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VERBAL AND MOTOR MEMORY IN THE AMNESTIC SYNDROME*

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Abstract—The subject of this study was a 43-year old man who developed a disorder of memory following herpes simplex encephalitis six years earlier. Recent memory was severely affected in contrast to the preservation of both intellect and immediate and remote memory. The impairment of recent memory functions was evident on tasks using verbal material whereas memory for motor tasks such as maze learning and the rendering of new compositions for the piano was preserved. The deficit in remembering verbal items varied with (1) the type of retrieval (recall vs. recognition), (2) the modality of stimulus presentation (acoustic vs. visual), and (3) the way in which learning was attempted (serial presentation vs. self-ordering and classification). Evidence of proactive interference in memory formation was demonstrated by intrusion errors.

INTRODUCTION

THE inability to recall recent events is a prominent feature of patients with disordered memory. The type and distribution of central nervous system lesions associated with this alteration in memory have been well documented [1, 2], but much less is known about the specific functional deficits of these patients. For instance, is the impairment of memory a reflection of some general disorder of information processing, or is it specific to the type of sensory stimulus employed (acoustic, visual, tactual)? Furthermore, is the defect of memory related to alterations in registration, storage, or retrieval, or are all three processes affected? TALLAND's [3] study on patients with Korsakoff's psychosis has shown that memory functions may indeed vary with the nature of the testing stimulus, and furthermore, that there is no single defect in the chain between perception and recall that can account for disordered memory.

We have had the opportunity to investigate these questions further in a 43-year old man with a severe disorder of recent memory secondary to an episode of herpes simplex encephalitis in 1960. The patient seemed particularly well suited for detailed study because (1) memory impairment was his primary neurological abnormality; (2) intelligence as

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measured on the WAIS was 135; (3) he had particular talents in mathematics and music, thus permitting the testing of performance in these subjects; and (4) he lived in the hospital and was available for testing over an extended period.

Our results suggest that the disorder of recent memory was not complete. The patient performed poorly on memory tests using verbal material but was able to remember certain motor tasks such as maze learning. Moreover, the deficit on verbal tasks was found to vary both with the methods of presentation and the manner of retrieval.

MATERIALS AND METHODS

The subject was a 43-year old right handed man (MK, Veterans Administration Hospital #562-26-7538) whose memory became impaired following herpes simplex encephalitis. The patient had been a mathematics and science instructor in high school prior to illness. In December of 1960 he developed headaches, fever, a "fine vesicular rash" on the forehead and lips and progressed to coma and convulsions. Cerebrospinal fluid studies showed 18 wbc/cc³ and a protein of 78 mg%. There was a rise in serum antibody titers to herpes simplex virus from 1:8 to 1:128 over a two week period whereas titers to mumps, St. Louis or Western Equine encephalitis varuses were unchanged. On regaining consciousness in early January of 1961 he was disoriented for time and place, confabulatory, and unable to remember new material. In April of 1961 he was transferred to the Veterans Administration hospital for domiciliary care where memory impairment persisted as the major neurological deficit. Psychological testing in March of 1965 (53 months after his acute illness) revealed an overall score of 125 on the Wechsler Adult Intelligence Scale (WAIS) 125 verbal scale and 121 performance scale. His memory for remote events was intact in contrast to his inability to recall recent events or to learn new material. He was described as emotionally immature and reacted to the examination in a childish manner. We tested the patient in January of 1967 (approximately six years after his acute illness). Neurological exam was normal except for an inability to taste the difference between salt, sugar, quinine, or acid (he described them all as "sweet") and to distinguish between the odors of camphor, tobacco, or lavender. Vision, hearing and touch were normal. Pneumoencephalogram showed enlargement of the third and lateral ventricles with a disproportionate dilatation of the temporal horns bilaterally (Fig. 1). The EEG was within normal limits. Clinical evaluation of memory showed superior immediate recall; the subject could repeat nine numbers forward or eight numbers backwards. His memory for events that had occurred many years earlier was intact. There was patchy recall of events in the years immediately preceding his illness. For instance, he remembered the details of his marriage and the birth of his first child but seemed unaware that he had two other children born within five years of his illness. Furthermore, he denied any particular familiarity with photography though it had been one of his best hobbies in the year immediately preceding his illness. The patient's recent memory was most impaired; he could not recall the names of three objects presented to him a few minutes earlier, nor could he recognize the examiner as familiar if he were briefly led out of the room during the course of the examination. His memory did not seem to improve even if the events evoked strong emotional responses. For instance, his wife noted that on one of the visits home the subject had been briefly angry at the son. When questioned immediately he could not recall what had affected him or his anger. It was apparent, however, that the patient had not totally lost his capacity for learning and retrieving new information. He was aware that he was in the hospital because of "memory trouble" and had developed the strategy of writing down reminders on slips of papers he carried in his breast pocket. He knew his way about the hospital grounds and was often used as a messenger by the ward clerks. He had learned the names of three of the hospital personnel in the course of the six years domicile: the ward doctor, the music teacher, and the swimming instructor. He was the pianist in the hospital band and knew that he had to be at rehearsals at 4 p.m. during the week. However, he would also be at the music building at 4 p.m. on weekends as well as he could not recall the day of the week even when reminded a few minutes before. He was aware of some major international events that had occurred in the interim since his illness such as the war in Vietnam and President Kennedy's assassination, though he could not recall their details.

The patient's memory deficit was evaluated over a six month period. The tests, the manner in which memory was assessed, and a summary of the results are listed in Table 1. The specific design and content of each of these tests will be presented in the Results section. The subject was tested in a small examining room for only a few hours on each day. Instructions had to be repeated frequently during each of the tests to insure continued optimal performance as the subject frequently seemed to forget the task. He generally enjoyed the testing, though he occasionally became irritated on difficult tasks.

RESULTS

The subject's performance on the WAIS are in Table 1 and show superior scores on all subtests except digit-symbol and picture assembly. Results on two different forms of the

Table 1. Test results

1. WAIS		Scaled Subtest Scores (Population Average=10; Range=0-19)	
Verbal IQ	135+	Verbal	
Performance IQ	110	Information (common knowledge)	14
Full Scale IQ	126	Comprehension (Why? How? What for?)	15
		Arithmetic (mental computation)	17
		Similarities (abstraction of common qualities)	17
		Digit Span (forward=9)	
		(backward=8)	19
		Vocabulary	14
		<u>Performance</u>	
		Digit-Symbol (copying; clerical-type skill)	8
		Picture Completion (supply missing parts)	11
		Block Design (speed and vis. mem. for designs)	15
		Picture Arrangement (comic strip sqs. arranged in logical order)	9
		Object Assembly (jigsaw puzzles)	11
2. Wechsler Memory Scale			
<u>Subtests</u>		<u>Form I*</u>	<u>Form II</u>
Information		1/poss. 6	1/poss. 6
Orientation		4/poss. 5	2/poss. 5
Mental Control		no errors	no errors
(Saying alphabet, counting backwards, and counting by 4s)		time: 6", 3", 10"	time: 4", 6", 15"
Memory for connected passages		av. score=9	av. score=9
Digits: Forward		av. score=6/poss. 46	av. score=5/poss. 46
Backwards		8 digits	8 digits
Visual Reproduction		7 digits	7 digits
Associate Learning		11/poss. 14 pts.	10/poss. 14 pts.
Easy (common free associates; e.g. "baby cries")			
Hard (e.g. "cabbage-pen")		4.5/poss. 6	4/poss. 6
		0/poss. 4	0/poss. 4
Total Score (age corrected)		90.5	84
MQ		89	80
3. Graham-Kendall Memory for Designs		No scores recorded. Evaluated clinically as normal; "No rotations of figures; better-than-average performance".	
4. Peterson Test of Memory for Single Items: Acoustic Presentation; English Words		Compared well with performance of normal subjects. See text and Fig. 1 graph.	
5. Free Learning: Acoustic Presentation; English Words		Recall (immediate and delayed) Recognition (immediate and delayed) Relearning Successive Recalls Intrusion Errors	SEE TABLED DATA
6. Connected Verbal Material: Acoustic Presentation		Recall and Recognition	SEE TABLED DATA

* Given approximately two months after Form II by different testers.

Table 1 (continued)

7. Free Learning: Visual Presentation; English Words; Abstract Designs; Common Objects	Recall (immediate and delayed) Recognition (immediate and delayed)	SEE TABLED DATA
8. Serial Anticipation: Visual Presentation; English Words	Correct Anticipations Recognition (delayed)	
9. Free Study Technique: Visual Presentation; English Words	Recall (immediate) Recognition (immediate)	SEE TABLED DATA
10. Maze Learning; Tactual	Trials to Criterion Time per Trial Errors Delayed Recall	SEE TABLED DATA
11. Music—Piano; Tactual; Acoustic	Learned popular tune and was able to recognize and play at a later date	
12. Automatic Conditioning using GSR	Not testable as there was no change in resting skin potential in response to novel stimuli	

Wechsler Memory scale (Table 1) revealed particular difficulties in recall of connected prose passages and in learning unfamiliar associations, but his overall scores (80, 89) did not seem to reflect the severity or extent of his memory impairment. His normal performance on one other standard test of memory, the Graham-Kendall memory for designs, prompted us to explore other means for quantifying memory.

1. Short-term memory for single items

The Peterson method of testing recall of single items after varying lapses of time was used to examine short-term memory [4]. A common English word [5] was read aloud to the subject and at varying times after presentation (0, 5, 10, 20, and 40 sec) a verbal recall of that item was requested. A different word was used at each trial. To minimize rehearsal in the

FIG. 2. Comparison of short-term memory in subject of this study (MK), two normal individuals, and two patients with diagnosis of Korsakoff's psychosis.

period between presentation and recall, the subject subtracted serial three's from a three digit number presented immediately after the word till recall was requested. When the recall interval was zero (immediate recall) the mathematical task was omitted. Figure 2 shows the performance of our patient, two normal subjects, and two individuals with memory impairment secondary to Korsakoff's psychosis on this task. Note that our patient's performance was comparable to normals whereas the two individuals with Korsakoff's psychosis showed impaired recall at the 40 sec time interval. These results suggest that the patient's memory for the short time periods tested was normal in contrast to his disability in recent memory.

2. *Free learning of acoustically presented material; single words*

A list of ten common English words was read aloud at a rate of one per second before recall was requested. The same list was presented twelve times in succession and recall performance tested after each reading (number of words correct, number and type of errors). A total of four different lists was used; list A and C were among those used the preceding day in testing short-term memory for single items while list B and D had not been previously presented. Table 2 summarizes the results of these tests and is significant in three respects. First, the patient was unable to recall all of the words in any of the lists even after twelve presentations whereas normal subjects could recall all items by the fifth presentation. Secondly, performance on the "old" lists (A and C) was slightly worse than on the "new" lists (B and D); and there was only minimal improvement when the lists were retested a second time. Thus, little or no learning would seem to have occurred in this task. However, an analysis of the type of errors made in recalling the lists indicated that storage of items was indeed taking place. Four of the eight errors made on initial recall of list A were intrusions of words derived from lists presented on the preceding day. On the next two sets, intrusion errors were only from the immediately preceding list. Intrusion errors no longer occurred after the third list, and there was an accompanying decrease in total number of errors. The occurrence of intrusion errors from previous lists is evidence of proactive interference and raises the possibility that inappropriate retrieval may contribute to disordered memory in this patient. Accordingly, we examined the effects of changing retrieval strategy from one of recall to that of recognition. Four successive recall and recognition tests were given for list D. The recognition test was administered by reading the ten items of list D interspersed with ten new words and asking a judgement of "new" or "old" for each of the items. Over the four tests the differences were quite small: there were 17 correct recalls and 25 correct recognitions with 3 false positive scores in both situations. Thus, changing the retrieval strategy had only a slight effect on memory performance.

3. *Free learning of acoustically presented material; connected verbal material*

The subject's ability to learn verbal material in the form of a story was examined using the Cowboy story [3].

"A cowboy from Arizona went to San Francisco with his dog which he left at a friend's while he purchased a new suit of clothes. Dressed finely, he went back to the dog, whistled to him, called him by name and petted him. But the dog would have nothing to do with him in his new hat and coat, but gave a mournful howl. Coaxing was of no effect, so the cowboy went away, donned his old garments, whereupon the dog immediately showed him wild joy on seeing his master as he thought he ought to be."

Both recall of the story and a multiple choice recognition task were used as an index of memory. On the first day the story was read to the patient on two different occasions

Table 2. Free learning word lists ($n=10$), acoustically presented

Testing sequence List		1	2	3	4	5	6	7	8
		A (old)	B (new)	C (old)	D (new)	A	B	C	D
Trial	1	5	2	0	5	4	5	5	5
	2	4	2	4	7	6	6	6	8
	3	5	3	4	8	6	8	5	7
	4	6	5	5	7	7	8	7	8
	5	5	7	7	8	7	8	5	8
	6	7	8	6	7	7	8	6	5
	7	6	7	4	8	7	7	7	7
	8	6	7	5	7	7	7	6	7
	9	7	7	8	6	6	7	7	8
	10	6	8	6	7	6	7	6	6
	11	6	7	6	8	8	6	8	8
	12	7	6	7	7	7	7	8	8
Average correct on 12 trials		5.8	5.8	5.2	7.1	6.5	7.0	6.4	7.1
Errors		8*	11†	14‡	2	2	2	6	4

* 4 intrusions from word lists used preceding day.

† 7 intrusions from List A.

‡ 5 intrusions from List B.

List D

	Recall		Recognition	
	correct	errors	correct	false positive
Trial 1	8	0	8	2
2	2	1	8	1
3	3	1	3	0
4	4	1	6	0

with recall requested immediately after each telling. On the first occasion he was correct about only one item, the dog, and then confabulated an entirely different story.

"The master of a dog—he had a regular name, but he called him by a different name and the dog was a little bit upset by not being called by his proper name until his master changed and went back to the correct one." (Q?) "That's all I remember."

On the second occasion he had 7 of the 27 items correct as well as a general idea of the story.

"Oh, (laughter) that's a good one. A cowboy from Arizona with his dog—left him while he went to get some new clothes. When he returned to the dog he wasn't recognized. The dog was all upset until he finally convinced the dog that it was his old friend (laughter) That's a cute story."

TALLAND's [3] multiple choice recognition test consisting of ten questions with four choices each was then given immediately, at 25 sec, 40 sec, 1 hr and finally at 24 hr. The results are shown in Fig. 3 and indicate that recognition was at chance level at the 24 hr test. After the 24 hr recognition test, the story was again read to the patient four more times.

FIG. 3. Recognition performance of MK on "Cowboy" story using 4-item multiple choice questions [3].

He was asked to recount the story only after the first telling while the multiple choice recognition task was given after each of the trials. In the recounting he was correct on only 8 of the 27 items, thus showing no significant savings from the preceding day. There was also very little improvement in the recognition tests.

"A cowboy from Arizona took his dog to the big city of San Francisco where he went out and purchased all new clothes and dressed himself up. And when he came back his dog did not recognize him; was very antagonistic, in fact, and didn't recognize the new clothes at all (laughter)." (Q: Any more?) "That's all I remember." (Q: How did he finally make up with the dog, or did he?) "Petting him? I'm not sure."

Thus, the patient demonstrated little or no capacity for learning of connected verbal material which is consistent with his poor performance in recounting material from newspapers or magazines he occasionally read.

4. Free learning of visually presented material

A new list of 10 common English words, printed on 3 × 5 in. cards, was shown to the patient at a one per second rate and verbal recall of the entire list was requested after each

presentation. His performance on this task was better than on any of the acoustically presented lists (Average Correct=7.9, Errors=4) and no intrusion errors were made. Three successive recall and recognition tests indicated that recognition (24 correct, 12 false positive) was only slightly better than recall (13 correct, 4 errors) similar to that observed with acoustically presented material. However, on another word list tested later that same day, recognition performance improved (26 correct and only 2 false positives). In this latter task no recalls were interposed between the time the list was presented and the three recognitions requested, a testing condition thought to optimize recognition performance [6].

Visual recognition was tested further using three different sets of cards, one containing drawings of common objects, the second containing abstract designs and the third containing common English words. Each set was tested on separate days. The patient was shown twenty cards from one of the sets and asked to memorize them. The cards were then gathered up and ten of them placed in matched pairs with ten other cards of the same set and the patient asked to identify which member of the pair he had seen before (immediate recognition). The patient was taken back to the ward and returned twenty minutes later for testing with the twenty original cards paired with the remaining twenty completely new cards from the same set (delayed recognition). It is of interest that the patient could not recall the test or the types of items shown to him after the twenty minute delay; and when presented with the cards, insisted that they were unfamiliar, and that he was only guessing. The results of the recognition test on the three types of items, shown in Table 3, indicate memory both for familiar objects and words whereas performance was at chance when distinguishing among the complex designs. Normal subjects were entirely correct on immediate and delayed recognition with the three types of material. Thus, evidence of memory using recognition could be demonstrated at a time when memory as tested by recall was apparently absent.

Table 3. Recognition after visual presentation

	Abstract designs (%)	Familiar objects (%)	Word (%)
Immediate	40	70	80
20 minute delay	55	80	70

50% is chance performance.

5. *Serial anticipation*

The effect of systematic ordering on memory performance was examined using a serial anticipation technique. A list of ten words, printed on 3 × 5 in. cards, was presented once every few seconds and the subject's task was to learn to predict correctly the word on the next card in the sequence. The card containing the first word was always preceded by a card containing an asterisk. Serial learning typically produces a serial position learning curve having a bow-shaped distribution in which items at the beginning and end of the list are acquired first and are better retained if other variables are equated [7]. The bend in the learning curve occurs in the latter part of the list. The serial learning task is difficult even for normal subjects and our patient's tolerance of difficult tasks was extremely low. He did

not enjoy this task and would not perform after the 11th trial. At this point he had only 4 correct anticipations. No more testing was done until 2 days later when a recognition test (judgment of "new" or "old") was given using the ten cards tested in the serial anticipation learning mixed with the ten new cards. The patient recognized 8 of the 10 original words as "old" and in the following serial order: 1, 2, 3, 4, 5, 7, 9, 10, and made no false positive identifications. Note that the errors fall at the expected "weak" positions in the bow-shaped curve. The use of the serial anticipation method may have improved performance by providing additional "cues" or "labels" not available when learning items presented in a random sequence.

6. Free study technique

After the recognition test of the words presented by serial anticipation was completed, the patient was given all ten cards of that list with the following instructions: "Arrange them in any order they make some kind of sense to you." He arranged them in two stacks, six of which were "pleasant" words, and four of which were "unpleasant". The cards were then removed and he was asked to write down the words in any order he chose. The entire procedure was repeated three additional times. Successive recall tests were then given at varying delay periods without further study trials. MK's arrangements on each of the free study trials are presented in Table 4 in the left-hand column, and his reproduction tests

Table 4. Free study technique

Trials	Arrangements of words by patient			Reproductions		
	<u>Pleasant</u>	<u>Unpleasant</u>	<u>Immediate</u>			
1.	heart school clear sky type post	hung cheap heat fail	cheap sky post	type clear (boat)	heat hung (roll)	Corr. =7 Errors =2
	When shown all 10 cards again he recognized those he left out and classified them: Fail =Unpleasant School =Pleasant Heart =Pleasant					
2.	<u>clear sky</u> -get <u>cheap heat</u> . In school a certain <u>type</u> of student will <u>fail</u> if he gets <u>hung</u> up on a certain kind of problem. (made up above para- graph leaving out 2 of 10 words).			clear sky cheap heat	school type fail	post Corr. =8 Errors =0
3.	Same as number 2			clear sky cheap heat	post hung school type fail heart	Corr. =10 Errors =0
4.	When we have a <u>clear sky</u> , we have <u>cheap heat</u> . In school a <u>type</u> of student that a <u>fail</u> grade would break his <u>heart</u> . So they went on a picnic and <u>hung</u> their lunch pail on a <u>post</u> .			clear sky cheap heat	school type fail heart	hung post Corr. =10 Errors =0

in the right-hand column. The words are reproduced as MK ordered and clustered them. This method results in the best learning performance shown by MK on any verbal material we have tested. Nevertheless, his ability to reproduce the words fell off at a rapid rate after the last study trial (Fig. 4).

Successive Recall After Free Study

FIG. 4. Successive reproductions of MK on the ten-item word list learned during free study (Table 5).

7. Maze learning

The patient's ability to learn to trace mazes when blindfolded and to retrace them at a later date was tested with Porteus mazes, Vineland Revision 1933, (Psychological Corp., 304 E. 46th Street, New York), which we copied onto plywood using strings as outlines for the paths. The patient was blindfolded and his finger placed in the starting box with instructions to find the exit point of the maze. The major cues available in solving this task are tactile, kinesthetic, and proprioceptive. Seven mazes (Porteus years 8, 9, 10, 11, 12, 14 and Adult 1 labeled #1 through 7 in this paper) were tested over three days beginning with the easiest and proceeding to the most difficult. The number of errors (i.e. blinks entered) and the time required per trial were used as measures of performance. The maze was considered to have been learned if there were five successive error-free performances. Retesting was carried out two weeks after the initial learning. The patient enjoyed the task and was always able to recall what he was to do when he sat down at the desk. He would close his eyes, raise his finger in the air, and say "those puzzles." This was in marked contrast to his failure to recall in any of the other types of tests from day to day. The results of the patient and a normal subject (a 22-year old college student) are shown in Table 5. It is apparent that the patient (1) required more trials to learn the mazes to criterion than did the control subject, (2) that the patient made more errors in learning the task, but (3) that the patient was also faster than the control subject in completing each of the mazes on the first trial. Performance on the relearning trials showed clear evidence of savings for both the patient and the control subject on all parameters of performance. Thus, the patient demonstrated that he could learn and remember tracing mazes utilizing tactile, proprioceptive, and kinesthetic cues. This finding is consistent with his ability to find his way about the hospital grounds and is in distinct contrast to his poor memory performance on tasks using verbal responses. The number of blinks in some of the mazes (13 in mazes 4 and 6) was considerably more than his immediate memory span, making it unlikely that the patient used verbal cues to accomplish this task.

Table 5. Maze learning

Errors per trial				Trials to criterion						Time (in seconds) on first trial			
Maze	Patient		Control		Patient		Control		Maze	Patient		Control	
	OL	RL	OL	RL	OL	RL	OL	RL		OL	RL	OL	RL
1	3.7	2.5	1.4	2.0	1	18	2	7	1	1	34	22	14
2	1.7	1.0	1.1	5.0	2	7	17	9	2	2	12	12	84
3	1.7	1.2	1.5	1.3	3	19	6	14	3	3	15	16	22
4	0.5	0.7	2.6	6.2	4	17	18	14	8	4	41	19	85
5	0.9	0.9	2.2	2.5	5	8	15	6	2	5	23	16	25
6	1.0	0.8	7.4	1.6	6	23	9	8	9	6	58	24	60
7	1.5	1.6	11.7	1.1	7	25	18	4	7	7	80	23	52
Total	11.0	8.7	27.9	19.7	Total	117	85	62	32	Total	263	132	340
										Average			
										per			
										maze	37.6	18.8	48.5

OL=original learning.
RL=relearning.

8. *Memory for music*

The patient was sufficiently skilled to play the piano in the hospital band. We wished to determine if he could learn to play a new melody and whether he could remember the piece on subsequent days. Both auditory and kinesthetic-proprioceptive clues would be necessary for such a performance. Accordingly, he was taught an unfamiliar melody ("South American Way") in one afternoon. On the following day he could not recall having learned a new piece nor did the name of the new melody seem familiar to him. The first few bars of the piece were then hummed and the patient immediately responded with "Oh, that piece," and promptly played the entire selection correctly. The results of this test correspond to reports of his family and the band leader that MK was able to learn to play new compositions "by heart."

DISCUSSION

The subject of this report demonstrated the major features of the amnesic syndrome with impairment of recent memory but preservation of immediate and remote memory, intellect, and perception. Our studies defined two new characteristics of the recent memory loss. First, the alteration of memory was restricted to tests with verbal items such as recall of word lists or connected prose passages whereas the memorization of certain motor tasks such as maze learning or the rendering of new compositions on the piano was preserved. Secondly, the finding of intrusion errors from items presented at an earlier time is evidence that the subject was capable of transferring verbal material into long-term memory.

The subject's daily behavior was consistent with the distinction between verbal and motor memories. He was adept at finding his way about the hospital grounds but inaccurate in reporting the contents of a conversation held a few minutes earlier. Similar observations have also been made in SCOVILLE and MILNER's [8] classic case, HM, in whom memory impairment followed bilateral surgical removal of the hippocampus. HM was deficient in memorizing verbal material but was able to learn some simple motor skills such as mirror writing [9], stylus tracking [10], the solution of simple tactual mazes [11], and operant responding to features of a visual display [12].

These results indicate that there may be distinct neural mechanisms for verbal and for motor memories in man and suggest that the functional deficit of the amnesic syndrome is in the use of language as guides for memory rather than in any global impairment of memory function. The possibility that motor and verbal memories involve different processes is relevant when comparing results from memory experiments in animals that can only test motor performance with experiments in man, that most commonly measure verbal responses. Were our patient unable to speak or comprehend language, his memory would have been judged as intact by his motor performance on the mazes, one of the standard tests used to evaluate memory in animals. Furthermore, bilateral hippocampal lesions in monkeys are not associated with generalized memory impairment [13] and when memory dysfunction occurs, it is specific to the type of test used [14].

The problems that individuals with memory impairment have in the use of verbal guides is not clear. The difficulty does not lie in the comprehension or generation of language since these patients have no deficit in understanding, storing, or retrieving verbal items over short periods as evidenced by their normal immediate memory span [15, 3, 16]. It has been suggested that their impairment on long-term memory tasks result from an inability to transfer information from short-term storage to a more permanent long-term store [17]. The finding of intrusion errors in both the present study and in other patients with memory

impairment [18] is evidence against this proposal. These patients, in the course of recalling one set of items, report items from other lists presented at an earlier date even though they would be unable to recall the earlier lists if directly questioned. We take this evidence to indicate that these patients are indeed capable of transferring verbal items into long-term storage, and their poor performance on memory of verbal items may be related either to the way in which storage occurs or to disturbances in retrieval.

Our experiments provide no evidence to select either of these alternatives as correct. Certainly, changing the manner of retrieval from recall to recognition resulted in improvement in memory performance for some items. The most striking examples were in tests of visual recognition when the subject could not recall the test, yet recognized the appropriate items to a significant degree. However, we were never able to demonstrate memory performance on par with normals by recognition, suggesting that retrieval difficulties alone may not account for the impaired memory in our subject. The best results in recall of verbal items occurred when the subject ordered the items into categories and generated a story using these items. Recall performance was perfect immediately following this procedure and then gradually decreased over a thirty minute span. The ordering into categories plus their linkage into a story may provide additional cues or labels for storage and subsequent retrieval not possible in the usual manner of item presentation and testing.

The classification of the amnesic disorder in these patients as a primary impairment in the use of verbal guides for memory, particularly in the way in which storage and retrieval is accomplished, make it difficult to conceive of this disorder as an alteration in the formation of "memory" molecules by the affected brain structures. Rather, the disturbance, in our view, takes the form of a functional disorganization of the processes used when language is the basis of memory. An awareness of the functional deficit in the amnesic syndrome in man may suggest alternatives for devising new strategies for memory in these individuals.

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Résumé—Le sujet de cette étude concerne un homme de 43 ans qui présentait des troubles de la mémoire à la suite d'une encéphalite herpétique, survenue six ans plus tôt. La mémoire des faits récents était profondément atteinte, ce qui contrastait avec la conservation des facultés intellectuelles et de la mémoire des faits anciens. Le trouble de la mémoire des faits récents était évident dans les épreuves où était utilisé du matériel verbal, tandis que la mémoire dans des épreuves motrices telles que l'apprentissage du labyrinthe et la possibilité de retrouver au piano des mélodies non familières, était conservée. Le déficit de la mémoire des items verbaux variait avec (1) le type de rappel (évoocation contre reconnaissance), (2) la modalité de présentation du stimulus (acoustique contre visuelle), (3) la façon selon laquelle l'apprentissage avait été pratiqué (présentation en séries contre classification et mise en ordre par le sujet lui-même). Des preuves d'interférence proactive dans la mémorisation étaient démontrées par le type de certaines erreurs (items appartenant à des listes précédentes).

Zusammenfassung—Gegenstand dieser Untersuchung war ein 43-jähriger Mann, der im Anschluß an eine 6 Jahre zuvor erlittene Herpes simplex-Encephalitis eine Gedächtnisstörung entwickelte. Das Neugedächtnis war stark befallen im Gegensatz zur Erhaltung von Intellekt und Altgedächtnis. Die Störung der Neugedächtnisfunktionen zeigte sich bei Aufgaben, die Wortmaterial umfaßten, wogegen das Gedächtnis für motorische Aufgaben, wie z.B. im Labyrinthtest, und die Wiedergabe neuer Klavierkompositionen erhalten blieben. Das Defizit bei der Wiedergabe verbaler Einzelheiten variierte je nach (1) Art der Wiedererlangung (Erinnerung oder Wiedererkennen), (2) Art der Reizvermittlung (akustisch oder visuell) und (3) Art, in welcher das Erlernen unternommen wurde (serienweise Vorstellung oder Eigenordnung und Klassifikation).

Der Nachweis proaktiver Störung der Gedächtnisbildung wurde durch eingestreute Fehler demonstriert.