

Priming of Face Matching in Amnesia

KEN A. PALLER, ANDREW R. MAYES, AND KATHERINE M. THOMPSON

University of Manchester, United Kingdom

ANDREW W. YOUNG

University of Durham, United Kingdom

JULIET ROBERTS

University of Lancaster, United Kingdom

AND

PETER R. MEUDELL

University of Manchester, United Kingdom

Priming was studied in a task that required a speeded response to photographs of faces. On each trial, subjects viewed two faces and decided if the same person was shown twice or if two different people were shown. Both familiar and unfamiliar (i.e., well-known and unknown) faces were used, and some face pairs were repeated with a mean delay of about 10 min. Repetition was associated with faster reaction times in young subjects (Experiment 1) as well as in amnesic patients and age-matched control subjects (Experiment 2). The patients' reaction times were slower overall, although the magnitude of the priming effect did not differ from that in the control subjects. This preservation of a normal reaction-time facilitation in subjects with impaired recognition memory for faces occurred for both familiar and unfamiliar faces, suggesting that amnesia does not necessarily interfere with the acquisition of new information as indexed by this priming effect.

© 1992 Academic Press, Inc.

This work was supported by MRC Project Grant G8902677 (to A.R.M. and P.R.M.) and ESRC Grant R000231922 (to A.W.Y.). Please address correspondence and reprint requests to Ken Paller, Research Medicine, 55-121, Lawrence Berkeley Laboratory, Berkeley, CA 94720.

INTRODUCTION

Amnesia is marked by a selective impairment in remembering that can include all types of material, yet performance can be normal on certain indirect measures of retention (for reviews see Richardson-Klavehn & Bjork, 1988; Schacter, 1987). In particular, amnesic patients can perform normally when a type of memory known as *priming* is tested. Priming, in general, refers to phenomena in which prior experience with certain stimuli influences behavioral responses to subsequent stimuli, but a direct memory query is not used to elicit responses. Rather, memory is accessed indirectly by asking the subject to engage in a different task, such as reading words. Identification or categorization responses, for example, tend to be faster and more accurate for recently presented words.

Evidence of normal priming effects in amnesia has been used to support distinctions between different types of memory. According to one hypothesis, priming depends on an *activation* process, which is intact in amnesia, whereas recall and recognition depend on additional processes or on the additional contribution of another memory system (see Graf & Mandler, 1984; Morton, 1969; Rozin, 1976; Shimamura, 1986; Squire, 1986; Tulving & Schacter, 1990). Activation can be thought of as an automatic process that occurs when a stimulus is encountered and the representation associated specifically with that stimulus is altered. The activation process thus requires that a representation exists in memory. However, if activation must be invoked to explain priming of both familiar and novel material, it is necessary to suppose that, in the latter case, new representations are formed as well as activated.

When familiar stimuli have been used to test priming in amnesia, numerous reports have substantiated the generalization that priming effects are normal (e.g., Cermak, Talbot, Chandler, & Wolbarst, 1985; Graf, Squire, & Mandler, 1984; Jacoby & Witherspoon, 1982; Shimamura & Squire, 1984; see Shimamura, 1986 for a review). On the other hand, when novel material has been used, the evidence for priming has been quite divergent. Thus, there is currently no consensus about whether novel-information priming is spared in amnesia. Three main types of novel material have been used in these studies: pseudowords, new associations between words, and nonverbal material. Most often, priming effects in amnesic patients were abnormal, but the findings have not been consistent for either pseudowords (e.g., Cermak et al., 1985; Cermak, Blackford, O'Connor, & Bleich, 1988; Diamond & Rozin, 1984; Gordon, 1988; Moscovitch, 1985; Musen & Squire, 1991; Smith & Oscar-Berman, 1990) or for new associations between words (e.g., Cermak et al., 1988; Cermak, Bleich, & Blackford, 1988; Graf & Schacter, 1985; Mayes & Gooding, 1989; McAndrews, Glisky, & Schacter, 1987; Moscovitch, Winocur, & McLachlan, 1986; Paller & Mayes, 1992; Schacter & Graf, 1986; Shi-

mamura & Squire, 1989). Studies using nonverbal material have been more likely to find intact priming effects in amnesia, although these have not been thoroughly explored and the particular factors critical for eliciting normal effects are presently unclear. Types of novel nonverbal material for which priming effects have been reported in amnesics include melodies (Johnson, Kim, & Risse, 1985), abstract line patterns (Gabrieli, Milberg, Keane, & Corkin, 1990; Gooding & Mayes, 1991), and drawings of three-dimensional geometric objects (Schacter, Cooper, Tharan, & Rubens, 1991).

Here we report on repetition priming effects using both well-known and unknown faces, such that the relevance of prior experience with the faces can be assessed. Repetition priming has previously been studied with faces using a familiarity-decision task, in which subjects decided whether or not each face presented was that of a familiar person (Bruce & Valentine, 1985; Brunas, Young, & Ellis, 1990; Ellis, Young, & Flude, 1990; Ellis, Young, Flude, & Hay, 1987). These studies showed that the reaction-time facilitation to repeated faces depended on the requirement to process facial identity, as priming was not observed when expression or gender decisions were required instead of familiarity decisions. Familiarity decisions, however, are not well-suited for studying priming in amnesia because comparisons between results with familiar and unfamiliar faces would be confounded with the response requirement. Also, amnesic patients with retrograde memory impairments may have difficulty recognizing some of the famous faces. To eliminate these problems, we adapted a face-matching paradigm previously used to study the mechanisms by which identity information is derived from the visual examination of a face (Young, Hay, McWeeny, Flude, & Ellis, 1985; Young, McWeeny, Hay, & Ellis, 1986). On each trial, photographs of two faces were shown simultaneously and subjects decided whether (a) the faces belonged to two different people or (b) the faces were two different views of the same person. Discriminative responses in this identity-matching task have been shown to be affected by prior experience with the faces. First of all, responses are faster for well-known faces than for unknown faces (Young et al., 1986). Second, responses are faster for faces shown earlier in the same task (Roberts, 1988). This repetition priming of the speeded categorization response can thus be examined as a function of the likelihood that a face has a preexisting representation.

We conducted Experiment 1 with young subjects to verify that robust repetition priming effects could be elicited in the identity-matching task. In Experiment 2 we studied priming effects in amnesic patients and in age-matched control subjects.

EXPERIMENT 1

Method

Subjects. Ten undergraduate students (three men and seven women) from the University of Manchester served as subjects. The mean age of the group was 22.8 years ($SE = 1.8$).

Materials. Monochrome photographs of faces were prepared such that each photograph showed a single face within a central circular area surrounded by white. The circular area measured 14.5 cm in diameter when displayed. There were two types of pairs: *same* pairs were two distinct views of the same person whereas *different* pairs showed two different people. The faces in each *different* pair were of the same gender and were selected to resemble each other with respect to features such as the presence or absence of glasses and facial hair. Faces were also designated *familiar* or *unfamiliar* (i.e., well-known or unknown, respectively) on the basis of prior ratings from 12 individuals. Two sets of 40 pairs, Set A and Set B, were formed by selecting 10 pairs that were *same* and *familiar*, 10 pairs that were *same* and *unfamiliar*, 10 pairs that were *different* and *familiar*, and 10 pairs that were *different* and *unfamiliar*. Furthermore, Set A and Set B were matched on the basis of ratings of expressions, camera angles, and backgrounds. For each group of 10 pairs, 3 were faces of women and 7 were faces of men. An additional 52 pairs of faces selected on similar criteria were used as fillers.

Procedure and design. The experiment included a training phase and a test phase, although there was no break between phases and subjects were not informed of any such distinction. Subjects performed the identity-matching task throughout the experiment, which lasted approximately 30 min, but during the test phase some of the pairs were identical to pairs shown in the training phase (i.e., *primed*). The two dependent measures were the latency and the accuracy of the identity-matching decisions made during the test phase.

Each subject was tested individually in a darkened room. The subject sat at a viewing distance of 150 cm in front of two projector screens arranged vertically. A response button labeled "SAME" was held in the left hand and a response button labeled "DIFFERENT" was held in the right hand. The subject was informed that pairs of faces would be presented and that a same/different categorization was to be made for each pair. The subject was not told that pairs would repeat. Instructions stressed that decisions should be registered with the response buttons as quickly as possible and that decisions should also be accurate. Practice with 8 filler pairs preceded the consecutive training and test phases, which comprised 160 trials presented in a pseudorandom order. There were short pauses after trial 60 and trial 120 while slide carousels were changed, and two filler pairs were included at the start of new carousels. The slides shown in the training phase included 40 filler pairs and 40 critical pairs from Set A (for half of the subjects) or Set B (for the other half of the subjects). The slides shown in the test phase included 40 pairs from Set A and 40 pairs from Set B. In this way, the particular pairs used in the primed and unprimed conditions were balanced across subjects.

Thus, three variables were manipulated within subjects: Priming (primed vs. unprimed), Familiarity (familiar vs. unfamiliar), and Response (same vs. different). Training set (A vs. B) was manipulated between subjects. Results were analyzed by analysis of variance (ANOVA) using the 5% level for significance.

Results and Discussion

Response latencies were calculated only for trials in the test phase that were not designated error trials. Error trials included trials in which the subject's response was incorrect (which amounted to 5% of the total number of trials) and trials in which the response latency was greater than 2 sec (a further 0.4% of the total number of trials).

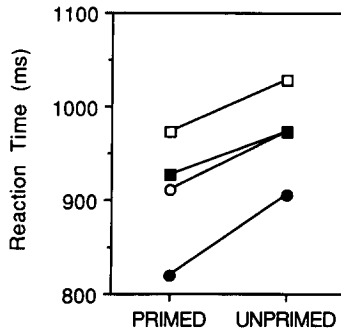


FIG. 1. Mean reaction time in each experimental condition, collapsed across the two training sets in Experiment 1. (□) Different/unfamiliar, (○) same/unfamiliar, (■) different/familiar, (●) same/familiar.

Mean reaction times in the test phase are shown in Fig. 1 for each condition, averaged across all subjects. Across conditions, an overall priming effect of 63 msec was found. Furthermore, the priming effect appeared to differ very little across conditions. A four-way ANOVA (Priming \times Familiarity \times Response \times Set) conducted on means for each condition for each subject confirmed the reliability of the priming effect [$F(1, 8) = 12.0, p = .008$]. In addition, responses to *familiar* pairs were significantly faster than responses to *unfamiliar* pairs [$F(1, 8) = 18.8, p = .003$]. Responses to *same* pairs tended to be faster than responses to *different* pairs, but this effect just failed to reach statistical significance [$F(1, 8) = 5.1, p = .053$]. None of the other effects were significant, indicating in particular that (a) the priming effect did not differ as a function of familiarity or response, and (b) similar outcomes were associated with the two training sets.

Priming effects were also analyzed in two other ways. First, reaction times associated with unprimed faces were subtracted from those associated with primed faces to yield a difference score for each condition for each subject. Second, a proportional score was computed as the ratio of the difference score to the average reaction time. Given that response latencies vary between individuals, the proportional score takes into account the expectation that larger difference scores will be associated with slower responses, as will be discussed further below. The mean difference and proportional scores for each condition are shown in Table 1. Consistent with the previous analysis, no effects of familiarity, response, or set were found on the priming effects reflected by these two measures [all effects from three-way ANOVAs (Familiarity \times Response \times Set) were nonsignificant].

For each condition and subject, the percentage of trials in which an incorrect response was made was subjected to a four-way ANOVA (Prim-

TABLE 1
PRIMING EFFECTS FOR EACH EXPERIMENTAL CONDITION IN EXPERIMENT 1

	Familiar		Unfamiliar	
	Same	Different	Same	Different
Difference measure ^a	86	47	64	56
(SE)	(21)	(14)	(34)	(32)
Proportional measure	.10	.05	.07	.05
(SE)	(.02)	(.02)	(.04)	(.03)

^a In milliseconds.

ing \times Familiarity \times Response \times Set). For *familiar* faces, 3.5% of the trials were incorrect, whereas 6.5% of the trials with *unfamiliar* faces were incorrect [$F(1, 8) = 10.0, p = .013$]. There was also a tendency for more incorrect responses with unprimed pairs than primed pairs (3.5% vs. 6.5%, respectively). This effect was marginally nonsignificant [$F(1, 8) = 5.2, p = .051$], although the Priming \times Response interaction was significant [$F(1, 8) = 6.5, p = .035$], indicating that priming was associated with a greater reduction in errors for *same* pairs (2.5% vs. 8.0%) than for *different* pairs (4.5% vs. 5.0%). In any event, the finding that the percentage of errors was greater for unprimed faces suggests that subjects were not sacrificing accuracy in responding faster to primed faces. In other words, the priming effect should not be regarded as an artifact of a trade-off of accuracy for speed.

In summary, these results showed that the identity-matching response is speeded when a face pair is repeated. This repetition priming effect was evident for *familiar* as well as *unfamiliar* faces, although reaction times were faster for *familiar* faces. The task is thus suitable for studying priming of familiar and unfamiliar information in amnesia.

EXPERIMENT 2

Method

Subjects. Two groups were studied: a group of amnesic patients ($N = 9$) and a group of control subjects who were matched to the patients on age, intelligence, and socioeconomic background ($N = 9$). Each group included eight men and one woman. The mean age in the amnesic group was 44 years ($SE = 5$, range = 23–62) and that in the control group was 41 years ($SE = 5$, range = 22–60). Age did not differ between the groups [$F(1, 22) < 1$]. The Wechsler Adult Intelligence Scale was given to each patient to obtain general estimates of intelligence. Mean scores for full-scale, verbal, and performance IQ were 104 ($SE = 5$), 108 ($SE = 5$), and 97 ($SE = 5$), respectively. An estimate of premorbid full-scale IQ, derived from the National Adult Reading Test (NART), was 110 ($SE = 3$). The mean IQ score for the control group, estimated using four subtests (similarities, vocabulary, picture completion, and block design), was 112 ($SE = 3$). Full-scale IQ did not differ between the groups [$F(1, 22) = 2.3$]. A standardized test of memory for faces (the Warrington recognition memory test for faces; Warrington, 1984) was given to each subject on

a separate session. All of the control subjects scored near 50, the maximum possible (mean = 47), whereas scores in the amnesics were clearly impaired (mean = 31, range = 23–39). The memory dysfunctions were due to viral encephalitis ($n = 3$), alcoholic Korsakoff's syndrome ($n = 2$), rupture and repair of an anterior communicating artery aneurysm ($n = 2$), meningitis ($n = 1$), and excision of an arterio-venous malformation, which also caused a left frontal subarachnoid hemorrhage ($n = 1$).

Materials, procedure, and design. The materials were the same as those used in Experiment 1. The procedure was identical except that only faces from Set B were primed in the training phase, because previous results showed no differences between the two sets. Also, cards marked "SAME" and "DIFFERENT" were placed one on each side of the projectors to correspond to the two response choices. These cards reminded subjects which hand was associated with which response. Care was taken to ensure that the amnesic patients remembered the task requirements by repeating them whenever the task was momentarily halted, for example, when carousels were changed. There was one between-subjects variable (Group) and three within-subjects variables (Priming, Familiarity, and Response).

Results and Discussion

Analyses focused on response latencies for test-phase trials in which the response was correct, as well as on the accuracy measures. In general, response latencies were much longer than those found in Experiment 1 and there was also greater variability between individuals. The problem of outlying responses was dealt with by analyzing three different measures: mean, median, and a corrected mean that excluded responses more than 2 sec greater than the mean in each condition for each subject. Results using these three measures all led to the same conclusions; here we report only the results for mean reaction times.

Mean reaction times for each condition are shown in Fig. 2 for the amnesic group and in Fig. 3 for the control group. Across conditions, the overall priming effect was 182 msec for the amnesic group and 152 msec for the control group. Results were submitted to a four-way ANOVA (Priming \times Familiarity \times Response \times Group). Reaction times were faster for *familiar* pairs than for *unfamiliar* pairs [$F(1, 16) = 7.4, p = .015$]. *Familiar* and *unfamiliar* pairs, furthermore, gave rise to opposite *same/different* effects [$F(1, 16) = 7.6, p = .014$]. For *familiar* pairs, reaction times were longer when the response was *different*, whereas for *unfamiliar* pairs, reaction times were longer when the response was *same*. The reversed pattern for *unfamiliar* pairs was unexpected, but one possible explanation (which is supported by the error results below) is that subjects found decisions with the particular pairs in the *same/unfamiliar* condition exceptionally difficult.

Nonetheless, the overall priming effect was highly significant [$F(1, 16) = 31.0, p < .001$]. Although reaction times were longer in the amnesic group than in the control group [$F(1, 16) = 28.8, p < .001$], the priming effect did not differ across groups [nonsignificant Priming by Group interaction, $F(1, 16) < 1$]. There was a nonsignificant tendency for the priming effect to be larger for *same* pairs than for *different* pairs [$F(1,$

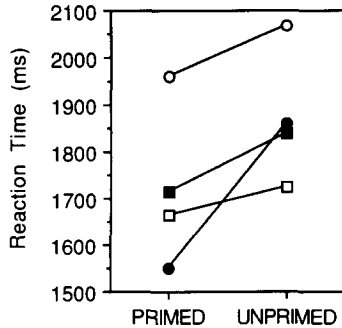


FIG. 2. Mean reaction time in each experimental condition for the amnesic group in Experiment 2. (□) Different/unfamiliar, (○) same/unfamiliar, (■) different/familiar, (●) same/familiar.

16) = 3.8, $p = .068$]. None of the other effects were significant [$F_s < 2.1$], and in particular, all interactions involving Group were nonsignificant [$F_s < 1$], indicating the lack of any other differences between the groups. Furthermore, the priming effect was significant when results from each group were analyzed separately [amnesic group $F(1, 8) = 15.5$, $p = .004$; control group $F(1, 8) = 15.5$, $p = .004$].

The similar magnitude of the priming effects in the two groups can be seen by comparing difference measures for each condition, which are shown in Table 2. The fact that response times were longer in the amnesic group, however, suggests the possibility that the apparent similarity in the magnitude of priming was due to a scaling effect. In other words, a normal priming effect for a 2-sec reaction time might be larger than a normal priming effect for a 1-sec reaction time. One way to allow for a possible scaling effect is to compute proportional measures of priming,

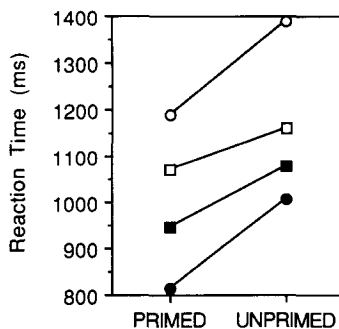


FIG. 3. Mean reaction time in each experimental condition for the control group in Experiment 2. (□) Different/unfamiliar, (○) same/unfamiliar, (■) different/familiar, (●) same/familiar.

TABLE 2
PRIMING EFFECTS FOR EACH EXPERIMENTAL CONDITION IN EXPERIMENT 2

	Familiar		Unfamiliar	
	Same	Different	Same	Different
Amnesic group				
Difference measure ^a	311	126	106	62
(SE)	(88)	(98)	(110)	(111)
Proportional measure	.18	.09	.06	.05
(SE)	(.05)	(.06)	(.05)	(.06)
Control group				
Difference measure ^a	190	129	198	91
(SE)	(39)	(39)	(116)	(59)
Proportional measure	.21	.12	.11	.08
(SE)	(.04)	(.04)	(.05)	(.04)

^a In milliseconds.

as shown in Table 2. These measures represent priming as a proportion of the overall mean reaction time. Although the proportional measure tended to be smaller for the amnesic group than for the control group, these differences were nonsignificant in a Familiarity by Response by Group ANOVA [Group main effect $F(1, 16) = 1.8$, interactions involving Group $F_s < 1$, F values to one decimal place unchanged by arcsine transformations]. Given the problem of possible scaling effects, the apparently normal priming effects in amnesic patients must be interpreted with caution. It should be noted, though, that the proportional measures of priming in the amnesic group were also quite similar in magnitude to those found in young subjects in Experiment 1.

For the error analysis, the percentage of responses that were incorrect was analyzed with a four-way ANOVA (Priming \times Familiarity \times Response \times Group). For *familiar* faces, 6.4% of the trials were incorrect, whereas 9.7% of the trials with *unfamiliar* faces were incorrect [$F(1, 16) = 8.3$, $p = .011$]. Also, there were more incorrect responses with *same* pairs than *different* pairs (10.0% vs. 6.1%, respectively [$F(1, 16) = 9.4$, $p = .007$]). There was also a significant Familiarity by Response interaction, however, as twice as many errors were made in the *same/unfamiliar* condition (13.1%) than in the *same/familiar*, *different/unfamiliar*, or *different/familiar* conditions (6.9, 6.4, and 5.8%, respectively [$F(1, 16) = 6.9$, $p = .019$, and a Scheffé test]). Finally, the error rate was greater in the amnesic group than in the control group (13.2% vs. 2.9%, [$F(1, 16) = 8.8$, $p = .009$]), but none of the other effects were statistically significant [$F_s < 3.1$].

GENERAL DISCUSSION

The results from Experiments 1 and 2 demonstrated a facilitation in the speed of the identity-matching response when identical photographs were repeated after a mean delay of about 10 min. The magnitude of this priming effect did not differ as a function of the objective familiarity of the face pairs. Furthermore, the reaction-time facilitation for repeated faces that was exhibited in a group of amnesic patients appeared normal when compared to that exhibited in a group of age- and IQ-matched control subjects. Assessing the size of these priming effects was complicated by the fact that reaction times were longer in the amnesic group than in the control group—a finding previously reported with other tests (Meudell, Mayes, & Neary, 1980; Moscovitch et al., 1986). Nevertheless, the absolute magnitude of the priming effect as well as a proportional measure of the priming effect did not differ significantly between the amnesic and control groups.

The finding of normal priming effects contrasts sharply with the severe memory impairments previously demonstrated by these patients. Unfortunately, the design of the experiment did not allow for recognition to be systematically tested along with priming. It is nevertheless highly likely that repeated faces would not be recognized as well by the amnesic patients as by the control subjects. Since the Warrington recognition memory test for faces used a retention delay and facial stimuli that were comparable to those in the identity-matching task, the significant impairment exhibited by the amnesic group in this test substantiates the patients' deficient abilities to recollect previously viewed faces.

Whereas many different tests have been used to study priming in amnesia, a serious problem for this approach is that indirect measures of retention are sometimes influenced by the conscious retrieval of studied items. In stem- or fragment-completion priming, for example, the contribution of conscious retrieval to observed priming effects can be difficult to assess. The identity-matching task used here has several advantages in this regard. First, retention is measured indirectly and subjects do not necessarily attempt to consciously remember previously viewed faces. In addition, the requirement for a speeded response may work against any mediation by conscious retrieval, due to time pressure. The fact that similar reaction-time facilitations were exhibited by amnesic and control subjects is consistent with the idea that conscious retrieval was not critical for the priming effect. On the other hand, it is always possible that the priming effect in amnesics does not reflect the same process as the priming effect in normal subjects. Therefore, some influence of conscious retrieval on performance in this task is difficult to rule out with certainty.

Another advantage of the identity-matching task is that it allowed prim-

ing to be examined as a function of prior experience with the material. Importantly, *familiar* and *unfamiliar* face pairs did not differ in terms of the type of task responses made (*same* and *different* decisions). Still, both normal and amnesic subjects showed faster reaction times to faces of famous people due to preexperimental familiarity with these faces (i.e., because structural representations of these faces were already established, see Bruce & Young, 1986). This familiarity effect was apparently not influenced by any retrograde memory impairments in the amnesic group.

The fact that identical task responses were required during the training and testing phases, however, gives rise to a possible disadvantage of the identity-matching test. Namely, the priming effect could reflect a facilitation of the decision-making processes for particular faces rather than memory for the faces themselves. However, a previous experiment showed that comparable priming effects were produced when a gender-decision task rather than an identity-matching task was used in the training phase (Roberts, 1988), suggesting that the reaction-time facilitation did not depend on repeating the identical decisions.

The finding that repetition priming occurred with unfamiliar as well as familiar faces suggests that either (a) preexisting representations were not critical for the repetition priming effects elicited or (b) priming with unfamiliar faces differs from priming with familiar faces. The idea that the priming mechanisms might be fundamentally different is consistent with evidence that familiar and unfamiliar faces are processed in different ways (e.g., Ellis, Shepherd, & Davies, 1979; Klatzky & Forrest, 1984; Warrington & James, 1967). On the other hand, it is conceivable that priming with unfamiliar faces simply involves an additional process: forming a new representation for each new face. The term *priming* itself entails the notion that an internal representation is "primed" or activated when the corresponding stimulus is encountered. This activation view requires that a representation exist, either from prior learning, from new learning, or perhaps from the existing organization of the perceptual system. The activation view can be contrasted with other views, such as Jacoby's (1983) hypothesis that priming effects are mediated through episodic memories rather than through abstract representations, in which case preexisting representations need not be considered critical for priming (see also Jacoby and Kelley, 1991; Ratcliff & McKoon, 1988; Roediger, Weldon, & Challis, 1989). In any case, it can reasonably be argued that the priming effects with unfamiliar faces must have involved new learning of some sort.

The finding that amnesic patients exhibited normal priming effects with unfamiliar faces has important theoretical implications pertaining to amnesia. Many viable hypotheses about the nature of the functional deficit of amnesia are currently under active debate (reviewed in more detail by Mayes, Paller, & Downes, 1992). Among these various theoretical views, three are noteworthy: (a) amnesia reflects a disconnection such that episodic memories cannot reach awareness (Schacter, 1989, 1990); (b) am-

nesia reflects a fundamental impairment in a consolidation process that is necessary for recalling and recognizing factual and episodic information, but not for other types of memory (e.g., Milner, 1965; Squire, Cohen, & Nadel, 1984; Wicklegren, 1979); and (c) amnesia reflects a primary difficulty processing or storing contextual information (e.g., Huppert & Piercy, 1976; Mayes, Meudell, & Pickering, 1985). Priming of novel information would be impaired in amnesia according to the consolidation view but intact in amnesia according to the context view or the disconnection view. Demonstrations that novel-information priming can be normal in patients with severe memory dysfunctions, such as in Experiment 2, thus lend support to the context and disconnection views. Further progress in this area will necessarily rely on evidence from many types of priming paradigms, and in this way converging evidence may mitigate against the limitations of individual paradigms. The present evidence suggests that patients with amnesia may be able to learn some new information when retention is tested in an appropriate way. It will thus be important in future research to determine the key differences between tests that do and do not reveal new-information priming in amnesia.

REFERENCES

- Bruce, V., & Valentine, T. 1985. Identity priming in the recognition of familiar faces. *British Journal of Psychology*, **76**, 373–383.
- Bruce, V., & Young, A. W. 1986. Understanding face recognition. *British Journal of Psychology*, **77**, 305–327.
- Brunas, J., Young, A. W., & Ellis, A. W. 1990. Repetition priming from incomplete faces: Evidence for part to whole completion. *British Journal of Psychology*, **81**, 43–56.
- Cermak, L. S., Blackford, S. P., O'Connor, M., & Bleich, R. P. 1988. The implicit memory ability of a patient with amnesia due to encephalitis. *Brain and Cognition*, **7**, 312–323.
- Cermak, L. S., Bleich, R. P., & Blackford, S. P. 1988. Deficits in the implicit retention of new associations by alcoholic Korsakoff patients. *Brain and Cognition*, **7**, 145–156.
- Cermak, L. S., Talbot, N., Chandler, K., & Wolbarst, L. R. 1985. The perceptual priming phenomenon in amnesia. *Neuropsychologia*, **23**, 615–622.
- Diamond, R., & Rozin, P. 1984. Activation of existing memories in anterograde amnesia. *Journal of Abnormal Psychology*, **93**, 98–105.
- Ellis, H. D., Shepherd, J. W., & Davies, G. M. 1979. Identification of familiar and unfamiliar faces from internal and external features: Some implications for theories of face recognition. *Perception*, **8**, 431–439.
- Ellis, A. W., Young, A. W., & Flude, B. M. 1990. Repetition priming and face processing: Priming occurs with the system that responds to the identity of a face. *The Quarterly Journal of Experimental Psychology*, **42A**, 495–512.
- Ellis, A. W., Young, A. W., Flude, B. M., & Hay, D. C. 1987. Repetition priming of face recognition. *The Quarterly Journal of Experimental Psychology*, **39A**, 193–210.
- Gabrieli, J. D. E., Milberg, W., Keane, M. M., & Corkin, S. 1990. Intact priming of patterns despite impaired memory. *Neuropsychologia*, **28**, 417–427.
- Gooding, P., & Mayes, A. R. 1991. Novel-information priming for abstract patterns in a group of amnesic patients and their matched controls. Manuscript in preparation.
- Gordon, B. 1988. Preserved learning of novel information in amnesia: Evidence for multiple memory systems. *Brain and Cognition*, **7**, 257–282.

- Graf, P., & Mandler, G. 1984. Activation makes words more accessible, but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behavior*, **23**, 553–568.
- Graf, P., & Schacter, D. L. 1985. Implicit and explicit memory for new associations in normal and amnesic patients. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **11**, 501–518.
- Graf, P., Squire, L. R., & Mandler, G. 1984. The information that amnesic patients do not forget. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **10**, 164–178.
- Huppert, F. A., & Piercy, M. 1976. Recognition memory in amnesic patients: Effect of temporal context and familiarity of material. *Cortex*, **4**, 3–20.
- Jacoby, L. L. 1983. Perceptual enhancement: Persistent effects of an experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **9**, 21–28.
- Jacoby, L. L., & Kelley, C. 1991. Unconscious influences of memory: Dissociations and automaticity. In A. D. Milner and M. D. Rugg (Eds.), *The neuropsychology of consciousness*. New York: Academic Press. In press.
- Jacoby, L. L., & Witherspoon, D. 1982. Remembering without awareness. *Canadian Journal of Psychology*, **32**, 300–324.
- Johnson, M. K., Kim, J. K., & Risse, G. 1985. Do alcoholic Korsakoff's syndrome patients acquire affective reactions? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **11**, 22–26.
- Klatzky, R. L., & Forrest, F. H. 1984. Recognizing familiar and unfamiliar faces. *Memory and Cognition*, **12**, 66–70.
- Mayes, A. R., & Gooding, P. 1989. Enhancement of word completion priming in amnesics by cueing with previously novel associates. *Neuropsychologia*, **27**, 1057–1072.
- Mayes, A. R., Meudell, P. R., & Pickering, A. 1985. Is organic amnesia caused by a selective deficit in remembering contextual information. *Cortex*, **21**, 167–202.
- Mayes, A. R., Paller, K. A., & Downes, J. 1992. An assessment of theories of human organic amnesia. Manuscript in preparation.
- McAndrews, M. P., Glisky, E. L., & Schacter, D. L. 1987. When priming persists: Long-lasting implicit memory for a single episode. *Neuropsychologia*, **25**, 497–506.
- McKoon, G., & Ratcliff, R. 1979. Priming in episodic and semantic memory. *Journal of Verbal Learning and Verbal Behavior*, **18**, 463–480.
- Meudell, P. R., Mayes, A. R., & Neary, D. 1980. Amnesia is not caused by cognitive slowness. *Cortex*, **16**, 413–420.
- Milner, B. 1965. Memory disturbance after bilateral hippocampal lesions. In P. M. Milner and S. E. Glickman (Eds.), *Cognitive processes and the brain*. Princeton, NJ: Van Nostrand. Pp. 97–111.
- Morton, J. 1969. The interaction of information in word recognition. *Psychological Review*, **76**, 165–178.
- Moscovitch, M. 1985. Memory from infancy to old age: Implications for theories of normal and pathological memory. *Annals of the New York Academy of Sciences*, **444**, 78–96.
- Moscovitch, M., Winocur, G., & McLachlan, D. 1986. Memory as assessed by recognition and reading time in normal and memory-impaired people. *Journal of Experimental Psychology: General*, **115**, 331–347.
- Musen, G., & Squire, L. R. 1991. Normal acquisition of novel verbal information in amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, in press.
- Paller, K. A., & Mayes, A. R. 1992. New-association priming of word identification in normal and amnesic subjects. Submitted for publication.
- Ratcliff, R., & McKoon, G. 1988. A retrieval theory of priming in memory. *Psychological Review*, **39**, 475–543.
- Richardson-Klavehn, A., & Bjork, R. A. 1988. Measures of memory. *Annual Review of Psychology*, **39**, 475–543.

- Roberts, J. 1988. *A new method for testing implicit memory in normal and amnesic subjects*. Unpublished M.Sc. thesis, University of Lancaster.
- Roediger, H. L., Weldon, M. S., & Challis, B. H. 1989. Explaining dissociations between implicit and explicit measures of retention: A processing account. In H. L. Roediger III and F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving*. Hillsdale, NJ: Erlbaum. Pp. 3–41.
- Rozin, P. 1976. The psychobiological approach to human memory. In M. R. Rosenzweig and E. L. Bennett (Eds.), *Neural mechanisms of learning and memory*. Cambridge, MA: MIT Press. Pp. 1–46.
- Schacter, D. L. 1987. Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **13**, 501–518.
- Schacter, D. L. 1989. On the relation between memory and consciousness: Dissociable interactions and conscious experience. In H. L. Roediger III and F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving*. Hillsdale, NJ: Erlbaum. Pp. 355–389.
- Schacter, D. L. 1990. Toward a cognitive neuropsychology of awareness: Implicit knowledge and anosognosia. *Journal of Clinical and Experimental Neuropsychology*, **12**, 155–178.
- Schacter, D. L., Cooper, L. A., Tharan, M., & Rubens, A. B. 1991. Preserved priming of novel objects in patients with memory disorders. *Journal of Cognitive Neuroscience*, **3**, 118–131.
- Schacter, D. L., & Graf, P. 1986. Preserved learning in amnesic patients: Perspectives from research on direct priming. *Journal of Clinical and Experimental Neuropsychology*, **8**, 727–743.
- Shimamura, A. P. 1986. Priming effects in amnesia: Evidence for a dissociable memory function. *Quarterly Journal of Experimental Psychology*, **38A**, 619–644.
- Shimamura, A. P., & Squire, L. R. 1984. Paired-associate learning and priming effects in amnesia: A neuropsychological study. *Journal of Experimental Psychology: General*, **113**, 556–570.
- Shimamura, A. P., & Squire, L. R. 1989. Impaired priming of new associations in amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **14**, 763–769.
- Smith, M. E., & Oscar-Berman, M. 1990. Activation and the repetition priming of words and pseudowords in normal memory and amnesia. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **16**, 1033–1042.
- Squire, L. R. 1986. Mechanisms of memory. *Science*, **232**, 1612–1619.
- Squire, L. R., Cohen, N. J., & Nadel, L. 1984. The medial temporal region and memory consolidation: A new hypothesis. In H. Weingartner and E. S. Parker (Eds.), *Memory consolidation: Psychobiology of cognition*. Hillsdale, NJ: Erlbaum. Pp. 185–210.
- Tulving, E., & Schacter, D. L. 1990. Priming and human memory systems. *Science*, **247**, 301–306.
- Warrington, E. K. 1984. *Recognition memory test*. Windsor, UK: NFER-Nelson.
- Warrington, E. K., & James, M. 1967. An experimental investigation of facial recognition in patients with unilateral cerebral lesions. *Cortex*, **3**, 317–326.
- Wickelgren, W. A. 1979. Chunking and consolidation: A theoretical synthesis of semantic networks, configuring in conditioning, S–R versus cognitive learning, normal forgetting, the amnesic syndrome, and the hippocampal arousal system. *Psychological Review*, **86**, 44–60.
- Young, A. W., Hay, D. C., McWeeny, K. H., Flude, B. M., & Ellis, A. W. 1985. Matching familiar and unfamiliar faces on internal and external features. *Perception*, **14**, 737–746.
- Young, A. W., McWeeny, K. H., Hay, D. C., & Ellis, A. W. 1986. Matching familiar and unfamiliar faces on identity and expression. *Psychological Research*, **48**, 63–68.