Contextual Cuing and Memory Performance in Brain-Damaged Amnesics and Old People

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In Experiment 1, groups of Korsakoff amnesics and alcoholic controls learned a list of paired-associate words in a standard testing room or in a room with distinctive contextual features. Recall was tested 48 hr later in the same or other context. This procedure was repeated in Experiment 2 with old people living in institutions or in the community, but matched for age, health, education, and socioeconomic background. The amnesic patients and institutionalized old people, relative to their comparison groups, were more impaired in recalling the lists under standard conditions and were more responsive to contextual cuing, especially when the distinctive cues were provided during original learning. The results highlight the susceptibility to interference of Korsakoff amnesics and institutionalized old people and offer further evidence that both groups are more responsive to salient contextual cues than either young people or old people living in the community. © 1987 Academic Press, Inc.

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In a series of studies on negative transfer and release from proactive inhibition, we found that new learning by both Korsakoff amnesics and institutionalized elderly subjects was impaired because of an exaggerated susceptibility to interference (Winocur & Moscovitch, 1983; Moscovitch & Winocur, 1983). We interpreted these deficits as arising from a failure to keep events distinctive in memory. In line with this interpretation, we demonstrated that manipulations which enhanced the distinctiveness of potentially conflicting experiences reduced interference and led to improved performance by both groups of subjects. Although, in general, the Korsakoff amnesic patients' deficits were greater than those of institutionalized old people, the similarities in the two groups' performance suggested common neurological impairment affecting frontal lobe, hippocampus, and related brain structures known to be important to learning and memory. The two groups are, of course, very different in other respects, but we have found that the neuropsychological approach provides a useful framework for studying cognitive decline with aging.

Our work to date has shown that distinctive environmental cues benefit new learning in experimental paradigms that have a high interference component built into them. If our hypothesis regarding the subjects' impairment in segregating one episode from another in memory is correct, then it follows that distinctive contextual cues should also enhance their performance on traditional tests of memory on which they are typically impaired. To perform well on such tests, the subject not only has to learn and retain new information, but also has to retrieve the episode in which the learning took place. Therefore, performance will vary in part with the extent to which the episode is recreated. By conducting the test in a highly distinctive context, the episode is made salient and, thereby, more easily accessible at a later time.

We asked the subjects to study pairs of highly associated words and tested their memory 48 hr later. We used these types of words because past research has shown that amnesic patients (Winocur & Weiskrantz, 1976) and institutionalized elderly people (Winocur & Moscovitch, 1983) can learn such pairs, whereas they find it difficult, if not impossible, to learn word pairs of low associative strength. In order to test memory, it was, of course, necessary to have the subjects achieve a respectable level of learning.

Our hypothesis predicts superior memory performance when learning and testing are conducted in a distinctive environmental context. In addition, we were interested in knowing whether it was necessary to present these cues both at learning and at recall. If distinctive cues serve to segregate episodes in memory, then their presence at learning is critical. Testing for recall in a distinctive context would be beneficial only if it
serves as a reminder for the initial, distinctive learning episode. An alternative, but unlikely, hypothesis is that distinctive cues have a non-specific arousal or motivating effect that is conducive to better performance. If that were the case, contextual manipulations would have equal effect at both initial learning and at recall.

**EXPERIMENT 1**

Korsakoff amnesic patients and alcoholic control subjects were taught a list of 24 paired associates either in a standard context which was an ordinary, familiar room in an institution, or in a context that was made distinctive by dimming the overhead lights, turning on a red lamp, and playing recorded music. Depending on the group to which the subject was assigned, recall testing was conducted in either the same or in a different context. The conditions in which environmental context was uniform throughout original learning and testing were replications of a study conducted with amnesic patients by Winocur and Kinsboume (1978).

**Method**

**Subjects**

The experimental subjects were 10 diagnosed Korsakoff amnesic patients in residence at London Psychiatric Hospital or Westminster Veterans' Hospital in London, Ontario. All had long histories of alcoholism prior to hospitalization and severe memory disorders as assessed by clinical methods. They were unable to recall day-to-day events and had retrograde amnesia for varying lengths of time prior to illness. The memory disorder of the Korsakoff patients was disproportionate to their level of intellectual function, which in all cases was assessed as normal. The average IQ for the Korsakoff population was 102 (WAIS, full scale prorated); the average age for the group was 56 years.

The control subjects for the experiment were 10 alcoholic patients from the recovery clinic, Civic Hospital, Peterborough, Ontario. All subjects were resident patients being treated for alcoholism at time of testing. This population was chosen as the control group for the amnesic patients because of their similar histories of alcoholism and institutionalization. The alcoholic control patients exhibited normal memory and none of the clinical symptoms associated with Korsakoff's syndrome. The average IQ for the control group was 97, the average age was 51 years.

**Materials and Test Conditions**

Two 24 paired-associate word lists were constructed. The word pairs were semantically related items (either nouns or adjectives) chosen from Postman and Keppel's (1970) list of word association norms, on the basis of frequency of occurrence and strength of association (Levels 3–9). Typical examples of paired stimulus and response words are house–garage (Set 1) and music–piano (Set 2). The words were hand printed using black lowercase letters printed on white (7.5 × 13-cm) index cards. Three identical versions of each list were prepared with the pairs arranged in different sequences to discourage rote order memorization over repeated trials.

Testing was conducted in either a standard (SC) or distinctive (DC) context. The SC consisted of an ordinary, familiar room in the hospital where the patient was residing. The room was normally used for examination or counseling purposes so that the patient would
have had several occasions to visit it for other reasons. The same room was used for DC testing except that overhead lights were dimmed and illumination provided by a bright red desk lamp aimed directly at the test material. Taped music in the background added to the distinctiveness of the environment.

Procedure

Testing procedure was identical for all subjects. Initially subjects were given four study trials in which each pair of words was presented simultaneously at a rate of one pair every 2 sec with 60 sec elapsing between versions. Subjects were instructed to read each pair aloud and try to associate the words because they would later be given the first word of each pair and asked to provide the second. Sixty seconds after the fourth study trial, subjects were told that, next, only the first word of each pair would be presented and that they were to provide the word that went with it. For the recall test, each stimulus word was presented for 10 sec or until subject responded, after which the correct response was always provided. The 60-sec intervals between trials were filled with distracting conversation, unrelated to the task itself.

Forty-eight hours later, the subject returned to the same testing room and was reminded that 2 days earlier he had learned to associate pairs of familiar words. He was then told that the first word of each pair would be presented and that he was to provide the second word of each pair. Following presentation of each stimulus word, subject had 10 sec to respond, after which the correct response was always given. There were four conditions in this experiment:

*SC–SC*. Original learning and retesting took place in the same room with sound and illumination levels normal.

*DC–DC*. Original learning and retesting took place in the same room but the distinctive context, as described above, prevailed in both sessions.

*SC–DC*. Original learning was conducted in the standard context; retesting in the distinctive context.

*DC–SC*. Original learning was conducted in the distinctive context; retesting in the standard context.

Because of the limited number of subjects available, it was not possible to comprise independent groups for each condition and maintain suitable members for statistical purposes. Thus, the amnesic and alcoholic control groups were divided so that half was assigned to one of the “context-same” conditions and to one of the “context-different” conditions. The other half was assigned to the other “context-same” and “context-different” conditions. Each subject was tested twice—one with List 1 in one of the conditions and once with List 2 in the other condition. Assignment of lists was semirandom to ensure that Lists 1 and 2 were presented equally in “context-same” and “context-different” conditions. Order of testing was counterbalanced and repeated testing was separated by at least 2 months. This procedure ensured that the testing experiences for each subject would be relatively independent. At the same time, all amnesic and control subgroups were treated equally in terms of experiencing the two lists, the learning and recall context, and the same or different test conditions.

Results and Comments

Learning and memory performance by amnesic or control groups could not be differentiated according to list. Nor did their ability to learn or recall either list depend on whether or not they had been tested previously. Thus, for purposes of presentation, original learning and test scores for each list were organized according to test condition and treated as in-
dependent measures. Table 1 presents the mean number of correct responses made by Korsakoff amnesics and alcoholic control groups at initial recall and retest sessions in the various conditions.

Within each subgroup, the level of original learning was the same in all conditions, although the alcoholic controls consistently recalled more words than the Korsakoff amnesic patients. Savings scores were uniformly high for the alcoholic control subjects in all conditions, whereas retention in the amnesic patients was strongly influenced by context. As predicted, a distinctive context at encoding improved retention in the Korsakoff amnesics, whereas the distinctive context at retrieval was effective only if it was preceded by the same context at encoding.

The above impressions were confirmed by a $2 \times 2 \times 2$ analysis of variance conducted on the percentage savings scores. A highly significant Group effect, $F(1, 32) = 61.69, p < .001$, confirmed that, overall, recall was worse for the amnesic group than for the control group. Significant Group $\times$ Learning-context, $F(1, 32) = 18.14, p < .001$, and Group $\times$ Recall-context, $F(1, 32) = 8.16, p < .01$, interactions indicated that context at learning and recall significantly influenced the savings scores. However, the effect of context was significant only for the amnesic group. Separate analyses of the group scores yielded significant learning-context and recall-context effects for the amnesic group (both $ps < .05$) but not for the control group (both $ps > .05$).

Although context at both recall and original learning affected amnesics' retention of the list, the distinctive context at recall was effective only when it was preceded by distinctive context at original learning. Amnesics' retention in the DC-DC condition was significantly higher than in all other conditions (all $ps < .05$), but the distinctive context at recall did not in itself significantly improve performance. A comparison of amnesics' recall between SC-SC and SC-DC conditions showed no significant difference ($t < 1$). In contrast, learning the list in a distinctive context significantly benefited amnesics' retention even when recall was tested in the standard context. Amnesics' savings score in the DC-SC condition was 72.3% as compared to 58.8% in the SC-DC condition, a statistically reliable difference, $t(8) = 3.2, p < .02$.

These results are consistent with our earlier findings that amnesic patients are more sensitive to environmental contextual manipulations than nonamnesic control subjects. They also show that the main effects of such contextual cuing occur primarily at the time that information is encoded, although maximum benefits for memory are obtained when a distinctive context is present at encoding and retrieval.

A possible concern with respect to the control subjects' data is that their performance approached ceiling levels, and it may be argued that, as a result, our contextual manipulations had no room to operate. In
<table>
<thead>
<tr>
<th>Condition</th>
<th>SC-SC</th>
<th>SC-DC</th>
<th>DC-SC</th>
<th>DC-DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>OL</td>
<td>Test</td>
<td>% Savings</td>
<td>OL</td>
<td>Test</td>
</tr>
<tr>
<td>Korsakoff amnesics</td>
<td>13.6</td>
<td>8.2</td>
<td>60.3</td>
<td>14.2</td>
</tr>
<tr>
<td>Alcoholic controls</td>
<td>20.6</td>
<td>20.6</td>
<td>100.0</td>
<td>21.2</td>
</tr>
</tbody>
</table>
fact, perfect scores were obtained on only 4 of 20 original learning occasions. Moreover, the scores on all but two occasions dropped at retesting, in comparison to their scores immediately following original learning. Thus, it was possible for contextual manipulations to alter degree of savings. The fact that they did not suggests, in line with our previous work, that control subjects are relatively unresponsive to extraneous contextual cuing. In contrast, amnesic patients, who are highly susceptible to interference because, presumably, they have difficulty segregating one memory from another, do benefit disproportionately from environmental contextual cues.

As predicted, the greatest benefits were derived at original learning, when the distinctive cues could isolate the learning episode from other competing memories. In the absence of this critical encoding effect, cues at retrieval had no influence. When learning occurred in a distinctive context, the reinstatement of that context at retrieval raised amnesics' retention scores to near perfect levels.

The results cannot be readily explained in terms of the contextual cues simply having nonspecific motivational, arousing, or attentional effects. If this were the case, performance at test would have been significantly higher in the SC–DC condition and lower in the DC–SC condition.

EXPERIMENT 2

We have previously noted that Korsakoff amnesic patients and institutionalized elderly people respond similarly to extraneous contextual cuing (Winocur & Moscovitch, 1983; Moscovitch & Winocur, 1983). Matched groups of community-dwelling old people, however, like young people, were generally unaffected by these contextual manipulations. Accordingly, we repeated Experiment 1 with two such groups of elderly people. Our previous work leads to the prediction that the institutionalized elderly, like Korsakoff amnesics, would benefit from distinctive contextual cuing whereas the community elderly group would not. On the basis of Experiment 1, it follows that these contextual manipulations will be especially effective at the time of original learning.

For this experiment, we shortened the list from 24 to 12 words, because pilot work had shown that similar effects could be obtained with a shorter list, and with less distress to our elderly subjects who, though not as impaired as Korsakoff amnesics, are much more sensitive to their failures. In addition, pilot work indicated that with lists of this length, young people show little forgetting over a 48-hr delay period. For this reason, and because the comparisons of interest for the hypothesis we are testing are between the two elderly groups, a young control group was not included in this experiment.
Method

Subjects

Two groups of old people were tested: elderly subjects between 70 and 85 years, residing in senior citizens homes (institutionalized aged group) or in their own homes (community aged group). All subjects resided in the Peterborough, Ontario area.

To qualify for the study, subjects had to be alert and free of gross cognitive deficits, neurological symptoms, cardiovascular disease, psychiatric problems, and sensory or perceptual disorders. Similarly, individuals receiving tranquilizers or other medication likely to affect their mental faculties were excluded. Prior to experimental testing, subjects were administered the Ammons and Ammons IQ test. Only those people scoring in the normal range or better were selected. There were no differences between any groups on this measure. The groups were also similar in terms of educational background and socioeconomic level.

Materials

The test, administered to all subjects, consisted of a list of 12 paired-associate words of high associative strength drawn from Lists 1 and 2 of the previous study. Each word was printed in large black letters on a white 7.5 × 13-cm index card. Three identical versions of the list were prepared with the pairs arranged in different sequences to discourage rote order memorization over repeated trials.

Testing was conducted in small rooms in which sound and illumination levels could be regulated. In the case of the institutionalized subjects, the rooms were somewhat removed from their actual living area; community aged subjects were tested in a similar room in the Peterborough Public Library.

Procedure

The testing procedure was identical to that of the previous study, except that only one shorter list was used and each subject was tested only once. Each subject was tested in one of four conditions as described in Experiment 1:

- **SC–SC.** Original learning and retesting were conducted with sound and illumination levels normal. Nineteen institutionalized old people (X age = 80.7 years) and 17 community old people (X age = 76.3 years) were tested in this condition.

- **DC–DC.** Original learning and retesting were conducted with illumination provided by a bright red desk lamp and background music playing on a tape recorder. Seventeen institutionalized old people (X age = 83.3 years) and 16 community old people (X age = 79.2 years) were tested in this condition.

- **SC–DC.** Original learning occurred in the standard context, retesting in the distinctive context. Ten institutionalized old people (X age = 83.6 years) and 9 community old people (X age = 78.2 years) were tested in this condition.

- **DC–SC.** Original learning occurred in the distinctive context, retesting in the standard context. Ten institutionalized older people (X age = 82.4 years) and 8 community old people (X age = 80.8 years) were tested in this condition.

Results and Comments

As can be seen from Table 2, institutionalized and community groups in the various conditions initially learned the list equally well (F < 1). At retest, the community old people resembled the alcoholic control group of Experiment 1 in demonstrating uniformly high savings in each of the test conditions. In contrast, the institutionalized old people were
### TABLE 2
Mean Number of Correct Responses and Percentage Savings at Original Learnings (OL) for Institutionalized and Community-Dwelling Aged Groups in All Conditions of Experiment 2

<table>
<thead>
<tr>
<th></th>
<th>SC–SC</th>
<th>SC–DC</th>
<th>DC–SC</th>
<th>DC–DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OL</td>
<td>Test</td>
<td>%</td>
<td>OL</td>
</tr>
<tr>
<td>Institutionalized</td>
<td>10.6</td>
<td>6.1</td>
<td>57.5</td>
<td>10.4</td>
</tr>
<tr>
<td>Community</td>
<td>10.9</td>
<td>9.0</td>
<td>82.6</td>
<td>10.6</td>
</tr>
</tbody>
</table>
differentially affected by cuing conditions and in much the same way as Korsakoff amnesics. The institutionalized subjects performed as well as the community elderly only when distinctive cues were provided at original learning. In the other conditions, the institutionalized old people performed significantly worse ($p < .01$).

The above observations were confirmed by a $2 \times 2 \times 2$ analysis of variance prior to the percentage savings scores. The Groups main effect was statistically significant, $F(1, 97) = 41.73, p < .001$, indicating that institutionalized old people were generally poorer at recalling the learned list than the community old people. A significant Group $\times$ Learning-context interaction, $F(1, 97) = 14.14, p < .001$, confirmed that context at original learning differentially affected retention. However, the significant interaction was due to the institutionalized old people's greater responsiveness to the distinctive context at acquisition. The mean savings score for the institutionalized old people following original learning in the distinctive context was 75.6% as compared to 53.5% when the list was learned in the standard context, $t(54) = 3.53, p < .001$. In contrast, the community old people averaged 72.5 and 75.6% savings when original learning occurred in standard and distinctive contexts, respectively ($t < 1$). Further analysis of the institutionalized groups' data showed that providing the distinctive context at original learning was sufficient to produce better recall. A comparison of savings scores by institutionalized subjects in the SC-SC and DC-SC conditions yielded a statistically significant difference, $t(18) = 3.88, p < .001$.

There was no evidence that contextual conditions at test affected memory performance in any of the groups. The Groups $\times$ Recall-context interaction and the main effect of Recall-context were both statistically nonsignificant. Thus, a distinctive context at encoding contributed significantly to later retention by institutionalized old people; the same contextual cues at retrieval did not add appreciably to their performance.

The finding that a distinctive context at encoding helped institutionalized old people remember the learned associations even when testing was conducted in a standard context contrasts with the results obtained for amnesic patients in Experiment 1. The reasons for this difference are unclear, but it may be that individuals with extremely bad memories can benefit from the additional cues specifically conferred by matching the distinctiveness of original learning and test conditions. This interpretation is consistent with informal observations relating to differences in responsiveness to contextual conditions. Although savings scores for the Korsakoff amnesics and institutionalized old people were generally similar, the old people were well oriented in space and time and, at test, exhibited good recall of the previous experience, regardless of the context. In contrast, Korsakoff amnesics were spatially and temporally disoriented.
and showed no episodic recall at test; the only sign of recognition occurred in the DC–DC condition where amnesics occasionally expressed a vague familiarity with the general situation, due undoubtedly to the consistent presence of distinctive cues.

Finally, it should be noted that, despite being matched with community elderly people for age, education, IQ, and health, the institutionalized elderly performed significantly worse in a test of recall conducted under standard conditions (condition SC–SC). This finding, along with their increased responsiveness to contextual cuing at original learning, offers further evidence of cognitive or memory impairment in these people reminiscent of that observed in patients with organic amnesia.

GENERAL DISCUSSION

The results of Experiments 1 and 2 extend our previous work in two important ways. The initial experiments assessed the effect of contextual cuing on new learning under conditions of experimentally induced high interference. Here, we show that similar benefits of contextual cuing for Korsakoff amnesic patients and institutionalized elderly people can also occur in recall as a result of the distinctiveness that contextual cuing confers on the task. Second, the design of the experiment allowed us to determine that contextual cuing has its primary influence at original learning.

These results are consistent with the hypothesis that the memory deficit of Korsakoff amnesic patients and elderly people results, in part, from their impaired ability to keep one learning episode distinct from others in memory. This impairment is probably especially disabilitating for those institutionalized subjects who live in restricted environments, where the potential for interference among similar events is already very high. By making the learning context distinctive, we helped segregate that event from other potentially interfering events, thereby enabling the subject to retrieve the items from memory at a later time. It follows from this hypothesis that the chief benefit of this type of contextual cuing must occur at original learning when the event is encoded in memory. Contextual cuing at test should confer no benefit for recall if the learning experience is not already distinctively encoded in memory. Our results are consistent with this view both with regard to encoding and retrieval. For individuals who do not suffer from similar memory problems and who live in a rich environment, contextual cuing should have little effect on their performance. This was indeed the case for the community elderly people.

Although the maximal effects of contextual cuing for amnesics and institutionalized old people occurred at encoding, it is unlikely that such cuing helped subjects to form new associations. There is no evidence that contextual cuing improved performance at acquisition. Moreover, the memory task was designed to exploit well-established existing as-
associations. In a separate study, we had institutionalized elderly people learn a list of 24 word pairs of low associative strength. Once again, contextual cuing had no beneficial effect at acquisition (Winocur & Moscovitch, 1986a). Rather than help form new associations, the contextual cuing seemed to make the experience more distinctive, thereby making the learned material more readily available for later recall.

As part of the study described in the preceding paragraph, community-living old people also learned the 24 weakly associated word pairs under standard or distinctive context conditions and recalled them under the same conditions. Consistent with previous findings (Winocur & Moscovitch, 1983; Moscovitch & Winocur, 1983), contextual manipulations did not affect the number of correct responses at acquisition (SC, $\bar{X} = 16.7$; DC, $\bar{X} = 17.5$) or recall (SC, $\bar{X} = 11.4$; DC, $\bar{X} = 13.3$). These results are important because they show clearly, in a test situation that is uncontaminated by ceiling effects, that normal old people living at home do not benefit from contextual cuing. The subjects in the SC–SC condition showed a drop in performance at retention testing that, in percentage terms, was substantially greater than that exhibited by control groups in Experiments 1 and 2, but comparable to that seen in Korsakoff amnesics (Experiment 1) and institutionalized old people (Experiment 2). Relative to the SC–SC condition, retention performance in the DC–DC condition improved by only 16.7% (11.4 vs. 13.3) as compared to 53.6% (8.2 vs. 12.6) by Korsakoff amnesics in Experiment 1 and 39.3% (6.1 vs. 8.6) by institutionalized old people in Experiment 2. Statistical comparisons are obviously inappropriate, but these observations strengthen the argument that normal control subjects, unlike Korsakoff amnesics and institutionalized old people, are relatively unresponsive to extraneous contextual cuing.

Institutionalized elderly people, though not suffering from the profound memory loss associated with amnesia, nevertheless perform similarly to Korsakoff patients on a number of memory tasks (see Craik, 1977, and Parkinson, 1982, for reviews). Two factors can account for these similarities. First, both groups may share a common neurological deficit that is simply more severe in the amnesic. We have previously emphasized the importance of hippocampal and frontal lobe dysfunction, because there is evidence that both structures deteriorate early and markedly with age, and because both are known to be at least indirectly affected in Korsakoff’s syndrome. Moreover, both structures have been implicated in processing contextual information in animals and humans (Pribram, 1973; Winocur, 1982).

A second factor, more psychological in origin, relates to both groups having been institutionalized for a number of years. Adverse effects of institutionalization on certain aspects of cognitive performance have been reported for the elderly (Storandt, Wittels, & Botwinick, 1975). We, too, have noted that institutionalized elderly people, despite being mentally
and physically healthy and matched for IQ with community elderly, are consistently impaired on tests sensitive to hippocampal and frontal lobe function (Winocur, Moscovitch, & Freedman, 1986). In the present case, institutionalization, through its effect on cognitive or even brain function, may have increased the elderly subjects’ susceptibility to interference, thereby making the contextual cues that much more distinctive and effective. The intriguing possibility that environmental influences interact with physiological processes to produce cognitive decline in the elderly has important theoretical and practical implications. It is currently the subject of a major longitudinal study that traces the performance of old people on cognitive tests sensitive to different types of brain function, from the time that they enter institutions and for several years thereafter.

REFERENCES