NOTE

ACQUISITION OF NEW CONCEPTS BY TWO AMNESIC PATIENTS

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There are now many studies which have demonstrated that even severely amnesic patients may show preserved or partially preserved learning abilities in a variety of tasks (Mayes, 1988; Shimamura, 1989). First, amnesics can acquire perceptual, motor and even cognitive skills (Brooks and Baddeley, 1976; Cohen and Corkin, 1981; Charness, Milberg and Alexander, 1988) and can also exhibit normal classical conditioning (Weiskrantz and Warrington, 1979; Daum, Channon and Canavan, 1989). Second, they have been found to perform normally on different perceptual and conceptual priming tasks (see Shimamura, 1989). Third, amnesic patients may learn more or less easily new factual and semantic information such as new computer-related vocabulary (Glisky, Schacter and Tulving, 1986), second language vocabulary (Hirst, Phelps, Johnson et al., 1988) or semantic interpretation of ambiguous sentences (McAndrews, Glisky and Schacter, 1987). Preserved priming and semantic learning in amnesic patients are theoretically important because this type of preserved memory concerns kinds of information (specific items such as words or objects) that amnesics are unable to recognize or recall (Mayes, 1988).

Various researchers have interpreted the pattern of preserved and impaired memory functions in amnesia by postulating the existence of several distinct memory systems, some of which are affected by the brain damage while some are not. In this perspective, it is widely agreed that episodic memory is impaired in amnesia and that procedural memory and perceptual representation systems remain intact (Squire, 1992; Tulving and Schacter, 1990; Gabrieli, 1991). The integrity of semantic memory is more controversial; one theory suggests that episodic and semantic memory are both impaired in amnesia (Squire, 1992; Gabrieli, 1991) while another theory considers that episodic memory is impaired whereas semantic memory is at least partially intact (Tulving et al., 1991). The first theory predicts that amnesics are no longer able to learn new semantic information anymore than they are to acquire new personal episodes while, according to the second theory, amnesic subjects might show relatively preserved semantic learning.

Little is known about the extent of semantic learning in amnesics, the kind of semantic information they can learn, the factors that affect such learning and the characteristics of the newly-acquired knowledge. As a matter of fact, several studies have provided conflicting findings. Thus, Gabrieli, Cohen and Corkin (1988, 1983) have shown that the amnesic patient H.M. and a small group of other amnesic patients could not learn, by means of a rote learning method, the meaning of 10 English words that they did not know before. On the other hand, Glisky, Schacter and Tulving (1986) found that amnesics were able to acquire a substantial amount of computer vocabulary by means of the method of vanishing cues designed to allow patients to use their preserved implicit abilities to respond to fragment cues (consistent learning was also observed with a standard anticipation learning method but the vanishing-cues method yielded higher levels of learning). However, such learning was slow compared to controls and acquisitions were relatively unflexible (even if the vanishing-cues method led to a more flexible knowledge than the anticipation method). Finally, Hirst

was sufficiently flexible to permit C.S. to use newly acquired words in varied tasks not presented during the tutoring.

According to Glisky et al., two factors could be responsible for the discordances between their own study and Gabrieli's studies: first, the use of the vanishing-cues method; second, the fact that the to-be-learned computer words in the Glisky et al. study were part of the patients' linguistic repertoire before the experiment (e.g. save, run) while the items used in the Gabrieli et al. studies were uncommon words (e.g. anchorite, manumit). Consequently, the patients in the Gabrieli et al. studies had to learn the words and then to associate them to their definitions. Hirst et al. suggested that the differences between their results and those obtained by Glisky et al. could reflect a difference in the relation between the new information and pre-existing knowledge. In their own study, the amnesic patient already had concepts in French vocabulary that she had learned and therefore, she only had to integrate the new vocabulary into an existing contextual framework. In the Glisky et al. study, the patients had probably no pre-existing concepts for the computer vocabulary terms they learnt and therefore, they had to build the concept and to associate the term with the concept. Thus, amnesics would easily learn a new flexible knowledge only when relevant pre-existing knowledge exists.

In a recent paper, Tulving, Hayman and MacDonald (1991) have also investigated semantic learning (and perceptual priming) in an amnesic patient (K.C.). The patient was presented 64 picture-sentence pairs (for example, the sentence "MEDICINE cured HICCUP" was paired with a picture of a man in a hospital setting whose forehead was dotted with electrodes) and then was tested for his ability to produce the final word of each sentence. Each target word could be cued with a perceptual cue (word fragments) or with a conceptual cue (the picture or part of the sentence that accompanied the target word at study). Despite a total lack of episodic memory, K.C. showed strong and long-lasting perceptual priming and semantic learning effects. Moreover, semantic learning occurred independently of perceptual priming. Such findings support the view that perceptual priming and semantic learning are subserved by two different memory systems other than episodic memory (Tulving and Schacter, 1990): PRS and semantic memory which were at least partially preserved in K.C. According to Tulving et al., the semantic learning effects observed in K.C. (and other amnesics) appear to be dependent on two factors: meaningfulness and interference. It seems that amnesic patients are able to learn factual or semantic information if it is meaningful that is to say if it concerns a domain they already know or if it is consistent with existing concepts. Furthermore, amnesics seem to show semantic learning when they are administered testing procedures that precluded interfering responses. In that perspective, Tulving et al. suggest that the absence of semantic learning effects in the Gabrieli et al. studies would reflect a testing procedure engendering a lot of incorrect responses and thus creating interferences in the course of learning.

To summarize, the ease with which amnesics can acquire new information (and the flexibility of the knowledge that is acquired) may depend on the relation between the new information and pre-existing knowledge as well as on the use of a testing procedure that prevents the production of competing associations. However, it could also be that semantic learning and flexibility of knowledge depend on the kind of activity required of the learner in the learning process and on the encoding variability (Booker and Schacter, 1988; Di Vesta and Peverly, 1984). The main purpose of the present study was to investigate the possible positive influence of active learning, in varied contexts, on the acquisition of new knowledge in amnesic patients. A concept-acquisition task adapted from Di Vesta and Peverly (1984) was administered to two Korsakoff amnesics and two control subjects.

Materials and Method

Subjects

The concept-learning task was proposed to two female patients suffering from Korsakoff's syndrome of alcoholic origin (cases A.G. and G.S.).

TABLE 1

Results of the Neuropsychological Assessment for Patients A.G. and G.S.

	A.G.	G.S.	Controls (N = 15)
WAIS			
Verbal I.Q.	87	97	
Performance I.Q.	82	99	
Full scale I.Q.	83	97	
Short-term memory			
Digit span	5	6	
Spatial span	6	5	
Long-term memory			
Auditory verbal learning test (15 words, 10 trials): mean score	5.3/15	5.2/15	12.4 (.85)
Free recall/cued recall test			
Free recall (max. = 48)	15	12.9	34.9 (6.79)
Total (free + cued) recall (max. = 48)	33	31.8	46.6 (2.28)
Warrington's forced choice recognition test (faces)	30	33	<perc.5
Completion (%)	20	25	31.8 (10.9)
Frontal tests			
Modified card sorting test			
Category	5	6	5.7 (.9)
Perseverative errors (%)	33	40	8 (2.2)
Stroop test (interference)			
Time (sec)	165	104	107.2 (10.62)
Verbal fluency	24	22	30.1 (6.06)

A.G. is a 49-year-old right-handed woman. She is the fifth child in a family of six. Her father was a factory worker and her mother a housewife. From primary school she went on to a vocational school where she learnt dress-making for three years. She then worked as a saleswoman in a large store until the age of 20 when she got married. From this marriage, she had 3 children but the last one died in a fire. The death of her husband in 1980 contributed to accentuate her inclinations for alcohol (and drugs). Already in 1984, she made several short stays in a local mental hospital. In 1986, she was again admitted to this hospital as an emergency having been found wandering in a confused state. The medical record noted that the patient was disoriented both in time and space and that she was amnesic and confabulating. The clinical diagnosis was a Wernicke-Korsakoff syndrome. She retained a profound amnesia and remained in institutional care.

G.S. is also a 49-year-old right-handed woman. She completed elementary school, when on to pursue vocational training for four years, then found employment in a paper mill while at the same time going to evening classes for secretarial training. She married a first time in 1960, then remarried again in 1970. At the time, she was employed as a secretary in an advertising magazine until she was made redundant in 1984. In 1987, she was hospitalized for the first time for 4 months in a local mental hospital due to a drinking problem, dating back for some years. In November 1988, she developed an acute confusional state and was rushed to hospital. She was restless, disoriented in time and space, amnesic and confabulating. The EEG taken at the time was within the normal limits. A diagnosis of Wernicke-Korsakoff's syndrome due to excessive alcohol intake was made. She remained in long-term care suffering from a stable and severe amnesia.

The patients' performance on neuropsychological examination is presented in Table 1. Their intellectual efficiency was assessed by the Wechsler Adult Intelligence Scale (Wais). The patient G.S. showed a verbal and performance I.Q. in the average range while the other

long-term memory was assessed by means of a 15 wordlist learning task (Selective Reminding Test, Buschke, 1973), a free recall/cued recall task adapted from Grober and Buschke (1986) and the Warrington (1984) forced choice recognition test (faces). A word-stem completion (an implicit memory task) was also administered. Performance of both patients was very poor in the explicit free recall, cued recall and recognition tests. On the other hand, word-completion performance was just within the normal range.

The patients were also submitted to three tests said to be sensitive to frontal lobe dysfunction: the Modified Card Sorting test (Nelson, 1976), a verbal fluency test, where the subject is asked to produce during one minute as many words as possible beginning by P, F and L, and the Stroop Test (in the Nehemkis and Lewinshon version, 1972). The scores were poor in the fluency test for both patients and in the Stroop test for A.G. Both patients made more perseverative errors than the normal subjects in the Modified Card Sorting test.

Material

The six concepts were adapted from those employed by Nitsch (1978) and Di Vesta and Peverly (1984). Each concept consisted of three parts: the name of the concept (the label), the context in which the concept originated and its definition. For instance, one of these concepts was: "CORUTIR (originally used by antique dealers), to use something for a purpose different from that for which it was originally intended". The names of the concepts were created in such a way as to prevent phonological associations with existing French words and contained 7 or 8 letters.

Different sets of examples illustrating the concepts were also selected to be used in the classification phase and transfer tests. The examples used were of two types: those with the original context given with the definition and those using a new context. As an illustration, a same-context example corresponding to the concept CORUTIR was: "The old milk can was painted a bright color and sold as an umbrella stand" and a different-context example was: "The cycle racing track was converted into a horse racing track".

Procedure

The concept-learning task was adapted from Di Vesta and Peverly (1984) and consisted of three phases: (1) learning the concept names and definitions; (2) practise with examples of the concepts through a classification task; (3) a transfer test in which the subjects have to apply the conceptual rule to other examples than those already practised.

The order of the first two phases (i.e. learning concept definitions followed by practice examples) was chosen because Di Vesta and Peverly (1984) have shown that such a sequence is more effective than the reverse (i.e. practice examples followed by learning of concept definitions). One of the reasons for the superiority of the concept-example sequence is that the examples recapitulate the structure of the abstract concept (each example provides a rehearsal of the concept). Furthermore, with practice examples first, the encoding of erroneous inferences could be induced, thus allowing interference to be built up in the course of learning.

Each patient was seen two to four times a week for sessions ranging from 30 to 60 minutes (according to the level reached during the procedure).

1. Learning the concept names and definitions

The learning phase was carried out by means of the vanishing-cues method designed by Glisky et al. (1986) to capitalize on the preserved implicit memory abilities of the amnesic patients. On Trial 1, the concept definitions and contexts printed on a cardboard were presented and the subjects' task was to produce or guess the corresponding labels. If they failed to produce the correct word within 10 seconds, they were presented with the first letter of the word ("P_____ for PERVALIR"). If they still did not complete the word correctly, one letter at a time was added until the subjects gave the right answer or until the word had been displayed in its entirety (P_____, PE_____, PER_____). In the next trial, the definition was presented along with a letter fragment that

was one letter shorter than the fragment required for successful completion in the previous trial. This procedure continued until the subjects could recall the six labels, twice consecutively and without cue.

Each session involved eight trials and stimulus presentation varied from session to session. At the beginning and at the end of each session, the subjects were given a production test and a matching test. On the production test, they were asked to give the word corresponding to the definition without any letter cues. In the matching test, the examiner set out in front of the subjects the six cardboards with the contexts and the definitions together and the six cardboards with the words alone. The subjects had to match the definitions to the corresponding words.

When the criterion of two successive correct responses was reached, the knowledge of the concepts was verified by asking the definition and origin corresponding to each label.

At the beginning of each session, the patients were asked to describe as accurately as possible the purpose of the experiment, the material that was used and the procedure adopted

2. Practice with examples of the concepts

Subjects had to classify examples of the concepts. This classification phase consisted of 5 stages:

(A) In the first stage, the subjects were given the six concepts (names, definitions and contexts). Then, six examples illustrating the concepts and using the context of origin (the context of the definition) were presented. The subjects had to identify the concept corresponding to the example presented. There was no time limit for this task. For each classification, the subjects had to justify their choice and, as the case may be, this justification was reformulated by the examiner to make sure they had understood the link uniting the example and the concept. If they made an error, the examiner corrected the answer and gave appropriate explanations. This procedure was continued until all the examples had been classified.

(B) The second stage was identical to the first one except that only the name of the concept and its definition (and no longer the context) were available to make the classification.

(C) At the third stage, the encoding variability was introduced. The subjects had to classify 24 examples (4 per concept). For three concepts, the 4 examples to be classified were set in the same context as that given in the definition: same-context examples; for the other three concepts, 2 examples were set in a new context: mixed-context examples. Presentation of same-context examples was randomized. For the mixed-context examples, those using the original context were presented before those using a new context. As for the previous stages, the subjects had at their disposal for the classification task, the labels, the contexts given in the definitions and the definitions together with the examples that they had classified during the two previous stages. The subjects also had to justify their responses and the examiner would correct them if necessary. The concepts illustrated with same-context examples and mixed-context examples were different for both patients.

(D/E) The fourth and fifth stages were almost identical to the previous one. In the fourth stage, the patient only had at his disposal the labels, the definitions and the example classified in stages A and B. In the fifth stage, they only had the examples classified in stages A and B.

3. Transfer tests (after 24 hours, 1 week and 1 month)

Subjects were tested on their ability to apply the concepts to new examples. They were given 30 new examples (5 per concept); three examples represented the concepts learned (correct examples): one used the old context (example a) and two used a new context (examples b and c); two examples did not represent any of the concepts learned (false examples): one of them used an old context (example d) and the other one shared neither the definition of the concepts nor the contexts (example e).

subject's task was to indicate by yes or no whether the example represented one of the concepts (recognition test) and if so, to point to the label of the corresponding concept (naming test). Three aspects of the patient's performance were therefore considered: (1) correct recognitions (i.e., recognition of the examples illustrating the concepts studied); (2) correct rejections (i.e. rejection of examples that did not illustrate the concepts studied); (3) identification of concepts corresponding to the examples correctly recognized.

Results

1 - Control Subjects

A - Learning the concept names and definitions

Subject 1 (matched to patient A.G.) needed two sessions (8 and 7 trials respectively) to reach the criterion of two successive evocations of the concept labels without any cue. At the end of these sessions, the subject succeeded in both production and matching tests.

Subject 2 (matched to patient G.S.) also needed two sessions (8 and 6 trials respectively) to reach the criterion. In the final production test, he gave 5 out of 6 labels in response to the definitions and the matching test was done without an error.

At the end of these acquisition sessions, both subjects could give the context and the definition in response to each concept label.

B - Classification of examples

Only the stages 1 and 5 were administered to the control subjects. Subject 1 succeeded these two stages of classification at the first trial without difficulty and Subject 2 made only one error during the first stage but, at the second trial, his performance was normal. He succeeded the second stage correctly and at first trial.

C - Transfer tests

Subject 1 made 5 errors in the test administered after 24 hours, 2 errors after one week and only 1 error after one month. The 8 errors were omissions of correct examples with a new context (examples b, c) and 6 out of these 8 errors concerned concepts that were practised with same-context examples. Subject 2 did not make any error in the three tests. In the naming test, both subjects were able to name the concepts corresponding to the examples correctly recognized.

2 - Patient A.G.

A - Learning the concept names and definitions

A.G. did not reach the criterion of two consecutive trials without error after ten sessions. However, the mean number of letters needed for successful generation of the concept labels decreased and at the end of the tenth session, just the first letter was required for a correct response (see Figure 1).

In the production tests administered at the end and beginning of each session, A.G. gave one correct label in response to the definition only at the beginning of the sixth session and two words at the end of that session, a performance which lasted till the tenth session. A.G.'s performance in the matching test was very irregular but culminated at the ninth session where she executed the matching test without an error: in this task, the patient always mentioned that she responded by guessing. Finally, when asked to give the context corresponding to the concept names, she only obtained one correct response. It should be stressed that at the beginning of the first eight sessions, the patient was unable to give any information (not even general) concerning the

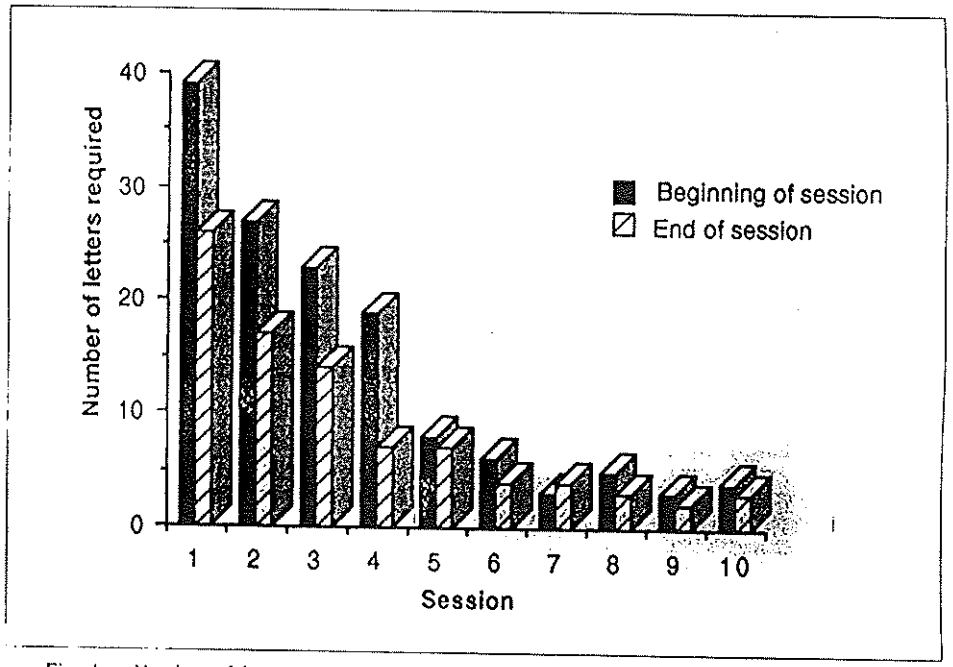

Fig. 1 – *Number of letters required by A.G. to find the concept labels in the presence of their definitions at the beginning and end of each session.*

doing exercises with words, but without any other details and without any conviction.

As the patient did not seem to progress any further in learning the labels and began to manifest some signs of lassitude, it was decided to interrupt this phase of the experiment. Nevertheless, she was administered 8 supplementary sessions dealing with the learning of the origin of the concepts by using an anticipation method: the name of the concept and its definition were presented and the patient was requested to give the original context; if it was wrong, the correct response was given. At the end of the eighth session, A.G.'s performance was perfect.

B - Classification of examples

A.G. succeeded the five stages of the practice task after one trial. At the end of the classification phase, A.G. was administered a definition test. For 5 concepts, the patient gave definitions which held adequate elements (e.g., Corutir: "To transform something into something else"). Only the definition of one concept could not be given, even partially.

C - Transfer tests

A.G.'s results in the recognition tests are described in Table II. In the test administered after 24 hours, the patient made 6 errors: 5 errors were omissions of examples with a new context (examples b anc c) and 4 of these errors concerned concepts that were illustrated only with the original context (same context) during the classification phase; 1 error was a false recognition of a false example using the original context. For the tests administered after one week and one month, A.G. made 10 errors and 12 errors, respectively. These errors were in majority omissions of examples b and c using a new context (respectively 8 out of 10 errors and 10 out of 12 errors); as the delay increased, the errors affected more and more the examples corresponding to the mixed-context concepts. The other errors were, as for the

TABLE II

Results of A.G. in the Recognition Tests

Concepts		Examples				
		a	b	c	d	e
	After 24 hours					
Same-context	A	+	−	−	−	+
	A	+	−	−	−	+
	A	+	−	−	−	+
Mixed-context	B	+	+	+	−	+
	B	+	+	+	+	+
	B	+	−	+	+	+
	After 1 week					
Same-context	A	+	−	−	+	+
	A	+	−	−	−	+
	A	+	−	+	+	+
Mixed-context	B	+	−	+	−	+
	B	+	+	+	−	+
	B	+	−	−	+	+
	After 1 month					
Same-context	A	+	−	−	+	+
	A	+	−	−	−	+
	A	+	−	−	+	+
Mixed-context	B	+	+	−	−	+
	B	+	+	−	+	+
	B	+	−	−	+	+

R +: recognition of correct examples (a, b, c) and rejection of false examples (d, e).
R −: omission of correct examples and recognition of false examples.
Examples a: correct examples with the original context; examples b, c: correct examples with a new context; example d: false example with an original context; example e: false example with a new context.
Concepts A: concepts practised with same-contexts examples; concepts B: concepts practised with different-context examples.

However, after one week and one month, in contrast to the control, her performance declined progressively except for recognition of correct examples with original context (examples a) and rejection of false examples with new context (examples e). Recognition of examples with a new context (b, c) was better for concepts that were practised with mixed-context examples, especially after 24 hours.

In the naming test, A.G. was able to identify the label of the concepts correctly recognized in 66.7% of the cases for examples with an old context (a) and only in 37.1% for examples with a new context (b, c). Moreover, 78% of the examples with a new context correctly recognized concerned concepts that were practised with mixed-context examples.

Finally, a definition test was administered at the end of the one week transfer test. For one concept, the definition given was correct and showed a certain generalization. Three concepts raised a correct definition but directly related to the original context (e.g., corutir: "to make a stool from a table"). Two concepts were incorrectly defined.

In the transfer tests administered after one week and then after one month, A.G. completely failed to show any detailed conscious recollection of the material and the learning episodes. In the test, 24 hours later, she could only give a vague description of the experiment: "I do exercise to classify cards... to find words".

3 - Patient G.S.

A - Learning the concept labels and definitions

G.S. reached the criterion of two consecutive evocations of the labels without cue after 5 learning sessions (see Figure 2). In the production and matching tests, G.S.'s performance was perfect at the fifth and fourth session, respectively. Finally, she [illegible] errors

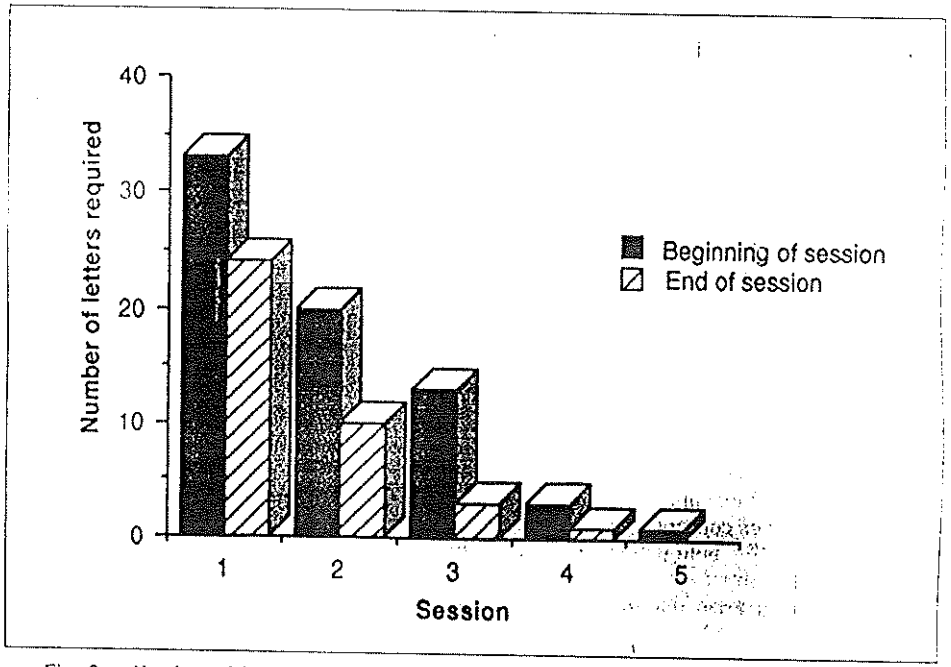

Fig. 2 – *Number of letters required by G.S. to find the concept labels in the presence of their definitions at the beginning and end of each session.*

learning, the patient showed no recollection of the learning episodes during the first 4 sessions: at the beginning of the fifth session, she could only give a very vague description of the experiment ("to do exercises with words").

B - Classification of examples

At the first classification trial, G.S. made many errors but at the second trial, the classification was almost perfect. After the classification task, the patient was asked to define the 6 concepts. The patient gave an adequate definition (Corutir: "to pass of something for something else", a vague definition with some correct elements and four definitions all incorrect but related to the context of origin.

C - Transfer tests

The analysis of G.S. responses in the three recognition tests suggests that her performance reflected a general trend to answer either "I don't recognize" (this was the case after 24 hours and one month as indicated by the high number of false rejections for the examples illustrating the concepts studied and also the high number of correct rejection for false examples), or "I recognize" (this is the case after one week as indicated by the high number of correct recognitions for adequate examples and the high number of false recognitions for false examples). However, after 24 hours, 4 of the 5 examples correctly recognized concerned examples with old context (a).

In the naming tests, G.S. was able to identify the name of the concepts correctly recognized in 83.3% of the cases for examples with an old context (a) and 50% for examples with a new context (b, c).

In the definition test [illegible] at the end of the one week transfer test, G.S.

to another concept name and two incorrect definitions but containing a correct element.

Similarly to A.G., G.S. did not manifest any evidence of recollection of the material and the episodes that led to the acquisition of the concepts.

Conclusions

Despite severe deficits in anterograde memory, both amnesic patients were able to acquire some new meaningful semantic knowledge even though they had little conscious recollection of the learning episodes. First, they demonstrated substantial learning when they were asked to associate the concepts' names with their definitions and contexts by means of the vanishing-cues procedure; however, one patient (A.G.) remained dependent on first letter cues (a dependance that was also found in the Glisky et al. study) while the other patient (G.S.) showed rapid progress (although not so rapid as that of the controls) and was able to produce the target words without fragment cues. Secondly, after having been actively submitted to practice with examples of the concepts, A.G. was able to apply, just as the matched control subject, the conceptual rules to novel examples after a 24-hour delay. After longer delays, her performance decreased but her scores still remained higher for concepts practised on mixed examples. On the other hand, G.S. showed poorer performance in the transfer test and her conceptual knowledge appeared to remain more dependent of the original context. Finally, both patients were able either to correctly define some of the concepts or to give some correct elements of definitions after a one-week delay.

On the whole, these findings indicate that some amnesics may implicitly acquire and retain new semantic information. This contrasts with the studies of Gabrieli et al. (1983, 1988) which failed to show semantic learning in H.M. and other amnesics but is consistent with the studies of Glisky et al. (1986), Hirst et al. (1988) and Tulving et al. (1991). Although the to-be-remembered material we used was similar in many respects to that in the Gabrieli et al. studies (in both cases, the names of the to-be-learned concepts were uncommon words and were unrelated to one another), there were several important differences in the learning strategies. Gabrieli et al. used a passive rote learning-strategy while in our study, there was a dual learning strategy: the vanishing-cues method (similar to that employed by Glisky et al.) followed by an active processing of the concepts. Finally, A.G.'s performance in the 24-hours transfer test suggest that under appropriate learning conditions (active learning and varied practice examples), such implicitly acquired knowledge may eventually become sufficiently flexible to be applied to novel situations.

Although the patients showed consistent learning, their progress was laborious by comparison to the controls (see also Glisky et al., 1986; Tulving et al., 1991): even after ten sessions, A.G.'s performance in the vanishing-cues procedure was still imperfect. Moreover, G.S.'s ability to apply the acquired conceptual knowledge remained very poor. Several reasons could explain this relative inefficiency of the semantic learning in amnesic patients. It could be that their semantic memory system which would subserve the new semantic learning was not intact. This is the view held by Squire (1992) when he suggests that amnesics show a deficit of declarative memory that includes both facts and events. According to Squire, the acquisition of episodic and semantic information depends on a common memory system that requires the intact functioning of the hippocampus and anatomically related structures. More specifically, the hippocampal system is needed to bind together distributed sites in the neocortex in order to create rapidly new and flexible relationships between a stimulus and its semantic context (thus representing a new concept). On the other hand, amnesic patients with hippocampal damage could acquire new associations but only slowly and after many repetitions (that is, by incremental and cumulative change, as in the development of a habit). The knowledge acquired with such a strategy should be relatively inflexible, that is, accessible only when the cues presented at retrieval are the same as those used during the study phase. But this view would not easily explain some aspects of our data. As a matter of fact, it actually appeared that one of our amnesic patients (A.G.) not only acquired a series of hyperspecific stimulus-response bonds but showed some capability to learn new flexible semantic knowledge. According to Tulving et al. (1991), these exist when

are compatible with the view that semantic memory is completely intact in amnesics. Thus, it could be that normal subjects use both episodic and semantic systems to learn new semantic information and/or to retrieve recently learnt semantic knowledge while amnesics can only rely on their semantic system. A possible contribution of the episodic system to new semantic learning could be to help the normal learner (and not the amnesic) to overcome the effect of interference. In that perspective, careful comparisons of semantic learning in normal subjects and amnesics are necessary. Finally, it could also be that the amnesic patients show a deficit of both the episodic and semantic systems but that the semantic memory is less severely impaired than episodic memory.

In order to claim that semantic memory is relatively preserved in amnesia, it must be demonstrated that semantic information can be acquired by amnesics and in addition, that semantic information is more efficiently acquired than episodic information. A direct comparison could be made between episodic and semantic memory if semantic knowledge was normally learned by amnesics in the context of severe episodic deficits. It is obvious that in the present study, the two Korsakoff patients did not show a perfectly normal memory for conceptual information. Furthermore, they also showed some "residual" learning of episodic information (this is evidenced from Table I where free recall and verbal learning are not at zero). In addition, the two memory systems have been tested with different methods — rote learning for episodic memory, active learning and varied practice examples for semantic memory. Consequently, a comparison of the amnesics' performance in the episodic and semantic memory tasks cannot be made. More generally, a direct comparison between episodic and semantic learning is not easy to undertake because we have no obvious criteria by which to actually compare the relative efficiency of acquisition and retention of episodic and semantic knowledge. In particular, equating learning time for conceptual and episodic information would be very problematic.

Another problem concerns the fact that A.G. demonstrated a good performance in the 24-hour transfer test but contrary to the patient K.C. in Tulving's et al. study, her long-term retention of conceptual knowledge was not excellent: her performance progressively deteriorated in the far-transfer tests. It must be stressed, however, that A.G. was very efficient and rapid in the execution of the active (classification) phase of the concept-learning task and therefore it is possible that more practice trials (and over-learning) could have led to a better long-term retention.

Finally, we should briefly discuss the differences between the learning efficiency demonstrated by A.G. and G.S. in the vanishing-cues learning phase and in the transfer tests: A.G.'s learning in the vanishing-cues phase was slow but she easily succeeded the practice phase and she acquired flexible knowledge while G.S. showed a reverse pattern. We have no ready explanation for this dissociation. In particular, both patients were very similar with regards to the educational level, severity of amnesia, or existence of frontal signs. It could be that the amnesic's performance in both learning phases was subserved by different memory processes or systems and that both patients differed in the efficiency of these processes or in their ability to add new information to these systems. Thus, performance in the vanishing-cues phase could be more dependent on a perceptual memory system while the performance in the classification task is more dependent on semantic memory. Concerning the active classification task, G.S. made many more errors than A.G. and therefore it is possible that those incorrect responses allowed the build-up of interference by competing with correct responses (Tulving et al., 1991). Finally, it is also possible that greater degrees of learning should have improved the performance of G.S. on the transfer tests. In any case, such findings indicate once more that a common etiology does not imply the existence of similar neuropsychological characteristics.

In conclusion, the present study confirms that amnesic patients may acquire new conceptual knowledge and that under adequate learning conditions, the patient's hyperspecificity to learning may be reduced. Further studies will be necessary to discover the processes which

the difficulties shown by the patients in semantic learning and finally to explore the variables that may affect such learning.

Abstract

Two Korsakoff amnesics (A.G. and G.S.) and two control subjects were taught six new concepts. Each concept was composed of three parts: the name of the concept, the context in which the concept originated and its definition. The learning procedure consisted of two phases: (1) learning the concept names and definitions by means of the vanishing-cues method; (2) practice on examples of the concepts through a classification task: examples were either set in the same context as that given in the original definition or in mixed contexts (same and new contexts). Subjects were then tested after 24 hours, a week and a month on their ability to identify new examples as belonging to one of the conceptual rules studied (transfer tests). Both patients showed substantial learning. Patient A.G. was slow and dependent of the first letter cues in the vanishing-cues learning phase but nevertheless, she acquired a large and flexible conceptual knowledge and this was especially true for concepts that were practised by means of mixed-context examples. Patient G.S. easily learned to associate the definitions with the concept names but her conceptual knowledge remained more limited. These results confirm the existence of a semantic learning ability in amnesic patients. They also suggest that under appropriate learning conditions, amnesics may eventually acquire a new flexible conceptual knowledge.

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