REFERENCES

Modulation of environmental reinstatement effects through encoding strategies

MARK A. McDANIEL
Purdue University

D. CHRIS ANDERSON
University of Notre Dame

GILLES O. EINSTEIN
Furman University

COLLEEN M. O'HALLORAN
University of Notre Dame

The influence of encoding strategies on context-dependency effects was investigated. In five experiments, recall of sentences or phrases was examined when the environmental context present at encoding was either reinstated or changed at the time of test. In Experiments 1 and 3, subjects were instructed to form mental images (visual) of the meaning of each sentence. In Experiments 2, 3, and 4, subjects were required to perform a nonimaginal encoding task for the target sentences (read and rate the sentences). Additionally in Experiment 4, other subjects were instructed to try to organize the sentences into sets of four. In Experiment 5, subjects either used a self-referent encoding task or a non–self-referent encoding task to process a list of phrases. Context-dependency effects emerged most consistently when the encoding task did not involve imagery, organization, or self-referent encoding; when the sentences did not describe implausible (bizarre) events; and when the memory measure reflected event access. We suggest that for recall, dependence on environmental context cues is partly a function of the degree to which available retrieval cues are provided by the target encoding per se.

The *environmental reinstatement effect* refers to the finding that memory performance is enhanced when the physical surroundings in which information was originally learned are reinstated at testing. This effect has been observed when the subjects' natural environment is manipulated in dramatic fashion by requiring subjects to learn a word list either underwater or on land and then requiring recall in either the same or contrasting situation (Godden & Baddeley, 1975). More typical laboratory demonstrations of the reinstatement effect have shown that

remembering is better when study and test are performed in the same rather than different rooms (Jensen, Dibble, & Anderson, 1971; Jensen, Harris, & Anderson, 1971; Smith, 1979; Smith, Glenberg, & Bjork, 1978). This effect has clear practical implications that may be especially noteworthy from an educational perspective (cf. Eich, 1985; although see Saufley, Otaka, & Bavaresco, 1985, for evidence to the contrary). The effect is also theoretically important because of the number of memory theories that utilize context as an explanatory factor (cf. Fernandez & Glenberg, 1985). Presumably, encoding of an event involves storage of contextual markers like time and place. In many current theories of memory, this contextual information is thought to guide retrieval on recall tests (Anderson & Bower, 1972; Raaijmakers & Shiffrin, 1981), and context is thought to be involved in recency effects (Glenberg, Bradley, Kraus, & Renzaglia, 1983), spacing effects (Glenberg, 1979), and interference and forgetting (Bellezza, 1985). Given the extent to which context is embraced in current theorizing, one would hope to find a strong empirical base to support these theoretical assumptions, as well as a detailed understanding of what kinds of factors affect the utilization of contextual (environmental) information in remembering.

Recent findings suggest, however, that environmental context effects may not be as readily obtainable as implied by current theories. In a series of eight experiments, Fernandez and Glenberg (1985) failed to find reliable variations in memory performance as a result of changing environmental context from study to test. Similarly, Saufley et al. (1985) in a series of seven experiments found that test scores of college students did *not* reliably vary as a function of the classroom in which the test was administered (same or different classroom from the lecture room). Eich (1985) reported a reinstatement effect, but only when subjects were instructed to associate the ambient background environment with the target materials (in the form of an interactive image). These studies reinforce Smith's (1979) conclusion that "It is not enough to state simply that SC [same context] conditions produce better memory than DC [different context] conditions, if one wishes to predict memory performance" (p. 460). Rather, context effects appear to be complex and, at present, not well understood. Current speculation is that contextual dependence might be affected by a range of factors including the type of material to be learned, instructional variables, the type of environmental context considered, the encoding tasks, and the test task (Eich, 1985; Fernandez & Glenberg, 1985; Smith, 1979). The purpose of the present investigation was to explore how one such factor, the type of encoding performed on the to-be-

remembered material, might impact the mnemonic influence of environmental context.

Most theoretical and empirical work has analyzed encoding processes in terms of the degree to which they explicitly or intentionally link target information to the physical context. When this intentional linkage occurs, perhaps because the learning environment is perceived as causing or enabling the event to occur (Fernandez & Glenberg, 1985) or because the instructions specify linking the target with the environmental context (Eich, 1985), context reinstatement appears to improve memory performance. Less attention, however, has been directed to the possibility that the encoding of the individual target item per se may be an important factor for the manifestation of context reinstatement effects (i.e., we are not considering encoding processes or tasks that explicitly or implicitly demand the integration of the target information with the environmental context). Some preliminary support for this notion has been reported by Smith (1986). He found that an encoding task that was presumed to involve "shallow" processing (processing items for a short-term memory task) produced context-dependent recognition performance, whereas an encoding task that was presumed to involve "deeper" processing (attempting to learn items for a long-term memory task) did not produce context-dependent recognition.

To account for these results, Smith (1986) proposed that the explicit cues that were available on a recognition test ordinarily provide access to descriptive information (information about a single target item) and structural information (interitem associations or subjects' organizations formed at the time of study), information that is presumably useful in the retrieval check and matching processes involved in recognition (p. 353). If items are shallowly encoded, however, the descriptive and structural information that is available may be sparse, thus necessitating the use of the more general background context (environmental) cue. Simply put, "a general cue [i.e., environmental context] is more effective when more specific cue sources are restricted" (Smith, 1986, p. 348).

In the present experiments, we attempted to extend the above framework linking type of processing with context dependency to the domain of recall. A priori, it was not clear whether type of processing would modulate context reinstatement effects in recall (again, keep in mind that the present discussion is not directed at comparisons in which one encoding strategy intentionally establishes target-context associations and one does not). Given that free recall does not provide the specificity of cues that recognition does, general cue sources like

environmental context might be used for recall regardless of the quality of the encoding processing. This idea is consistent with the observation that context-dependent recall obtains when subjects are instructed to learn a list of items for a long-term memory test (Smith, 1979; Smith et al., 1978), even though context-dependent recognition does not obtain under similar encoding instructions (Smith, 1986; Smith et al., 1978).

Alternatively, some types of processing might afford the generation during recall of internal cues that aid in recovery of target information. These internally generated cues could decrease subjects' reliance on environmental cues (much as the external cues on a recognition test are assumed to attenuate the use of environmental cues), thereby obviating context reinstatement effects in recall. The assumption that some encoding processes afford the generation of internal cues more than other encoding processes do is consistent with several contemporary memory theories (e.g., Bellezza, 1987; Desrochers & Begg, 1987; Greenwald, 1981; Paivio, 1986). The present experiments were conducted to explore the alternatives outlined above.

EXPERIMENT 1

In our initial attempts to influence context reinstatement effects by varying the encoding of the to-be-learned material, we employed variation in imaginal encoding. We used imaginal encoding because we wanted to include a potent encoding condition that might be expected to facilitate retrieval more than would standard intentional learning instructions used in previous studies of context-dependency effects on recall. In a within-subjects manipulation, noun triplets were encoded either with bizarre imagery or with common imagery. Previous findings have suggested that material encoded in connection with bizarre images is more accessible for recall than material encoded with ordinary images (Einstein, McDaniel, & Lackey, 1989; McDaniel & Einstein, 1986), possibly because bizarre images provide more distinctive or specific cues (McDaniel & Einstein, 1986). Thus, we thought it possible that recall of nouns encoded with bizarre images would not be context dependent, but recall of nouns encoded with common images might be more subject to context reinstatement effects. Environmental context was manipulated by having subjects move to a markedly dissimilar room for recall testing in the different-context conditions.

METHOD

Subjects and design

Sixty-four undergraduates enrolled in introductory psychology courses participated for extra credit. The design was a 2 (Retrieval Context) × 2 (Sentence Type) mixed factorial. Retrieval context (same or different room from that at encoding) was the between-subjects factor, and sentence type (common or bizarre) was the within-subjects factor. Each of the two retrieval-context conditions had 32 subjects.

Environmental contexts and materials

The environmental contexts were two distinctly different rooms on the second floor of the University of Notre Dame Psychology Building. One room was a windowless animal-colony room in which laboratory rats were housed. The room contained two racks of cages, situated against opposite walls, that housed the rats. The subject sat in a chair with a desk top. The chair was placed between the cages such that one cage was approximately 4 ft in front of the desk and the other cage was approximately 4 ft behind the desk. The second room was a smaller human experimental laboratory room located at the opposite side of the building from the animal-colony room. This room had a window and contained a desk and chair. Across subjects, each room was used equally often as an encoding and as a retrieval room for both the same and different retrieval-context conditions.

The study materials were 24 sentences, each containing three target nouns, that were developed and normed by McDaniel and Einstein (1986; refer to that paper for the complete list of sentences). Each sentence described an interaction between the set of three nouns. For half of the sentences, the interactions described were unusual or bizarre (e.g., "The DOG rode the BICYCLE down the STREET"), and for the other half of the sentences the descriptions of interactions were usual or common (e.g., "The BABY put the RATTLE in its MOUTH"). For counterbalancing purposes, two lists were constructed using the same noun triplets; in each list a particular noun triplet appeared in a different sentence frame (bizarre or common) from that in which it occurred in the other list. (For example, the alternative sentence frames for the preceding noun triplets were "The DOG chased the BICYCLE down the STREET" and "The RATTLE put the BABY in its MOUTH.") Thus, across subjects each noun triplet appeared equally often in a bizarre sentence and in a common sentence.

The sentences were recorded on a cassette audiotape, with the bizarre and common sentences randomly interspersed with the constraint that no more than three of the same type of sentence were blocked together. Three demonstration sentences preceded the 24 target sentences. The sentences were read by a female speaker. Between each of the sentences, 10 s of silence was interposed to allow for imaging and a vividness rating. A short tone was recorded at the end of the 10-s interval to signal the start of the next sentence.

Procedure

Subjects were tested individually in a single experimental session of approximately 20 min. Each subject was taken to the appropriate encoding context (depending on the particular counterbalancing condition assigned), read and signed an informed consent form, and was seated. Subjects were told that they would be presented with a list of sentences, and they were instructed to form a mental image of the activity described in each. To maintain an incidental learning situation (so that encoding strategy could be better controlled), subjects were not forewarned about the recall test. All sentences were presented using a cassette tape player. After imaging the meaning of each sentence, subjects rated the vividness of their mental image by recording a number from 1 (*clear, vivid image*) to 5 (*not very clear image*) on a sheet of provided paper. The sheet had numbered lines, one for each target sentence, and the rating scale was provided at the top of the sheet. To allow subjects to familiarize themselves with the presentation rate and other aspects of the procedure (e.g., the rating task), the three demonstration sentences were presented first.

After processing the sentences, subjects were required to solve multiplication and division problems for 2 min. Subjects then were told that they and the experimenter would "take a break and walk down the hall." When the retrieval task was in a different room from the encoding task, the subject was escorted down the hallway into a different room. When the retrieval task was in the same room as the encoding task, the subject was escorted halfway down the hallway and then back to the original encoding setting. (This procedure was adopted to equate the conditions for "disruption" effects that could occur when subjects leave the room and move about, cf. Smith et al., 1978.) Once seated again, all subjects were instructed to write down as many sentences from the tape as they could remember. Subjects were encouraged to write down fragments of the sentence, especially nouns, if they could not remember the complete sentence. Subjects were allowed as much time as they needed for the recall task.

RESULTS AND DISCUSSION

For all analyses the alpha level was set at .05. Common images were rated as significantly more vivid than bizarre images $F(1, 62) = 426.15$, $MS_e = .27$ (see Table 1 for means of all dependent measures). No other significant effects were found for the vividness ratings.

The recall protocols were scored to yield the following measures: number of nouns (of the target noun triplets) recalled, number of verbs recalled, and number of sentences accessed (a sentence was scored as accessed if at least one noun or verb from the sentence was recalled). Two-factor mixed analyses of variance (ANOVAs), with retrieval context (same vs. different) as the between-subjects factor and sentence type as the within-subjects factor, were performed on each

Table 1. Mean vividness ratings and nouns, verbs, and partial sentences recalled in Experiment 1

Dependent measure	Sentence type	Retrieval context	
		Same	Different
Vividness rating[a]	Bizarre	3.7	3.6
	Common	1.8	1.6
Noun recall[b]	Bizarre	10.0	10.0
	Common	8.5	8.3
Verb recall[c]	Bizarre	3.0	3.4
	Common	2.6	2.4
Sentence access[d]	Bizarre	4.3	4.3
	Common	3.5	3.3

Note. "Same" indicates that retrieval took place in the same room as encoding, and "Different" indicates retrieval took place in a different room. [a]Lower rating indicates more vivid image. [b]Average number of 36. [c]Average number of 12. [d]Average number of 12; see text for description.

of these dependent measures. None of the recall measures yielded retrieval context effects (largest F = .05). Thus, there was no advantage for reinstating at test the environmental context present at learning.

The only significant effects were main effects of sentence type. On all of the recall measures there was a significant recall advantage for imaging bizarre sentences compared with common sentences: $F(1, 62)$ = 5.33, MS_e = 14.36; $F(1, 62)$ = 6.46, MS_e = 2.45; and $F(1, 62)$ = 11.36, MS_e = 2.31, for nouns, verbs, and sentence access, respectively. These findings extend previous demonstrations of the mnemonic benefits of bizarre imagery in a mixed-list design (e.g., McDaniel & Einstein, 1986) by showing that the effect obtains with auditory presentation and with relatively long lists.

The more critical outcome for the present purposes, however, was that context dependency was not observed. The absence of context-dependency effects in this experiment for the common imagery condition was not anticipated. We had expected that because common imagery was less mnemonically effective than bizarre imagery, more reliance on environmental context would be evidenced in recall of material encoded with common images.

An explanation for the absence of context-dependency effects that is in line with the notions outlined in the Introduction is that imaginal encoding per se provides subjects with supplementary memory codes (Paivio, 1986), privileged retrieval routes (cf. Conway, 1988), and salient cues that aid retrieval (Hishitani, 1985), so as to preclude or

negate the use of environmental cues. Assuming that nonimaginal encodings of verbal material may provide fewer or less definitive retrieval cues (or routes) than imaginal encodings, it may be that nonimaginal encoding of the target sentences might be more susceptible to context-dependency effects.

EXPERIMENT 2

This experiment was identical to Experiment 1 with the exception that subjects were not requested to form visual images of the target sentences. Instead, they were instructed to rate each sentence for the "typicality" of the propositions expressed. Previous research with these materials indicated that this task is unlikely to promote the use of visual imagery to encode the sentences (McDaniel & Einstein, 1986). Thus, if imagery per se provides cues that override the influence of contextual cues, then the absence of imaging should be associated with context-dependency effects.

METHOD

Subjects

Forty-nine undergraduates enrolled in introductory psychology courses participated for extra credit. Twelve subjects were randomly assigned to counterbalancing conditions AA (encode in Room A and retrieve in Room A), AB, and BA; 13 subjects were assigned to counterbalancing condition BB.

Procedure

The environmental contexts, materials, and procedure were the same as those used in Experiment 1 with the following exception. Subjects were *not* instructed to image the meaning of the sentences, but instead were required to rate the "typicality" of the event described by the sentence. On a rating scale of 1 to 5, 5 indicated that the event was *very unusual or atypical*, and 4 to 1 indicated decreasing degrees of unusualness.

RESULTS AND DISCUSSION

For all analyses,[1] the alpha level was set at .05. As expected, bizarre sentences were rated as more unusual (atypical) than common sentences, $F(1, 47) = 1856.06$, $MS_e = .11$. (Table 2 shows the means of the ratings and the recall measures.) No other factors significantly affected the ratings (largest $F = 1.39$). As in Experiment 1, the recall

Table 2. Mean typicality ratings and nouns, verbs, and partial sentences recalled in Experiment 2

| Dependent measure | Sentence type | Retrieval context | |
		Same	Different
Typicality rating[a]	Bizarre	4.4	4.5
	Common	1.6	1.5
Noun recall[b]	Bizarre	11.0	9.7
	Common	12.2	8.1
Verb recall[c]	Bizarre	3.4	3.2
	Common	3.9	2.4
Sentence access[d]	Bizarre	4.5	4.2
	Common	4.7	3.1

Note. "Same" indicates that retrieval took place in the same room as encoding, and "Different" indicates retrieval took place in a different room. [a]Lower rating indicates sentence is more typical. [b]Average number of 36. [c]Average number of 12. [d]Average number of 12; see text for description.

protocols were scored to yield three measures: nouns recalled, verbs recalled, and sentences accessed. Each of these measures was submitted to a two-factor mixed ANOVA with retrieval context (same vs. different) as the between-subjects factor and sentence type as the within-subjects factor. For all three recall measures, there was a significant context reinstatement effect such that recall levels were higher when the environmental context present at study was reinstated at test: for nouns recalled, $F(1, 47) = 5.23$, $MS_e = 34.23$; for verbs recalled, $F(1, 47) = 4.60$, $MS_e = 4.21$; for sentences accessed, $F(1, 47) = 4.77$, $MS_e = 4.67$. Thus, when the sentences were encoded with a nonimaginal orienting task, a context-dependency effect was obtained.

There were no main effects of sentence type (largest $F = 1.93$), further supporting the idea that subjects generally did not use imagery (McDaniel & Einstein, 1986, found that sentence bizarreness does not enhance recall in general when sentences are encoded nonimaginally). The sentence-type variable was involved in a significant two-way interaction (with retrieval context) for verb recall, $F(1, 47) = 5.19$, $MS_e = 1.79$, and for sentence access, $F(1, 47) = 4.94$, $MS_e = 2.04$. This interaction approached significance for nouns recalled, $F(1, 47) = 3.52$, $p < .07$, $MS_e = 13.87$. Examination of Table 2 reveals that these interactions were due to a dampening or diminution of the context reinstatement effect for bizarre sentences relative to common sentences. That is, changing environmental contexts at retrieval was more detrimental for recall of components of common sentences than for

recall of components of bizarre sentences. This pattern is further considered in the General Discussion. No other significant effects emerged from the analyses.

EXPERIMENT 3

To try to replicate the context-dependency effects in Experiment 2 and to try to obtain direct support for the interaction (between encoding processes and context-dependent recall effects) suggested by the diverging pattern of effects across Experiments 1 and 2, we combined the features of those experiments into a single experiment with encoding instructions as an independent variable. Half of the subjects were instructed to encode the sentences with the visual imagery encoding task and the other half to encode the sentences with the "typicality" rating task.

METHOD

Subjects and design

Eighty subjects in introductory psychology courses participated for extra credit. The design was a 2 (Retrieval Context) × 2 (Encoding Task) × 2 (Sentence Type) mixed factorial. The retrieval context (same or different room from that at encoding) and encoding task (imagery or typicality rating) manipulations were between subjects and the sentence-type manipulation (common or bizarre) was within subjects. Each of the four conditions represented by the factorial combination of the retrieval context and encoding task manipulations had 20 subjects.

Procedure

The environmental contexts and materials were the same as in the previous experiments. The particular rooms in which subjects performed the encoding and recall tasks were counterbalanced so that each room served equally often as encoding and retrieval contexts in both the same and different context conditions. Subjects in the imagery encoding conditions were instructed as in Experiment 1 (i.e., performed vividness ratings), and subjects in the nonimagery encoding conditions were instructed as in Experiment 2 (i.e., performed typicality ratings). Other than this encoding manipulation, the procedure was identical to that of the previous experiments.

RESULTS

The alpha level was set at .05 for all analyses. The ANOVAs[2] performed for each of the recall measures (nouns recalled, verbs recalled,

and sentences accessed) indicated that significantly more sentences were accessed when recall was performed in the same environmental context in which the sentences were encoded than in a different environmental context (Table 3), $F(1, 72) = 4.33$, $MS_e = 3.05$, and this effect held regardless of encoding task ($F < 1$ for the interaction). This context reinstatement effect was not significant for either the noun-recall or verb-recall measures (largest $F = 1.97$).

More of the bizarre sentences were accessed than common sentences, $F(1, 72) = 22.28$, $MS_e = 2.92$; more nouns from bizarre sentences were recalled than from common sentences, $F(1, 72) = 9.22$, $MS_e = 21.48$. The bizarreness effect for verb recall approached significance, $F(1, 72) = 3.61$, $p < .07$, $MS_e = 2.50$. Also approaching standard significance levels were interactions between sentence type (bizarre vs. common) and encoding task. The superior accessibility of bizarre sentences (relative to common sentences) was nominally more pronounced after imaginal encoding than after nonimaginal encoding (the mean difference between bizarre and common access was 1.8 for imagery encoding and 0.8 for nonimaginal encoding), $F(1, 72) = 3.09$, $p < .09$, $MS_e = 2.92$. Nominally, more of the bizarre verbs were recalled than common verbs after imagery encoding but not nonimaginal encoding (mean differences between bizarre and common verbs were 1.0 for imagery encoding and 0.1 for nonimagery encoding), $F(1, 72) = 3.61$, $p < .07$, $MS_e = 2.50$. The parallel interaction for noun recall did not meet marginal significance levels, $F(1, 72) = 2.46$. No other effects were found in any of the analyses (all $Fs < 1$).

Table 3. Mean number of nouns, verbs, and partial sentences recalled in Experiment 3

Dependent measure	Sentence type	Encoding task			
		Semantic		Imagery	
		Same[a]	Different	Same	Different
Noun recall[b]	Bizarre	11.1	9.4	13.0	10.6
	Common	9.3	9.1	8.6	8.2
Verb recall[c]	Bizarre	2.9	2.8	3.6	3.0
	Common	3.0	2.8	2.2	2.5
Sentence access[d]	Bizarre	4.8	4.2	5.7	4.6
	Common	3.8	3.6	3.6	3.2

[a]Retrieval context (same or different from encoding context). [b]Average number of 36. [c]Average number of 12. [d]Average number of 12; see text for description.

DISCUSSION

Reinstatement of the original encoding context significantly aided access of target sentences. Surprisingly, this effect obtained even for those subjects who were instructed to use imagery. The robust advantage for recall of bizarre sentences relative to common sentences for those subjects instructed to use imagery suggests that these subjects complied with the instructions (cf. McDaniel & Einstein, 1986). The context-dependency effects under imagery encoding are puzzling because in addition to not finding such context-dependency effects in Experiment 1 (in which imagery encoding was used), we have failed to find context-dependency effects in two unpublished pilot experiments (that used the same materials used in the present study) in which encoding was performed under imagery instructions. Moreover, Eich (1985) also did not obtain context reinstatement effects in recall for imaginally encoded items (when the items were encoded under instructions that did not induce subjects to explicitly link the to-be-remembered words to the environmental context). Thus, the evidence for context-dependency effects after imaginal encoding is not overwhelming; at best, context-dependency effects with imagery encoding (that focuses on the target per se) are minimal.

Given the uncertain nature of the influence of imaginal encoding on the degree to which context dependency is evidenced in free recall, we proceeded to explore encoding dimensions other than imagery/nonimagery. The selection of the particular encoding manipulations (orienting tasks) was guided by the idea introduced at the outset that encoding tasks that afford the generation of retrieval cues during recall may decrease subjects' reliance on environmental cues, thereby eliminating context-dependency effects. Accordingly, in Experiments 4 and 5, in addition to some subjects encoding material with a relatively nonelaborative orienting activity, other subjects engaged in an orienting activity for which previous empirical and theoretical work suggested internal retrieval cues would be developed. Specifically, in Experiment 4 we devised a task to try to encourage organizational processing, and in Experiment 5 we selected to-be-learned materials that could be encoded self-referentially.

EXPERIMENT 4

To gather more direct evidence for the idea that the encoding task may modulate the degree to which context reinstatement influences recall, in addition to the retrieval-context and sentence-type manipulations, we varied the instructed encoding task. Half of the subjects

were instructed to process the sentences as in Experiment 2 (i.e., nonimaginally), and half were instructed to try to find some basis by which to relate the sentences into groups. Based on our idea that encoding activities that promote the formation of effective retrieval routes may lead to less reliance on environmental cues (and therefore attenuate context-dependency effects) and on the the idea that organizational processing provides effective retrieval routes (Masson & McDaniel, 1981), we hypothesized that the subjects instructed to try to group the sentences would not be as susceptible to environmental context changes as would subjects who performed an encoding task that focused on each sentence individually.

METHOD

Subjects and design

Eighty-two undergraduate students in introductory psychology courses participated for extra credit. Encoding task (isolated-sentence processing vs. organizational processing) and retrieval context (same room as encoding vs. different room) were manipulated between subjects, and sentence type (bizarre vs. common) was manipulated within subjects. Subjects were assigned to groups as follows: 21 to organizational encoding/same context; 21 to isolated encoding/different context; 20 to organizational encoding/different context; and 20 to isolated encoding/same context.

Procedure

The environmental contexts and materials were the same as in the previous experiments. As before, the sentences were presented by a tape recorder, one sentence every 10 s. Subjects in the isolated-sentence processing conditions were instructed to rate the typicality of the event described by each sentence. That is, these subjects were instructed just like those in Experiment 2. Subjects in the organizational processing conditions were instructed to think about how unusual or usual each sentence was and in addition to try hard to relate each sequence of four sentences together in *any way possible* so that the relationships in the sentences might become more sensible. After listening to the four sentences, subjects rated how usual or unusual the group of sentences was in general. They then tried to relate the next four sentences and to rate those sentences as a group, and so on. Subjects were warned that organizing the sentences would be a challenging task and that they should do the best they could. The remainder of the experiment proceeded as described in Experiment 1.

RESULTS

Examination of the means representing recall performance (see Table 4) indicates that there were no context-dependency effects in

Table 4. Mean number of nouns, verbs, and partial sentences recalled in Experiment 4

Dependent measure	Sentence type	Encoding task			
		Isolated		Organizational	
		Same[a]	Different	Same	Different
Noun recall[b]	Bizarre	8.0	11.7	8.1	8.8
	Common	10.6	9.6	7.3	7.5
Verb recall[c]	Bizarre	2.4	3.6	2.5	2.4
	Common	3.2	3.0	2.0	1.8
Sentence access[d]	Bizarre	3.2	4.4	3.8	3.8
	Common	4.2	3.4	3.0	3.1

[a]Retrieval context (same or different from encoding context). [b]Average number of 36. [c]Average number of 12. [d]Average number of 12; see text for description.

general. In the isolated-sentence encoding condition, however, sentence access was affected by whether recall occurred in the same context as original learning, such that access of common sentences was nominally better when recalled in the same as opposed to a different context. This context-related decrement was not observed with access of bizarre sentences (similar to the findings in Experiment 2). Separate, three-factor mixed ANOVAs for sentence access, noun recall, and verb recall confirmed these impressions. The only statistically significant effect involving the retrieval context variable was a three-way interaction for sentence access involving context (same vs. different), encoding condition (isolated encoding vs. organizational encoding), and sentence type (bizarre vs. common), $F(1, 78) = 4.00$, $MS_e = 2.59$. This interaction reflected the pattern described above.

For what it is worth, the Retrieval Context × Sentence Type interaction approached significance for all three dependent measures. Nouns and verbs embedded in common sentence frames were recalled slightly better when the retrieval context was the same as the encoding context, whereas nouns and verbs embedded in bizarre sentence frames tended to be better recalled when the retrieval context differed from the encoding context, $F(1, 78) = 3.93$, $p < .06$, $MS_e = 17.54$, and $F(1, 78) = 3.32$, $p < .08$, $MS_e = 1.84$, respectively. Also, common sentences tended to be accessed in same-context conditions better than in different-context conditions, whereas the reverse was true for bizarre sentences, $F(1, 78) = 3.16$, $p < .08$, $MS_e = 2.59$, although this interaction was qualified by the three-way interaction reported above.

The only other effects to emerge from the ANOVAs were main effects of encoding task. The isolated encoding task produced significantly better noun recall and verb recall than the organizational encoding task, $F(1, 78) = 4.74$, $MS_e = 35.05$, and $F(1, 78) = 6.39$, $MS_e = 4.50$, respectively.

DISCUSSION

The most robust finding was that context-dependency effects tended to be obtained with common but not bizarre sentences. This is nominally consistent with a finding from Experiment 2, and it is at least partly consistent with our original rationale for using such materials. We originally reasoned that bizarre sentences would not be subject to context-dependency effects because they seem to provide distinctive cues for retrieval (Einstein & McDaniel, 1987; McDaniel & Einstein, 1986). Common sentences do not provide such cues, and therefore subjects must rely on other cues to help retrieve these sentences— cues that apparently include environmental context cues. This pattern seems to be limited to instances when the sentences are encoded in a nonimaginal fashion, because under imagery encoding instructions (Experiments 1, 3, and two pilot studies) this finding did not emerge.

More important for present purposes, the sentence-access scores produced the first direct demonstration (to our knowledge) in which encoding tasks that do not explicitly establish associations between target items and environmental context (cf. Eich, 1985) nonetheless differ in the degree to which context-dependency effects are manifest. Specifically, when access of common sentences was presumably mediated by whatever idiosyncratic organizing scheme subjects could generate (the organizational encoding condition), no dependency on environmental cues was evidenced in terms of trying to access the sentence. However, when these same common sentences were not interrelated (isolated-encoding condition), dependence on environmental cues for sentence access was evidenced. Moreover, in this latter encoding condition, the decrement in sentence access due to context change at retrieval was limited to common sentences. This pattern is consistent with the notion that context dependency is most likely when the encoding of the to-be-remembered material does not afford ready access at recall.

The finding that organizational encoding did not lead to better sentence access than isolated encoding may appear to be at odds with the above ideas. The sentences, however, were explicitly designed to be minimally related (they were originally constructed to investigate the mnemonic effects of bizarre imagery). Also, the sentence blocks

that subjects were instructed to organize all contained at least one bizarre and one common sentence, further complicating the subjects' task. Thus, organization of the sentences was not easily, if at all, accomplished. Nevertheless, subjects' organizational efforts may have modulated their dependence on environmental cues for accessing the sentences, especially common sentences. Perhaps in recall, the subjects in the organizational encoding conditions relied on whatever inter-sentence links they had established (albeit not necessarily strong links) to try to access the sentences, whereas subjects in the isolated con-ditions turned to environmental-context cues if aspects of the indi-vidual sentence itself (e.g., bizarreness) did not foster access.

   Although the pattern of sentence-access effects is suggestive of mod-ulation of context dependence due to the way in which the target items per se are encoded, more evidence is needed to support the idea that a critical feature of the encoding task for such modulation is the degree to which the encoding leads to internally generated retrieval cues upon which the subject can rely.

EXPERIMENT 5

   One kind of encoding activity that appears to provide learners with readily available retrieval cues is self-reference encoding. Self-refer-ence encoding has been shown to produce enhancement of free recall relative to other orienting activities (e.g., Bower & Gilligan, 1979; Rogers, Kuipers, & Kirker, 1977), presumably because such encoding organizes target items within a highly entailed and elaborated self-schema. Based on the reasoning developed throughout this study, we would thus expect that self-reference encoding would not lead to context-dependency effects (because subjects could rely on the ubiq-uitous self-schema to help retrieve target items, thereby precluding the need to utilize environmental cues). On the other hand, we would expect that as in the previous experiments, an encoding task that does not necessarily provide the learner with readily available retrieval cues would be more likely to lead to context-dependency effects in free recall.

METHOD

Subjects and design

   Sixty-four undergraduates participated in partial fulfillment of require-ments for an introductory psychology course. The design was a 2 (Same Retrieval Context vs. Different Retrieval Context compared with the en-

coding context room) × 2 (Self-Referent Encoding vs. Non–Self-Referent Semantic Encoding) between-subjects factorial. Each of the four conditions had 16 subjects.

Environmental contexts and materials

The environmental contexts were two distinctly different rooms in two different buildings at Furman University. One was a small, sparsely furnished human experimental laboratory room with metal chairs and tables, windowless, with fluorescent lights and concrete walls. The other room was a luxuriously appointed conference room that was approximately 10 times larger than the lab room. This room contained wooden paneling, oak tables and cushioned chairs, walls lined with book shelves, curtained windows, and an ornate, lighted chandelier.

The stimulus materials were 48 phrases, each consisting of an article, a modifier, and a noun (e.g., "a beautiful night"). The first 4 and last 4 items served as primacy and recency buffers, respectively, leaving 40 target phrases. The list of phrases was prepared as slides, one phrase per slide.

Procedure

Subjects were tested in groups of 3 to 5. The phrases were presented by a slide projector at the rate of one phrase every 7 s. Subjects in the self-referent processing conditions were instructed to judge whether or not each phrase referred to a specific, personal event or object that they had experienced and to indicate their judgment by circling *yes* or *no* on a response sheet. Subjects in the semantic processing conditions were instructed to judge whether or not the phrase described a social or interpersonal interaction; they, too, responded by circling *yes* or *no* on a response sheet. To maintain an incidental learning situation, all subjects were told that the experiment was investigating judgments of certain types of phrases.

After rating the phrases, subjects were escorted from the presentation room to a large outdoor fountain that was equidistant from the two rooms. Then, depending on the context condition, subjects were either escorted back to the original presentation room or to a different room. (The particular rooms used for presentation of the phrases and for recall testing were completely counterbalanced across subjects for both the same-context and different-context conditions.) Upon being seated, subjects were given a 10-min free-recall test in which they were asked to write down as many of the rated phrases as they could remember.

RESULTS

The number of *yes* responses given for the encoding judgments was analyzed (see Table 5 for mean proportions) with a two-factor between-subjects ANOVA (encoding task and retrieval context were the independent variables). The only significant effect was the main effect of encoding task, with more *yes* responses elicited in the self-

Table 5. Mean free recall (proportion of *yes* responses during encoding in parentheses) in Experiment 5

	Retrieval context	
Encoding task	Same	Different
Self-referent	26.4 (.75)	32.8 (.70)
Social interaction	20.1 (.48)	16.2 (.48)

Note. Average recall of 80. "Same" indicates that retrieval took place in the same room as encoding, and "Different" indicates retrieval took place in a different room.

referent task than in the non–self-referent task, $F(1, 60) = 105.25$, $MS_e = 14.73$.

The following scheme was used to score the recall protocols: If both the adjective and noun of a phrase were correctly recalled, two points were given. If only the noun or only the adjective of a phrase was correctly recalled, one point was given. The mean numbers of items recalled (points) as a function of retrieval context and encoding task are displayed in Table 5. A two-factor between-subjects ANOVA of these data indicated that the self-referent encoding task produced higher recall than the non–self-referent encoding task, $F(1, 60) = 27.64$, $MS_e = 72.05$. There was no main effect of retrieval context ($F < 1$), but as expected, the retrieval context variable significantly interacted with the encoding task variable, $F(1, 60) = 6.95$, $MS_e = 72.05$. This interaction reflected the finding that under non–self-referent encoding, reinstating the original learning context at recall produced nominally higher performance than when recall was attempted in a context different from the original learning context; under self-referent encoding, the reverse occurred.

DISCUSSION

With markedly different encoding tasks and materials than those used in the previous experiments, once again the nature of the incidental encoding task proved to be a critical factor for whether context-dependency effects were manifested. Further, the effects of the particular encoding task were consistent with the framework proposed to explain the effects in Experiment 4. The encoding task that presumably facilitated the generation of effective internal retrieval cues (i.e., the self-referent task), perhaps due to embedding of target information into some well-articulated memory structure (cf. Bower & Gilligan, 1979), was *not* associated with a context-dependency effect.

In fact, recall after this kind of encoding tended to be better when the retrieval context was different from the original learning context. On the other hand, an encoding task that was not expected to provide especially distinctive or easily generated retrieval cues (i.e., the non–self-referent task) produced context-dependency effects. The above interpretation is strengthened by the current finding that the encoding task that was presumed to provide more effective retrieval cues (self-referent encoding) did produce better recall in general.

Incidentally, the present results do not clarify the extent to which the general mnemonic advantage of self-referent encoding was due to the use of an organized self-schema per se or to the possibility that more target phrases were successfully integrated into general semantic memory structures (drawn upon to facilitate retrieval, cf. Craik & Tulving, 1975) during self-referent as opposed to non–self-referent encoding. The latter idea is suggested by the greater number of positive responses under self-referent encoding instructions than under non–self-referent encoding instructions.

GENERAL DISCUSSION

We have reported five experiments focusing on context-dependency effects (or lack thereof) in free recall. An initial impression of the general outcome of this work might be based on a simple tally of the number of times that statistically significant effects involving the environmental context manipulation emerged relative to the number of statistical tests involving the context variable. Considering that there were several recall measures analyzed in all of the experiments except one (Experiment 5) and that all of the experiments contained at least one variable in addition to context, there were 38 statistical tests involving the context variable. Of these 38 tests, 8 were significant at the .05 level.

Based on somewhat inconsistent and infrequent occurrences of significant context effects in this study, the apparently inexplicable nominal *increases* in recall due to context change in two experiments (Experiments 4 and 5), and the absence of context-dependency effects in other recent studies (e.g., Fernandez & Glenberg, 1985; Saufley et al., 1985), one might be led to conclude parsimoniously that context effects are at best meager and at worst unreliable. Yet even Fernandez and Glenberg (1985), who failed to find reliable context-dependency effects in eight experiments, preferred to suggest that their experiments not be taken as evidence against the existence of context-dependency effects, but might best be viewed as a demonstration that experimenters are not capturing critical components of the effect. In

an evaluation of the studies noted above, including that of Eich (1985), Wickens (1987) arrived at a similar conclusion: "These three carefully conducted sets of studies support the opinion that the magnitude of the context effect does vary considerably. We need to address our research to the problem of identifying the factors responsible for this variation" (p. 152).

Accordingly, another way to view our results is that they represent a beginning effort toward meeting Wicken's (1987) challenge. In the present discussion we thus present an interpretation of the data that acknowledges the absence of context-dependency effects, but also attempts to account for the instances when they occurred. We believe that this reconciliation is warranted considering that the number of significant effects associated with the environmental-context manipulation, although modest, was still substantially higher than would be expected due to chance, based on the established Type I error rate.

The most consistent finding was that when context-dependency effects were obtained with sentential materials (Experiments 1-4), the effects were limited to (Experiments 3 and 4) or included (Experiment 2) the memory measure that primarily reflected access. This is in line with the idea that environmental information can serve as a cue to help the learner retrieve (access) the items (events) in the list (Anderson & Bower, 1972; Raaijmakers & Shiffrin, 1981), and it might be that measures that index memory access (rather than redintegration, familiarity, etc.) will be the most sensitive in the detection of context-reinstatement effects.

As Wickens (1987) has argued, however, people's experiences have taught them that the room in which something is encoded is not a dependable cue for retrieving a specific set of responses (target items). It follows that if more useful cues can be generated, then subjects may prefer (although not necessarily in a conscious fashion, cf. Wickens) to exploit those cues. The failures in this study to find enhancement of recall when memory was tested in the same environmental context (versus a different environmental context) may be related to the degree to which the encoding activity and the to-be-remembered information attenuates the need for subjects to depend on environmental information for retrieval cues. This view converges in general with Smith and Vela's (1986) hypothesis that context reinstatement effects are not found when more specific retrieval cues are available that override environmental context retrieval cues. Following is a more detailed accounting of the data within this framework.

Context reinstatement effects were generally not found when the target sentences (Experiments 1–4) or phrases (Experiment 5) were encoded with an elaborative orienting activity. Specifically, when sub-

jects were instructed to image the sentences (Experiment 1), to try to organize the sentences during encoding (Experiment 4), or to try to encode phrases with regard to the "self" (Experiment 5), recall was not enhanced by reinstating the environmental context present at encoding. The only exception to this was Experiment 3 in which context-dependency effects emerged under imagery encoding instructions. It is not clear what to make of this finding given that in three experiments in addition to Experiment 1 (two pilot experiments and Eich's, 1985, condition in which the targets were not encoded in an image that explicitly integrated the target with the environment), context-dependency effects were not obtained after imagery encoding instructions.

Theoretically, elaborative activities (the encoding activities enumerated above would commonly be classified as such) are mnemonically effective, especially in recall, because they presumably enhance the retrievability of target information (Anderson & Reder, 1979). More specifically, organizational and self-referent encoding are explicitly viewed as providing a greater number of retrieval routes or easily generated retrieval cues useful for free recall by virtue of the interitem or schema-related associations that are prompted by such encoding (cf. Bellezza, 1987; Bower & Gilligan, 1979; Einstein & Hunt, 1980; Masson & McDaniel, 1981). Again, it is plausible that these types of cues are preferable to those provided by the environmental context. Thus, one conclusion that seems tenable is that context reinstatement effects will be less likely with encoding tasks that provide effective retrieval cues.

The above interpretation might also help account for another trend in the results that was related to the context-dependency effects. In Experiments 2 and 4 (but not Experiment 3) context-dependency effects were limited to or were most prominent for the common sentences; in these experiments such effects were attenuated or eliminated for the bizarre sentences. Bizarre sentences are typically thought to be more distinctively or elaboratively encoded when presented in a list with common sentences (Einstein & McDaniel, 1987; Hirshman, Whelly, & Palij, in press, respectively), possibly providing additional cues for retrieving those sentences (cf. Desrochers & Begg, 1987). These cues may reduce subjects' dependence on contextual cues for recalling the (bizarre) sentences. In contrast, common sentences would not have the benefit of such cues directly emerging from the target material, thereby forcing more reliance on environmental cues to aid retrieval.

An alternative is that the elaborative encoding tasks and the bizarre sentences might have required such extensive processing resources

that they attenuated encoding of the environmental context or pre-cluded the formation of incidental associations between context and target items (sentences) (cf. Fernandez & Glenberg, 1985). Following Eich (1985), we consider this possibility unlikely because subjects were given ample time to perform the encoding tasks.

Finally, the viewpoint being considered is not inconsistent with the tendency in Experiments 4 and 5 for bizarre sentences (in the isolated-sentence encoding condition) and self-referent encoding, respectively, to be associated with increased recall when the environment was different from that at encoding. Perhaps, when subjects attempt to recall in the same context as was present at encoding, there is some (but not substantial) reliance on environmental cues. Having such cues present may inhibit the use of other, more effective cues (that are available for bizarre sentences or "self-coded" material) that must be relied upon when the environmental context is not reinstated.

We offer the present interpretation as one possible account of the results, an account that may prove fruitful for guiding research and theory on the mnemonic effects of context. As implied, though, this interpretation is not without shortcomings. First, as noted above, several of the patterns that are encompassed by our interpretation are not uniformly obtained (primarily due to the results in Experiment 3).

Second, we have speculated that bizarre sentences and organiza-tional encoding provide retrieval cues that override the need to use environmental-context cues, thereby eliminating contextual-depend-ency effects (Experiments 2 and 4). Yet these hypothesized retrieval cues did not serve to enhance recall relative to common sentences and isolated-sentence encoding, respectively (in Experiments 2 and 4). Thus, a more precise specification of what these cues are and how they might function would be desirable.

Third, it is not entirely clear to what extent the present findings and the account of these findings generalize to other types of encoding variations and materials. Reasoning along the lines discussed herein, Fernandez and Glenberg (1985, Exp. 4) had subjects either generate or read sentences with the expectation that generation would im-munize subjects from context-dependency effects due to the greater availability of self-generated cues for remembering the generated material. As expected, there were no context-dependency effects for recall of words used in the sentence-generation task, but inexplicably there were also no context-dependency effects for the reading task. It might be relevant that Fernandez and Glenberg's "read" condition required more processing than standard read conditions (their subjects were required to check the sentences to make sure they contained a

requisite list of target words, to write the sentence, and to estimate the amount of time it would take to generate the sentence from the prescribed word list), perhaps resulting in a higher degree of elaborative encoding. Consistent with this idea, the read conditions produced free-recall performance that was comparable to that produced by the generate conditions.

An intriguing finding was that in Experiments 2 and 4 bizarre and common encodings did not significantly differ in terms of their mnemonic effectiveness in general, but recall levels of bizarre relative to common encodings varied depending on whether recall was in a same or different context (from that of encoding). This pattern raises the interesting possibility that existing research concerned with the effectiveness of different encoding strategies may be limited, because most studies assess the relative mnemonic effectiveness of various encoding strategies by requiring study and test in the same environmental context. For at least some encoding tasks, different patterns might emerge if the study and test contexts were varied. In addition to the theoretical importance of such a possibility, from an ecological standpoint (especially in terms of educational considerations) it may be more important to assess the mnemonic effectiveness of encoding strategies in different-context rather than same-context conditions.

In conclusion, the present findings complement and extend current conceptualizations of context-dependency effects (e.g., Smith & Vela, 1986; Wickens, 1987). Most generally, it appears that environmental context may have some influence on recall, but its influence does not seem ubiquitous. More important, the current results may contribute to understanding the necessary and sufficient conditions for obtaining context reinstatement effects. Previous interpretations of failures to find context-dependency effects have raised the possibility that associations between target items and environmental context are not usually automatically acquired. For instance, Eich (1985) proposed that special instructions that produce integrated target/context associations may ordinarily be required for robust context-dependency effects to emerge, and Fernandez and Glenberg (1985) proposed that the environment may have to be perceived as causing the event or enabling the event to occur for the promotion of context effects (in the absence of special instructions). In Experiments 2–5, we found at least modest context-dependency effects, despite the absence of special efforts to link context and target items and despite the absence of environments that were intrinsically related to target items. This finding, along with previously published work (e.g., Jensen et al., 1971; Smith, 1979; Smith et al., 1978), implies that special instructions to link the targets

and the encoding context or ecologically related contexts are not necessary factors for context-dependency effects, although these factors may be involved in obtaining strong context-dependency effects.

Experiments 2–5 further demonstrate that intentional learning of the target material is also not required to obtain context-dependency effects. In most of the studies cited reporting context reinstatement effects, subjects have intentionally tried to learn the target material for a subsequent memory test (for an exception, see Smith et al., 1978, Exp. 3). Thus, the present findings suggest that target/context associations presumed to mediate the context reinstatement effect (Smith, 1979) can be automatically or inadvertently acquired, but the nature of the encoding activity directed at the target per se can affect whether or not context-dependency effects emerge.

Notes

1. The analyses of variance were computed with the BMDP2V program, which allows for unequal cell sizes in mixed designs.

2. These ANOVAs included the particular encoding contexts and recall contexts (i.e., the counterbalancing conditions) as between-subjects factors. We could not reanalyze these data as in the other experiments (collapsed across counterbalancing conditions) because this data file was misplaced. We had analyzed the other experiments both ways, however, with both analyses producing the exact same pattern of results. Thus, it is very unlikely that a reanalysis of Experiment 3 (collapsing across counterbalancing conditions) would have produced a different pattern.

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