Published in final edited form as:

Neuropsychologia. 2006 ; 44(5): 834–839.

Increasing the salience of fluency cues reduces the recognition memory impairment in amnesia

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Abstract

The present study examined whether the recognition memory deficit in amnesia would be attenuated under conditions that increased the salience of study-induced fluency. Studied and unstudied items were drawn either from separate pools of letters (no-overlap condition) or from the same pool of letters (overlap condition). Study-induced fluency was more salient in the no-overlap than in the overlap condition, because in the no-overlap condition, such fluency occurred at the letter level as well as at the word level. The recognition memory impairment in amnesia was smaller in the no-overlap than in the overlap condition. These findings are consistent with the idea that enhancing the salience of fluency cues promotes reliance on a fluency heuristic that ordinarily is not fully engaged in amnesia, and reduces the recognition memory impairment in amnesia.

Keywords

Memory; Familiarity; Recollection

Memory for a past experience can be based on recollection of specific details from the experience or on a sense of familiarity that accompanies re-exposure to information from that episode. For example, we might recognize a passerby as an acquaintance either because we recollect specific details from an earlier meeting (time, place, conversation, etc.), or because we recognize the face as familiar. Analogously, in a laboratory test of memory, we might judge that we have seen a particular word on an earlier list either because we recollect the specific associations that we had upon seeing the word before, or because the ease (fluency) with which we are able to process the word confers a sense of familiarity that we attribute to the prior encounter. These two bases for remembering have been formalized in dual-process models of memory that draw a distinction between the processes underlying recollection and familiarity (e.g., Jacoby & Dallas, 1981; Mandler, 1980). In recent years, it has been suggested that such models may provide a useful framework for understanding patterns of memory performance in amnesic patients.

Amnesia is characterized by impaired memory for recent events and experiences, and such deficits are measurable in explicit memory tasks of recall and recognition. Although a number of studies have found that amnesic patients show equivalent impairments in recall and recognition tasks (Haist, Shimamura, & Squire, 1992; Kopelman & Stanhope, 1998; MacAndrew, Jones, & Mayes, 1994; Manns, Hopkins, Reed, Kitchener, & Squire, 2003), others have reported that the impairment in amnesia is less severe in recognition than in recall tasks (Bastin et al., 2004; Giovanello & Verfaellie, 2001; Hirst, Johnson, Phelps, & Volpe,

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1988; Hirst et al., 1986; Yonelinas et al., 2002). Moreover, some researchers have reported that recognition memory may be entirely spared in amnesic patients with circumscribed hippocampal lesions (Aggleton & Shaw, 1996; Aggleton et al., in press; Mayes, Holdstock, Isaac, Hunkin, & Roberts, 2002; Vargha-Khadem et al., 1997; see also Barbeau, Felician, Joubert, Sontheimer, Ceccaldi, & Poncet, 2005), although this is not always the case (Manns & Squire, 1999; Manns et al., 2003; Reed & Squire, 1997).

Although the status of the relative recall/recognition impairment in amnesia is a matter of continuing debate (e.g., see Wixted & Squire, 2004a, 2004b; Yonelinas et al., 2004), studies showing a relative sparing of recognition memory in amnesia are typically interpreted with reference to the processes underlying performance on these tasks: recognition performance may be supported either by recollection or by familiarity, whereas recall performance depends largely or exclusively upon recollection. Amnesia may reflect a relatively greater deficit in recollection than in familiarity, resulting in disproportionate impairments in recall relative to recognition. Indeed, in a comprehensive review of studies that evaluated recollection and familiarity in wide range of amnesic patients, Yonelinas, Kroll, Dobbins, Lazzara, and Knight (1998) concluded that although both processes are typically compromised in amnesia, the deficit in familiarity is less severe than that in recollection.

In dual-process models of memory (Yonelinas, 2002), familiarity in recognition tasks is thought to reflect fluent processing of an item that is attributed to recent exposure to that item. According to some views, the processing fluency that gives rise to familiarity judgments in recognition memory tasks is the same mechanism that mediates priming in implicit memory tasks (e.g., Jacoby & Dallas, 1981; Johnston, Hawley, & Elliott, 1991). By this view, given that priming effects are largely spared in amnesia (for review see Verfaellie & Keane, 2001), it is unclear why fluency does not more fully support familiarity-based recognition memory in amnesia. Indeed, it has been argued that demonstrations of intact priming effects coupled with at-chance recognition memory performance in some amnesic patients constitute powerful counterevidence to the view that priming and recognition familiarity share a common basis (Hamann & Squire, 1997; Levy, Stark, & Squire, 2004).

Another way to think about the findings in amnesia, however, is to consider the fact that priming effects are a direct (unmediated) consequence of fluent processing (i.e., performance is simply faster or more accurate as a result of the fluency conferred by recent exposure to task stimuli), whereas familiarity-based recognition responses require an additional step wherein the participant attributes fluent processing to a memorial source (see Aggleton & Brown, 1999 for a similar suggestion). Thus, upon finding that a word is particularly easy to read (e.g., it “jumps out” from the page; Jacoby & Dallas, 1981), one may attribute that ease of processing to a recent encounter with the word in a study list. Under ordinary circumstances, amnesic individuals may not engage in that attributional process as readily as do control participants. Prior work in our laboratory has shown that task instructions that are designed to encourage such attributions can reduce the memory impairment in amnesia (Verfaellie, Giovanello, & Keane, 2001). In the present study, we examined whether an increase in the salience of fluency cues would also lead to a reduction in the recognition memory deficit in amnesia.

In normal participants, reliance on fluency in recognition memory tasks may be enhanced by increasing the availability and salience of fluency cues. Such cues may or may not be accurate markers of the studied/unstudied status of a test item. When they are inaccurate, these cues may engender a false sense of familiarity for unstudied items with a concurrent increase in false alarms (e.g., Diana, Peterson, & Reder, 2004; Jacoby & Whitehouse, 1989). However, when salient perceptual cues do serve as accurate markers of the studied/unstudied status of an item, accuracy in recognition memory may be enhanced.

For example, in a study by Parkin et al. (2001), studied and unstudied items were drawn either from separate pools of letters (no-overlap condition) or from the same pool of letters (overlap condition). In the no-overlap condition, prior study engenders letter-level fluency unique to studied items, whereas in the overlap condition, the study-induced letter-level fluency is equally present for studied and for unstudied items (and therefore does not distinguish the two classes of items from each other). Thus, the fluency “contrast” between studied and unstudied items is greater in the no-overlap condition (in which study-induced fluency differences occur both at the letter level and at the word level) than in the overlap condition (in which study-induced fluency differences occur only at the word level). Parkin et al. (2001) found that recognition memory performance was better in the no-overlap than in the overlap condition, and that this effect was more pronounced in older than in younger participants. They attributed the latter finding to an age-related increase in reliance on familiarity in making recognition memory judgments. Importantly in the context of the present study, Parkin et al. demonstrated that control participants were unaware of the overlap manipulation (i.e., they could not articulate in what way studied and unstudied words differed in the no-overlap condition), suggesting that its effect on recognition performance was not due to a recollection-like strategy in which participants noticed and recalled the constituent letters of studied items in the no-overlap condition and made their recognition judgments accordingly. Instead, it appears that the effect of the overlap manipulation on recognition performance occurred at the level of fluency.

It has been shown that amnesic patients, like control participants, can be induced to rely on fluency cues when such cues are made salient by presenting test words through a gradually clearing mask, so that ease of identification (fluency) is apparent to subjects (Conroy, Hopkins, & Squire, 2005; Verfaellie & Cermak, 1999). However, because the unmasking test condition in those studies was not compared to a standard recognition memory test condition (in which item fluency would be less salient), it is unclear whether recognition memory accuracy in amnesia was enhanced by the unmasking procedure. Further, Verfaellie and Cermak (1999) noted that in this paradigm, “the influence of natural variations in fluency far overpowered the effects of study-induced fluency” so that perceptual fluency did not provide an effective means to distinguish studied from unstudied items. Verfaellie and Cermak (1999) suggested that the unmasking procedure itself may have contributed to the salience of natural variations in fluency, and therefore may have contributed to the reduced usefulness of fluency cues.

In the present study, we examined whether recognition memory accuracy in amnesia would be enhanced under a condition in which the salience of fluency cues was high, compared to a condition in which it was low. Our paradigm was modeled on that of Parkin et al. (2001) described above, and included one condition in which the constituent letters for studied and unstudied items were distinct (no-overlap condition) and another condition in which the constituent letters for studied and unstudied items were the same (overlap condition). We hypothesized that the increased salience of the fluency cues in the no-overlap condition (resulting from the enhanced fluency contrast between studied and unstudied items in that condition), would lead to increased reliance on familiarity-based responding, particularly in the amnesic group, and would be associated with a corresponding enhancement in recognition memory performance. Importantly, the overlap manipulation not only affects the salience of the fluency cues, but unlike the unmasking procedure used by Verfaellie and Cermak (1999) and Conroy et al. (2005), it does so by increasing the fluency contrast between studied and unstudied items, increasing the likelihood that study-induced fluency changes will be greater than natural variations in fluency. Such conditions may increase the likelihood that fluency will contribute to accurate recognition memory judgments.

1. Method

1.1. Participants

The amnesic group consisted of 12 participants (9 men, 3 women) with presumed medial temporal-lobe damage resulting from anoxia ($n = 9$) or encephalitis ($n = 3$). The mean age of the amnesic group was 49.6 and the mean education level was 14.6 years. On the Wechsler Adult Intelligence Scale-III (WAIS-III), this group had a mean verbal IQ of 103.7. These participants had normal working memory, as indicated by a mean working memory index of 95.3 on the Wechsler Memory Scale-III (WMS-III), but impaired long-term memory as indicated by a mean WMS-III general memory index of 54.3, a visual delay index of 60, and an auditory delay index of 59.4.

The control group consisted of 12 healthy participants (1 man, 11 women) who were in good health and had no history of psychiatric illness. They had a mean age of 52.6 years, a mean education level of 14.8 years, and a mean WAIS-III Verbal IQ of 103.5. The control and amnesic groups did not differ significantly in age, education, or verbal IQ (all t 's < 1).

Written informed consent was obtained from all participants, and the experimental procedures were approved by the Institutional Review Boards of the Boston University School of Medicine and the Boston Veterans Affairs Healthcare System.

1.2. Materials

The materials for the current experiment were taken from Parkin et al. (2001). The stimuli consisted of two 25 word lists in the no-overlap condition, and two 25 word lists in the overlap condition. In the no-overlap condition, one list consisted of words made up of 13 letters of the alphabet (a, e, y, b, d, g, j, l, n, r, t, w, z) and the other consisted of words made up of the remaining 13 letters of the alphabet (i, o, u, c, f, h, k, m, p, q, s, v, x). In the overlap condition, the words in both lists were drawn from the entire alphabet. The mean frequency (Francis & Kucera, 1982) of the words in the overlap condition (52.8, S.D. = 121.0) did not differ from that of the words in the no-overlap condition (93.6, S.D. = 233.8), $p > .25$.

1.3. Design

The experiment consisted of a 2×2 mixed factorial design with a between group factor of group (amnesic versus control), and a within-group factor of overlap condition (overlap versus no-overlap).

1.4. Procedure

The overlap and no-overlap conditions were administered in two sessions separated by at least 1 week. The order of conditions was counterbalanced across participants. Each session consisted of a study and test phase.

In the study phase, 25 words appeared one at a time on a computer screen, and participants were asked to read the words aloud in preparation for an unspecified memory test. Each word was displayed for 1000 ms with an interstimulus interval of 1500 ms. There was a 4 min unfilled break between the study and test phases.

In the test phase, 50 words (25 studied and 25 unstudied) appeared one at a time on the computer screen, and participants were asked to indicate (yes/no) whether they had seen the word in the prior study phase. Across participants, stimuli were counterbalanced across studied and unstudied conditions. In the overlap condition, studied and unstudied words were drawn from the same letter pool, and the in no-overlap condition they were drawn from separate letter pools.

2. Results

Table 1 shows the mean proportion of studied and unstudied items endorsed by amnesic and control participants in the overlap and no-overlap conditions, and the corrected hit rate (hits minus false alarms) in the two groups in each condition. For hits, a 2-way analysis of variance (ANOVA) with factors of group and overlap shows that the hit rate was higher in the control group (.79) than in the amnesic group (.66), $F(1, 22) = 4.68, p < .05$, but was unaffected by overlap condition, $p > .50$. The interaction between group and overlap condition shows a trend toward significance, $F(1, 22) = 3.07, p = .09$, reflecting the fact that the hit rate was numerically higher in the no-overlap than the overlap condition in the amnesic group, and shows the reverse pattern in the control group. However, in neither group was the hit rate significantly different in the overlap and no-overlap conditions (p 's $> .20$). For false alarms, a 2-way ANOVA shows that the false alarm rate was higher in the amnesic group (.21) than in the control group (.06), $F(1, 22) = 14.20, p < .01$, and higher in the overlap condition (.16) than in the no-overlap condition (.11), $F(1, 22) = 6.16, p < .05$. The interaction between group and overlap was not significant, $p > .40$. The critical findings concerned the corrected hit rates (hits minus false alarms). A 2-way ANOVA of corrected hit rates shows that performance was impaired in the amnesic group (.44 versus .73 in the amnesic and control groups, respectively), $F(1, 22) = 29.50, p < .001$, and was better in the no-overlap condition (.61) than in the overlap condition (.56), $F(1, 22) = 4.28, p = .05$. There was an interaction between group and overlap condition, $F(1, 22) = 4.28, p = .05$. Planned contrasts indicated that, whereas control participants performed similarly in the overlap and no-overlap conditions ($p > .50$), amnesic patients performed better in the no-overlap than in the overlap condition ($p < .01$).

An analysis of recognition memory accuracy using A' as an estimate of sensitivity led to similar conclusions. A 2-way ANOVA with factors of group and overlap indicated that performance was higher in the control group (.91) than in the amnesic group (.80), $F(1, 22) = 31.1, p < .001$, and was higher in the no-overlap (.87) than in the overlap (.85) condition, $F(1, 22) = 6.3, p < .05$. The interaction between group and overlap was significant, $F(1, 22) = 6.2, p < .05$. Planned contrasts indicated that control participants performed similarly in the overlap and no-overlap conditions (.92 in both conditions, $p > .50$), but amnesic patients performed better in the no-overlap than in the overlap condition (.83 versus .78, $p < .01$).

3. Discussion

In the present study, an increase in the salience of fluency cues—induced by eliminating letter-level overlap between studied and unstudied words—reduced the recognition memory impairment in amnesia. The enhanced salience of study-induced fluency in the no-overlap condition (due to the increased fluency contrast between studied and unstudied words in that condition compared to the overlap condition) may have increased the likelihood that amnesic patients would use such fluency as the basis for recognition memory judgments, leading to an improvement in recognition memory accuracy.

In the control group, recognition memory accuracy was unaffected by the overlap manipulation. The differential effect of the overlap manipulation in the control and amnesic groups in the present study is reminiscent of a finding in young and elderly participants from Parkin et al. (2001). Parkin et al. suggested that the increased susceptibility of older compared to younger participants to the overlap manipulation was tied to age-related changes in the relative contributions of recollection and fluency-based processing to recognition memory: whereas younger participants may rely largely on recollection, older participants (in whom recollection is compromised) may rely more heavily on fluency-based processes to make recognition memory judgments, and may therefore be more susceptible to manipulations of fluency cues. Likewise, in the present study, the availability of recollection in the control group

may have decreased their reliance on fluency and their sensitivity to a fluency manipulation. Prior studies have provided more direct evidence that control participants are likely to use fluency as a basis for recognition memory only when recollection is unavailable (Johnston et al., 1991; Verfaellie & Cermak, 1999). The unavailability of recollection to amnesic patients (and their disinclination to attribute fluency to a memorial source under ordinary circumstances) may have made them particularly susceptible to a manipulation that enhanced the salience of fluency cues.

Not surprisingly, recognition memory performance was higher in the control group than in the amnesic group. In light of this difference, one might ask whether the two groups would have been similarly affected by the overlap manipulation had they been equated in overall performance, for example by prolonging the study-test delay for the control group or by providing additional study phase exposure for the amnesic group. Prior work in our laboratory (Giovanello & Verfaellie, 2001) suggests that the answer to this question would depend on the method used to equate performance in the two groups: prolonging the study-test delay for the control group may have the effect of equating the processes underlying recognition memory performance in control and amnesic groups (such that both groups rely largely on fluency), whereas allowing additional study phase exposure for the amnesic group may not alter the processing differences underlying performance in the two groups (leaving the control group largely reliant on recollection and the amnesic group largely reliant on fluency). Under the former condition we would expect performance in the control group, like that in the amnesic group, to be higher in the no-overlap than in the overlap condition (reflecting the control group's reliance on fluency and their consequent susceptibility to a manipulation of the salience of the fluency cue). Under the latter condition we would expect the effect of the overlap manipulation to be greater in the amnesic than in the control group, as in the present study.

Consistent with the findings from the present study, Verfaellie et al. (2001) found that, when task instructions promoted reliance on fluency cues, recognition memory performance in amnesic patients was enhanced. In their study, participants were informed during the recognition test phase about the alleged proportion of studied items (30% versus 70%) that would appear in the test list. The actual proportion of studied items in the test phase was constant across conditions. The logic of this manipulation was that, under conditions in which many of the test items had purportedly appeared in the study phase, participants would relax their response criterion and rely to a greater extent on processing fluency (familiarity) as a basis for responding. For control participants, it was expected that this manipulation would induce a criterion shift. For the amnesic participants, by contrast, it was expected that the manipulation would lead to enhanced recognition accuracy because it would promote fluency attributions that amnesic patients are ordinarily unwilling to make. The contribution of recollection and familiarity to performance was evaluated by collecting remember/know judgments following each recognition decision (Gardiner & Parkin, 1990). As predicted, the overall endorsement rate (for studied and unstudied items) in the control group was greater in the 70% than in the 30% baserate condition. Importantly, amnesic patients (but not control participants) showed enhanced memory accuracy in the 70% baserate condition compared to the 30% condition.

Not every attempt to increase amnesic patients' reliance on fluency, however, leads to enhanced recognition memory performance. For example, Stark and Squire (2000) employed a speeded forced-choice recognition memory task to encourage participants to make quick familiarity-based recognition judgments, and found that the performance of amnesic patients did not exceed chance. Further, two studies that used a criterion manipulation to vary reliance on familiarity (explicitly instructing participants to use either a strict or a liberal familiarity-based criterion for recognition judgments) found no effect on the recognition accuracy of amnesic patients (Reber & Squire, 1999; Verfaellie et al., 2001). Further study will be needed to clarify

the conditions necessary to promote amnesic patients' use of a fluency heuristic in recognition memory tasks.

In summary, the results of the present study suggest that the deficit in recognition memory in amnesia may be somewhat attenuated when the salience of fluency cues promotes reliance on a fluency heuristic that ordinarily is not fully engaged in amnesia. The failure of amnesic patients under ordinary conditions to make more effective use of a fluency heuristic may be due to an awareness of the memory impairment and a concomitant reluctance to attribute fluency to a memorial source. It remains to be seen whether other sorts of processing manipulations that affect the availability of fluency cues in normal cognition [e.g., manipulations that promote non-analytic versus analytic processing of to be remembered stimuli, Whittlesea & Price, 2001] will modulate the recognition memory impairment in amnesia.

Acknowledgements

This work was supported by grants MH57681 and MH70830, and by the Medical Research Service of the United States Department of Veterans Affairs. We are grateful to Katie Page for research assistance.

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Table 1

Mean proportion hits, false alarms (FA), and corrected recognition (Hits-FA) (standard deviation in parentheses)

	Group	
	Control	Amnesic
Overlap		
Hits	.80 (.13)	.64 (.20)
FA	.07 (.08)	.24 (.14)
Hits-FA	.73 (.11)	.40 (.16)
No-overlap		
Hits	.77 (.13)	.67 (.17)
FA	.04 (.06)	.18 (.14)
Hits-FA	.73 (.14)	.49 (.15)