injury, he showed no impairment on tests of memorizing, learning, abstraction or construction. Retrograde amnesia was assessed as 24 hours and post-traumatic amnesia as seven weeks.

When interviewed by one of us (M. W.) three months after discharge, the patient was able to recollect several events which had occurred the day before the accident, when he had taken part in a motor-cycle trial. He had a vivid recollection of the intense cold and of drinking rum to keep warm. At the same time, his memory for a period before this was grossly impaired. Thus, he was unable to recall that he had been off work with a mild attack of influenza during the greater part of the week before the accident, although this event was recalled and recounted by his parents. He was also unable to recall much of his most recent work. According to his parents, he had been looking after a litter of pigs for the month or so before the accident and

had taken home daily descriptions of their progress. The patient was unable to recall the pigs at all, his last recollection of farm work being that of carting sugar beet two months previously.

The discrepancy in this case between the events remembered by the patient and those by his parents indicates that the patient's haziness of memory for pre-traumatic events cannot be ascribed to ordinary forgetting with lapse of time.

It will be noted in the above account that, although the patient's most recent memory dating from before the injury related to the day preceding it, there was none the less considerable amnesia for events which fell within the previous few weeks.

Similar phenomena observed in three further cases may be communicated more briefly.

Case 4.—K. G., a girl aged 22 (R.I. No. 73415), fell from her bicycle, sustaining a mild concussion. Post-traumatic amnesia was 24 hours and retrograde amnesia a few seconds. Her last memory, which was very vivid, was of a cat running across the road a few seconds before the accident. As in Case 2, however, the patient testified to complete amnesia for the circumstances and general intention of her journey. She knew where she was and could recall how she had arrived there, but was unable to say with what intention she was making the journey or where she was heading for. These were still unknown to her two weeks after discharge.

Case 5.—E. C., an ambulance driver aged 38 (R.I. No. 141508), sustained a frontal fracture as a result of a motor-cycle accident. On discharge after four weeks in hospital, post-traumatic amnesia was assessed as 12 hours and retrograde amnesia as 30 minutes or less. He could describe very precisely a visit to a friend's house only half an hour before the accident and the full circumstances surrounding it. On the other hand, memory for the week preceding the accident was very defective, and the patient insisted that this was not in keeping with his normal powers of recollection. He was unable to give any details of his activities during the Whitsun holiday three days before the accident, and qualified any statements he did make with phrases such as, "I think I went . . .", and, "I have a strong suspicion I did". In addition, his memory for the order of sequence of several journeys which he made during the week in question was exceedingly vague, whereas his memory for similar journeys made in previous weeks was correct. In his own words, "Normally I'd be able to tell you what I had picked up, who, and where. But last Tuesday we had rather a busy night; I know it included one accident, but I can't tell you where it was."

In this case, therefore, there was a patchy amnesia covering about a week in addition to the complete retrograde amnesia of 30 minutes or less.

Case 6.—T. F., an engineer aged 40 (R.I. No. 131865), sustained a mild head injury which gave rise to an intracerebral haematoma. He was confused and amnesic for some weeks after operation, and on recovery retrograde amnesia was assessed as one week and

post-traumatic amnesia as four to five weeks. At about the time of discharge, when he showed above average performance on tests of intelligence and memorizing, it was ascertained that the patient could in fact recall certain events which fell within the scope of the retrograde amnesia ("islands" of memory). Some excursions undertaken by himself and his wife during this time, details of which were given to us by the latter, were also described adequately by the patient when he was directly asked about them. He had not referred to them before, however, because they appeared to him to date from a much earlier and ill-localized period of his previous life. Their proper time-reference was only established firmly after several conversations with his wife.

Analysis of Memory Defects

The principal dysmnesic features (other than retrograde amnesia and post-traumatic amnesia) shown in this series of cases are as follows:—

Memory Gaps.—Gaps in memory for events leading up to the accident, yet not falling within the duration of the retrograde amnesia, were shown most clearly by Cases 1 and 3. These gaps remained after retrograde amnesia had shrunk to its final brief duration and did not appear to be spontaneously recoverable.

Defective Recollection.—Hazy and ill-defined recollection of pre-traumatic events which had occurred up to a week or more before the accident was noted in Cases 2, 3, and 4. In one of these cases at least retrograde amnesia as conventionally assessed was extremely brief. The forgotten events, as far as could be judged, do not extend far back into the remote past.

Time Errors.—Disturbances in the recall of sequence of recent events was noted in Case 5. In Case 6 some disturbance of the "sense of pastness" (Gillespie, 1937) was apparent.

There seems to be little doubt that these lapses are due to genuine defects of memory and are not explained by normal forgetting. This is clear, first, from the fact that the patients themselves often later recover memories for events at first thought to have been forgotten, as in Case 2; and, secondly, from comparing accuracy of recollection of the same events by the patient and his relatives or friends, as in Cases 4 and 6.

It also seems clear that the defects are associated with the head injury itself and not with either the accident or subsequent stay in hospital, although amnesia arising from fright has been reported (Cairns and Holbourn, 1943). In one instance a husband and wife, both highly intelligent people, were involved together in a car accident. The wife sustained a mild head injury, with retrograde

amnesia and post-traumatic amnesia of some hours, and a diffuse patchy amnesia for events preceding her "last memory" by some days. Information about her activity was readily supplied by the husband, who, though seriously injured, sustained no concussion and had no difficulty in recollecting these events.

Incidence of Memory Defects

A further study has been made of 24 cases of closed head injury of varying grades of severity, from the point of view of residual memory defects of the kind described. Only patients from whom adequate information could be obtained and verified and who proceeded to a full intellectual recovery have been included in this series, which thus constitutes a small group selected from the many initially observed. The cases have been divided into three groups on the basis of duration of post-traumatic amnesia, and hence of presumptive severity of injury (Symonds and Russell, 1943). The incidence of memory defects falling into any of the categories listed above and their distribution in the three groups of subjects is shown in Table I.

It will be seen from Table I that two-thirds of the cases gave evidence of a memory defect extending beyond the duration of retrograde amnesia as clinically ascertained. There is some suggestion that the incidence of such defects is more frequent in the more severe injuries (Groups 2 and 3).

TABLE I
DISTRIBUTION OF MEMORY DEFECTS

Group	Cases	P.T.A.	Residual Memory Defects	
			Present	Absent
1	8	> 1 hr.	3	5
2	8	1-24 hrs.	7	1
3	8	1 week or over	6	2
	24		16	8

P.T.A. = post-traumatic amnesia

The relationship of residual memory defect to duration of retrograde amnesia in this series of cases was likewise studied and is shown in Table II. The figures suggest that, regardless of the length of post-traumatic amnesia, patients with retrograde amnesias longer than a few seconds are more likely to have other memory defects of the type described than are those with retrograde amnesia lasting only a few seconds.

TABLE II

RELATIONSHIP OF RESIDUAL MEMORY DEFECT TO DURATION OF RETROGRADE AMNESIA (R.A.)

Duration of R.A.	Group 1		Group 2		Group 3	
	Memory Disturbance	No Memory Disturbance	Memory Disturbance	No Memory Disturbance	Memory Disturbance	No Memory Disturbance
Seconds ..	5	3	2	1	1	2
Up to 1 hr. ..	—	—	4	0	1	0
Over 1 hr. ..	—	—	1	0	4	0

Discussion

Retrograde amnesia of long duration has commonly been observed in the post-traumatic confusional state, and its gradual "shrinkage" during recovery is a common-place. Although this "shrinkage" is most obvious during the later stages of confusion (the so-called Korsakoff phase), it not uncommonly continues after the period of post-traumatic amnesia is at an end (Symonds, 1949). Our observations make it clear that even after the retrograde amnesia has shrunk to its final (usually brief) duration, memory for events preceding the injury is not necessarily intact. When the residual retrograde amnesia is extremely short, as in Cases 1, 2, and 4, closer enquiry may disclose further amnesic gaps or haziness in recollection of events preceding the injury by days or even weeks. In some cases, e.g., Cases 5 and 6, events may be recalled but their localization in time is defective. This is, of course, a common feature in the milder amnesic states. In view of these considerations, it may be concluded that the full extent of memory defect for events preceding the injury is not necessarily given by the duration of retrograde amnesia as conventionally ascertained. This does not mean, however, that the usual means of assessing retrograde amnesia are necessarily unreliable. It appears more likely that there are two separate aspects of the memory disturbances following head injury: (1) the short and usually complete retrograde amnesia; and (2) more diffuse and widely distributed disturbances of memory for pre-traumatic events.

The latter have their parallel in observations which have been made of residual amnesias following electro-convulsive therapy (E.C.T.). Although the duration of post-convulsive retrograde amnesia is as a rule well under a minute (Mayer-Gross, 1943), more extensive memory defects are not uncommonly found. Cohen (1939) has called attention to retrograde amnesia covering a period of up to a day or more, but recovering spontaneously within a

few hours. Delay (1943) has noted, in addition to retrograde amnesia of variable duration, isolated disturbances in general memory for information and events which may persist for a considerable period. Similar observations have been reported by Brody (1944) in a small number of cases. More recently, Janis (1950) has demonstrated by means of special techniques, extensive disturbances in the recall of well-established personal information after E.C.T.

Although the amnesias reported after E.C.T. were somewhat resistant, they were regarded, in principle at least, as reversible. In this paper we have only described retrograde memory disturbances which showed no improvement after several weeks. In addition, however, we have observed a large number of patients in whom, although the actual duration of the retrograde amnesia has not shortened, there has been considerable improvement in memory for events on the threshold of the amnesic gap. Although in the instances observed here the memory defects concerned events of fairly recent origin, it is possible that with more extensive means of enquiry and verification disturbances of very remote memory might also be discovered. These amnesias, however, do not seem to be due so much to a genuine abolition of the memory traces as to a blocking of recall which can be removed by certain circumstances such as conversations with relatives or return to the pre-traumatic environment. One of our patients told us that in the weeks following his discharge a meeting with a friend or a visit to a place known previously would often serve to bring back memories of recent experiences which he had been unable to recollect since his injury. In view of these considerations, it may be suggested that residual memory defects of the type described in this paper are severe grades of reversible disturbances and due to impairment of recall rather than absolute amnesia. In this respect they appear to differ from the absolute retrograde amnesias lasting a matter of a few seconds, which may be due to

failure of registration in the first instance and are probably not recoverable. Absolute retrograde amnesias of longer duration may be due to a combination of both inaccessibility and lack of registration. In certain cases they have been shown to behave like the more diffuse disturbances of pre-traumatic memory, in that certain aspects are recoverable. The work of Russell and Nathan (1946) suggests that some yield to investigation under barbiturate hypnosis, while Klein and Kral (1933) have reported a traumatic retrograde amnesia reduced by reconstructing the situation which had obtained shortly before the accident.

It is apparent from these observations that, besides the shrinkage of absolute retrograde amnesia seen during recovery, which has been found by Russell and Nathan (1946) to follow a time sequence, there is a "filling-in" of more extensive retrograde memory disturbances which can continue after the absolute retrograde amnesia has reached its static level, and in which other factors as well as time are of importance.

The anatomical lesion associated with the incidence of retrograde memory disturbances is obviously a question of great importance. Little can be said on this score from the small number of cases reported in this paper, but it is clearly a subject which merits further investigation.

In conclusion, it may be noted that the presence (or absence) of residual memory defects for pre-traumatic events might have some value as an additional criterion in assessing the progress of recovery. When taken in conjunction with the respective duration of retrograde and post-traumatic

amnesia, it might lead to a more accurate appraisal of the extent of general cerebral disturbance. It is also possible to regard such memory defects as constituting the mildest grade of post-traumatic intellectual loss. Should they appear in more outspoken form, it may be surmised that recently acquired information, knowledge, and skills would be appreciably affected.

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