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Unconscious influences on amnesics' word-stem completion

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Abstract—Amnesic patients and control subjects were asked to complete three-letter word-stems under one of three retrieval conditions. In a direct condition, they were told to use the stems as retrieval cues for words that had just been presented in a study list. In an indirect condition, they were told to use the first word that came to mind with no reference made to the study list. Finally, in an oppositional condition, they were told to use the first word that came to mind unless it had appeared on the study list. During the study list presentation, the patients and controls had analyzed each word according to either semantic (associating to each word) or graphemic (counting letters with enclosed spaces) instructions. The results revealed that the control subjects produced a different number of study words during retrieval as a function of retrieval instructions and encoding condition. The amnesics, however, did not vary their performance as a function of retrieval instructions. Under all conditions, they completed the word-stems far more frequently with words from the study list than would be expected by chance and they consistently produced more semantic than graphemic responses. We concluded that semantic analysis might affect the fluency with which an item occurs for the amnesic, but that the item itself remains independent of the source of that fluency for these patients. Thus, the level of analysis performed on a word during study can affect the unconscious performance of amnesic patients but is unavailable for use during conscious retrieval.

Key Words: amnesia; implicit memory; fluency.

Introduction

Utilizing the method of opposition developed by Jacoby *et al.* [12], we have previously demonstrated that amnesics use considerably more study list items to complete word-stems than do controls when told specifically not to use these previously presented words during word-stem completion [6]. In fact, when amnesic patients were told to complete the word-stems with any word except those that had been on the target list, they continued to use these study list items just as frequently as they did during the standard inclusion condition of the word-stem completion task. Normal controls, on the other hand, had the ability to withhold the words that had appeared on the prior study list when they were told that those words could not be used in the word-stem completion task.

Jacoby [10, 11] has theorized that performance on the standard 'inclusion' condition of the word-stem completion task reflects both conscious and unconscious influences operating in the same direction. He points out that a subject's ability to consciously recollect the items on the study list, and the subtle unconscious influences that an item's presentation might have on subsequent presentations of even a portion of that word, both work in the same direction to add to the probability of producing a study word on the word-stem completion task. However, completing a word-stem with a word from the previously presented list following exclusion instructions must solely be a function of the unconscious influences that accompany the appearance of the beginning portion of a specific word. Any conscious recollection, under instructions to exclude study items, would be diametrically opposed to the utilization of study list members. Jacoby reasons that by contrasting inclusion instructions with exclusion instructions, the extent of unconscious influences can be assessed since conscious recollection should produce target list completions only under inclusion instructions while unconscious influences should affect performance on both.

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Because amnesic patients produce the same number of target word-stem completions under each set of instructions, we previously [6] concluded that their performance even on standard word-stem completion tasks is probably dictated by unconscious influences. Since the control subjects produced almost no target items under exclusion instructions, we concluded that they must be able to differentiate the recently presented words from other, perhaps less fluently retrieved, words when performing the word-stem completion task. We reasoned that the control subjects' ability to disregard the unconscious influences generated by recently processed study list items might be a consequence of their ability to perform differential encoding at the time of study. In other words, normal control subjects may have the ability to perform sufficient elaborative encoding at the time that the word is initially presented so that, at the time of word-stem completion, they are able to differentiate the recently presented word from all other words that could be used to complete the word-stem. Amnesic patients, on the other hand, have frequently demonstrated their inability to spontaneously perform such analyses at the time of input [4]; thus, they find themselves more influenced by the unconscious influences generated by the perceptual features of the stem at the time they are asked to complete it.

One way this hypothesis could be investigated would be to provide encoding instructions at the time of word list presentation which could theoretically provide more semantic level differentiation of each word at the time of input [2, 7]. At the time of word-stem completion, the patient might then be able to differentiate the context in which he just saw these same three letters and be able to withhold that inappropriate response in the exclusion condition. Richardson-Klavehn *et al.* [13] have already shown that instructions to analyze the semantic features of words as they are being presented influences the performance of normal subjects on a subsequent word-stem completion task. They reported that when subjects perform graphemic encoding during study list presentation, they have more trouble inhibiting target list words during a word-stem completion task than they do when performing semantic encoding during study. In other words, their performance appears to be more amnesic-like when the level of encoding is minimal than is the case when they perform more elaborative levels of analysis. Richardson-Klavehn *et al.* proposed that items encoded semantically are probably more associated with conscious memory than are items encoded graphemically and that this occurs involuntarily, or automatically, just as a result of the encoding instructions. If such association is truly involuntarily, then it is possible that it could also occur for amnesics, since such automatic processes of encoding would be the most likely form of encoding to occur in amnesia. They, like normals, might be able to inhibit more target list items following semantic analysis than following graphemic analysis on an exclusion word-stem completion task. To assess this possibility, the following task was performed.

Methods

Subjects

Four groups of subjects participated in this experiment. The first group consisted of seven amnesic males, all of whom were alcoholic Korsakoff patients residing at various private care facilities in the greater Boston area. All had histories of chronic alcoholism, were unable to recall day-to-day events, were disoriented to time and place, and had retrograde amnesias of varying degrees. The mean age for this patient group was 65 years, and they had an average education of 10 years. The average WAIS-R VIQ for this group was 93.9, WMS-R Attention score was 93.1, General Memory score was 79, and Delayed Memory score was 56.7. These patients received a full neuropsychological test battery upon admission to the Memory Disorders Research Center and, on this battery, they scored significantly below normal on the Warrington Faces and Words Test, the Rey Auditory Verbal Learning Test, the California Verbal Learning Test and Continuous Visual Memory Test, as well as retrograde memory assessments using the Boston Famous Faces and Events, Crovitz Autobiographical Questionnaire, and the Transient Events Test. They scored at, or above, normal on non-memory neuropsychological tests including, but not limited to, the Boston Naming Test, Boston Diagnostic Aphasia Examination, National Adult Reading Test, Wide Range Achievement Test, Line Orientation, Face Recognition, and Drawing tasks.

The control group for the Korsakoff patients consisted of seven chronic alcoholic men living in private homes in the Boston area. None of these men evidenced any signs of neurological or psychiatric illness. All had abstained from alcohol for at least 4 weeks prior to testing. Their average age was 58 years, and the group had an average education of 12 years. The mean WAIS-R score for this group was 102.3, WMS-R Attention score was 100.7, General Memory score was 109.1, and the Delayed Memory score was 106.4. They were at, or above, average on all the neuropsychological screening tests included in the Memory Disorders Research Center Assessment Battery, described above.

A second amnesic group was comprised of six patients with varying diagnoses, all residing in private homes in the greater Boston area. One subject in this group suffered from anoxia due to a severe asthma attack. Two patients suffered from encephalitis, one of whom has been a subject of several single case studies [3, 5]. This patient has extensive bilateral damage to the medial and anterolateral temporal lobes. An MRI scan of the other patient with encephalitis also showed damage to the medial temporal lobes. Of the three remaining patients in this group, one became amnesic following a bilateral medial thalamic infarction, confirmed by CT imaging. The second underwent surgery for a left hematoma following a head injury and subsequently became amnesic after an episode of status epilepticus. According to MRI scans, this patient showed extensive tissue loss in the area of the left temporal lobe, including all of the anterior hippocampus, amygdala and anterior efferent pathways. The last amnesic patient in this group suffered from a subarachnoid hemorrhage due to a ruptured aneurysm. A CT scan for this patient showed a right internal capsule infarct. The mean age for this group was 47 years, with an average education of 15 years. Their mean WAIS-R score was 102.0, mean WMS-R Attention Score was 106.7, General Memory was 81.2 and Delayed Memory was 58.5. This group was impaired on precisely the same set of subtests as the Korsakoff group on the MDRC neuropsychological assessment battery.

The final group consisted of six normal adults who were matched in terms of age, WAIS-R VIQ, education and socioeconomic background to the non-Korsakoff amnesic group for whom they served as controls. These controls had a mean age of 65.8 years, with an average education of 13.2 years. Their mean WAIS-R VIQ was 107.5. All were living in private homes in the Boston area.

Design and materials

The opposition methodology we used was developed in a series of experiments by Jacoby *et al.* [12] and subsequently by Richardson-Klavehn *et al.* [13]. At test, subjects were presented with three-letter stems corresponding to the first three letters of studied and non-studied target words. There were three test conditions: In an Indirect Condition, subjects were told to complete the stem with the first word that came to mind. In this condition, no mention of the previously studied words was made. In a Direct Condition, subjects were instructed to use the stems as retrieval cues for previously studied items. In an Opposition Condition, subjects were also instructed to complete the stems with the first word that came to mind. However, subjects in this condition were also told that if they had previously studied the word they thought of, they were to use a different word to complete the stem. In addition, we used a depth-of-processing manipulation during the study phase. For each word shown during the study phase, subjects either had to generate a semantic associate (semantic condition) or count enclosed spaces in the letters of the word (graphemic condition).

Each subject received the tests in the same order: indirect, direct, then opposition, with a new set of study lists shown prior to each test. The indirect test was always presented first in order to avoid having subjects use an explicit strategy to produce the stem completions for that test. Then the direct test was given followed by the oppositional in order to avoid confusion for the subjects, since each subject participated in all three conditions.

All words in the study lists were six-letter words from Webster's Third International Dictionary that fulfilled the criteria that their three-letter stem was unique in the set of 180 words and could be completed in at least six different ways. The 180 target words were divided into three lists, each containing 60 words. These words were divided in such a way that the first two letters of each word were unique within the list in which they occurred. Each list was used within each test condition (indirect, direct, or opposition), counterbalanced across subjects.

In order to avoid systematic exclusion of previously encountered items from opposition test responses based on some property common to all the study items, there were 90 filler items shown in addition to the critical items in the study lists. The filler items were distributed evenly across the three lists of critical items. The filler items were adjectives and verbs selected from the dictionary and none of them had the same first three letters as any of the critical items. The filler items ranged in length from four to ten letters, but no six-letter words were included. Had all items in the study lists been six-letter nouns, subjects might have been able to exclude previously encoded items during the opposition test by responding only with adjectives and verbs that were not six letters in length. Including verbs and adjectives of different lengths ensured that subjects would have to rely on memory for specific items to comply with the test instructions.

Within each of the three lists, both critical and filler items were randomly assigned into six subsets, each containing 10 critical items and five filler items. These 15-item subsets formed the 60-item word lists that were presented to subjects. Subjects saw four of the six subsets, with two subsets in the semantic condition and two in the graphemic condition. The semantic and graphemic conditions were alternated during the administration of the four subsets, regardless of which condition was used first, and the four subsets were always presented in the same order. The remaining two subsets were never seen by the subject. The order of critical and filler items within each list was unsystematic, except that the first and last items were always fillers, and there were no consecutive occurrences of fillers. As a control for item effects, all nine possible combinations of the three lists and the six subsets within each list were used in a partially counterbalanced manner across subjects.

The test for each of the three encoding conditions consisted of three-letter stems corresponding to all 40 target words from the encoding phase plus stems corresponding to 20 critical items that had not been previously presented. The list was divided into 10 blocks of six items each. Each block contained two items from each of the three lists. Order within a block was random, subject to the constraint that items from a particular list could not occur more than twice consecutively on the list.

Procedure

In the graphemic encoding condition of the study phase, subjects were told that they would see words appear on a computer monitor one at a time, and that they should look at the word carefully and tell the experimenter how many letters in the word contained enclosed spaces (spaces completely surrounded by lines), as demonstrated by examples of letters with enclosed spaces on index cards (such as the letters A, B, D, O, P, Q and R). Before beginning the computer trial, they were given a few practice trials on index cards.

In the semantic condition, subjects were asked to say a word closely related in meaning to the word they saw on the screen. They were told to say the first word that came to mind, as long as it was related to the word shown on the screen. A few practice trials, with example words on index cards, were given and the subjects were instructed not to use words that were just variations of the target word (e.g. "if shown open, don't say opening"). After the presentation of the first two lists (one given in the semantic condition, the other in the graphemic condition), the subjects were given abbreviated forms of the instructions before the second two lists.

After each set of instructions, one of the 15-word subsets were presented, with the words appearing for 2.5 sec. in the center of the screen in uppercase letters. After the word had disappeared from the screen, the experimenter pressed a key to advance to the next trial. Once all four subsets (two graphemic and two semantic) of the 60-word list had been presented, subjects were given instructions for the memory test. These instructions varied depending on the test condition. The first test condition was the indirect test condition. In this condition, subjects were told to say the first word that came to mind as a completion to each stem. In the direct condition, subjects were told to use the three-letter stems as cues to help them recall the words that had been presented on the computer screen in the first part of the session. They were informed that some of the stems on the test list did not correspond to items they had seen earlier; therefore, they should not guess, but should only say a word if they believed they had seen it on the computer screen earlier. In the opposition condition, subjects were given the same instructions as those in the indirect condition, but in addition were told that if the first item that came to mind was one of the words seen earlier, they should say another word instead. Test items were also shown on the computer screen in uppercase. A break of at least 15 min was given between each condition for each subject.

Results

For each condition, the proportion of stems completed with a previously studied word was tabulated. Then the proportion of non-target words that were completed was subtracted from the proportion of target words in both the semantic and graphemic categories. All analyses were then performed on these revised values which are shown in parentheses in Table 1. The Korsakoff patients and the mixed etiology amnesic subjects were combined into one group because preliminary analyses between these two groups revealed no significant group effect and no interactions with the encoding or the test variables. The alcoholic controls and the normal controls were likewise combined into one control group after preliminary analyses revealed no between group or interaction effects for these two control groups.

An overall ANOVA with group (control, amnesic) as the between-subjects variable and encoding manipulation (graphemic, semantic) and test manipulation (indirect, direct, opposition) as the within-subjects variables revealed significant main effects of test manipulation [$F(2,48) = 11.98$, $P < 0.01$] and encoding manipulation [$F(1,24) = 26.39$, $P < 0.01$]. In addition, there was a significant group × test manipulation interaction [$F(2.48) =$ 3.78, $P < 0.05$]. Tests of simple effects revealed that amnesics used significantly more studied words to complete stems than did controls in the indirect [$F(1,69) = 5.88$, $P < 0.05$] and the opposition condition [$F(1,24) = 20.66$, $P < 0.01$]. Amnesics and controls did not differ significantly in the number of studied words that were used to complete the stems in the direct condition.

Examining the three test manipulations separately, using an ANOVA for the indirect test manipulation with group (amnesics, controls) as the between-subjects variable and encoding manipulation (graphemic, semantic) as the within-subjects variable, revealed an overall effect of group [$F(1,24) = 5.17$, $P < 0.05$] and of encoding manipulation [$F(1,24) = 13.17$, $P < 0.01$]. There was no group × encoding manipulation interaction.

An ANOVA for the direct test manipulation with group (amnesics, controls) as the between-subjects variable and encoding manipulation (graphemic, semantic) as the within-subjects variable revealed no overall group effect. However, the ANOVA also revealed a significant main effect of encoding manipulation [$F(1,24) = 12.06$, $P < 0.01$]. There was no group × encoding manipulation interaction.

An ANOVA for the opposition test manipulation with group (amnesics, controls) as the between-subjects variable and encoding manipulation (graphemic, semantic) as the within-subjects variable revealed an overall group effect [$F(1,24) = 14.75$, $P < 0.01$]. There was no significant main effect of encoding manipulation. There was also no significant group × encoding manipulation. Test of simple effects revealed that the controls did not use significantly more than zero target words to complete the stems in the opposition test while the amnesics did. Due to this finding and the fact that the group × encoding manipulation interaction approached significance [$F(1,24) = 2.983$, $P < 0.10$], further tests of simple effects were performed. These analyses revealed that the controls showed no significant difference between the graphemic and semantic conditions, while the amnesics demonstrated a difference [$F(1,24) = 4.31$, $P < 0.05$]. Amnesics also used more of the studied words to complete the stems than did the controls in both the graphemic [$F(1,43) =$ 4.55, $P < 0.05$] and semantic conditions [$F(1,43) = 17.07$, $P < 0.01$].

Discussion

The amnesics' performance on the indirect test is not at all surprising based upon most prior research on word-stem priming with amnesic patients. The amnesic patients were clearly not impaired on this indirect test of their retentive ability and actually selected the target word more often than did the control subjects. Enhanced target selection of this magnitude by amnesics during an indirect memory task was originally noted by Graf *et al.* [9] who attributed the outcome to the poor performance of their particular control group. But, subsequent studies have replicated the finding. One study in particular (reported in Cermak *et al.* [6]) manipulated the frequency value of the target words and found that amnesics were increasingly more likely than were controls to produce target words in direct relationship to the pre-experimental frequency value of the word. It appears that the amnesics are more susceptible to, more drawn into, the fluency generated by a prior item's presentation than are controls. Controls are more capable of generating a non-target word during the stem-completion task than seems to be the case for amnesics. This is not to imply that the control

Table 1. Proportion of stems completed as a function of type of study list analysis and retrieval instructions

	Controls			Amnesics		
	Semantic	Graphemic	New	Semantic	Graphemic	New
Indirect	0.38(0.24)*	0.28(0.14)*	0.14	0.48(0.37)*	0.34(0.22)*	0.12
Direct	0.30(0.19)*	0.18(0.07)*	0.11	0.29(0.22)*	0.19(0.12)*	0.08
Opposition	0.13(0.01)	0.15(0.03)	0.12	0.41(0.26)*	0.31(0.16)*	0.15

*Significantly different from zero.

subjects are not giving the first word that comes to mind, but rather that they are not as stimulus-bound as are the amnesics. Our amnesics cannot express 'why' a particular word pops into mind during word-stem completion, but they do report that it seemed to be the most obvious choice.

Even our finding that the level of analysis employed at the time of an item presentation plays a parallel role in amnesics' and controls' indirect performance is not entirely novel. In their seminal article, Graf *et al.* [9] used 'vowel counting' and 'liking' queries during list presentation and reported the same outcome; namely, that both amnesics and controls completed more stems following the semantic task than following the graphemic task. The level of processing effect is not as dramatic as it is in free recall, where controls profit considerably while amnesics show no effect at all, but it clearly does occur in word-stem completion tasks. In the present experiment, the effect is significant and both groups contribute to the outcome to the same extent. Thus, it can be concluded that the word-stem completion task has been influenced by level of initial processing.

The outcome of the direct test is also a frequent finding in the amnesia literature. Warrington and Weiskrantz have demonstrated on several occasions [15, 16] the outcome that occurred in the present task; namely, that cued retrieval with word-stems is normal in amnesics. When control subjects do show a distinct advantage with cueing is when they are informed at encoding that retrieval is going to eventually occur. In the present task, where such instructions were not given, the amnesic patients performed at the same high level as the controls. In the Graf *et al.* report [9], their amnesics also performed at the same cued-recall level as the controls, at least in the 'vowel-sharing' condition (a result that these authors again attributed to the bad performance of their control group). In the present task, the amnesics not only performed at the same level as the controls on the graphemic task but on the semantic as well. This was probably due to the fact that the presentation list in the present experiment was only 15 items long, while it was well beyond that (as many as 40 items) in the Graf *et al.* report. Also, they restricted guessing during direct retrieval, while we did not. When patients are permitted to guess they do perform normally on this task, probably because the fluency provided by prior presentations plays a role similar, if not identical, to the role it plays in indirect performance. What has to be taken away from this outcome is the fact that level of processing has a parallel effect on amnesics and controls during direct cued-recall, with semantic analysis producing higher levels of direct cued-recall than does graphemic.

The dramatic 'difference' in performance between the amnesic and control groups occurred on the oppositional task. Instructions for this task required that the subjects reject the first word that occurred to them as a solution to the word-stem completion task if that word had appeared on the target list. In other words, they had to remember that this fluent item had been presented previously, then they had to inhibit that item in order to complete the word-stem with an alternative word. Normal controls could do this easily, but the amnesic patients had enormous difficulty rejecting these items. In fact, they gave these items as responses more frequently than they did when they were asked to use the word-stem as a cue for direct recall of the target list items. They seemed to be totally unaware of the source of the fluency with which the word had occurred to them and they simply produced the first word that occurred regardless of its source. Thus, while control subjects rejected target words because of their ability to recognize that the words had been presented, amnesics responded as if they had not seen the words and just happened to think of them during the word-stem completion task.

Also of interest is that the amnesic patients' word-stem completion was greater for target words analyzed on a semantic level than on a graphemic level. It did not matter whether the test involved directed retrieval of the specific items on the list, or instructions to respond with the first item that came to mind, or directions not to use the items on the list; the amnesic patients consistently utilized more semantically analyzed words than graphemic. Apparently, words for which an associate had to be generated became more fluent than words for which enclosed letters were counted. This fluency resulted in more target words being present for the amnesics during word-completion; but, the ability to access the source of the fluency did not increase when an item was analyzed semantically as it did for controls. Semantic analysis did not produce any greater ability to inhibit that word than that which occurred for words analyzed at lower levels. The control subjects also used semantically analyzed words more often than graphemically analyzed words to perform word-completion tasks when they were asked to use the words from the list, or to use the first word that came to mind. However, they were able to inhibit this tendency when they were asked to reject target words. The subjects in the original Richardson-Klavehn *et al.* study [13] actually inhibited the use of the semantically analyzed words well below the level of graphemically analyzed words or new words, but the controls in our task performed so closely to floor level that such relative differentiation could not be demonstrated. The point still remains that the controls did not respond to the greater fluency generated by semantically analyzed words when instructed to reject these words. Instead they were able to successfully withhold these words, while the amnesics could not do so.

In summary, what has been demonstrated by these results is that amnesics' indirect task performance is influenced by more than just the perceptual characteristics of the stimulus material. Information analyzed on a semantic level produced a greater level of performance for these patients than did information analyzed on a more perceptual level. This even occurred following instructions not to respond with specific words, demonstrating that semantic analysis has an effect upon these relatively unconscious levels of retention. A second point that this study suggests is that conscious and unconscious levels of retention might exist in parallel for normal individuals who can shift from one to the other depending upon task instructions and upon their desire to check the source of influence. However, the conscious level of retention does not appear to be present for the amnesics or, at the very least, is dissociated from the unconscious. From this perspective, it may be possible to explain much of the apparently facilitated performance that amnesics demonstrate on direct tests without having to hypothesize that amnesics occasionally succeed on these tasks by using their intact implicit memory. Indeed, it may be unnecessary to have to invoke the concept of two independent systems of memory representation [14] at all. Implicit task performance may occur not because the information resides in a special system but rather because it does not have to be contacted consciously. While this proposal is not unique [1, 8, 10, 12], it is generally not supported by data within the area of the study of memory disorders. However, the results of the present experiment do lend some support to such an interpretation.

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