

Amnesia Observed: Remembering and Forgetting in a Natural Environment

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The purpose of the present study was to provide information about the relationship between an amnesic patient's memory performance on laboratory tasks and in a natural environment. Several of the patient's mnemonic functions were systematically observed during two rounds of golf. The patient's memory for the events of the round, as indexed by his ability to find his tee shots and to remember his strokes on each hole, was severely impaired. In contrast, he demonstrated extensive general knowledge of golf and played the game with a substantial degree of skill. The pattern of preserved and impaired mnemonic abilities demonstrated by the patient on the golf course closely resembled his performance on laboratory tasks.

Little is known about the mnemonic capacities of amnesic patients in everyday life. Although investigators of normal human memory have demonstrated increasing interest in naturalistic studies (Neisser, 1982), and some researchers have suggested that this approach may be useful in the analysis of memory disorders (Crowder, 1982; Schacter, Note 1), most contemporary investigations of memory pathology have bypassed naturalistic observation in favor of laboratory paradigms derived from experimental psychology (Schacter & Tulving, 1982a). The results of such investigations have provided an extensive body of data that has served as a basis for a recent flurry of theoretical activity (see Moscovitch, 1982; Squire, 1982, for review). It is not known, however, whether the results of laboratory investigations of memory disorders can be generalized to the world outside the laboratory, even though the problem is clearly an important one: If amnesics' performance in the laboratory does not generalize to natural settings, then theories that are based on the results of laboratory studies are likely to be of limited value. Two recent studies have furnished some preliminary evidence concerning amnesic patients' recollection of everyday events (Kaushall, Zetin, & Squire, 1981; Zola-Morgan & Oberg, 1980). The present investigation was designed to provide a broader view of the problem by system-

atically observing several memory functions of an amnesic patient in a natural setting.

Recent laboratory research has demonstrated that not all memory functions of amnesic patients are equally impaired. In spite of their inability to recall and recognize recently experienced events, amnesics are able to gain access to general knowledge and can use and acquire various skills and procedures (Cohen & Squire, 1980; Kinsbourne & Wood, 1975, 1982; Schacter & Tulving, 1982b; Warrington & Weiskrantz, 1982). Numerous theoretical interpretations of the observed dissociations have been put forward, each of which describes impaired and preserved memory functions somewhat differently. For heuristic purposes, we can label the form of memory that is impaired in amnesic patients *episodic* memory and label the relatively unimpaired forms *semantic* memory and *procedural* memory, although it should be acknowledged that impaired episodic memory may be restricted to postmorbid knowledge and that intact semantic memory may include only premorbid knowledge (Cohen & Squire, 1981; Huppert and Piercy, 1982; Zola-Morgan, Cohen, & Squire, in press). It would be desirable to observe an amnesic patient in a natural context that requires the use of each of these types of memory to determine the generalizability of laboratory investigations of preserved and impaired functions. One real-world activity that taps all three forms of memory and, hence, provides a unique opportunity for naturalistic study is the sport of golf. For example, to find a ball after striking it a player needs to remember the location of his or her shot, and to keep score accurately he or she must recall the sequence of shots taken on each hole. An ability to perform these episodic-memory tasks with little or no error is presupposed by the structure

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of the game. Golf also draws upon a variety of semantic-memory functions, such as knowledge of rules, etiquette, and jargon, that are unique to the sport. In addition, retention and utilization of acquired skills or procedures are necessary to strike the ball consistently and to execute a variety of specialized shots. All of the foregoing mnemonic functions were examined during two rounds of golf that the investigator played with an amnesic patient who is an experienced golfer.

Method

Clinical Background

M.T. is a 58-year-old man who first began showing signs of memory impairment shortly after he turned 50. His memory function has steadily deteriorated since that time. A diagnosis of Alzheimer's disease was made in 1979. M.T. had no prior history of neurological or psychiatric illness. He had a high school education, and had worked as a furrier and a computer programmer before the onset of his illness. He is currently unemployed and lives at home with his wife.

M.T. exhibits gross deficits on standard laboratory tests of episodic recall and recognition. For example, he performs at the chance level on a two-alternative forced-choice recognition test that immediately follows presentation of a 60-item list of words. His recognition of pictures from a 32-item list, tested by both yes/no and forced-choice recognition, is also at chance. He is unable to recall any items from a 20-item blocked categorized list on a free-recall test, and his performance is not improved by presentation of category cues. M.T.'s memory quotient (MQ) on the Wechsler Memory Scale (WMS) is 62; he exhibits virtually no evidence of retention on delayed tests. In spite of these extensive episodic-memory deficits, M.T.'s speed of reading word pairs and sentences is facilitated by practice to the same degree as that of control subjects, which suggests that his procedural memory is relatively preserved (Moscovitch, Note 2). The patient attained a near-normal Verbal IQ of 95 on the revised form of the Wechsler Adult Intelligence Scale (WAIS-R), including scaled scores of 10 or higher on Similarities, Information, and Vocabulary subtests. This pattern of results, in conjunction with M.T.'s unimpaired performance on the Benton Visual Naming Test, indicates a good deal of preservation of semantic-memory function. M.T.'s Performance IQ is 74, yielding a Full-Scale IQ of 86. The patient's scaled scores on all performance subtests were less than seven, which reflects substantial impairments. He also performed extremely poorly on the Benton Line Judgment task, which indicates a deficit in spatial perception. Thus, M.T.'s memory disorder

does not exist independently of other forms of cognitive deterioration, as is frequently observed in the amnesic syndrome. However, his MQ is nearly 25 points lower than his Full-Scale IQ. This pattern is characteristic of other amnesic patients and indicates that M.T.'s memory deficit is disproportionate to his intellectual deficit.

According to his own reports and those of his wife, M.T. began playing golf in 1955. He played regularly until the onset of his illness; now he plays a few times per year with relatives who take him out to the course. M.T. characterized himself as a "duffer" who had never taken the game too seriously and played for enjoyment and relaxation. His best scores had been in the high 90s but were usually well over 100, suggesting that he was not a highly skilled player.

Design and Procedure

Although this study is primarily observational, two independent variables were manipulated to gain some experimental control over the events of interest. One variable concerned the familiarity of the golf course on which the rounds were played. The first round was played on a familiar course that M.T. had played on regularly for many years beginning in the late 1950s. The second round was played one week after the first on an unfamiliar course. This variable was manipulated to determine whether any of M.T.'s memory-dependent behavior varied systematically as a function of familiarity with the golf course. The second independent variable was M.T.'s tee-off-position—whether he hit first or second on each hole. This manipulation made it possible to assess the effects of delay on M.T.'s ability to recall the location of his tee shot. Thus, on half of the holes the investigator teed off first and the patient hit second, which enabled M.T. to engage in immediate search for his ball. On the other half of the holes, the patient hit before the investigator and, hence, engaged in delayed search for his ball. The patient's tee-off position was alternated from hole to hole in both rounds. The length of the delay between the patient's tee shot and initiation of search for his ball was usually about 30 to 60 seconds; it was not possible to control precisely the amounts of time that elapsed on delayed-search holes. Care was taken to ensure that M.T. always perceived the location of his tee shot by pointing to it and eliciting a verbal acknowledgement from him that he had registered the location of the ball. On most holes, the patient's memory for the location of his tee shot was evaluated by permitting him to search for his ball until he found it or until his behavior indicated that he did not remember its location, at which point the investigator interrupted M.T.'s

Table 1
Recollection of Tee-Shot Location as a Function of Search Condition and Familiarity of Golf Course

Search condition	Golf course		M
	Familiar	Unfamiliar	
Immediate	.50 (4/8)	.67 (6/9)	.59
Delay	.13 (1/8)	.11 (1/9)	.12
M	.31	.39	.35

Note. The raw numbers of tee shots recollected and the total number of observations are in parentheses.

search and showed him the location of the ball. M.T.'s search was interrupted when one of the two following conditions was satisfied: (a) The patient walked more than 10 to 15 yards past the ball, or (b) the patient walked in the wrong direction from the tee and initiated search at an incorrect location. There were two circumstances in which the patient's ability to point to the location of the ball was used as a memory index. First, if the patient's tee shot was lost in trees or in water, he was given credit for remembering its location if he pointed out the general area where his ball was lost. Second, on several occasions when the patient hit the ball a short distance directly in front of the tee (less than 50–75 yards), the investigator asked him to point to the location of the ball before he reached it. This was done in order to minimize the possibility that M.T. would receive credit for remembering the location of the ball when, in fact, he might have found it by chance.

Recordings of events were made as they occurred in the course of playing each hole, on a portable Sony TCN-121 cassette recorder. The patient was aware of the recording of his performance. In addition to noting in detail M.T.'s search for his shots, the investigator recorded observations concerning all of the patient's golf-related behavior and conversation. He also recorded the recall and recognition tests that were administered throughout the round in the following manner: After completion of a particular hole, the patient, while standing on the next tee, attempted to recall the shots he had taken on the previous hole. If a distinctive or atypical event occurred on a given hole (e.g., the patient hit the ball in the water, holed a long putt, and so on), M.T.'s memory for the event was probed with a yes/no recognition test (e.g., "Did you hit a ball in the water on the last hole?"). Approximately 1 to 2 minutes elapsed between completion of a hole and subsequent recall and recognition testing. A final free-recall test, in which M.T. tried to recall as many

shots as he could, was administered after completion of each round.

Results and Discussion

A thunderstorm halted play after completion of only 16 holes of the first round. All 18 holes were completed in the second round.

Episodic Memory

Memory for location of shots. M.T. had difficulty remembering the location of his tee shots in both rounds. As indicated by the data presented in Table 1, the patient's ability to find his tee shot was not influenced systematically by familiarity of the golf course, but it was affected by tee-off position.

When he was permitted to search immediately for his ball, M.T. found it on more than half of the trials (.59). M.T.'s failure to remember the location of his shots on 41% of the immediate search trials can be partly attributed to his spatial-perception deficits. However, there were also numerous opportunities for interference during the time that elapsed after he left the tee; even a momentary distraction may have been sufficient to disrupt his memory. This interpretation is consistent with the finding that M.T.'s performance was highly sensitive to the delay manipulation: He remembered the location of his ball on only 2 of 17 delay trials (.13). On most delay trials, the location of M.T.'s search bore no relation to the actual location of his tee shot. For example, after reaching a par-three green with his tee shot, and indicating his satisfaction with this accomplishment, M.T. waited for the investigator to hit his shot. The patient then searched for his ball in a creek to the left of the fairway and was astonished when the investigator told him that his ball was on the green. On several delay trials, M.T. forgot the location of his own tee shot and "found" the investigator's ball; he expressed surprise when told that the ball was not his. Particularly striking examples of the extent of M.T.'s amnesia occurred on five delay trials during which the investigator waited an additional 30–60 seconds before teeing off because the players in front were still within his driving range. Although M.T. had already hit his shot, he drew a club from his bag as soon as the investigator completed his drive and teed up again. M.T. had not only forgotten his ball's location on these trials, but had also forgotten that he had hit his tee shot just minutes earlier. These observations indicate that M.T.'s memory disorder had a profound impact on his ability to carry out an activity that most golfers execute effortlessly and without error.

It was difficult for various practical reasons to monitor systematically M.T.'s search on all shots

after the tee shot on each hole. The general pattern, however, was similar to the foregoing observations: If M.T. could search immediately for his ball he usually found it, but if he became distracted after hitting, the investigator had to lead him to the location of his forgotten shot.

Recollection of events from immediately preceding holes. There were three possible outcomes of the recall tests that were administered 1 to 2 minutes after the completion of each hole: (a) The patient could recollect all of his shots on the preceding hole, (b) he could recollect some of his shots, or (c) he could recollect none of his shots. The data presented in Table 2 indicate that on most holes of both the familiar and unfamiliar courses, M.T.'s recall fell into the third category. He was unable to recall specific information about individual shots and instead provided vague responses such as "I hit a few bad ones" or "I didn't do too well." M.T. did recall one shot from 9 holes and two shots from 4 holes, yielding a total of 13 holes across the two rounds in which he recollect some shots. For example, on one hole during the second round he recalled accurately that he hit one shot behind a large elm tree but could only add that "I messed up all my other shots." In fact, M.T. had hit one of his best drives on that hole and had also made a long putt. The most striking feature of M.T.'s performance, however, is that he could not reconstruct the entire sequence of shots he had taken on any of the 34 holes that he had played. Recollection of all shots from a preceding hole is necessary to keep score accurately and is accomplished with little or no error by golfers with intact memories.

The results of the recognition test provide further evidence concerning the extent of M.T.'s memory deficit. His recognition performance was similarly impoverished on the familiar and unfamiliar courses: M.T. said "yes" to 2 out of 11 items on the familiar course and to 3 out of 12 items on the unfamiliar course. Although the items on the recognition test were selected to be distinctive events, no distractor items were used, and just minutes elapsed between the event and the tests, M.T. denied the occurrence of 16 of the 21 events that he was asked about.

When given a final free-recall test at the conclusion of each round, M.T. was unable to recall any specific shots from the day's play. Encouragement and prompting (e.g., "You hit your tee shot in the woods on the 17th hole. What happened after that?") yielded no evidence of recall. In addition, prior to the start of the second round, when the investigator questioned the patient concerning the first round, M.T. claimed that he had never previously played golf with him.

Neither M.T.'s recollection of his shots nor his recall of tee-shot location were affected by famil-

Table 2

Percentage of Holes on Which M.T. Recollected All, Some, or None of His Shots from the Immediately Preceding Hole

Shots recollected	Golf course		M
	Familiar	Unfamiliar	
All	.00 (0)	.00 (0)	.00
Some	.31 (5)	.39 (7)	.35
None	.69 (11)	.61 (11)	.65

Note. The raw numbers of holes contributing to each category are in parentheses.

ilarity of the golf course. This observation implies that performing in a familiar environment is not a sufficient condition for improving the level of his episodic-memory function. However, M.T.'s memory of the familiar course was somewhat limited: When asked to describe each hole before the start of the round, he accurately recalled the first four and the final two holes. A serial-position effect was also evident in M.T.'s behavior on the course. He could independently find his way from hole to hole on the first six holes and on the final two holes that were played but could not do so on the other holes. This course, then, was only partially familiar to the patient.

Procedural and Semantic Memory

The level of golfing ability demonstrated by M.T. in both rounds was consistent with his description of himself as a moderately skilled player. M.T. generally hit the ball straight and frequently hit it for respectable distances (up to about 185 yards from the tee); he missed the ball on only one swing in the two rounds. M.T. also putted reasonably well, usually requiring two or three strokes to hole out once he was on the green. He frequently sank putts up to 5 or 6 feet long, and twice holed out from over 20 feet. Overall, M.T. played at a level consistent with an 18-hole score of about 120 (no attempt was made to keep score formally), which is well within the performance range of normal golfers. It is not clear whether M.T.'s golf skills have deteriorated as a function of his illness, but his performance indicates that he is still able to execute a complex set of acquired perceptual-motor procedures in a relatively fluent manner.

M.T. demonstrated substantial semantic knowledge of golf both by his behavior and by his linguistic use of golf jargon. Consider first the variety of golf-appropriate behaviors that M.T. engaged in during the two rounds: On both the familiar and unfamiliar courses, M.T. consistently oriented toward the green on his shots, teed up in the area

designated by wooden markers on each tee, selected the correct clubs for his shots, replaced dislodged turf (divots) after hitting from the fairway, marked his ball on the green, checked the label of the golf ball if he was not sure that it belonged to him, avoided taking the pullcart that contained his golf bag onto the greens, lined up his putts in an appropriate fashion, and replaced lost balls in the manner indicated by the rules of golf. These behaviors demonstrate that M.T. retained his knowledge about rules, etiquette, and strategies of golf and also his ability to carry out these complex cognitive activities. Appropriate club selection, for instance, requires the use and coordination of information from various sources: (a) One must remember what specific functions are performed by each club, (b) one must judge accurately the distance required for a shot and take into account any hazards that may be encountered, and (c) one must be able to apply knowledge of a specific club's function to a particular situation in an appropriate manner. M.T.'s club selection was virtually flawless. He consistently used the club called for by his distance from the green and several times demonstrated even more subtle knowledge of club selection. For example, when his ball was about 200 yards from a green that had a creek approximately 50 yards in front of it, M.T. realized that he probably could not hit over the water and chose a short iron to lay up safely in front of it. Similarly, when standing on the first tee of the familiar course, from which the first green is not visible, M.T. indicated correctly which clubs would be necessary to reach the green on the second shot from different locations on the fairway. There was only one instance in each round when M.T. demonstrated grossly inappropriate club selection. On both occasions, M.T. selected a fairway wood when his ball was less than 100 yards from the green.

Two of the golf-appropriate behaviors mentioned in the preceding paragraph merit further commentary because they occurred in conjunction with episodic-memory failures. Consider first the observation that on several greens M.T. replaced his ball with a marker (a coin) when it was in a direct line between the investigator's ball and the hole. Marking the ball is a common courtesy among golfers and M.T. engaged in this behavior spontaneously. However, instead of replacing his ball after the investigator completed putting, M.T. walked off the green and placed his putter in his bag; the patient was surprised and confused when told that he had not yet putted. The second behavior that merits commentary was consistently demonstrated by M.T. throughout the two rounds: When he encountered a golf ball on the fairway or green, he checked its label to determine whether the ball belonged to him. This strategy is fre-

quently used if there is doubt concerning the location of a player's ball. When the ball did in fact belong to him, M.T. identified it as his own on all but two occasions, and on the several times that he encountered a ball with a different label than his own he correctly indicated that the ball did not belong to him. Yet when the investigator asked M.T. to name the label of his ball he could not do so. These observations raise a question: How did M.T. recognize the label of his ball? One clue is provided by a consideration of the two instances in which he failed to recognize a ball as his own. On one occasion, M.T. had just found an orange-colored ball in the woods after losing his own ball. He used this ball for his next shot, noting that he had never played an orange one before. But when he saw the orange ball beside the green minutes later he denied that he had hit it there and suggested that "somebody must have left his ball here." A similar phenomenon occurred after M.T. lost a ball and used a new ball of his own with a different label. Thus, the patient's ability to recognize the label of his ball deteriorated when a ball with a new and different label came into play. A later inspection revealed that most of M.T.'s golf balls were the same brand, which probably minimized the mnemonic demands of label recognition.

The 33 terms and expressions that are listed below provide further evidence that M.T. retained a great deal of semantic knowledge about golf. These bits of golf jargon were consistently used in appropriate contexts by the patient on both the familiar and unfamiliar courses. No instances were observed in which the patient used a golf expression in an inappropriate manner.

birdie	lip (of sand trap)
bogey	on in two
chip shot	on the fringe
divot	par
dogleg	play through
drive	punch shot
driver	putt
dubbed	putter
duffed	rough
duffer	sand trap
fairway	shanked
fairway wood	skulled
finesse shot	tee
green	tee shot
handicap	wedge
three iron (and other irons)	your honour
lay up	

Concluding Comments

The results of the present study indicate that M.T.'s mnemonic function in a natural environ-

ment closely resembled his performance on laboratory tasks: His recollection of experiences just minutes after they occurred was severely impaired, whereas both his general knowledge and his skills pertaining to golf were largely preserved. It is, of course, entirely conceivable that M.T.'s performance reflected impairments of semantic and procedural memory that were not detectable. However, the present observations suggest that his episodic-memory deficits were a great deal more extensive than any possible deficits of semantic or procedural memory. The disproportionate severity of M.T.'s episodic-memory deficits, relative to other forms of memory, constitutes the most striking similarity between his mnemonic function on the golf course and in the laboratory. Similarities between an amnesic's real-world and laboratory-memory performance have also been reported by Zola-Morgan and Oberg (1980). In a naturalistic study of a Korsakoff patient's recollection of several trips to the city, they observed a variety of episodic-memory deficits that concurred with the patient's performance on laboratory tasks. But they also found that he recalled some details of the trips 2 years after they occurred. No evidence of long-term recall was found in the present study: M.T. could not recollect any details of either round of golf at the conclusion of play and denied that he played the first round when asked about it 1 week later. The fact that M.T.'s memory deficits in the laboratory, as assessed by the WMS (MQ = 62), are a good deal more severe than the deficits of Zola-Morgan and Oberg's Korsakoff patient (MQ = 83) suggests that laboratory- and real-world memory tasks may be telling a similar story about the comparative severity of their amnesias. The possibility that there is a positive correlation between the magnitude of episodic-memory deficits observed in the laboratory and in natural settings clearly requires investigation with larger numbers of patients.

M.T.'s relatively intact semantic-memory function, as indexed by his ability to make use of general knowledge of golf, was expected in some respects and surprising in others. It was expected because laboratory testing indicates that some of his semantic-memory abilities are relatively unimpaired: On WAIS verbal subtests that presumably rely upon semantic memory, such as Information, Vocabulary, and Similarities, M.T. scored normally. The surprising aspect of his performance concerned the extent and specificity of his knowledge. M.T.'s golf vocabulary was not confined to a few frequently used expressions; it covered a wide range of words and expressions whose meanings are specific to particular situations and actions. Similarly, M.T.'s behavior on the golf course indicated an appreciation of many facets

of the game. He exhibited knowledge of strategies, rules, and etiquette much in the manner of non-amnesic golfers; the only observed instances of inappropriate behavior during the two rounds were all attributable to the patient's episodic-memory deficit. Indeed, M.T.'s preserved cognitive abilities extended to domains in which the results of laboratory tests might lead one to expect otherwise. For example, M.T. exhibited severe spatial deficits in the Benton Line Judgment task and was impaired on WAIS performance subtests that tap complex perceptual-cognitive abilities. Yet he executed with little or no impairment the sophisticated perceptual and cognitive judgments entailed in activities such as selecting the appropriate club and estimating the length and direction of a putt. These observations suggest the more general possibility that when patients possess extensive knowledge of a particular activity (e.g., a hobby or an area of expertise), their everyday ability to carry out that activity may exceed the functional level suggested by performance on laboratory tests of general cognitive function.

Finally, a comment about the theoretical implications of the results is in order. M.T.'s mnemonic function on the golf course has been described in terms of an episodic-memory impairment that exists in the absence of—or is more severe than—any deficits of semantic or procedural memory. Note, however, that M.T.'s semantic and procedural knowledge of golf was acquired well before the onset of his illness, whereas his episodic knowledge of the round depended upon postmorbid function. Thus, it is possible to argue that the observed patterns of performance can be attributed to differential preservation of premorbid and postmorbid memory functions. The present study does not provide a basis for distinguishing between the two foregoing interpretations of M.T.'s preserved and impaired memory function, but it does establish that dissociations between different types of memory that are found in the laboratory can also be observed in a natural environment.

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