DISORDERS OF TEMPORAL JUDGMENT ASSOCIATED WITH AMNESIC STATES.

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I. INTRODUCTION.

IT is widely recognized that judgment of time may be grossly disturbed in amnesic states of organic origin. Korsakoff (1890), in his classic exposition of the syndrome which has come to bear his name, pointed out that memory for time is often more severely affected than memory for events, and that temporal reference may remain markedly defective, even after remission of the psychosis. Thus one of his patients was able to recall recent events with fair accuracy, but was unable to state whether a given event had occurred yesterday or three years before. After recovery, moreover, this patient presented disturbances in the temporal sphere as the most outspoken residual symptom. Korsakoff further observed that defects of temporal localization might appear as the most prominent manifestation in mild cases of the amnesic syndrome. It would seem, then, that disorders of time judgment form an integral part of this syndrome and may well reflect a disturbance of memory at its highest levels of psychological organization.

Temporal disturbances in amnesic states have been noted by a number of writers interested in memory disorders of the Korsakoff type. Bonhoeffer (1901) called attention to gross defects in retaining the temporal succession of events and to inability to appreciate the passage of time. Similar defects are also mentioned by Coriat (1904) in a discussion of reduplicative paramnesia and by Meggendorfer (1928) in his authoritative account of the alcoholic Korsakoff psychosis. It is to Van der Horst (1932), however, that we owe the first detailed analysis of temporal disorders in the amnesic syndrome. This writer pointed out that many of the errors of memory observed in such cases derive not so much from loss of retention as from improper temporal reference of recent events. Thus a patient who was given a cigar was able to recall this episode after a quarter of an hour, but incorrectly assigned it to the previous week. Again, the same patient stated that a doctor who withdrew from an interview for a few moments and then returned had been present at an interview on the previous day. Many further examples are given of cases in which recent events are correctly recalled but in which the patient is unable to estimate how long ago they took place. Order of sequence, in particular, is poorly retained. Thus the patient may correctly retain a number of instruc-

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tions, but invariably carry them out in the wrong order. In the light of these observations, Van der Horst concludes that the amnesia bears especially on the temporal position and chronological sequence of recent events. On his view events themselves may still be remembered in the Korsakoff state, but their " temporal signs " are lost. He regards this inability to order consecutive events and the consequent loss of continuity in personal experience as the fundamental disorder in the amnesic syndrome. One may, however, point out that this interpretation, although viewed with favour by Gillespie (1937) in a well-known analysis of amnesia, has not won general acceptance (*cf.* e.g. Mayer-Gross and Guttmann, 1936).

Lidz (1942), in a more recent discussion of the amnesic syndrome, is also constrained to place emphasis on the defect of temporal synthesis. The amnesic patient, he points out, is incapable of linking events sequentially or with the general background of his experience. His impressions remain more or less isolated and can therefore be recalled with difficulty, if at all. Lidz calls attention, in particular, to defects in synthesis observed on tests of picture-arrangement and the like. Thus the patient, when given a series of pictures which form a connected sequence, fails to grasp the import of the series as a whole. Lidz does not, however, regard the loss of " time sense " as the basic defect, as does Van der Horst. He believes the fundamental disorder to be one of inaccessibility of memory material, i.e. a defect of recall. The patient is unable to regain material which has been followed by subsequent impressions: he cannot transpose himself in imagination into the recent past and set up the necessary orientation for adequate recall. The disorders in temporal reference and sequence are ascribed to this inability freely to evoke and utilize past experience.

A tendency on the part of amnesic patients to *antedate recent events* which they remain able to recall is evident from the examples given by Van der Horst (1932). A similar tendency was noted in a case of post-traumatic Korsakoff syndrome communicated by Paterson and Zangwill (1945). In this case not only was there gross over-estimation of the passage of time (e.g. one minute being estimated as a quarter of an hour), but also a notable tendency to refer quite recent events to a relatively remote past. Thus the patient would recognize his doctors from day to day, but would always allege that it was a matter of weeks or even months since he had last seen the particular member of the staff with whom he was now confronted. On one occasion a visit to a music-hall on the previous day was recounted with fair accuracy, but was said to have taken place at least a week before. There was evidence, too, that this tendency to over-estimate the interval which had elapsed since a given event increased with the further passage of time. Unfortunately, no systematic analysis of this effect was undertaken.*

* We may note in passing that somewhat similar disorders in the temporal sphere have also been reported by Kleist (1934) in cases of brain injury, more especially in connection with lesions in the general region of the hypothalamus (*cf.* Delay, 1942, p. 98). It will be borne in mind that a number of cases of Korsakoff's syndrome have been described in which the lesion predominantly involves the basal parts of the diencephalon. It is possible, therefore, that both retention and appreciation of time are subserved, in part at least by neural mechanisms situated at a subcortical level. We shall not, however, consider further the problem of cerebral localization in the present paper.

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The purpose of the present paper is to communicate some preliminary observations on temporal defects observed in amnesic states. First, an account will be given of errors of localization in time shown by three cases of chronic organic memory defect and by a small number of additional cases showing transient amnesic defects as a result of E.C.T. Second, some simple experiments on recall of order of sequence will be described. Third, some observations on the perception of sequence in both chronic and transient amnesic states will be briefly reported. It is hoped that our observations will be of help in defining with greater precision the role of temporal defects in the amnesic syndrome and thereby throw light on the organization of memory in general.

II. Experiments on Temporal Localization.

(1) *Chronic Amnesic Syndromes.*

Let us consider first some simple observations on time localization in three cases of relatively severe organic memory disturbance. The first was a case of outspoken Korsakoff syndrome; the second a case of disseminated sclerosis with profound changes in the mental sphere; and the third a case of presenile dementia. Co-operation on the tests was good in all cases.

Experiment 1.—The first patient, who exhibited a pronounced Korsakoff syndrome of some months' duration, was shown four simple designs at intervals of one minute and required to copy them in turn. Five minutes after the last design had been drawn, reproductions from memory were demanded. Only one design was reproduced with any semblance of accuracy. A recognition test was then given in which the four original designs were presented along with six new ones. The patient identified the original designs correctly, but *strenuously denied that they had been shown to her on this day*. She considered that they might have been shown her *several weeks previously*.

It will be seen that the patient, whilst recognizing the test designs correctly, grossly overestimated the length of time which had elapsed since their first exposure. An interval of five minutes is judged in retrospect to be a matter of several weeks.

Experiment 2.—The second patient, who gave evidence of a marked memory defect of organic type, was shown three successive designs each for a few seconds. He was then requested to draw them from memory. The first and third were correctly reproduced, but the second was not attempted. The patient recollected that there had been a second design, but was unable to recall what it was like. After a short distraction, in which certain other pictures were presented, the patient was entirely unable to recall having been shown the three designs. When shown them along with others, however, the original three were identified without difficulty, and the patient recalled having attempted to reproduce them. Asked when he was first shown them, however, he replied: " A long time ago; not this morning." When requested to be more precise, he specified: "*About a fortnight ago.*"

This observation is very similar to the first. An interval of a few minutes between presentation and representation of the test material is again treated as a matter of weeks.

Experiment 3.—The third patient, who displayed gross defects of recent memory, was shown three consecutive designs and required to draw them from memory. Only one of the reproductions was in the least like the original. After a brief interpolated task, in which three pictures were shown and described, the original designs

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were represented along with seven others. Six of this series, including the three originals, were treated as familiar. When asked when she had seen them last, the patient stated, " About a fortnight ago." and altogether denied that they might have been shown on the same morning. A further test of recognition was then given in which the three interpolated pictures were given along with a number of others, which the patient had not previously seen. Two were correctly and two incorrectly recognized. When asked how long ago the pictures had been shown, the patient replied : " I don't know how long ago it is since I last saw you ; perhaps some weeks, perhaps yesterday." She again denied that the pictures had been given on this day.

The above observations bring out clearly, in a test setting, the defects of temporal reference to which Van der Horst (1932) and Lidz (1942) have already drawn attention. Test material is identified, often with accuracy and confidence, but the patient has a very poor idea of when the original experience took place. In general, the errors in judging time-lapse were consistently *errors of overestimation.* Material which had in fact been shown only a few minutes earlier is said to have been given two or more weeks previously. It is probable that this tendency to antedate recent events is quite general in organic amnesic states.

(2) *Post-convulsive Confusional States.*

Some experiments analogous to those reported above were carried out on patients undergoing E.C.T. and may be briefly described. First, an attempt was made to study time reference in the later recall of material presented shortly before the administration of E.C.T. Second, an attempt was made to study time reference in the recall of material presented during the post-convulsive confusional state. It is hoped that the findings will supplement those obtained in chronic amnesic states.

Experiment 4.—The patient was an hysterical psychopath, aged 31. Design A was shown thirteen minutes and designs B and C one minute before the administration of E.C.T. Ten minutes later, after return to the ward, the patient was shown two further designs, D and E. On the following morning all five designs were re-presented along with others with which the patient was unfamiliar, and a recognition test given. The patient picked out Design A with confidence, B with less confidence and C " by guesswork." Designs D and E were not recognized at all. When asked when Designs A, B and C had been previously shown the patient's reply was quite correct in the case of A. Designs B and C, on the other hand, were referred to an occasion *during the previous week* when the patient had had an interview with the present examiner.

Experiment 5.—A similar test was given to a second patient undergoing E.C.T. In this case a Rorschach card was shown one minute before the shock was administered. When shown the card again on the following day, the patient commented : " Someone showed it to me yesterday ; *a long time before my treatment.*"

The above experiments show that, in some cases at least, material presented a minute or so before administration of E.C.T. is identified correctly, but its original perception is referred to a time appreciably more remote than is actually the case. As in the chronic states, there appears to be a tendency to antedate recent events in recalling them. In a few cases, however, errors in the estimation of time were found to be in the opposite direction, i.e. material

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shown before administration of E.C.T. was erroneously referred to the post-convulsive period. Two examples of this " post-dating " effect may be given :

Experiment 6.—A patient who was shown two pictures just before the current was applied was found to recall them correctly when interrogated 25 minutes after termination of the treatment. On the following morning, however, she alleged that the pictures had been shown her *after* treatment on the previous day. Three days later, E.C.T. was again given and on the day following the patient was found still to recall one of the pictures. She declared, however, that it had been shown to her on the *previous* day after her treatment. It would thus appear that the original perception was post-dated in recall by a period of some three days.

Experiment 7.—A patient shown two pictures just before administration of E.C.T. was found to recall them both quite clearly shortly after termination of treatment and on the following day. On the latter occasion, however, she alleged that the pictures had been shown her *after* treatment and not before. Three days later E.C.T. was again given, and on the day following the patient still remembered one of the pictures but alleged that it had been shown her just after treatment on the previous day. This indicates that the memory of the picture was post-dated by three days.

This post-dating effect will be discussed further at a later stage.

Striking defects in the temporal reference of material presented during the *post-convulsive confusional state* were also observed in some cases.

Experiment 8.—The patient mentioned in Experiment 7 was shown an unfamiliar picture 25 minutes after termination of E.C.T. Ten minutes later she recognized the picture correctly, but ascribed its first presentation to the *morning of the same day* ; i.e. an hour or more before the time at which her E.C.T. was administered.

The above observation is typical of many which we have been able to record. Material perceived during the post-convulsive confusional state may, in some cases, be retained, but the original experience is apt to be placed at a considerably earlier time than was actually the case. As a rule, it is referred to a time an hour or more before the beginning of the treatment. No instances of a post-dating tendency were recorded.

(3) *Summary.*

(1) Marked defects in the time reference of recent memories are reported in cases of chronic amnesic syndrome and in the post-convulsive confusional state.

(2) These defects commonly take the form of gross overestimation of the time-interval which has elapsed since the original experience whose recognition or recall is demanded. In severely amnesic cases the tendency to antedate recent events may transform an interval of a few minutes into one of days or even weeks.

(3) In a small number of cases material exposed immediately before the administration of E.C.T. is post-dated on subsequent tests of recognition or recall.

III. Experiments on Serial Order.

We may now pass on to describe some experiments on the recall of the order of sequence of simple test items. These experiments were undertaken

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only with the chronic amnesic cases which included, in addition to those already mentioned, a deteriorated epileptic patient with gross impairment of retention and recent memory.

Experiment 9.—The above-mentioned patient was shown three simple designs in close succession and asked to reproduce them from memory. She drew the first two correctly but was unable to recall the third. Three pictures of common objects were then shown. Next, the patient was given a recognition test in which she was asked to select the original three designs from a set of ten. This she accomplished perfectly. At this stage, however, she entirely denied having been shown pictures of common objects. On a further recognition test, however, in which the three pictures were mixed with others, she identified correctly those which had been already shown to her and which she claimed earlier to have forgotten. Recognition, it is true, was greatly lacking in confidence. She now stated that she recalled having seen them but affirmed with some liveliness that they had been shown her *before the designs*.

The above observation shows that the order of sequence of the two sets of test material has been transposed. The pictures, in fact shown second, are said to have been shown first. It suggests, further, that items which can be spontaneously recalled or identified with conviction are ascribed to a more recent past than is the case with items which cannot be recalled spontaneously and which are identified only with hesitation.

Experiment 10.—This experiment was conducted with the patient who featured in Experiment 3 and who showed marked errors of over-estimation in recalling the times of recent events. On the present test the patient was shown three pictures of common objects, viz. (1) a pair of glasses, (2) a clock and (3) a fork. These items were correctly recalled after one minute. She was then shown three more pictures, viz. (4) a gun, (5) a chair and (6) a boot. On a test of recall of these latter items after one minute, the patient gave: "Gun, fork, chair and clock." She was then shown all six pictures, together with others, and asked to select those with which she was already familiar. The original six items were correctly chosen. Asked to specify the *order of sequence* in which they had been shown, however, she gave: (1) Boot, (2) glasses, (3) clock, (4) gun, (5) chair and (6) fork. It will be noted that the patient assigned the two items which she was *unable* to recall, viz. "boot" and "glasses" to the first two places in the series. It will also be noted that the patient, in her attempt at recollection, condensed two sets of three pictures into a single set of four.

The above observation suggests that, in recalling the serial order of unrelated items, those which are least well retained are assigned to the earliest places in the series. Items relatively well retained, on the other hand, are assigned to the later places, i.e. are treated as the more recent. It may be suggested that there is an important relation between adequacy of retention and the "time ordering" of recent events.

IV. Experiments on Numerical Sequence.

The last series of observations is concerned with the conditions under which consecutive events are perceived as building a related sequence. In the first place it might be suggested on general grounds that the order of sequence of items forming a conventional series is better retained than the order of sequence of disconnected items. This expectation appears to be borne out in the following observation.

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Experiment 11.—The patient mentioned in Experiments 3 and 10 was first shown three simple designs and then some pictures of common objects. After a short distraction, it was found that she could not recollect any of the material, but identified all the items hesitatingly on a recognition test. She was quite unable to say whether the designs or the pictures had been shown first and, when asked to arrange all the items in order of sequence, did so with many mistakes. The experiment was then repeated in exactly the same way except that, in place of the three designs, the numbers 8, 9 and 10 were presented, each on separate cards. After an interval of some minutes, it was found that the patient could recall this series of numbers and in their correct order.

This observation shows that a simple numerical sequence can be retained despite failure to reproduce the serial order of disconnected items. In more severe amnesic states, on the other hand, even the capacity to form and retain the simplest numerical sequence may be grossly disturbed. This is well seen in the following examples:

Experiment 12.—The case of Korsakoff's syndrome mentioned in Experiment 1 was given four cards bearing the numbers 9, 10, 11 and 12 respectively. The cards were presented in serial order at intervals of one minute. The intervals were filled by copying designs. It was found that the patient entirely failed to relate the successive items as a numerical sequence and was able to recall only the third number at the end of the fourth minute. On a recognition test, further, this number alone was said to be familiar.

In the above case it would appear that the successive numbers are not perceived as forming a series and are rapidly forgotten.

A similar failure to appreciate sequence was noted also in certain patients when examined shortly after the termination of E.C.T.

Experiment 13.—A patient undergoing a course of E.C.T. was shown in the normal state a set of four cards bearing the numbers 5, 6, 7 and 8 respectively. The cards were given singly at intervals of 20 minutes. On the following day, all four digits were immediately reproduced on request. On another occasion, the same patient was given similar cards before and after administration of E.C.T. The numbers used in this case were 4, 5, 6 and 7. The first card was given 7 minutes and the second one minute before administration of E.C.T. The third and fourth cards were given respectively 23 and 62 minutes after its termination. On the following day the patient was given a set of cards bearing numbers from 1 to 15, presented in random sequence, and asked to choose those which had been shown on the previous day. Only the numbers 4 and 6 were chosen. When instructed to pick out others, the patient chose 3, 2 and 5. *No attempt was made to form them into a series.*

Experiment 14.—In a similar case to Experiment 13, cards bearing the numbers 7 and 8 were shown respectively, 15 and 1 minute before administration of E.C.T. and the numbers 9 and 10 respectively, 17 and 60 minutes after its termination. On a test of recall shortly after the last card had been given, the patient remembered only the first two numbers. On a recognition test next day, however, she chose 8 and 10 and believed both had been given after treatment. On being pressed to choose others, she hesitantly selected 7 and 9. The fact that *these four numbers formed a sequence appeared wholly to escape her.*

The above examples indicate that administration of E.C.T. may signally interfere with the capacity to grasp and retain a simple numerical sequence. In the second case it will be noted that the four numbers are correctly chosen on a recognition test, but that their serial order has been lost.

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V. Discussion.

The most consistent finding brought to light by these various experiments is the tendency in recall to *antedate recent events*. This tendency has been noted in both chronic and transitory amnesic states and obviously calls for an explanation. The simplest explanation that might be advanced is to suppose that the " temporal sign " of a recent event depends on the intensity, vividness or clarity of its recollection. If this were the case, it might then be argued that a defect of retention, by reducing the clarity of a remembered event, causes it to be assigned to a past more remote than is in fact the case. An explanation of this kind, however, is almost certainly too simple. As many psychologists have pointed out, the clarity or vividness of a memory image is not a trustworthy guide to its age. Many experiences dating from early life may be recalled with great vividness and circumstantiality, but are not on that account referred to a more recent past. Indeed, it appears to be rather unusual for the vividness of a recollection to be used as a clue to its temporal location in past experience. We must conclude that time reference, in general, is to be ascribed to other and more complex psychological conditions.

It is probable that localization in time in normal remembering depends in large degree upon the retention of proper chronological relations between successive events which are accessible to recall. In memory for quite recent events, e.g. those of a single day, the normal individual has little difficulty in ordering his more outstanding experiences in proper sequence. Although these relations become rapidly disrupted with the passage of time, it is probable that they provide adequate time localization in short-term memory. In the recall of long-past events, on the other hand, it is probable that a broader chronological scheme is employed. The points of reference in such a scheme must be taken to be given by outstanding events in the course of personal life. Indeed, as Bartlett (1932) has suggested, the " dating " of a remote event may be a highly complex activity making use of inference and judgment in addition to recall in the narrower sense. It is an affair of construction rather than mere reproduction.

Now it is noteworthy that the defect in Korsakoff states almost certainly involves a breakdown in the chronological organization of recent experiences. One may hazard the view that an amnesic patient attempting to " date " an event which took place a few moments earlier is in much the same position as a normal individual attempting to " date " an event which took place some days or weeks previously. In both cases the original event is retained in memory, but lacks a firm anchor in the memory train. Portions of the latter continuous with the previous experience of what is now recognized or recalled are reinstated only with great difficulty. In anterograde amnesia, therefore, any recent event which is retained in memory has a certain quality of isolation. It is devoid of firm chronological links with neighbouring experiences which have preceded or followed it. It has an isolation comparable to that of a much more remote event recalled by a normal individual. This may well be the reason why it will appear to the patient as belonging to a more remote past than is in fact the case. It is also possible that, on tests of recognition, the

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patient interprets his lack of confidence as indicating that the material in question belongs to a more remote period. Although other factors may well be involved, an explanation along these lines is the most complete that can be offered in the present state of our knowledge.

It is still necessary to explain the *post-dating* effect described in certain cases of transient confusion following E.C.T. In these cases it is probable that the error arises from a condensation of two memories, viz. (*a*) the original presentation prior to E.C.T.; and (*b*) the post-E.C.T. test of recall. On the following day the original material was correctly remembered, but the time-reference given is that of (*b*), the earlier test of recall. In this connection it is noteworthy that the post-dating effect was apt to become more marked with further lapse of time, suggesting that the original memory had undergone further condensation with more recent experiences. Analogous confusions in the dating of recent events are common in normal remembering.

The experiments on *serial order*, inadequate as they are, undoubtedly suggest that "time order" is, in part at least, a function of the ease with which the individual members of the series can be recognized or recalled. In general, items which are poorly retained are displaced to the earlier positions in the series and, in particular, an item which can be recognized but not recalled is assigned to an earlier position than one which can be both recognized and recalled with ease. These displacements in recall of serial order may perhaps be viewed as rationalizations of the memory failure. It is commonly supposed that forgetting depends solely on lapse of time and it would be easy for the patient to explain his inability to recall a given item by assuming that it had been presented less recently than one which he is able to remember. At all events, it must be borne in mind that order of sequence, even in normal subjects, is a factor extremely liable to disturbance. As Bartlett (1932) suggests, it may well be that the capacity to assign particular events to their correct sequential positions is a relatively late development in the evolution of mind. If this view is correct, recall of temporal relationships might be expected to prove particularly vulnerable to dissolution in organic mental disorders.

The experiments on the perception of *number sequences* do little more than confirm in a more systematic fashion the observations reported by Lidz (1942). Whether the disturbance of sequence-formation is to be regarded as primary or as secondary to the retention defect would appear very much a matter of opinion. We ourselves incline to the view that the disturbance is an effect of the memory impairment and not a primary want of synthesis in the sense of Van der Horst (1932). It is interesting, however, to compare this defect in temporal organization with the somewhat analogous defect in spatial synthesis which has been described as "simultaneous agnosia" in the German literature (*cf.* Lange, 1936). One might even speak of the disturbance noted in this paper as an "agnosia for succession,"

It is impossible in the present paper to enter into any discussion of temporal perception and its relation to memory in general. These problems have already been discussed in some detail by Janet (1928) and Schilder (1942). We must also refrain from attempting to bring our observations into relation with modern neurophysiological conceptions of the memory process, e.g. those

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developed by Ritchie Russell (1947, 1948). It is our hope that experimental studies of the type reported in this paper will have value in defining with greater precision the pattern of amnesic disability and thereby throw further light on the organization of memory in general. In these ways they may come to contribute towards the formulation of a comprehensive theory of memory and its physical basis in the central nervous sytem.

VI. Summary.

(1) A short review is given of disturbances in the temporal sphere which have been described in the amnesic syndrome.

(2) Experiments are reported on defects in the time localization of recent events observed in both chronic and transient amnesic states. It is pointed out that cases of amnesic syndrome commonly antedate recent events and that the resulting overestimation of time-interval is often gross. A similar though less extreme, tendency to antedate recent events is also described in the post-convulsive confusional state. In a few cases, on the other hand, errors are in the opposite direction and a post-dating effect is obtained. A tentative explanation of these errors in temporal judgment is attempted.

(3) Some further experiments are reported on the recall of serial order and the apprehension of numerical sequence. It is pointed out that order of sequence is exceptionally poorly retained in amnesic conditions and that those items which are best remembered tend to be regarded as the most recent. In severely amnesic states, disturbances in the apprehension of sequence itself may also be found.

(4) It is concluded that localization in time and the recall of serial order of recent events are aspects of memory particularly liable to dissolution in organic amnesic states.

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