Memory & Cognition
1981, Vol. 9 (3), 308-316

Context and repetition effects in recognition memory

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The demonstration of a repetition effect in recognition memory when context at the time of test is different from that occurring during presentation places limits on the role played by context in interpretations of recognition memory. Four experiments are reported that explore those limits, including a situation in which the repetition effect does not obtain due to the nature of the context. The data are interpreted in terms of the important interaction between item information and contextual information in theoretical accounts of recognition memory.

Recent research on recognition memory has placed great emphasis on the role of retrieval processes. Since Light and Carter-Sobell (1970) first demonstrated the existence of context effects in recognition memory, the theoretical discussion of recognition has focused on questions related to accessibility. Tulving's (1968) work on recognition failure of recallable words has placed even further emphasis on retrieval processes in recognition.

Prior to the demonstration of recognition failure and context effects, recognition was viewed as a very simple process, dependent solely on some unidimensional characteristic of the memory trace. Theoretical statements were based on the notion of strength or familiarity. Access to the memory trace was viewed as automatic. The parameters of signal detection theory were calculated and reported almost as automatically. The demonstrated existence of context effects in recognition forced theoretical revision, but in our new enthusiasm for the role of retrieval in recognition performance, we have lost sight of one important fact. Retrieval is a process that must have something upon which to operate. There must be some substrate, some trace, to be retrieved. And in our enthusiastic efforts to tackle the retrieval problem, we have often ignored the problem of what is stored.

In support of such a charge, consider a paper by Davis, Lockhart, and Thomson (1972). Virtually ignored in the contemporary recognition memory literature, Davis et al. demonstrated a repetition effect in recognition memory that strongly suggests the need for a strength component. The question that they asked was simple. How do multiple presentations of the to-be-remembered material interact with the typical context effect? The answer was equally simple: They do not. Recognition performance improves as a function of repetition, and the amount of improvement is independent of whether the recognition test occurs in the same context as existed during presentation or in a changed context. Such a finding is difficult to accommodate within the framework of models that interpret the basic context effect solely as an access problem.

Since the present paper extends the Davis et al. (1972) findings, a more detailed look at their paper is in order. While all three of their experiments demonstrated essentially the same effect, Experiment 3 will serve as the reference point. Subjects were presented a long list of word triads such as SWEEP, WASH, IRON. Such a triad occurred either once or three times in a list, multiple presentations being distributed. Following presentation of the list, subjects were given a yes-no recognition test on the critical, homonymic items (IRON), with those items being presented for test either in the same context (SWEEP, WASH, IRON) or in a different context (COPPER, ZINC, IRON). The results, presented in Table 2 for comparison with the present data, are clear. Looking at hit rates on the critical items, there are two main effects and no interaction. Testing in the context used during presentation produced a higher hit rate than that obtained with a changed context. Presenting a word three times produced a higher hit rate than did a single presentation. But the important finding is that the repetition effect was independent of whether the presentation context was maintained or changed at the time of test. To quote Davis et al. (1972, p. 102), the demonstration "that retrieval processes as currently conceived cannot account for simple repetition phenomena places an important boundary condition on the range of retrieval effects obtainable in recognition."

Two recent attempts have been made to take the mnemonic substrate of retrieval into account in considering recognition memory. Neither, it might be noted, references the Davis et al. (1972) research. Rabinowitz, Mandler, and Barsalou (1977) suggested a dual access theory of recognition based on a distinction between

Initial interest in this problem was stimulated by Larry Jacoby while the author was on sabbatical leave at McMaster University. The leave was made possible by a Canada Council Leave Fellowship 451-770818. I am grateful to Michael Humphreys for a stimulating review of an earlier version of the manuscript.

0090-502X/81/030308-09$01.15/0

presentation codes and conceptual codes. The presentation code encompasses such concepts as occurrence information and familiarity and is seen as being automatically accessed (no retrieval problem) upon presentation of a copy cue. The conceptual code includes the kinds of information, usually semantic in nature, that operate in retrieval processes. The presentation and conceptual codes are usually viewed as operating serially and conditionally, although more recently, Mandler (1980) has suggested that both processes may begin upon item presentation. Upon presentation of an item in a recognition test, the presentation code is automatically accessed and leads to a response if the available information exceeds either of two criteria. A "yes" response will occur if the information exceeds a high criterion, and a "no" response will occur if the information fails to reach a low criterion. Only if the presentation of the copy cue leads to an intermediate level of mnemonic information does the second stage, the utilization of the conceptual code, come into play. The process is like that suggested by Atkinson and Juola (1974).

Humphreys (1976, 1978) has advanced a somewhat similar argument using the labels item and relational information. Humphreys appears to disagree with the Rabinowitz et al. (1977) formulation on at least two points. First, Humphreys argues that item information must contain some semantic component, whereas the concept of presentation code appears not to do so. Second, the models differ on how the two types of information (codes) enter into recognition performance. For Rabinowitz et al., the retrieval of the conceptual code occurs only when the presentation code is inadequate, whereas for Humphreys, the retrieval of relational information is dependent on the prior retrieval of item information. However, since the Rabinowitz et al. formulation requires some access to the presentation code, above some lower criterion, before the conceptual code is used, that difference may be more apparent than real. The difference is even further reduced in two ways. Mandler (1980) suggests that access to the presentation code (the familiarity evaluation) and to the conceptual code (the retrieval process) may begin together. And Humphreys (1978) suggests that relational information may be accessed via the context rather than the item. The important point is that both formulations include a critical role for item information. Superficially, at least, neither model of the recognition process is embarrassed by Davis et al.'s (1972) repetition effect data, although a problem will be raised in the discussion following Experiment 2 and considered more fully in the final discussion.

It should also be noted here that a recent paper by Slamecka and Barlow (1979) extends the repetition effect to a recall paradigm. Slamecka and Barlow found equivalent repetition effects for twice-presented homographs regardless of whether the same or different meanings were emphasized on separate occurrences during presentation. They argued for the importance of common surface features mediating the repetition increase, an interpretation that seems similar to either the presentation code or item information proposals outlined above. Whether or not access to item information, in the form of a familiarity evaluation as developed by Mandler (1980), can handle the recall data is a theoretical question beyond the scope of this paper.

Finally, in a related area of research, Conrad (1974) and Underwood (1980) have reported data suggesting that lexical access of ambiguous words is nonselective. Both meanings of an ambiguous word appear to be available, and one can facilitate access to the other.

The current series of studies represents a replication and extension of the Davis et al. (1972) work. Experiment 1 was designed primarily as a replication of their third experiment, with the addition of a mixed condition in which repeated target words occurred in different contexts on each presentation and were tested in one of the two presented contexts. This manipulation parallels Slamecka and Barlow's (1979) different-meaning condition and extends their observations to the recognition situation. Experiment 2 was a repeat of the first experiment, except that no context was present during the test phase. Experiment 3 eliminated a frequent confounding in context effect studies in which changed test contexts are also usually "new," previously unexperienced contexts. The elimination of the confounding also eliminated the changed-context repetition effect. Experiment 4 tested an interpretation of this finding by relating recognition performance to the retrieval effectiveness of the changed context. Together, these four experiments place even stricter boundary conditions on the retrieval effects in recognition memory and help to clarify the role such effects do play.

EXPERIMENT 1

The task employed was very similar to that used by Davis et al. (1972) in their third experiment. Subjects were presented a long list of word triads in which the third word was always a homonym. The first two words biased one meaning of the homonym. A typical triad would be TELLER, LOAN, BANK. Under instructions to notice the relationships between the words in each triad and to remember the words, subjects went through a list of triads and were then given a recognition test. The critical, homonymic words were tested either in the same context (TELLER, LOAN, BANK) or in a different context (RIVER, STREAM, BANK). Triads occurred either once or twice in the list. In addition, some homonyms occurred twice in the list but in different contexts each time. In what we will refer to as the mixed condition, the word BANK would occur once in the TELLER, LOAN context and once in the RIVER, STREAM context. The recognition test on mixed-

condition words was always a "same-context" test. The mixed condition is equivalent to Slamecka and Barlow's (1979) different-meaning condition, but we avoid their term because of possible confusion with our different-context test condition.

Two basic questions were asked. First, could the Davis et al. (1972) data be replicated? Second, how would people perform on mixed-condition words?

Method

Design and Subjects. Subjects read through a list of 92 word triads. The first six and last six triads served as primacy and recency buffers, respectively, and were not tested. The remaining 80 triads presented 48 critical items, 16 in each of three conditions. One-third of the triads occurred only once in the list. One-third of the triads occurred twice, being repeated after an average lag of 6.5 other triads. Finally, the critical homonym of the remaining 16 triads was repeated, but with two words that biased the alternate meaning of the homonym, the mixed condition. The mean repetition lag was again 6.5 other triads.

Following the presentation of the list, subjects were given a recognition test on the 48 critical items. The format followed Davis et al. (1972, Experiment 3). Three words were presented simultaneously, but in an order scrambled relative to the prior presentation, and each word was numbered with asterisks (e.g., *LOAN, **BANK, ***TELLER). After the words had been read, they were removed and the subject was given a cue (**) as to which word should be subjected to a recognition decision. This procedure was used to ensure that all words were read prior to a decision.

Forty-eight subjects enrolled in the introductory psychology course participated for course credit. Subjects were tested in small groups of up to four at a time.

Materials. A set of 48 homonyms was selected from the Perfetti, Lindsey, and Garson (Note 1) norms, with two restrictions. Each word selected has only two predominant meanings, and the two meanings are not widely divergent in dominance. Additional words were selected from the normative responses given to the homonyms to serve as the context words in the triads and as the distractors in the recognition test.

Six different presentation lists were constructed by rotating words through the three different presentation conditions and by counterbalancing the two different meanings of each homonym in each condition. Four different test decks were constructed such that across decks, every presented item could be tested in four ways. Two of the four tests involved a presentation of the homonym, once in the previously presented context and once in the nonpresented context. (For homonyms that occurred in the mixed condition, both of these tests represented presented, or same-context, tests, one in each of the two presented contexts). The other two types of tests involved the presentation and test of a new, distractor item, one in a context that had occurred either once or twice during presentation and one in a new context. (In the mixed condition, the two new items tested were one in each of the two presented contexts.) Thus, in each test deck, half (24) of the tested items were old and half were new.

Table 1 provides an outline of the study and test conditions. In the portion of the presentation list shown, the once-presented, twice-presented, and mixed-condition items were CHARGE, BANK, and CASE, respectively. Other presentation lists counterbalanced these words across conditions. The four test deck

Table 1
Outline of the Different Study and Test Conditions in Experiment 1

Presentation Deck A

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RIVER STREAM BANK
ADVANCE CAVALRY CHARGE
COURT LAWYER CASE

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RIVER STREAM BANK
COKE CONTAINER CASE

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Test Deck A	Test Deck B	Test Deck C	Test Deck D
.	.	.	.
.	.	.	.
.	.	.	.
RIVER	TELLER	RIVER	TELLER
STREAM	LOAN	STREAM	LOAN
BANK	BANK	MEADOW	VAULT
ADVANCE	CARD	ADVANCE	CARD
CAVALRY	BUY	CAVALRY	BUY
ATTACK	SPEND	CHARGE	CHARGE
COURT	COURT	COKE	COKE
LAWYER	LAWYER	CONTAINER	CONTAINER
CASE	TRIAL	CASE	BOTTLE
.	.	.	.
.	.	.	.
.	.	.	.

Note–See text for explanation.

portions show the various test conditions. The critical items are underlined for clarity only. Using the twice-presented item (BANK) as an example, it is tested as a same-context old item in Deck A, as a different-context old item in Deck B, as a same-context new item in Deck C, and as a different-context new item in Deck D. Decks A and B provide hit rate data; C and D provide false positives.

The combination of six presentation lists and four test lists thus required 24 subjects. Two subjects were tested with each combination of lists.

Procedure. Word triads were typed in uppercase letters, on 3 x 5 in. note cards, one triad per card. Subjects were paced through the deck of 92 presentation cards at the rate of one card every 5 sec. They were instructed to read the words on each card, notice the relationship that existed between the words, and try to remember the words. They were told to expect to see words repeated but were not informed about the precise nature of the memory test beyond the fact that it would involve recognition.

The recognition test consisted of a deck of 96 cards. Half of the cards contained three words typed in identical format to those in the presentation deck, except that the order of the three words was randomized and the three words were "numbered" from top to bottom with one, two, or three asterisks. After a subject had read such a card, he turned to the next card in the deck, which cued the word to be responded to with the appropriate number of asterisks. The subject was instructed to write down the cued word, respond "yes" or "no" to indicate whether he thought it had occurred in the presentation deck, and then rate his confidence on a 3-point scale. Subjects were permitted to look back to the previous card if they were in any doubt as to which word was being cued, but such behavior rarely occurred. After responding, subjects proceeded to the next card, which contained another triad. The test was self-paced.

Analyses. The basic data are number of "yes" responses in the various conditions. Hit rates and false alarm rates were analyzed separately. All analyses were carried out in two ways. First, the data were analyzed by combining over different homonyms and treating subjects as a variable. Second, the data were combined over subjects, treating the different homonyms as a variable. The results of the separate analyses were then combined to yield a min F′ (Clark, 1973). The level of significance for all tests was set at $p < .01$, although values of $p < .05$ will be reported for the conservative min F′ statistic.

Results and Discussion

The basic results, consisting of proportion of "yes" responses and standard errors of the proportions, are presented in Table 2. In none of the experiments did recognition performance differ as a function of the various counterbalancing decks.

The first obvious point to be made is in the comparison of Davis et al.'s Experiment 3 data (included in Table 2) and the present data. Of the eight comparable conditions, seven provide data that are within 1 standard error of the mean. The success of the replication is obvious.

Analyses of variance on hit rates (excluding, for the moment, those from the mixed condition) yielded a significant effect of test context [$\min F'(1,208) = 25.47$] and a significant repetition effect [$\min F'(1,211) = 11.32$]. The interaction between the two was not significant. In a separate analysis, treating subjects as a variable, the hit rate for items from the mixed condition (i.e., items that were presented twice in two different contexts and tested in one of the two contexts) did not differ from that obtained when the item occurred twice in a single context and was tested in the same context [$F(1,24) = 2.89$].

Analyses of variance on false alarm rates yielded a significant effect of test context [$\min F'(1,204) = 13.07$], but no effect of repetitions [$\min F'(1,204) = 2.67$]. The false alarm rate in the mixed condition was the same as that for the same-context tests.

A portion of this paper was presented at the Eastern Psychological Association meeting in Philadelphia, and a member of the audience suggested that the lack of an interaction between context and repetition may not be the critical outcome. More important for theoretical purposes would be the clear demonstration of a repetition effect under changed-context test conditions. To

Table 2
Proportion of "Yes" Responses (P) and Standard Errors

		Hit Rate				False Alarm Rate			
		Test Context				Test Context			
		Same		Different		Same		Different	
		P	SE	P	SE	P	SE	P	SE
Davis et al. (1972, Experiment 3)	Nonrepeated	71		48		32		19	
	Repeated	90		70		29		20	
Experiment 1	Nonrepeated	73	3	52	4	31	4	16	3
	Repeated (One Context)	89	3	67	4	39	4	22	3
	Repeated (Mixed)	84	3			36	3		
		No Test Context				No Test Context*			
Experiment 2	Nonrepeated	56		3		35	6	20	4
	Repeated (One Context)	75		4		37	5	22	5
	Repeated (Mixed)	75		4		33	3		
Experiment 3	Nonrepeated	73	3	48	4	28	3	28	4
	Repeated	85	3	52	4	32	4	34	3

**See text for explanation.*

that end, an analysis of variance by subjects carried out on only the changed-context data showed a significant repetition effect [$F(1,24) = 14.00$].

The data were also analyzed by using the rating data and combining hits and false alarms to generate R, the area under the ROC curve (Brown, 1974). The mean values for same-context testing were .75 and .80 for single and double presentations, respectively. For changed-context testing, the values were .69 and .76. Analysis of variance showed a significant effect of test context [$F(1,72) = 6.37$, $p < .025$] and a significant repetition effect [$F(1,72) = 9.55$]. Finally, an analysis of only the changed-context data again showed a significant effect of number of presentations [$F(1,24) = 6.82$, $p < .025$].

Only two brief points of discussion need to be included here. The first is the obvious observation that we have replicated Davis et al. (1972), suggesting again the need for something like a strength component underlying recognition memory. The second point takes us a step closer to understanding the mechanism. While a model like that of Rabinowitz et al. (1977) specifies that the item information must be accessed first, the basic Davis et al. data would not have been embarrassing to a position that argued for a contextually driven system. For example, consider a model in which the familiarity of the test triad as a whole is judged, followed by an evaluation of, or search for, the item in context when the context is judged as familiar and an evaluation of the item independent of context when the context is judged as unfamiliar. Assuming repetition information to be part of the item information, that sequence of operations could accommodate the same- and different-context repetition effects. The more restricted item-in-context search has a higher probability of success, which produces the context effect. However, such a position will need modification to account for the high level of performance in the situation in which a twice-presented item occurred in different contexts on its two presentations, the mixed condition. The reasoning is straightforward. If in such a situation the test context was judged as familiar, the item-in-context search would be for a once-presented item, and if the context were judged as unfamiliar, the search would be for a repeated but different context test item. The actual level of performance in the mixed condition (84% hit rate) was substantially higher than the observed performance level in either of those situations (73% and 67%, respectively). Such a finding seems to require access to the repetition information contained in the item even when the search is for the item in a once-presented, familiar context. Further discussion will be postponed until the additional constraints imposed by further studies have been reported.

EXPERIMENT 2

Method

Experiment 2 was a repetition of Experiment 1 with but one change. The test decks consisted of 48 cards, on each of which was typed a single word to which the subject responded "yes" or "no" and gave a confidence rating. The words tested were simply all of the tested words from the Experiment 1 test decks with the context stripped away. All other details were identical to those in Experiment 1.

The subjects were 24 undergraduates from the same source used previously.

Results and Discussion

The data are again presented in Table 2. The hit rate data provided no basis for assessing context, since with no context present at test a BANK is a BANK regardless of the initial presentation condition. The analyses of variance showed a significant effect of repetitions [$\min F'(1,65) = 8.65$]. Again, the hit rate on items presented in the mixed condition was the same as that for items presented twice in the same context.

The Experiment 2 hit rate data were then compared with the hit rate data from Experiment 1 with different test context. The only significant source of variability in the analysis was the repetition effect [$F(1,15) = 16.64$]. There were no significant differences, either main effects or interactions, between the Experiment 1 different-context condition and the Experiment 2 no-context manipulation.

The false alarm data were partitioned on the basis of context even though none was presented at test. The partitioning can best be described in relation to Experiment 1. In that experiment, following presentation of RIVER, STREAM, BANK, a subject might have been tested on RIVER, STREAM, MEADOW or on TELLER, LOAN, VAULT, the last item in each triad being tested. The former produced the same-context false alarms, and the latter produced the different-context false alarm data. In Experiment 2, the difference between them is in whether an "appropriate" context had occurred during list presentation.

Analyses of variance on the false alarm data so partitioned yielded data comparable to the data obtained in Experiment 1. The only significant source of variability was a "context" effect [$\min F'(1,63) = 6.88$, $p < .05$]. Comparable Experiment 1 and 2 data points all fell within 1 standard error of each other.

The only important point to be made in discussion is that the false alarm differences found in this experiment place a further constraint on the interpretation of the differences in Experiment 1 and in Davis et al. (1972). The current data would seem to force an interpretation whereby the Experiment 1 false alarm effects reside in the items themselves and not in the context that surrounds them at the time of test. More support is thus provided for the priority of item access. But a theoretical problem begins to emerge at this point. Some mechanism is needed to account for the new item "context" effect. A number of possibilities exist, such as Underwood's (1965) implicit associative response idea, but the problem is to understand why two presentations do not produce a higher false positive rate than does a single presentation. In other words, why is there no

repetition effect on "appropriate-context" new items? Discussion of this problem will be postponed until after the final two experiments are reported, the results of which place further restrictions on the priority of item access.

EXPERIMENT 3

Experiment 3 was conducted to remove what turns out to be a serious confounding that occurs in most studies of context effects and recognition. When an item is tested in the same context as that accompanying its initial presentation, such a context is also, by definition, an old, previously experienced context. In contrast, when an item is tested in a different context from that occurring during presentation, the test context is typically a new, previously unexperienced one, as well as being different, with respect to the specific critical item. One exception to this usual confounding can be found in a somewhat different situation in Humphreys' (1976) rearranged pairs condition. In the more typical contextual recognition paradigms, however, the confounding exists between being new and being different. Experiment 3 removed that confounding.

Method

Experiment 3 was a modified version of Experiment 1. One modification consisted of the elimination of the mixed-condition words. That then left only two presentation conditions, single and double presentations, the latter always occurring in a complete repetition of the triad. The second modification involved the addition of 48 cards to each presentation deck. Each added card had typed on it a triad that "balanced" one of the critical triads. Thus, if a subject saw TELLER, LOAN, BANK on a particular card, then one of the newly added cards would contain the triad RIVER, STREAM, HILL. All "balance" triads occurred only once. The addition of such a card then made a different-context test condition (RIVER, STREAM, BANK), one in which the context was also old, as in the same-context test condition. The addition of those cards also served to increase the average lag between repetitions to 11 intervening cards. The elimination of the mixed-context condition reduced the required number of counterbalancing presentation decks to four. Otherwise, all other details were exactly like those in Experiment 1.

Thirty-two subjects from the same source used previously served in the experiment.

Results and Discussion

The data are presented in Table 2. Analyses of hit rates showed a significant context effect [min $F'(1,162) = 39.84$] and a nonsignificant repetition effect [min $F'(1,159) = 2.57$]. The separate analyses, by subjects and by words, both showed repetition effects at $p < .05$. The interaction was not significant. Analyses on false alarms showed no differences anywhere. An analysis of variance by subjects, carried out only on the changed-context data, showed no significant repetition effect [$F(1,16) = .41$]. Finally, the R values for single and double presentations were .71 and .80 for same-context tests and .61 and .60 for different-context tests.

Given the unexpected nonsignificant repetition effect with changed-context testing, it was decided to attempt a complete replication. The results were essentially the same, showing a significant context effect [min $F'(1,121) = 32.81$] and, this time, a repetition effect [min $F'(1,121) = 4.93$, $p < .05$], and no interaction. An analysis on only the changed-context hit rate showed no repetition effect [$F(1,16) = 2.12$]. The R values for single and double presentations under changed-context testing were .63 and .67, respectively.

Besides the loss of a changed-context repetition effect, the false alarm data were also affected by the additional contextual information. The addition of "balance" triads such as RIVER, STREAM, HILL served to increase the false recognition rate to the last word in the RIVER, STREAM, MEADOW triad to the level of the same-context false alarms. Such a result is not surprising, of course, because the manipulation served to make the distinction between same and different test contexts meaningless in the case of the false alarms.

It appears, then, that the changed-context repetition effect may be due to a confounding of changed context with new context. However, extensions of the current work (Donaldson & Williams, Note 2; States & Donaldson, Note 3) have consistently demonstrated a changed-context repetition effect even when the changed test context had previously occurred. The only difference between the experiments leading to the contradictory data was the nature of the context. The research in this paper biased homograph meaning by including the critical words in a triad (RIVER, STREAM, BANK). The research that produced the repetition effect used sentence contexts (We had a picnic by the river bank). A balance sentence (We cashed a cheque in the corner store) occurred during presentation, and a changed-context recognition test would be on BANK in the context "We cashed a cheque in the corner bank." With such sentences, changed-context repetition effects consistently occur.

One possible explanation of the different results obtained with triad and sentence contexts relates to their differential effectiveness as retrieval cues. A sentence frame with the critical word missing may well be a better retrieval cue for that word than would be the first two words in a triad. The hypothesis would then be that when a changed context leads to a correct recall of the balance word (STORE in the above example), recognition of the critical word (BANK) can occur independently of the context, thus leading to a repetition effect. This would parallel the situation in Experiment 1 in which a changed context can be ignored because it is known to be new. On the other hand, if the changed context does not lead to successful retrieval of the balance word, then the critical word will be evaluated in context and will not show a repetition effect. The difference between sentence and triad

contexts, then, is that the former is more likely to lead to successful recall. Experiment 4 was designed to test that hypothesis. One could do so by simply comparing the cued recall effectiveness of the two types of context. A more direct test, however, would be to demonstrate with triads that the changed-context repetition effect could be obtained following successful recall of the balance word but not otherwise.

EXPERIMENT 4

Method

Experiment 4 was the same as Experiment 3 except for two changes. First, prior to the recognition test, subjects were given the first two words from each of the 48 "balance" triads and were asked to try to recall the other word that had occurred with them. Second, on the recognition test, subjects were tested only under changed-context conditions. This was done to increase the amount of data obtained from each subject. Thus, of the 48 recognition tests, 24 were on old items, 12 of which had occurred once and 12 twice in the presentation deck. Thirty-two subjects were tested.

Results and Discussion

On the recall test, 32.4% of the balance words were correctly recalled. To 5.3% of the cues subjects recalled the critical target items in the recognition test. The remaining cues were either not responded to (53.2%) or generated intrusions (9.1%).

On the overall recognition test, the hit rate on singly presented items was 62.8% with a standard error of 3.7%, and on twice-presented items it was 70.8% with a standard error of 3.6%. Analysis of variance indicated a reliable repetition effect [$F(1,24) = 7.86$]. The false alarm rate on both once- and twice-presented items was 35.4%. This finding of an overall repetition effect contradicts the findings of Experiment 3 but may be due to the fact that same-context tests were never administered and/or to the effect of the interpolated recall test.

The important recognition data are conditionalized on recall performance. The critical comparison is between recognition performance on the 32.4% of the triads for which successful balance-word recall occurred and the 53.2% of the triads for which no recall occurred. Subjects of course varied considerably in their level of recall. The conditionalized recognition data showed high variability partly due to a fair number of 0/1 and 1/1 ratios. The hit rates conditionalized on nonrecall were 67% and 70% for one and two presentations, respectively. The hit rates conditionalized on successful balance-word recall were 52% and 59%. The false alarm rates also differed, being 41% following nonrecall and 22% following recall. To obtain a more sensitive measure, the confidence rating data were used to obtain four R values (Brown, 1974) for each subject, one vs. two presentations and prior recall vs. nonrecall. The means ±1 standard error are shown in Figure 1.

An analysis of variance was carried out on the data. The analysis indicated a reliable repetition effect [$F(1,72) = 19.18$], confirming what was previously reported for the overall recognition hit rate. Of more importance, the interaction between repetitions and recall performance was also significant [$F(1,72) = 6.86$, $p < .025$]. As predicted, the changed-context repetition effect occurred only following successful recall of the balance item.

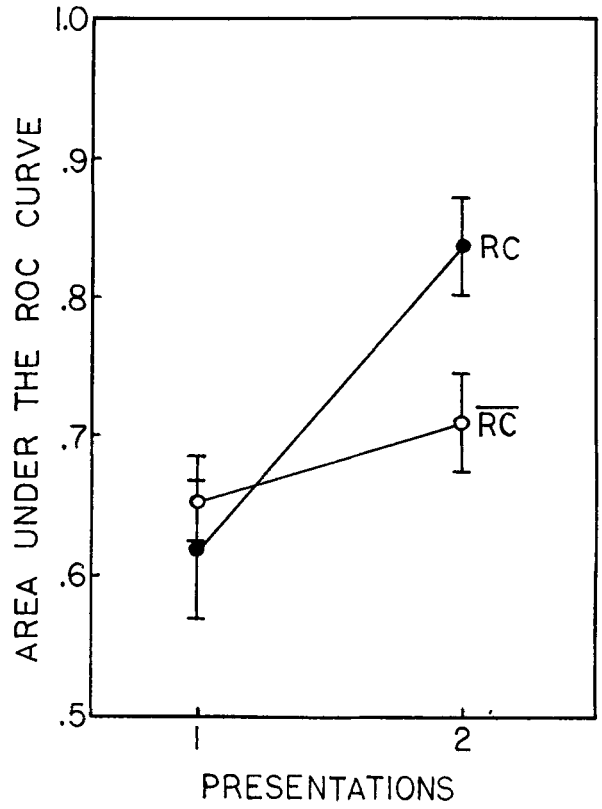

Figure 1. The area under the ROC curve (R) ±1 standard error as a function of number of presentations and of the successful (RC) or unsuccessful ($\overline{RC}$) prior recall of contextually related "balance" items.

We seem to have come full circle. While the first two experiments focused attention on access to item information, the final two experiments reintroduced the importance of context.

GENERAL DISCUSSION

For discussion purposes, the data are best divided into three sets. First, we will explore the basic repetition effect, as evidenced in Experiments 1 and 2. Second, the failure to find a repetition effect under different-context conditions in Experiment 3 and the relation to cue effectiveness demonstrated in Experiment 4 will be examined. Finally, we will consider the mixed-presentation effects of Experiments 1 and 2.

Looking at hit rates in Experiments 1 and 2 we have established (1) that a twice-presented item is better recognized than a once-presented item, (2) that an item

tested in its originally presented context is recognized better than if the presentation context is either changed or eliminated at the time of test, which does not matter (as long as the changed context had not previously been experienced), and (3) that the repetition and context variables do not interact. For false alarms, we have established (1) that the probability of falsely recognizing an item is higher if some appropriate context occurred during presentation, (2) that the effect is independent of whether the presented context occurred once or twice during presentation, and (3) that the effect is independent of whether or not context is present during test.

Considering the false alarm data first, the importance of the item information (or surface features or presentation code) can perhaps best be understood if we start with the simplest situation, namely, Experiment 2. Here, there was no context present at test; items were assessed by themselves. New items were differentially responded to on the basis of whether a "relevant" context had occurred during presentation. It seems necessary to conclude that the differences reside in the items themselves, that through some process of feature or attribute overlap, or implicit association (Underwood, 1965), those items related to a particular context acquired some familiarity increment. Essentially, identical false alarm differences were found in Experiment 1, in which context was present at test. The obvious interpretation is that items in old, familiar contexts are more likely to be responded to positively than are items in new, unfamiliar contexts. Such an interpretation is clearly excess baggage in the light of the Experiment 2 findings. The differences must be in the items and not in any contextually based biases. Since the Experiment 1 differences are indistinguishable from those found in Experiment 2, no additional mechanisms need be postulated. The item information component handles both.

But if that is so, why is there no repetition effect? If a context confers some familiarity increment on related, new items, then multiple presentations of the context should further increment the familiarity. Obviously, any explanation must not be incompatible with the clear demonstration that changed-context repetition effects do occur with old items. One possibility is to consider the encoding that might occur with multiple presentations. In the framework of Mandler's (1980) dual coding conception, the argument might be made that the initial presentation of a triad results in the establishment of both the presentation code (the familiarity evaluation) and the conceptual code (the retrieval information). When the triad is presented again, it is recognized as familiar. Such a recognition increments the presentation code, the familiarity component, but the retrieval information is not reencoded. Such an argument would be compatible with some explanations of the repetition-lag effect (e.g., Jacoby, 1978; Underwood, 1970). The lack of a repetition effect with new items is thus argued to be because retrieval information is encoded only once, on the first presentation, and it is the encoding of retrieval information that increments the familiarity of items related to the context.

The same order of analysis clarifies the hit rate data. In Experiment 2, with no context provided at test, we found a large effect of number of presentations. Two presentations produced substantially better performance than did a single presentation. The effect would seem to be due to information present in the items. Experiment 1 added a test context. If that context is different from any that had occurred during presentation, there is no change in performance level, so no further mechanisms need to be considered. Finally, however, we do change the data if we test for recognition of an item in the same context as that which accompanied it during presentation. But in the light of the preceding discussion, the change is very simple. We have added a constant, a constant that represents the context effect in recognition memory. That increment can be interpreted as either the retrieval of relational information (Humphreys, 1978) or the utilization of the conceptual code (Rabinowitz et al., 1977).

The second important effect occurred in Experiment 3. Here, the repetition effect with different test contexts was eliminated when the test context had previously been presented, although with a different item. This finding suggests that when a test context is likely to be familiar, there is a role for contextually guided search. This is in contrast to those situations in which the context is unfamiliar, as in Experiment 1, or missing altogether, as in Experiment 2, in which the search would appear to be guided solely by the item information. Being tested in a familiar but rearranged context (to use Humphrey's term) appears to make the repetition information contained in the item unavailable. Experiment 4 suggests that the repetition information becomes available when the subject is able to recall the item that previously occurred in the changed or rearranged context. Put another way, if the subject can reject the recognition target as having occurred in that context, then that target can be evaluated independently of the context. Such an evaluation leads to a changed-context repetition effect, as in Experiment 1, in which the context could be rejected because of its unfamiliarity, and as in Experiment 2, in which no context occurred. On the other hand, when recall is unsuccessful, the subject evaluates the target in that context and shows no repetition effect. Recognition performance is above chance, however, with R values around .67. In line with the earlier argument, it may be that the encoding of retrieval information (on the first presentation only) includes access to multiple meanings. Then the evaluation of an item in a changed (but old) context depends in effect on the single encoding. A context-independent evaluation, on the other hand, can be based on the familiarity differences following single and double presentations.

The final important set of data comes from Experiments 1 and 2 in what we have called the mixed condi-

tion. Items were presented twice, but with different meanings biased on each presentation. They were then tested in one of the two presented contexts. This manipulation produces recognition data comparable to Slamecka and Barlow's (1979) cued recall data. Twice-presented items tested with no context present are recognized at the same high level regardless of whether the two presentations occurred in identical contexts during presentation or in totally different contexts. When test context was added, the level of performance on mixed-context items was again comparable to items presented twice and tested in the same context. As with Slamecka and Barlow's recall data, the role of surface features or item information would seem to be implicated. To be consistent with the present discussion, however, it must also be noted that multiple presentations in different contexts would result in the encoding of retrieval information on both presentations. The parallel in the repetition-lag literature is Madigan's (1969) forced encoding variability. This double encoding of retrieval information thus accounts for the high level of performance in Experiment 1, in which the test context was familiar at test.

Taken together, the findings indicate the need to consider both item and contextual information. Access to the repetition information contained in the item occurs in same-context tests, no-context tests, and different-context tests when the context can be rejected because it is unfamiliar or inappropriate. The repetition information has no effect when a different test context cannot be so rejected. In addition, the appropriate contextual information that occurs in a same-context test produces the superior recognition performance labeled the context effect. However that contextual information is characterized, as the use of relational information or conceptual codes, its role must be considered in conjunction with that played by the information contained in the item.

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(Received for publication June 19, 1980;
revision accepted November 17, 1980.)