Journal of Experimental Psychology:
Learning, Memory, and Cognition
1988, Vol. 14, No. 4, 758–762

0278-7393/88/$00.75

More on Recognition and Recall in Amnesics

William Hirst
New School for Social Research

Marcia K. Johnson
Princeton University

Elizabeth A. Phelps
Princeton University

Bruce T. Volpe
Cornell Medical College

Hirst et al. (1986) reported that amnesic forced-choice recognition was relatively preserved when compared with amnesic recall. They equated normal recognition and amnesic recognition by extending exposure time for the amnesics and then comparing amnesic recall and normal recall. Amnesic recall was worse than normal recall, despite equated recognition. We conducted two experiments to extend that result. Experiment 1 established that the findings of Hirst et al. are not paradigm specific and hold when amnesic recognition and normal recognition are equated by increasing the retention interval for normals. In Experiment 2 we further established the generality of the result by examining yes–no recognition. Findings further specify the selective nature of the direct memory deficit in amnesics.

Although it is generally accepted that amnesia leaves intact what has been called semantic memory (Cermak, Talbot, Chandler, & Wolburst, 1985; Tulving, 1983), procedural memory (Cohen, 1984; Squire, 1982), implicit memory (Graf & Schacter, 1985), memory without awareness (Jacoby & Whitherspoon, 1982), and indirect memory (Hirst et al., 1986), the nature of the disruption of another component of memory—be it called episodic memory, declarative memory, explicit memory, or direct memory—is poorly understood. This latter component of memory very likely draws on several (or at least more than one) processes (Johnson, 1983). On the basis of evidence that amnesic recognition is relatively preserved when compared with amnesic recall, Hirst et al. argued that various of these direct memory processes may be differentially disrupted in amnesics (see also Johnson & Kim, 1985). Hirst et al. equated forced-choice recognition of amnesics and that of normal controls by extending the study time of amnesics and then comparing amnesic recall with control recall. Even when recognition was equated (also see Huppert & Piercy, 1977, for a similar success at raising amnesic recognition), normal free recall was on the average 200% to 1,200% better than amnesic recall, depending on the nature of the list (categorized or unrelated) and patient type (Korsakoffs or nonalcoholic amnesics). Hirst et al. concluded that some aspects of processing underlying recognition may remain unaffected by amnesia.

Squire and Shimamura (1986) subsequently reported data that they claimed failed to support the findings of Hirst et al. (1986). Squire and Shimamura's argument, however, seems to be based on the fact that the amnesics in their study showed an absolute deficit in recognition relative to normals. They failed to take into account the basic logic of the Hirst et al. study, namely, that the deficit of amnesics compared with that of controls is greater on recall than on recognition. In fact, an examination of the relevant data in Squire and Shimamura's study (1986, p. 870, Figure 2) reveals that when recognition of amnesics and controls is at comparable levels (after five exposures to the to-be-remembered list for the amnesics and one exposure for controls), amnesics' recall still remains below that of controls. Thus the alcoholic controls recalled approximately 40% of the items on the first trial, whereas the Korsakoffs recalled only approximately 28% on the fifth trial.

Inasmuch as the claims for relatively preserved recognition rest solely on the one study directed specifically at this issue reported by Hirst et al. (1986), the present experiments were undertaken to expand the relevant data base. In the Hirst et al. study, extending the study time evidently provided the amnesics an opportunity for processing that was more beneficial for recognition than for recall. We were interested in exploring what would happen if normals were given the same opportunity for increased study time. For instance, recognition of amnesics and that of normal controls might be equated by giving both groups equal amounts of study time but extending the retention interval for normal controls. If, under these conditions, amnesic recall and normal recall was also equated, then the results of Hirst et al. may be specific to the way they equated recognition. On the other hand, if amnesic recall still remained depressed relative to normal recall, then the results of Hirst et al. may be independent of the paradigm used to equate recognition. With these considerations in mind, we provided both amnesics and normal controls 8 s of study time but tested them at different retention intervals. Using a similar technique, Mayes and Meudell (1981a, 1981b) reported that normal controls' recognition decreased to levels comparable to amnesics' after about a 1-day delay.

Experiment 1

Method

Subjects. The experimental group consisted of six amnesic patients without a history of alcoholism. Their only cognitive complaint

We gratefully acknowledge the support of the Burke Foundation, National Institutes of Health Grant NS1776 awarded to William Hirst, and a National Science Foundation grant awarded to Marcia Johnson.

Correspondence concerning this article should be addressed to William Hirst, Department of Psychology, Graduate Faculty of the New School of Social Research, 65 Fifth Avenue, New York, New York 10003.

was poor memory. The experiment was completed at least 1 year after each patient's acute injury. In the 6 years that we followed the patients, their memory deficit remained stable. Two men and one woman suffered diffuse injury after global cerebral hypoxic ischemia (lack of adequate oxygen supply and obstruction to circulation). One man and two women had rupture and repair of anterior communicating artery aneurysm (arterial dilation owing to pressure of blood on weakened tissues, forming a sac of clotted blood). One man had undergone surgery for the removal of a left posterior tumor.[1]

The average age of the patients was 53.0 years. Although there were differences in etiology, neuropsychological examinations were remarkably similar. Patients showed no perceptual or linguistic impairment in neuropsychological examinations, had above-normal intelligence, did not confabulate, and were aware of their memory problems. They had an average of 17.7 years of education. Their Wechsler Adult Intelligence Study average full-scale score was 117.9 (range = 103–131); Ravens Progressive Matrices, 81% (range = 50–95); Boston Diagnostic Aphasia Examination, normal; and Token Test (for aphasia), no errors. The patients showed no signs of frontal lobe damage on a set of standard neuropsychological tests. They achieved six categories on the Wisconsin Card Sorting Test with an average of 13.1 errors (range = 6–42). (Milner, 1963, reported that the patients with frontal lobe damage that she studied achieved 1.3 categories with an average of 78 errors.) Our patients could also accurately interpret proverbs and performed in the upper quartile on the controlled word association test (Benton, 1968). Frontal lobe damage typically impairs performance on these tasks.

Memory deficits were assessed by using tests probing free recall of pictures and words. The patients could recall an average of 1.6 unrelated words out of 10 after 30 s of distraction (which is significantly different from the controls' 5.8 words on the Mann-Whitney U test, $U = 0, p < .002$) and 1.1 out of 20 objects depicted in complex pictures (controls = 7.6 words, $U = 0$, $p < .002$). Five patients did not remember a single difficult word pair on the paired-associate learning task of the Wechsler Memory Scale; two remembered one word pair.

The control group consisted of five women and one man who were matched for age (an average of 56 years) and years of education (an average of 17 years) with the amnesics. The control subjects were paid for their efforts; the amnesic subjects worked on a volunteer basis.

Material. Each of the two lists contained 30 words. The words were unrelated, and no word appeared in both lists. They were one or two syllables long and of a frequency greater than 20 occurrences per million (Kucera & Francis, 1967). Words were presented by using an Apple IIc computer, with the words centered on a cathode-ray tube (CRT) screen. The order of the words in each list was randomly determined.

A two-item forced-choice recognition test was constructed for each list. The distractions were selected from the Kucera and Francis (1967) study to match the overall target set in syllable length and word frequency. Targets and distractors were presented on a CRT screen with left and right positions of each equated across items.

Design and procedure. A word list was presented to the subjects, one word every 8 s. Subjects were told to study the words so that they could remember them when tested. For the amnesics, the study phase was followed by a ½-min distraction period, in which they were asked to solve simple arithemtic problems at a rate of one problem every 3 s, and then by the testing phase. For the controls, at the end of the study phase, the experimenter asked them to come back the following day for testing. In the testing phase, subjects were asked to recall as many of the words as they could from the studied lists and were given 3 min to do so. They were then given the forced-choice recognition test and asked to indicate which of the two words had appeared on the studied list and to assign a confidence rating to their judgment, with 1 indicating least confident and 3 indicating most confident.

The amnesics received the two lists in two sessions separated by at least 1 week. The controls were tested in four sessions over a 2-week period. The study and test sessions for a list were always separated by 1 day. The order of presentation of the lists was counterbalanced across subjects.

Results and Discussions

The recall and recognition scores did not differ across lists. Consequently, data from the two lists were averaged and presented in Table 1. An analysis of variance was performed on these data. The main effect for type of test was significant, $F(1, 10) = 481.55$, $p < .001$, but the main effect for subject group was not, $F(1, 10) = 3.33$, $p > .05$. More important, there was an interaction between type of test and subject group, $F(1, 10) = 5.12$, $p < .05$. At an 8-s acquisition rate, delaying testing of controls successfully equated recognition performance of amnesics and that of controls at a level above chance and clearly below ceiling, $F(1, 10) = 0.06$, $p > .05$. At the same time, controls' recall was significantly greater than that of amnesics, $F(1, 10) = 5.46$, $p < .05$.

The average confidence rating for the correctly recognized items was 1.66 for the amnesics and 1.67 for the controls; the average rating for errors was 2.39 for the amnesics and 2.51 for the controls. Neither main effects nor the interaction was significant, $F(1, 10) < 3.60$ for all analyses, $p > .05$, suggesting that recognition of amnesics and that of controls were equated even when confidence ratings were considered. Figure 1 includes the proportion correct at each level of confidence. As can be seen, amnesics appeared to assign confidence ratings in a meaningful manner: The higher the confidence rating, the higher the level of accurate recognition. An average of 1.17 new items intruded into the amnesics' recall, whereas an average of 1.67 new items appeared in controls' recall. This difference was not significant, $t(10) = .37$, $p > .05$.

We examined the effect of recall on recognition by calculating (a) the conditional probability of recognizing a recalled item and (b) the conditional probability of recognizing an item that was not recalled. Amnesics recognized 92% of the items that they recalled and 86% of the items that they did not recall. Controls recognized 100% of the items that they recalled and 84% of the items that they did not recall. The probability of recognizing a recalled item did not differ for amnesics and controls, $t(10) = 1.0$, $p > .05$, nor did the probability of recognizing an item that was not recalled, $t(10) = .27$, $p > .05$. The meaning of the comparison for recalled items is ambiguous because of potential ceiling effects.

Even when recognition of amnesics and that of controls were equated by using a methodology different from Hirst et al. (1986), free recall of amnesics was much worse than that of normal controls. That is, the same pattern of recall and recognition is observed when study time is held constant across groups and retention interval is allowed to vary *and* when retention interval is held constant and study time is allowed to vary. Consequently, the observed relatively pre-

[1] For neurological details of patients, see Volpe & Hirst's, 1983a, 1983b, articles or write to Bruce T. Volpe, Cornell Medical College, Burke Rehabilitation Center, White Plains, New York 10605.

Table 1
Recall and Forced-Choice Recognition of Amnesics and Controls

Subject group	Recall PC	Recall *SD*	Recognition PC	Recognition *SD*
Amnesics	.06	.02	.85	.07
Controls	.22	.16	.86	.08

Note. Retention interval was 30 s for amnesics and 1 day for controls. PC = proportion correct.

served recognition of amnesics is not paradigm specific and appears to reflect a qualitative difference in amnesic and normal direct memory.

Experiment 2

A possible objection to the findings of Hirst et al. (1986) and those in Experiment 1 of this article is that recall may be a more sensitive test than recognition. Consequently, a difference between amnesics' and controls' recall may emerge when a difference in their recognition does not (e.g., see Chapman & Chapman, 1978). We explored this possibility in Experiment 2 by using the methodology adopted in the original Hirst et al. study. Here, however, amnesics were given enough study time to raise their recognition level above that of controls. In this instance, the recognition test is sensitive enough to detect a difference between subject groups. The question is, Does amnesic recall remain depressed even with superior recognition?

Although our primary aim in this experiment was to test the sensitivity issue, we also examined whether the Hirst et al. (1986) results can be extended to yes–no recognition. Yes–no recognition presents demands on subjects that are quite different from those of forced-choice recognition. In a forced-choice recognition experiment, subjects must choose among alternatives. Their criteria for distinguishing memories from noise should have little effect on performance. In yes–no recognition, subjects must decide whether an item was in the studied list. Their decisions depend on their criterion to say yes. A loose criterion may lead to false alarms, whereas a strict criterion may lead to misses. The reasonable assignment of confidence ratings in Experiment 1 suggests that amnesics can make accurate criterial judgments and, consequently,

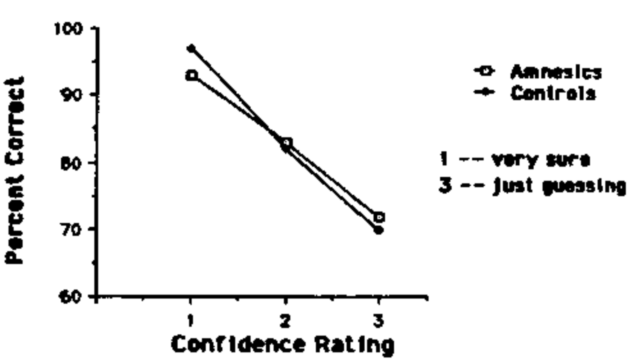

Figure 1. Recognition as a function of confidence for amnesics and controls.

might perform as well with yes–no recognition as they do with forced-choice recognition. On the other hand, amnesics may not be able to make the necessary criterion judgments if, as several investigators (Hirst, 1982; Rozin, 1976) have suggested, amnesics do not experience the sense of familiarity that normals do.

Method

Subjects. Both the amnesic subjects and the controls were the same as those tested in Experiment 1. As before, the controls were paid for their efforts; the amnesics vounteered. For the amnesics and controls, Experiments 1 and 2 were conducted in different sessions at least a week apart.

Material. Each of the two lists contained 20 words. As in Experiment 1, the words were unrelated, one or two syllables long, and of a frequency greater than 20 occurrences per million (Kucera & Francis, 1967). As in Experiment 1, the words were presented on a CRT under the control of an Apple IIc. There were two orderings of the words in the lists, each randomly determined. No words used in Experiment 1 were used in this experiment.

A yes–no recognition test was constructed for each list. There were 20 "old" items and 20 "new" items. The new items were selected from the Kucera and Francis (1967) study to match the old items in syllable length and word frequency. The order of the words was random.

Design and procedure. A word list was presented to the subjects, one word at a time. Subjects were told to study the words so that they could remember them when tested. This task was followed by 2 min of distraction, in which subjects solved simple arithmetic problems. They then tried for 3 min to recall the words from the studied list. Finally, they were given the yes–no recognition test. On the recognition test, they were asked to indicate whether a word had appeared on the studied list and to assign a confidence rating, with 1 indicating least confident and 3 indicating most confident. Amnesics studied the list once, with a 5-s-per-word exposure, and then immediately studied it again, in the same order and for the same exposure time. Normal controls were given a study time of ½ s per word with only one exposure. Timing for the retention interval began with the completion of the study phase.

The order of the words in the lists and the ordering of the presentation of the two lists were counterbalanced. The testing of the lists occurred in two separate sessions with an average of a week between sessions.

Results and Discussions

The recognition or recall scores did not differ across lists. Consequently, data from the two lists were averaged and presented in Table 2. The main effect for test type was significant, $F(1, 8) = 1{,}325.17$, $p < .001$, but the main effect for subject group was not, $F(1, 8) = .16$, $p > .05$. More importantly, the interaction between subject group and test type was significant, $F(1, 8) = 18.90$, $p < .01$. Two exposures of 5 s each raised amnesics' recognition scores to a level significantly higher than that of the controls, $F(1, 8) = 10.33$, $p < .02$. Despite this advantage, amnesic recall was still significantly worse than control recall, $F(1, 8) = 6.92$, $p < .05$.

The probability of recognizing a recalled item was 1.00 for the controls and 1.00 for the amnesics, and the probability of recognizing an item that was not recalled was .72 for controls and .82 for amnesics. Neither difference was significant, $t(10) < 1.8$, $p > .05$.

Table 2
Recall and Yes–No Recognition of Targets Versus Distractors

Subject group	Recall		Recognition	
	PC	*SD*	PC	*SD*
Amnesics	.07	.07	.85	.05
Controls	.16	.04	.77	.02

Note. PC = proportion of targets and distractors correct.

As for free recall, amnesics produced an average of 1.14 prior-list intrusions, whereas controls produced an average of 2.34 prior-list intrusions. An average of 1.40 new items intruded into the amnesics' recall, whereas an average of 1.30 new items appeared in controls' recall. Neither difference was significant, $t(10) < 1.8$, $p > .05$.

Results suggest that the findings of Hirst et al. (1986) can be extended from forced-choice recognition to yes–no recognition. Moreover, the presence of a cross-over interaction indicates that the relatively preserved recognition observed in this experiment cannot be attributed to differences in sensitivities of recall and recognition tests. Even when amnesic recognition was significantly better than normal recognition, amnesic recall remained significantly worse than normal recall.

General Discussion

Results reinforce the findings of Hirst et al. (1986). Amnesic recognition is relatively preserved when compared with amnesic free recall. This finding suggests that some processes underlying direct memory tasks are relatively spared in amnesics. It is possible that the relative sparing of amnesic recognition may be a product of their intact indirect memory, in that some investigators have claimed that recognition involves processes similar to those tapped by priming tasks (Mandler, 1980). We are currently investigating this hypothesis in another context. Another possible explanation for the current results is that direct memory is not uniformly disrupted by amnesia. Some aspects of direct memory are preserved, but others are disrupted. Amnesics can decide whether an item occurred in the studied list, if probed with a recognition test, much better than one would expect given their extremely bad recall. This pattern suggests a retrieval problem, but the problem cannot rest with retrieval alone. Retrieval deficit theories, such as those of Warrington and Weiskrantz (1970), cannot account for the ability of some amnesics to recall events that occurred before the onset of their amnesia (Marslen-Wilson & Teuber, 1975).

Thus the pattern of results observed here and in the Hirst et al. study (1986) may arise because of differences in the way normals and amnesics represent events in memory. The representation must be such that a past event can be recognized, with the appropriate level of confidence, better than one would expect given the difficulty with which the items are recalled. Whatever the nature of mnemonic representations formed by amnesics, they must be more useful for recognition than for recall.

It appears that a full account of the present findings should include a discussion of the manner in which events are encoded by amnesics and the form of the resulting mnemonic representation. The present findings, and related findings (Hirst et al., 1986; Johnson & Kim, 1985), suggest that amnesics may have difficulty supplying the glue that holds individual events together and creates a larger picture. This glue could include contextual information (Hirst, 1982; Hirst & Volpe, 1982, 1984a, 1984b; Mayes, Meudell, & Pickering, 1985) and the kind of reflective activity (including elaborated semantic processing) that allows people to relate one event to another (Johnson, 1983). Although amnesics may be able to link events sufficiently to support some indirect memory task (Graf & Schacter, 1985, 1987), their failure to supply sufficient glue can have severe detrimental effects on direct memory tasks, with a more pronounced effect on recall than on recognition. The elaboration or the formation of associations between intralist items, for instance, benefits recall more than it does recognition (see Johnson, 1983, for a review), and recall is more damaged than is recognition when the environmental context of study and testing differs (Smith, 1979; Smith, Glenberg, & Bjork, 1978). Without sufficient glue, memory would consist of a collection of individual records of past events unconnected to one another. An amnesic may be able to obtain access to these memories if provided an appropriate probe, but he or she would not be able to retrieve memories in a systematic fashion. Future studies of amnesia may allow one to understand the nature of this glue and how it interacts with recall and recognition.

References

Benton, A. L. (1968). Differential behavioral effects in frontal lobe damage. *Neuropsychologia, 6,* 53–60.

Cermak, L. S., Talbot, N., Chandler, K., & Wolburst, L. R. (1985). The perceptual priming phenomenon in amnesia. *Neuropsychologia, 23,* 615–622.

Chapman, L. J., & Chapman, J. P. (1978). The measurement of differential deficit. *Journal of Psychiatric Research, 14,* 303–311.

Cohen, N. J. (1984). Preserved learning capacity in amnesia: Evidence for multiple memory systems. In L. R. Squire & N. Butters (Eds.), *The neuropsychology of memory* (pp. 83–103). New York: Guilford.

Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11,* 501–508.

Graf, P., & Schacter, D. L. (1987). Selective effects of interference on implicit and explicit memory for new associations. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 45–53.

Hirst, W. (1982). The amnesic syndrome: Descriptions and explanations. *Psychological Bulletin, 91,* 435–460.

Hirst, W., Johnson, M. K., Kim, J. K., Phelps, E. A., Risse, G., & Volpe, B. T. (1986). Recognition and recall in amnesics. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 445–451.

Hirst, W., & Volpe, B. T. (1982). Temporal order judgments with amnesia. *Brain and Cognition, 1,* 294–306.

Hirst, W., & Volpe, B. T. (1984a). Automatic and effortful encoding in amnesia. In M. S. Gazzaniga (Ed.), *The handbook of cognitive neuroscience* (pp. 369–386). New York: Plenum Press.

Hirst, W., & Volpe, B. T. (1984b). Encoding of spatial relations with amnesia. *Neuropsychologia, 22,* 631–634.

Huppert, F. A., & Piercy, M. (1977). Recognition memory in amnesic patients: A defect of acquisition? *Neuropsychologia, 15,* 643–652.

Jacoby, L. L., & Whitherspoon, D. (1982). Remembering without awareness. *Canadian Journal of Psychology, 36,* 300–324.

Johnson, M. K. (1983). A multiple-entry, modular memory system. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research theory* (Vol. 17, pp. 81–123). New York: Academic Press.

Johnson, M. K., & Kim, J. K. (1985). Recognition of pictures by alcoholic Korsakoff patients. *Bulletin of the Psychonomic Society, 23,* 456–458.

Kucera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English.* Providence, RI: Brown University Press.

Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review, 87,* 252–271.

Marslen-Wilson, W. D., & Teuber, H.-L. (1975). Memory for remote events in anterograde amnesia: Recognition of public figures from news photographs. *Neuropsychologia, 13,* 347–352.

Mayes, A. R., & Meudell, P. R. (1981a). How similar is immediate memory in amnesic patients to delayed memory in normal subjects? A replication, extension, and reassessment of the amnesic cueing effect. *Neuropsychologia, 19,* 647–654.

Mayes, A. R., & Meudell, P. R. (1981b). How similar is the effect of cueing in amnesics and in normal subjects following forgetting? *Cortex, 17,* 113–124.

Mayes, A. R., Meudell, P. R., & Pickering, A. (1985). Is organic amnesia caused by a selective deficit in remembering contextual information? *Cortex, 21,* 487–511.

Milner, B. (1963). Effects of different brain lesions on card sorting. *Archives of Neurology, 9,* 100–110.

Rozin, P. (1976). A psychobiological approach to human memory. In M. R. Rozenzweig & E. L. Bennett (Eds.), *Neural mechanisms of learning* (pp. 3–48). Cambridge, MA: MIT Press.

Smith, S. M. (1979). Remembering in and out of context. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 460–471.

Smith, S. M., Glenberg, A. M., & Bjork, R. A. (1978). Environmental context and human memory. *Memory & Cognition, 6,* 342–353.

Squire, L. R. (1982). The neuropsychology of memory. *Annual Review of Neuroscience, 5,* 241–273.

Squire, L. R., & Shimamura, A. P. (1986). Characterizing amnesic patients for neurobehavioral study. *Behavioral Neuroscience, 100,* 866–877.

Tulving, E. (1983). *Elements of episodic memory.* New York: Oxford University Press.

Volpe, B. T., & Hirst, W. (1983a). Amnesias following the rupture of an anterior communicating artery aneurysm. *Journal of Neurology, Neurosurgery, and Psychiatry, 46,* 704–709.

Volpe, B. T., & Hirst, W. (1983b). The characterization of an amnesic syndrome following hypoxic ischemic injury. *Archives of Neurology, 40,* 436–440.

Warrington, E. K., & Weiskrantz, L. (1970). Amnesic syndrome: Consolidation or retrieval? *Nature, 228,* 628–630.

Received November 24, 1986
Revision received October 16, 1987
Accepted October 23, 1987 ■