Semantic integration and context

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Context effects in recognition memory were examined by manipulating the semantic integration of sentential contexts. Subjects studied words embedded in congruous, incongruous, and anomalous sentences and were tested for recognition of the targets in either the same or changed contexts. Recognition was impaired if the test item appeared in a new sentence, and the extent of the decrement was greatest for congrous sentences. The results suggest that consistence with past experience affects the integration of the representation, and that the stronger the integration, the more difficult it is to recognize the target in a new context. The data are discussed in terms of a relative specificity of encoding effect.

A number of recent investigations have demonstrated strong influences of context on subsequent recognition abilities; typically, recognition is impaired if contextual changes are made from study to test. These context effects have been obtained under a variety of contextual manipulations. Most frequently, homographic stimuli have been used (Davis, Lockhart, & Thomson, 1972; Hunt & Ellis, 1974; Light & Carter-Sobell, 1970; Paul, Bernbach, & Snuttjer, 1975; Pellegrino & Salzburg, 1975). In the typical paradigm, subjects study the homographs in a context biasing one or the other interpretation, and then are tested for recognition in a context biasing the same or different sense. Recognition is consistently better if the test items bias the encoded rather than a different sense of the word. Similar effects have been obtained with nonhomographic stimuli, simply by pairing the target with different words at study and test (Hunt, 1975; Thomson, 1972; Tulving & Thomson, 1971). Martin (1975) has provided a relatively simple explanation of contextual effects in recognition by assuming that the unit of recognition has been disrupted. Although the nominal stimulus is the same, the functional stimulus might represent a completely different underlying concept, as in the case of homographs, or it might represent a different sense of a nonhomograph, as all words are somewhat polysemous.

A few experiments have also begun to demonstrate that the quality of the initial encoding interacts with the general context effect. Within a recall paradigm, Baker, Santa, and Lamwers (Note 1) found that external retrieval cues are less effective if the encoding context

is well integrated. This suggests that the more unified the initial context, the harder it is to access the material in a different way. Several recognition experiments also provide evidence of this differential effect. Winograd, Karchmer, and Russell (1971) found greater context effects for cue-target pairs unitized through imagery instructions than for pairs that were only associatively linked. Horowitz and Manelis (1972) found greater decrements for idiomatic adjective-noun phrases tested out of context than for meaningful or anomalous phrases, because idioms are so well integrated that the meanings of the individual words are obscured. Recognition decrements due to changed context are also stronger when an entire list is well organized (categorically blocked) than when it is randomly presented (Jacoby, 1972; Jacoby & Hendricks, 1973). Similarly, context change is more detrimental when words are presented in meaningful or thematic sequences (Ciccone & Brelsford, 1975; Pompi & Lachman, 1967).

By now, it seems clear that the degree of initial integration places certain constraints on subsequent recognition and retrieval abilities. The better the original encoding, the harder it is to break that context and recognize the material in a new way. However, with sentential or thematic material, the interaction of context constraint with quality of representation has only been shown by contrasting fully thematic material with random word lists. It remains to be seen if the level of semantic integration is alone sufficient to influence the contextual constraint. It is quite possible that the representation of a semantically well formed sentence will be more compelling than one which is syntactically permissible but semantically peculiar. The present experiment examined this hypothesis. Sentences were presented which were either congruous, incongruous, or anomalous. Since the encoding of a target word in a congruous sentence is consistent with preexperimental semantic knowledge, the representation should be better integrated than when the targets are encoded in contexts not likely to have been previously encountered. The

detrimental effects of context change should therefore be greatest for congruous encodings, due to the quality of the initial representation.

METHOD

Stimulus and Test Materials

Sixty concrete nouns with a concreteness rating between 6.0 and 7.0 were selected from the Paivio, Yuille, and Madigan (1968) norms.[1] Each word was embedded in three sentences which provided three different semantic contexts: (1) Congruous, which described situations that occur frequently in everyday life (e.g., "The TRUCK carried milk from Dallas to New York"); (2) Incongruous, which described situations not likely to occur in everyday life, although they could possibly occur (e.g., "The TRUCK was parked on top of the high school"); and (3) Anomalous, which described imaginary situations that could not possibly occur in everyday life, primarily because they violated selection restrictions (e.g., "The TRUCK was making pancakes when the phone rang"). The target noun was the subject of half of the sentences and the direct or indirect object of the other half. The position of a given target was constant across the three sentences in which it appeared.

The stimulus materials consisted of three lists of 60 sentences, of which 20 were congruous, 20 incongruous, and 20 anomalous. The lists counterbalanced particular items with encoding context, so that a target that was in a congruous context on one list appeared in an incongruous context on the second list, and in an anomalous context on the third. The sentences were typed with the target nouns appearing in capital letters.

Thirty-six additional concrete nouns selected from the same norms served as distractors on a recognition test. Half of the distractors replaced target nouns in the study sentences, with six appearing in each of the three semantic contexts. Eighteen completely new sentences were constructed for the remaining distractors, six of each sentence type.

The recognition-test materials consisted of 72 sentences, with the test item in capital letters. There were 36 old target items, 18 of these occurring in their original sentences, and 18 in changed (new) sentences of the same semantic condition. For both of these target-item types, there were six for each of the three semantic conditions. There were also 36 new distractor items, 18 in new sentences, and 18 in old sentences, in which a distractor was substituted for a target. Again, the two types of "new" items were evenly divided among the three encoding conditions.

Three separate recognition-test booklets were used, corresponding to the three different study lists. Thus, recognition was always tested in a sentence of the same semantic condition in which the item had originally appeared. The order of testing of particular items was constant across test versions. The five targets at the beginning and the five at the end of the study list were not tested, to eliminate primacy and recency effects on recognition.

Design

The experiment consisted of a 3 by 3 by 2 by 2 mixed factorial design. The between-subjects conditions differed only with respect to the counterbalancing variable of lists (1, 2, or 3). The within-subjects factors were encoding condition (anomalous, congruous, incongruous), sentence context (same, changed), and embedded-item type (target, distractor). All subjects studied words embedded in congruous, incongruous, and anomalous sentences. They were then tested for recognition of the targets in either same or changed sentences, but the semantic context of particular items remained the same from study to test. A total of 45 introductory psychology students participated in the experiment as part of a course requirement, with 15 subjects

tested on each of the three lists. Each list was presented to two separate groups of approximately equal size.

Procedure

Subjects were informed of the three types of semantic contexts they would see, and were given examples of the various types. They were instructed to read each sentence carefully, to take note of the semantic context, and to pay particular attention to the word in capital letters. They were told that they would later be asked to classify the sentences according to semantic context and they would be tested for memory of both sentences and capitalized words.

The 60 study sentences were presented at a 4-sec rate by means of an automated overhead projector. Recognition-test booklets and answer sheets were then distributed. The recognition test involved three separate tasks. For each of the 72 sentences, subjects were to classify the sentence as congruous, incongruous, or anomalous; to decide whether the sentence frame was old or new (regardless of whether the capitalized word was old or new); and to decide whether the capitalized word was old or new. Subjects were to give confidence ratings for the sentence and word judgments, on a 6-point scale ranging from -3 (sure it's new) to $+3$ (sure it's old). The sentence-judgment task was included to control for the possibility that subjects were attending solely to the capitalized words, ignoring the remainder of the sentence. The classification task was included to induce further semantic processing, by directing subjects' attention to differences in semantic congruity. Subjects were allowed as much time as needed to complete the task (approximately 35 min).

RESULTS

The ability to recognize target words was of primary interest; the sentence-recognition data will only be considered briefly, and the context-classification task will not be discussed. The target-recognition data were first examined by plotting memory operating characteristic (MOC) curves to aid in the selection of an appropriate correction for guessing. Each of the corrections, $p(H) - p(FA)$, $p(H) - p(FA)/1 - p(FA)$, and d', predicts different MOC curves. However, the curves did not discriminate among the corrections and, therefore, the data were analyzed using all three measures. A consistent pattern of results was obtained, and so only one analysis $[p(H) - p(FA)]$ will be considered in detail for both sentence frames and test items.

Sentence-Frame Recognition

Table 1 shows the corrected recognition of the sentence frames, along with the probabilities of hits and false alarms, for the three semantic-encoding conditions and two types of embedded items, collapsed over lists. Overall sentence recognition was very good; in fact, it was generally better than target recognition. The analysis of variance revealed reliable main effects of list (1, 2, 3) $[F(2,42) = 3.22, p < .05, MSe = .09]$, encoding condition (anomalous, congruous, incongruous) $[F(2,84) = 8.66, p < .01, MSe = .03]$, and type of embedded item (target, distractor) $[F(1,42) = 5.65, p < .05, MSe = .018]$. The list effect was due to lowest

Table 1
Sentence-Frame Recognition and Probabilities of Hits and False Alarms

| | Encoding Condition | | | | | | | | |
| | Anomalous | | | Congruous | | | Incongruous | | |
	p(R)*	p(H)	p(FA)	p(R)	p(H)	p(FA)	p(R)	p(H)	p(FA)
Targets	.80	.88	.08	.77	.87	.10	.86	.96	.10
Distractors	.72	.87	.15	.76	.87	.11	.87	.90	.03

Correction for guessing is p(H) − p(FA)   Note—p(R) = p(Recognition); p(H) = p(Hits); p(FA) = p(False Alarms)

performance on List 3. List interacted with item type [$F(2,42) = 3.50$, $p < .05$, MSe = .018], with List 3 showing a decrease in recognition when old words were used, as opposed to the increase shown by the other two lists. The main effect of encoding condition was due to the higher overall recognition of incongruous sentence frames; anomalous and congruous frames were recognized equally well. The main effect of embedded-item type reflects a context effect: A sentence frame was better recognized as old when the entire sentence was the same; substitution of a new word (distractor) led to a decrement in performance.

Target Recognition

The corrected probability of target recognition is presented in Table 2 for the six encoding condition by sentence context cells, collapsed over lists. The probabilities of hits and false alarms are also included. Analysis of variance revealed reliable main effects of list [$F(2,42) = 4.45$, $p < .01$, MSe = .095], encoding condition [$F(2,84) = 11.13$, $p < .001$, MSe = .043], and sentence context (same, changed) [$F(1,42) = 42.18$, $p < .001$, MSe = .047]. Reliable interactions were obtained for List by Sentence Context [$F(2,84) = 4.01$, $p < .05$, MSe = .047], and Encoding Condition by Sentence Context [$F(2,84) = 4.12, p < .025$, MSe = .05]. The List by Encoding Condition interaction was not reliable [$F(4,84) < 1.0$], nor was the triple interaction [$F(4,84) = 1.16$, $p > .10$]. The main effect of the list was again due to the lower overall performance level of subjects studying List 3 and is not of theoretical interest. The List by Sentence Context interaction was due to the smaller decrease in performance from same to changed sentences for List 3 subjects than for the other two groups. However, the difference was still

in the expected direction, and thus the interaction does not compromise interpretation of the results.

The effect of encoding condition was somewhat unexpected: Words in the incongruous encodings were better recognized than were words in either the anomalous or congruous encodings. Further analysis of subjects' confidence ratings suggests the advantage of incongruously embedded items arises primarily from an increased confidence in rejecting distractors. The effect of sentence context demonstrates that words embedded in their original contexts are better recognized than are words appearing in changed sentences. The interaction of Encoding Condition by Sentence Context is due to the fact that, when sentences were changed, words in congruous encodings were recognized less well than were words in anomalous and incongruous encodings. With old sentences, recognition of congruously embedded items was intermediate to that of the other two conditions.

DISCUSSION

The present experiment reveals three clear effects. First, changing the embedding context from study to test produced strong decrements in recognition performance. Second, there was a reliable main effect of encoding condition, such that incongruous sentences produced overall better memory of both sentence frames and target items. Finally, the result of central interest in this investigation is that encoding condition interacted with changing context. As we expected, items embedded in a congruous, well integrated sentence were much more difficult to recognize when tested in a new context.

The interaction of Encoding Condition by Sentence

Table 2
Target Recognition and Probabilities of Hits and False Alarms

| | Encoding Condition | | | | | | | | |
| | Anomalous | | | Congruous | | | Incongruous | | |
	p(R)*	p(H)	p(FA)	p(R)	p(H)	p(FA)	p(R)	p(H)	p(FA)
Old Sentences	.64	.91	.27	.70	.89	.19	.79	.94	.15
Changed Sentences	.56	.83	.27	.43	.70	.27	.62	.80	.18

Correction for guessing is p(H) − p(FA)   Note—p(R) = p(Recognition); p(H) = p(Hits); p(FA) = p(False Alarms)

Context was predicted on the assumption that semantic goodness is a variable which affects integration of the representation, and that the better integrated the encoding context, the more difficult it will be to recognize the target item in a changed context. The results can best be explained in terms of differences in the extent of integration with respect to semantic knowledge. Whereas congruous sentences are consistent with experience, incongruous sentences involve unusual or bizarre situations, and anomalous sentences involve events that are impossible in real life. In other words, when subjects have a congruous sentence, the target is encoded in a binding, meaningful context based on semantic experience. The target loses its identity and becomes an integral part of the whole. This integration makes it difficult for the subject to break the context and recognize the word in a new environment. However, incongruous and anomalous sentences do not allow for such unitary encoding of the material. The target cannot be readily integrated with the surrounding context on the basis of semantic knowledge; the encoding is based primarily on experimental contact with the sentence. The word is not in an unbreakable context and can be easily isolated from the sentence. Consequently, the recognition decrements with changed context are of lesser magnitude than those obtained for congruous sentences.

Finally, it should be noted that the present data provide both support and qualification of episodic theories of memory (Tulving & Thomson, 1973). In way of support, it is seen that a change in context from study to test produces a clear decrement, suggesting that subjects employ contextually bound representations. However, the decrement is far from absolute, as might be expected from strict encoding specificity or rigid partitioning of episodes. A much weaker specificity of encoding is suggested by the observed influence of semantic goodness. Each episode might be relatively circumscribed and isolated, but some are much less accessible than others.

REFERENCE NOTE

1. Baker, L., Santa, J. L., & Lamwers, L. L. *The better the representation, the harder it is to retrieve.* Paper presented at the meeting of the Eastern Psychological Association, New York, April 1975.

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NOTE

1. Although normative data were not used, the nouns were considered nonhomographic. A subsequent dictionary consultation revealed seven words which had a second distinct meaning. However, all sentence contexts biased the same sense of these words, so recognition differences cannot be attributed to homographic factors.