Remembering the Data: Analyzing Interactive Processes in Reading

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Past experience can facilitate subsequent perceptual activities as well as serve as the basis for recognition memory. However, the memory underlying perception is commonly assumed to be more "general" and, consequently, to preserve less information about the initial event than does the memory that underlies recognition for a specific episode. In contrast, experiments are performed which demonstrate that perceptual identification and recognition memory both rely on memory for single prior processing episodes. In these experiments, the subjects' reliance on data-driven rather than conceptually driven processing of a word was changed by varying the context in which the word was read. A greater degree of data-driven processing of a word, such as having a subject read the word out of context, facilitated later perceptual identification of that word. Conversely, a greater degree of conceptually driven processing of a word, such as having the subject generate the word from a conceptual clue, resulted in better recognition memory and less facilitation of perceptual identification. This sensitivity of perceptual identification to the balance between data-driven and conceptually driven processing in a single prior processing episode provides a means of analyzing interactive processes in reading.

Memory for past experience can be revealed by perceptual activities as well as by performance on tests of recognition memory or recall. However, the memory underlying perception and that underlying either recall or recognition memory have been treated in very different manners in the recent literature. Performance on tests of recognition memory or recall is typically treated as relying on memory for a particular prior episode while perception is seen as utilizing more general abstract representations of knowledge, such as schemas or logogens (e.g, Friedman, 1979; Morton, 1969, 1979; McClelland & Rumelhart, 1981; Tulving, 1972). These abstract representations are said to be utilized in a relatively invariant fashion across situations and to change only slowly, although temporary priming can occur. The extreme variability in encoding that is observed in studies of

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recognition memory and recall is treated as being due to processing that is postperceptual, and that serves to provide a semantic interpretation or to elaborate the encoding of a perceptual event (e.g., Anderson & Reder, 1979; Craik & Tulving, 1975). It has been suggested that the perceptual characteristics of any event are rapidly forgotten so that it is primarily the meaning of an event that is remembered over the long term (e.g., Craik & Lockhart, 1972; Sachs, 1967).

For perception, context has been manipulated as a means of investigating the interaction between conceptually driven and data-driven processing. When a word is read in context, expectations gained through conceptually driven processing are said to compensate for or complement the evidence gained by visual processing, datadriven processing. Context can act to "prime" the abstract representation of a word (e.g., a logogen) and, thereby, make the reader less reliant on visual information so the word can be read more rapidly (e.g., Ehrlich & Rayner, 1981: McClelland & Rumelhart, 1981: Morton, 1979). By theories of perception, any effects of context on memory for a presented word are of

0022-5371/83/83,00 Copyright - 1983 by Verdemic Press, Tric VII rights of reproduction in any form reserved no interest since perception is thought to rely on abstract representations rather than memory for particular prior episodes.

In contrast to the above view, the position put forward here is that a single episode of perceptual processing is remembered over the long term and does influence subsequent perception. This long-lasting effect on perception will be shown to be subject to the same encoding variables that have been well documented in studies of recognition memory and studies of recall for particular events. Effects of manipulating the context in which a word is read on its later perception are shown to be useful for analyzing the interaction between conceptually driven and data-driven processing. The interpretation of these effects will be that rather than relying on memory systems that differ in stability and abstraction, perception and recognition memory both rely on memory for prior episodes.

To support the notion that both perceptual identification and recognition memory are dependent on memory for prior episodes, an experiment is needed in which the processing of a word is varied and the consequences of that variation are observed on both dependent variables. The general procedure employed for the experiments in this paper is outlined in Figure 1. In the first phase of the experiment, three conditions are used that are similar to those employed by others to investigate interactive processes in reading, and that are meant to vary the balance of the contributions of data-driven and conceptually driven processing. A given word is either read out of context, read in the context of a word that predicts its occurrence, or generated by a subject from a context word (the antonym of the intended word). Datadriven processing is maximal when a word is read out of context since, given no basis for expecting the word, the reader must rely on a visual analysis of the word in order to identify it. In contrast, data-driven processing is minimal when a word is generated in response to a context word but

not actually presented to be read. Conceptually driven processing is identified with the use of context to generate a word, or to generate expectations about a word that is to be read. Conceptually driven processing is maximal in the generate condition and minimal when a word is read without context. Both the amount of data-driven and the amount of conceptually driven processing required to read a word in context are intermediate to those required in the other two conditions. The reader can use expectations gained from context to reduce his or her reliance on the analysis of visual information, data-driven processing (e.g., Ehrlich & Rayner, 1982). If differences among the conditions are later assessed with a test of recognition memory, we have a familiar study from the memory literature. Generating a word would be expected to produce higher recognition performance than would reading that word (e.g., Jacoby, 1978; Slamecka & Graf, 1978). That is, we would expect that recognition memory performance would increase as the amount of conceptually driven processing increased across conditions.

However, what should we expect if we followed these encoding conditions with a test of perceptual identification? That is, if we flashed words followed by a mask, would we expect the subject to be able to report words more accurately that had been presented in the first phase of the experiment than words that had not? Further, would we expect the differences among the three encoding conditions to make a difference in this later test of perceptual identification? We could note that the three encoding conditions differ in the extent to which the subject has to rely on the visual stimulus in the first phase of the experiment. When the word is read without context, the reader has to rely most heavily on a visual analysis of the word, and the perceptual operations employed may be more similar to those required for later perceptual identification of the word presented without context than are the operations that are em-

ployed when a word is read in context. Effects of reading a word on its later perception may depend on the similarity of the operations employed on the two occasions (Kolers, 1979). When the word is not presented at all, as in the generation condition. there is surely least similarity between that prior experience and the operations required for perception of the word. That is, effects of the encoding conditions on later perceptual identification might be opposite to those expected for recognition memory. Perceptual identification performance might be expected to increase as the amount of data-driven processing increases across conditions.

In contrast, by current theories of word perception (e.g., Morton, 1979; McClelland & Rumelhart, 1981), perception always utilizes an abstract representation of a word so subsequent perceptual identification should not reflect variability in the encoding of a particular prior presentation of a

word. The logogen model of word perception has been modified in response to the results of recent experiments (Morton, 1979) but even this modified model cannot account for effects on perception that rely on memory for prior episodes. In the original logogen model the effect of recent prior experience on perception is accounted for by claiming that reading a word temporarily lowers the threshold of its corresponding logogen, so less visual information is needed to identify the word when it is later presented. To accommodate the findings that visual perceptual identification is not enhanced by hearing a word (Jacoby & Dallas, 1981: Morton, 1979), generating a word as a name for a picture (Morton, 1979), or generating a word in response to its definition (Winnick & Daniel, 1970), Morton postulated separate logogen systems for identification of words that are presented visually and those that are heard or generated. By this more recent model, reading a word ei-



Phase 1

Recognition Memory

FIG. 1. Outline of procedure.

ther in context or without context should do more to enhance its subsequent perceptual identification than would generating the word as an antonym of a context word. However, postulating separate logogen systems does not provide for an effect of the context in which a word is read on its later perceptual identification. Regardless of context, reading a word must utilize the same logogen system and lower the threshold of its corresponding logogen. A reduction in threshold can be used to record that a word has been recently read: however. since a logogen is an abstract representation, its threshold cannot preserve any effect of context on the amount of visual processing required for the reading of a word.

To summarize, the balance of conceptually driven and data-driven processing was varied by requiring subjects to read a word without context, read the word in the context of its antonym, or generate the word as an antonym of a context word. Data-driven processing should be maximal when a word is read out of context, whereas conceptually driven processing should be maximal when a word is generated but not presented to be read. Reading a word in context was expected to require both a level of data-driven processing and a level of conceptually driven processing that is intermediate to the extremes represented by the other two conditions. In line with the results of prior experiments, recognition memory was expected to reflect the amount of prior conceptually driven processing by being highest in the generate condition. By most current theories of word perception, perception uses an abstract representation that does not preserve information about the processing of any particular prior presentation of a word so subsequent perceptual identification should not vary across encoding conditions. By postulating separate logogen systems, Morton (1979) provides a basis for predicting that reading a word will enhance its subsequent identification more than will generating the word but provides no basis

for predicting an effect of the context in which a word is read. By the episodic view of perception put forward here, perceptual identification, like recognition memory, relies on memory for prior episodes but is expected to reflect the amount of prior data-driven processing rather than the amount of prior conceptually driven processing. Reading a word in context requires less data-driven processing than does reading the word without context and, consequently, should do less to enhance its subsequent identification. The ordering of conditions predicted for perceptual identification is the opposite of that predicted for recognition memory.

The first three experiments are reported together. Experiment I followed the procedure described in Figure 1 but employed a test of perceptual identification only. Experiment 2 employed the same general procedure but used two groups of subjects. Subjects in one group received a test of recognition memory after the test of perceptual identification, whereas subjects in the second group received only a test of recognition memory. In contrast to earlier experiments, the procedure employed in Experiment 3 required subjects to overtly generate an antonym of each context word prior to the antonym being presented, or prior to the presentation of the series of question marks. Without this requirement. subjects may not begin generating an antonym until a series of question marks is presented and, thereby, reduce the difference in processing between words that were read in context and those that were read without context. That is, the effects of context may not be "automatic" but. rather, be dependent on subjects generating a word prior to its presentation to be read. Requiring subjects to say an antonym aloud also allowed perceptual identification to be conditionalized on whether a word had been correctly generated prior to being read. Of particular interest in the contextpresent condition were occasions on which subjects generated a word that was not the

antonym that they later read. On these occasions, the context was apparently misleading so that the word that was read was not the word that subjects expected to read. Reading a word that is counter to expectations may require the processing of more visual information than would reading the same word with no context and, consequently, further enhance later perceptual identification. Evidence in line with this possibility is provided by Experiment 3. Experiment 4 further examined the effect of reading a word in a misleading context. Across experiments, it is shown that reading a word in context can produce either better or poorer later perceptual identification than does reading the word without context, depending on whether the context accurately predicts or is misleading with regard to the word that is to be read.

EXPERIMENTS 1-3

Method

Subjects. Subjects in all experiments were volunteers enrolled in an introductory psychology course at McMaster University. Sixteen subjects served in the first experiment, 40 in the second experiment (24 received both a test of perceptual identification and one of recognition memory while 16 received only the test of recognition memory), and 24 in the third experiment.

Design and materials. Sixty pairs of antonyms were selected from a reference book. An attempt was made to select pairs such that the first member of a pair was unambiguous with regard to its meaning and would easily allow subjects to generate the second member of the pair as its antonym. Owing to problems encountered by subjects attempting to generate the second member of a pair, a few of the pairs employed in the first experiment were replaced by new pairs in the second experiment. The target word (second word) in antonym pairs varied from 4 to 6 letters in length. Of these target words, 36 appear with a high frequency in the language (A and AA) as indexed by Thorndike and Lorge (1944); the average frequency of occurrence of the remaining 24 words was 23.2 per million. A set of 60 additional words was used in a procedure to determine, for each subject, the duration at which words would be presented for the test of perceptual identification, and as practice items for the test of perceptual identification. The 50 words used to set a presentation duration were all high frequency while the 10 words employed as practice items included 5 high and 5 low frequency words.

The set of antonym pairs was divided equally among four experimental conditions that were represented within subjects, and differentiated by details of the presentation of words during the first phase of an experiment. In the first experimental condition (no context), only the second member of an antonym pair was presented, preceded by a series of X's, both members of a pair were presented in the second condition (context present) and only the first member of a pair followed by a series of question marks was presented in the third condition (generate). In a fourth condition (new), neither member of an antonym pair was presented, so words from this condition were new on the test. For all conditions, the second member of each antonym pair was presented for a test of perceptual identification and a test of recognition memory. For both forms of test, words were presented in an order that was random except for the restriction that words representing each of the four experimental conditions were spread evenly through the list. Four formats were constructed by rotating antonym pairs through experimental conditions such that across formats each pair represented each condition equally often. Further, two orders of presentation of items in the first phase of each experiment were constructed. These orders were random with

the restriction that items representing the different conditions were distributed equally through the list. Each of the eight combinations of list format and presentation order was used equally often in each of the experiments.

Procedure

An Apple computer interfaced with a television set having a 14-in. screen was employed to present stimuli. Character size produced on the television screen was approximately 5.7×6.6 mm; words were presented in all lower case letters. Subjects were seated such that their viewing distance was 70 to 75 cm.

The index of perceptual identification was the probability of identification of words exposed for a brief interval, the interval being set individually for each subject. An experimental session began with a test of perceptual identification that was employed to set a presentation duration for each subject that would yield a desired probability of correct identification. A list of 50 words was presented as 5 blocks of 10 words each. Words in the first block were presented for a duration of 40 milliseconds1 while words in later blocks were presented at either shorter or longer durations as required to obtain a duration that would produce the desired level of performance. The presentation duration determined in this original test was employed for the later critical test of perceptual identification. The intended probability of correct perceptual identification was .50 in the first and third experiments and .60 in the second experiment.

The experiment was described to subjects as being concerned with the effects of context on reading speed. Subjects were informed that there would be three types of event in the first phase of the experiment. In some instances, a series of X's would appear on the screen and then be replaced by a word. They were to read the word as rapidly as possible. As a second type of event, a word would appear on the screen and be replaced by the antonym of that word; they were instructed to read the second word (antonym) as rapidly as possible. As a third type of event, a word would appear on the screen and be replaced by a series of question marks; they were to say the antonym of the presented words as rapidly as possible when the question marks appeared. In Experiment 3, the instructions were changed so that for the latter two types of event subjects were required to generate an antonym and say it aloud prior to the presentation of the word that was to be read or the series of question marks. If a series of question marks appeared, they were to repeat the antonym that they had just said. If a word appeared, they were to read the word aloud as rapidly as possible regardless of whether or not the word was the antonym that they had just said. Subjects were informed that their speed of responding was of primary interest and that latencies were being recorded by means of a voice key. Latency of responding was not actually recorded.

The sequence of events that comprised the presentation of stimuli in the first phase of the experiment was as follows. First, the message "Press return when ready" appeared on the screen, and remained there until the subject pressed the "return" button on the computer terminal keyboard. After the return button was pressed, the original message left the screen and two sets of markers (two short horizontal lines) appeared on the screen for one second with one set of markers being above the other. The sets of mark-

¹ The presentation duration and other intervals were only approximate due to the screen not being directly controlled by the computer, so the "refresh" cycle of the screen was a source of error. This source of error resulted in the large majority of events being of near the intended duration, but the true duration of some events was a maximum of plus or minus 17 milliseconds from the intended duration. This variability of the presentation duration was random so does not compromise the results.

ers surrounded the location in which a context word or a series of X's would be presented. Next, the context word or series of X's appeared surrounded by the top set of markers and remained on the screen for one second while the space surrounded by the bottom set of markers remained empty. The context word or series of X's was then removed, and the space surrounded by each of the sets of markers was empty for one second. At the end of this interval, a clicking sound occurred coincident with the appearance of either a word that was to be read or a series of question marks surrounded by the bottom set of markers. The space surrounded by the top set of markers was empty during this latter interval. The clicking sound was to further attract subjects' attention to the occurrence of the target word or series of question marks, and was used in Experiments 2 and 3 but not Experiment 1. The target word that was to be read aloud or the series of question marks that signaled subjects to say the antonym of the context word remained on the screen for one second. Next, the message "Press return when ready" again appeared, and the sequence was repeated until the list had been presented.

A test of perceptual identification was given to all subjects in Experiments 1 and 3, and to one group of subjects in Experiment 2. Prior to the test of perceptual identification, subjects were informed that words would be flashed on the screen and that they were to report each word immediately after its presentation. Subjects were encouraged to respond to each test item, guessing if necessary. The sequence of events in the test of perceptual identification was as follows. The message "Press return when ready" appeared on the screen and remained there until the subject pressed the "return" button. The original message then left the screen and a set of markers (two short horizontal lines) appeared on the screen for 500 milli-

seconds, surrounding the location in which the word would be presented. Immediately after presentation of the word, a mask (a series of ampersands of the same length as the word) appeared in the same location as had the word, and remained on the screen for one second. This sequence of events was then repeated until the entire test list had been presented. For the main test list, words were presented for a duration that was determined separately for each subject by means of the initial test of perceptual identification that was described earlier. Before presenting the main test list, a practice list that contained 10 words that did not appear elsewhere in the experiment was presented at the same duration as the words in the main test list.

A test of recognition memory was given to subjects in Experiments 2 and 3. For all subjects in Experiment 3 and one group of subjects in Experiment 2, the test of recognition memory followed that of perceptual identification. A second group of subjects in Experiment 2 received only the test of recognition memory. The test of recognition memory contained the same words as did the test of perceptual identification but was prepared as a typed sheet with the "old" and the "new" words being intermixed. Subjects were instructed to circle words that they had either read or generated in the first phase of the experiment. In Experiment 2, subjects were also required to indicate whether they had read a word or generated the word in the first phase of the experiment. Next to each word on the recognition test sheet were the letters "R" and "G". Subjects were to circle the letter "R" if they had read the word in the first phase of the experiment or the letter "G" if they had generated that word in the first phase of the experiment but not read it. Subjects were required to circle one of the two letters for each of the words in the test list regardless of whether or not they had circled the word as being one that they recognized as having encountered in

the first phase of the experiment. For each of the experiments, the test of recognition memory was subject paced.

RESULTS AND DISCUSSION

For each experiment, an analysis that included each of the four presentation conditions as a within-subject factor was done as a means of obtaining an estimate of the error variance, MS_{e} . This estimate of the variance with its corresponding df was then employed to compute the least significant difference, the smallest difference between two probabilities that was significant at the .05 level when assessed by a t test. These values were computed for one-tailed tests since the direction of all differences that are of interest were predicted on a priori grounds. Rather than the results of tests being reported separately for each comparison, the estimates of MS_e along with df are reported in the text of the paper while the least significant difference (1sd) is reported in the final column of tables that display probabilities that are being compared. Unless noted as being otherwise, all differences that are commented on in the text of the paper were significant. It is recognized that the procedure of employing t tests for multiple comparisons is not a conservative one. However, any lack of conservatism in the statistical tests employed is compensated for by replicating the results that are of interest across experiments.

The rationale of the experiments made it important to establish that the relationship between the antonyms that were employed was sufficiently apparent to subjects to allow one member of a pair to serve as an effective context for presentation of the other member of the pair. The probability of the antonym of a context word being correctly generated in the first phase of the experiment was .83 in both Experiment 1 and in the group that received a test of perceptual identification in Experiment 2; the corresponding probability for subjects in the group that received only a test of recognition memory in Experiment 2 was .89. In Experiment 3, the probability of an antonym being correctly generated was .78 and .81 in the Context and Generate conditions. respectively. Some of the predictions that were made rely on subjects having been able to predict the word that was to be read prior to its presentation, or on their ability to generate that word. When possible, the probability of correct perceptual identification or recognition memory conditionalized on an antonym having been correctly generated, as well as the unconditionalized probabilities, will be reported.

Perceptual identification. The exposure duration employed for the test of perceptual identification in Experiment 1 ranged from 15 to 38 milliseconds and had a mean of 23.7 milliseconds. In Experiment 2, the range was from 15 to 32 milliseconds with a mean of 22.13 milliseconds. The range in exposure durations in Experiment 3 was from 15 to 35 milliseconds with a mean of 20.8 milliseconds.

The probability of perceptual identification in Experiments 1-3 is displayed separately for each experimental condition in Table 1. The MS_e for Experiments 1-3 was .017, .010, and .014, while the *df* were 45. 69, and 69, respectively. The 1sd for significance at the .05 level in each of the experiments is displayed in the last column in Table 1.

Reading a word without context (XXX COLD) enhanced the subsequent perceptual identification of that word as compared to both new words and words that had been generated in the first phase of the experiment (HOT ???). The differences among these conditions was consistent across the three experiments. Reading a word in the context of an antonym (e.g., HOT COLD) produced a level of subsequent identification performance that was intermediate between the levels produced by the other two conditions. The difference in the probabilities of later identification produced by having read a word without context rather than in context was significant in Experiments 2 and 3 and approached significance

INTERACTIVE PROCESSES

	Phase 1				
Experiment	No context	Context	Generate	New	1 sd
1	.620	.544	.466	.466	.078
2	.822	.755	.669	.600	.048
3	655	583	525	.472	.058

TABLE 1 PROBABILITIES OF LATER PERCEPTUAL IDENTIFICATION AS A FUNCTION OF THE TREATMENT OF WORDS IN PHASE 1

in Experiment 1. Reading a word in context produced a significantly higher probability of subsequent perceptual identification than did generating that word in each of the three experiments.

Perceptual identification conditionalized on generating. In Experiment 3, subjects were required to generate an antonym of the context word and say it aloud prior to the presentation of the antonym that was to be read. It was thought that this procedure would produce a further reduction of datadriven processing and, consequently, less enhancement of subsequent perceptual identification than found in Experiments 1 and 2 where saying an antonym prior to presentation of the word to be read was not required. However, the magnitude of the difference in perceptual identification produced by reading a word in context rather than out of context was only slightly larger in the third experiment (.08) than in the first two experiments (.07). The procedure in the third experiment allows one to compute the probability of identification conditionalized on an antonym having been correctly generated prior to its presentation to be read. These conditional probabilities revealed that subsequent identification of a word that had been correctly generated prior to being read was substantially lower (.56) than that of words that had not been generated prior to being read (.68), t(23) = 2.55, SEM = .045. On .57 of the occasions, an error in generating an antonym in the first phase of the experiment involved subjects saying a word other than the word that was presented to be read,

while on the remaining occasions the errors were ones of omission. When subjects did generate a wrong word prior to presentation of the antonym that was to be read, the probability of later identification of the word that had been read was .74. This probability of identification is higher than that produced by reading a word without context in the first phase of the experiment (.66). Similar results are presented in Experiment 4 where words were intentionally presented in a misleading context to be read and then presented for a test of perceptual identification.

Effects of generating a word on perceptual identification. Generating a word as an antonym of a context word was expected to involve only conceptually driven processing and, due to the lack of data-driven processing, have no effect on subsequent identification. However, the effect of generating a word was inconsistent across the three experiments. Words that had been generated as antonyms but not presented to be read held an advantage over new words that was significant in Experiment 2 and that approached significance in Experiment 3. In Experiment 1, the probability of identifying words that had been generated was identical to that of new words. For each of the experiments, it was possible to compare the probability of perceptual identification conditionalized on the tested word having been correctly generated with that when the target word was not generated in the first phase of the experiment. To compute these conditional probabilities, two subjects had to be dropped from the

second experiment and one subject from the third experiment due to their not producing any errors in generating antonyms and, thereby, not providing a meaningful basis for computing a probability of perceptual identification conditional on the test word not having been generated. In each of the experiments, the probability of perceptual identification, given that the target word had been correctly generated, was greater than that given that the word had not been generated: .48 versus .42, .68 versus .64, .55 versus .44, in Experiments 1-3, respectively. The variability was quite high, however, so that the difference between these conditionalized probabilities approached significance only in Experiment 3, t(22) = 1.16, SEM = .088.

Although the effect may be a small one, it seems likely that generating a word can influence its subsequent perceptual identification. Generating a word may sometimes provide access to information that is similar to that typically gained by means of datadriven processing. As well as generating a phonological representation of the antonym to allow the word to be said aloud, subjects may sometimes generate information about the typical appearance or constituent letters of the word, and this latter form of information may serve as a basis for transfer to subsequent perceptual identification. In this vein, Finke (1980) has argued that imaging is sometimes functionally equivalent to perception. An experiment by Seidenberg and Tanenhaus (1979) provided evidence that, although words were presented auditorily, subjects gained access to information about the orthographic characteristics of the words. In general, the effects of generating on later identification are likely to depend on what is being generated.

In Experiment 3, the conditionalized probabilities revealed that correctly generating a word produced essentially the same probability of perceptual identification (.55) as did reading a word immediately after it had been correctly generated (.56). By that comparison, then, reading a word in context can involve almost as little datadriven processing as does generating a word.

The perceptual identification results can be readily summarized by saying that the effects of encountering a word on its subsequent perceptual identification depend on the amount of data-driven processing involved in that prior encounter. A reduction in subjects' reliance on the processing of visual information in the first phase of the experiment resulted in poorer subsequent perceptual identification performance.

Recognition memory. The probability of recognition memory is displayed in Table 2 separately for each of the conditions in Experiments 2, 2R, and 3. In terms of procedures employed, Experiments 2 and 2R differed from one another in that in Experiment 2 the test of recognition followed a test of perceptual identification while in Experiment 2R only a test of recognition memory was given. In Experiment 3, the test of recognition memory followed one of perceptual identification. The MS_n in Experiments 2, 2R, and 3 was .018, .019, and .028, while the df were 46, 30, and 46, respectively. The 1sd's between probabilities required for significance at the .05 level for each of the experiments are displayed in the last column of Table 2.

TABLE 2 PROBABILITIES OF RECOGNITION MEMORY AS A FUNCTION OF THE TREATMENT OF WORDS

		Phase	e l	
Experiment	No context	Context	Generate	Isd
2 2R 3	.558 .400 .372	.719 .654 .741 (.74)	.780 (.83) .700 (.75) .647 (.69)	.065 .082 .081

Note. The numbers in parentheses refer to the probability of recognition conditionalized on the target word having been generated in the first phase of the experiment. The 1sd's are for unconditionalized probabilities.

Across the experiments, the ordering of conditions in recognition memory was largely the opposite of that produced by the test of perceptual identification. Consistent with the results of prior experiments (e.g., Jacoby, 1978: Slamecka & Graf, 1978), generating a word as an antonym of a context word produced a higher probability of later recognition memory than did reading that word out of context. Further, reading a word in context produced a higher probability of recognition memory than did reading a word without context. Preceding the test of recognition memory with one of perceptual identification increased the overall probability of recognition memory but left the pattern of results largely unchanged.

Analyses of the overall probabilities of recognition failed to reveal a significant advantage of generating a word as compared to reading the word in context. However, when the probability of recognition memory was conditionalized on a word having been generated in the first phase of the experiment, generating a word produced a higher probability of recognition than did reading the word in context in both Experiments 2 and 2R; t(23) = 4.20, SEM = .027. t(15) = 2.27, SEM = .042 for Experiments 2 and 2R, respectively. The conditionalized probabilities seem more appropriate than unconditionalized probabilities for assessing effects on recognition memory. If subjects did not generate a target word in the generate condition, they had no experience with that word prior to the test of recognition memory and, consequently, had no basis for recognizing the word. Conditionalized probabilities are presented along with unconditionalized probabilities in Table 2. In contrast to the procedure employed in the earlier experiments, subjects in Experiment 3 were required to generate an antonym of the context word and say it aloud prior to reading the word in context. With this additional requirement, reading a word in context produced a higher probability of recognition memory than did simply generating the word. Although the direction of this difference was maintained, the difference was no longer significant when recognition memory was conditionalized on subjects having generated the correct antonym in the first phase of the experiment.

Becker (1980) distinguishes between a specific prediction strategy and a general expectancy strategy for the use of context in a lexical decision task. By this distinction, subjects predict the specific word that is to be presented when a word is presented in the context of its antonym. In contrast, the recognition memory results of Experiments 2 and 2R lead to the conclusion that antonyms were not fully generated (predicted) prior to their presentation to be read in the context present conditions. If antonyms had been fully generated, one would expect recognition memory performance in those conditions to be equal to that in the context-present condition in Experiment 3, and to be equal or superior to the level of recognition memory in conditions that only generated a word but did not read it. Despite a word not having been fully generated prior to its presentation, reading a word in context produced less enhancement of subsequent perceptual identification than did reading a word without context in Experiments 2 and 2R. Specific prediction of a word is apparently not necessary to produce an effect of prior context on later perceptual identification of the word.

The recognition memory results are easily summarized by claiming that the increase in conceptually driven processing that comes from providing subjects with a basis for expecting a word prior to its presentation and the further increase in conceptually driven processing that comes from requiring subjects to generate a word lead to an enhancement of recognition memory. There may be two bases of recognition memory so that recognition sometimes relies on memory for perceptual characteristics (gained by data-driven processing) or familiarity rather than meaning (e.g., Atkinson & Juola, 1974; Jacoby & Dallas, 1981; Mandler, 1980); however, in the present experiments it was clearly differences in conceptually-driven processing that were the primary determinant of recognition memory performance.

Reality monitoring. In Experiments 2 and 2R, subjects had to indicate for each word on the recognition test whether they thought that word had been read or had been generated during the first phase of the experiment. For words that were correctly recognized as being old, Table 3 presents the probability of subjects judging that words had been read in the first phase of an experiment separately for each condition in Experiments 2 and 2R. As an indication of a bias toward responding that a word had been read, the probability of subjects indicating that words that they correctly recognized as being new were read in the first phase of the experiment was .72 in Experiment 2 and .57 in Experiment 2R. The stronger bias toward indicating that a word had been read in Experiment 2 is likely due to performing the test of perceptual identification that preceded that of recognition memory.

Subjects were relatively accurate in their judgments of whether a word had been previously read or only generated. Words that had been read without context were much more likely to be judged as having been read than were words that had only been generated. When a word had been read in context, however, subjects were somewhat less likely to judge that they had actually read that word than they were when the word had been read without context;

TABLE 3 Probabilities of Judging that a Recognized Word Had Been Read

	Phase I			
Experiment	No context	Context	Generate	
2	.82	.76	.38	
2R	.79	.71	.27	

t(23) = 1.92, SEM = .032, and t(15) = 1.80, SEM = .048 in Experiments 2 and 2R, respectively.

A reduction in data-driven processing due to the provision of context can be held responsible for subjects' poorer ability to remember that a word had actually been read when that word was read in context rather than without context. It seems likely that it is memory for data-driven processing that allows a person to be certain of having actually read a word. Johnson and Raye (1981) have made a similar claim in their discussion of how people are able to discriminate between memory for having engaged in a particular task as compared to having simply thought about engaging in that task.

Summary. Perceptual identification in the first three experiments reflected differences in data-driven processing while recognition memory performance reflected differences in conceptually driven processing. That is, increasing the subject's reliance on context produced opposite effects on the two measures. In line with the claim that providing context allows conceptually driven processing and, thereby, reduces the reader's reliance on the analysis of visual information (e.g., Ehrlich & Rayner, 1981), reading a word in context did less to enhance later perceptual identification but more to aid later recognition memory than did reading a word without context.

A possible alternative account of the results is that subjects did not always actually read words that were presented in context but, rather, sometimes only generated those words, fully ignoring their visual presentation. Such an account would be in line with a claim that context increases redundancy and allows less sampling of visual information by allowing the visual presentation of some words to be fully ignored (e.g., Goodman, 1967). Against this account, the recognition memory results revealed that, in Experiments 2 and 2R, subjects did not fully generate antonyms in the context-present condition, yet reading a

word in context still did less to enhance its later perceptual identification than did reading the word without context. Further, the context word did not perfectly predict the word that was presented to be read. On a substantial proportion of the occasions on which subjects generated an antonym and said it aloud, the word that they generated was not the antonym that was presented to be read in the context-present condition. Since there were essentially no errors in reading words in the first phase of the experiments, subjects must have consistently made some use of the visual information provided by words that were presented in context. Rather than being all or none in that a word is either looked at or ignored, it appears that the analysis of visual information varies continuously with the extent of that analysis being dependent on context. Further evidence that this is the case is provided by the conditionalized probabilities of perceptual identification from Experiment 3. When subjects incorrectly generated and said a word that was not the target word, reading the target word in the context-present condition did more to enhance later perceptual identification than did reading the word without context. A misleading context may result in the visual analysis of a word being more extensive than would be carried out if the word was read without context. This possibility is further investigated in Experiment 4.

EXPERIMENT 4

The results of the first three experiments highlight the beneficial effects of context. As well as benefits, however, inhibitory effects of context have been reported (e.g., Posner & Snyder, 1975; Stanovich, 1981). Context can be misleading with regard to an item that is to be presented, and result in it taking longer to identify the item or to recognize it as being a word than if no context had been provided. Although this increase in processing time may largely reflect time spent resolving an incongruity at the semantic or syntactic level, the results of Ex-

periment 3 provided some evidence that "cost" in processing time is at least partially due to a more extensive visual analysis being carried out to read an unexpected word. Reading a word in the context-present condition after having generated a different word produced higher later perceptual identification than did reading a word without context. Costs in processing that result from presenting an item in a misleading context were further investigated in the present experiment. The procedure was identical to that of earlier experiments with the exception that the 'generate'' condition in those experiments was replaced by an "incongruent context" condition. In the incongruent context condition, the target word that subjects read was unrelated to the antonym that they had just generated from the context word. The context-present condition from earlier experiments was retained as a congruent context condition in which subjects read a word immediately after having generated that word as an antonym. The manipulation of conditions was within subjects so that, given a context word, subjects could not predict whether the word that would be presented to be read would be congruent or incongruent with the context.

Modifying the procedure of the earlier experiments to include the incongruent context condition in Experiment 4 constitutes a reduction in the overall probability that a context word will be a valid cue for the word that is to be read. Reduction in the validity of a cue has been shown to result in a reduction in both costs and benefits associated with "priming" (Posner & Snyder, 1975). With regard to the benefits of context, Tweedy, Lapinski, and Schvaneveldt (1977) reported that the facilitative effect of semantic context in a lexical decision task can be reduced by decreasing the proportion of pairs in a list that are comprised of related words, thereby reducing the overall probability of the meaning of one member of a pair being congruent with that of the other member of a pair. Results from ex-

periments that have varied cue validity can be used to suggest that the visual processing of words read in a congruent context will be influenced by including words that are read in an incongruent context in the same list. Due to the reduction in the probability of context being a source of valid cues, subjects might engage in less conscious, attention-demanding processing of a sort that is important for gaining benefits from context (Posner & Snyder, 1975: Stanovich, 1981). Conceptually-driven processing could not be fully avoided by subjects in Experiment 4 since they were required to generate an antonym of each context word and say it aloud prior to the presentation of the target word that was to be read. However, even if the amount of conceptually driven processing is not reduced, subjects might be less willing to rely on information gained from conceptually driven processing and so require more visual information to be confident in their reading of a word presented in a congruent context when the overall cue validity of context is reduced. The decrease in overall. cue validity might result in a congruent context producing a smaller reduction in visual processing and, consequently, less disadvantage in later identification than was observed in earlier experiments.

Method

Subjects and design. The subjects were 24 students enrolled in an introductory psychology course at McMaster University who served in the experiment for course credit.

The design was identical to that employed in Experiments 1-3 with the exception that the "generate" condition in those experiments was replaced by an incongruent context condition. For the test of perceptual identification and that of recognition memory, then, there were four conditions: new words, words that had been read without context, words that were read in the context of their antonyms (congruent context), and words that were read in the context of words that were not their antonyms (incongruent context).

Materials and procedure. With the exception of a few antonym pairs that were replaced due to one member of the pair not reliably leading to generation of the other member of the pair, the materials were the same as employed in prior experiments. Four sets of 15 antonym pairs were formed such that the sets were balanced with regard to the length of target words and their frequency in the language. For the incongruent context condition, pairs were formed by re-pairing members of antonym pairs. This re-pairing was done in a random fashion with the restrictions that there was no obvious relationship between members of the new pairs, and that no two pairs could coincide with regard to the antonyms that they contained. For example, "HOT DOWN" could not constitute one pair while "UP COLD" constituted another. Four formats were constructed by rotating the sets of antonym pairs through experimental conditions such that across formats each set of pairs represented each condition equally often. Two orders of items were employed for the first phase of the experiment: within each order, items representing each of the experimental conditions were spread evenly through the list. For words representing the incongruent context condition, the member of an antonym pair that was presented to be read had to appear equally often before and after, and be widely separated from the member of that pair that was presented as a context word. Otherwise, the order of items was random. Three subjects received each of the eight lists formed by combining the four formats and two orders of items presented in the first phase of the experiment.

An initial test of perceptual identification was given to determine a presentation duration for each subject that would yield a probability of correct perceptual identification that was near .50. The procedure and apparatus employed for presenting items in the first phase of the experiment were identical to that in prior experiments. As in Experiment 3, subjects were instructed to generate an antonym of the context word and say it aloud prior to the presentation of the word that was to be read, and then read that later word aloud when it appeared. The details of the presentation of stimuli, including the timing of events, the test of perceptual identification, and the test of recognition memory were the same as in prior experiments.

RESULTS AND DISCUSSION

The probability of subjects correctly generating the antonym of the context word was .79 in the congruent context condition and .87 in the incongruent context condition. The presentation duration employed for the test of perceptual identification ranged from 15 to 40 milliseconds and had a mean of 26.7 milliseconds. The probabilities of perceptual identification are presented in Table 4 separately for each of the experimental conditions. An analysis of variance that included all four experimental conditions yielded $MS_e = .010$ with 69 df. Employing that estimate of the error variance, the difference between probabilities that is required to reveal significance at the .05 level when a one-tailed t test is employed is .049.

Regardless of context, reading a word in the first phase of the experiment enhanced later perceptual identification. Unlike the results of prior experiments, however, reading a word immediately after having generated that word as an antonym (congruent context) did not produce a level of later identification performance that was lower than that produced by reading a word without context. Perceptual identification in both of these conditions was poorer than that produced by reading words in an incongruent context. In the congruent context condition, a comparison of conditional probabilities produced results that parallel the difference in overall probabilities between the congruent and incongruent context conditions. Although the difference was not significant, the probability of perceptually identifying words that had been generated prior to being read in the congruent context condition (.67) was lower than that of perceptually identifying words in that condition that had not been generated prior to being read (.75). The conditionalized probabilities in the incongruent context condition provided no evidence that generating a word as an antonym, widely separated in time from the reading of that antonym, had any effect on its subsequent perceptual identification.

The concern with cue validity makes it worthwhile to compare the results of the present experiment with those of prior experiments. Perceptual identification of words that had been read with no context and that of new words in the present experiment was comparable to that observed in prior experiments. However, reading a word in a congruent context produced higher perceptual identification performance in the present experiment than in prior experiments. The probability of perceptually identifying words that were read in an incongruent context (.74) was higher in the present experiment than that in other conditions, and identical to the conditional probability in Experiment 3 of perceptually identifying a word that was read in the con-

 TABLE 4

 Probabilities of Later Perceptual Identification as a Function of Context in Phase 1

	Context			
	No context	Congruent	Incongruent	New
Probability	.680	.669	.736	.527

text-present condition after an incorrect word had been generated. The results of the perceptual identification test provide evidence that the visual analysis of words read in an incongruent context is more extensive than that of words read without context. Further, the reduction in reliance on visual information that is gained when a word is read in a congruent context apparently depends on the overall probability of the context word providing a valid cue for the word that is to be read. Even when subjects were required to fully generate a word prior to reading that word in a congruent context, reducing the probability that the cues provided by context were valid largely eliminated the difference in later perceptual identification between words that had been read in a congruent context and those read without context. Subjects were apparently less willing to rely on information gained from conceptually driven processing and, consequently, relied more heavily on an analysis of visual information to read a word when cue validity was decreased.

Recognition memory performance was expected to reflect conceptually driven processing and, consequently, not reveal any difference between the congruent and incongruent context conditions. Conceptually driven processing should have been approximately equal in the congruent and incongruent context conditions. In both conditions, target words were generated although the word that was generated was then immediately read only in the congruent context condition. Analyses of the recognition memory data revealed that the congruent and incongruent context conditions produced nearly identical probabilities of recognition memory (.733 and .725), and each produced a higher probability of recognition memory than did reading a word without context (.38), t(46) = 10.24and 9.06, SEM = .034 and .039. Although perceptual identification performance revealed that subjects reading words in an incongruent context relied more heavily on analysis of visual information, it was apparently conceptually driven processing that provided a basis for recognition memory since the incongruent context condition did not hold any advantage over the congruent context condition in recognition memory. Conditionalizing recognition memory on a word having been correctly generated in the first phase of the experiment did not change the pattern of results.

GENERAL DISCUSSION

The results weigh on a number of issues. The conclusions that I draw are (1) perception, like recognition memory, relies on memory for prior episodes, so the two can be described within the confines of a single model; (2) generating, as compared to reading, a word does not produce a better memory but, rather, produces a difference in what is remembered; (3) perceptual identification and recognition memory utilize different forms of information rather than reflecting the operation of different memory systems; and (4) finally, effects on visual perceptual identification reflect the extensiveness of prior visual analysis, and are useful for analyzing interactive processing in reading.

Perception, like recognition memory. relies on memory for prior episodes, so the two can be described within the confines of a single model. The present results show that perceptual identification is not only sensitive to a word having been read but also reflects differences in the types of information utilized during that prior reading. By current models of word recognition (McClelland & Rumelhart, 1981; Morton, 1979), in contrast, identification of a word utilizes an abstract representation such as a logogen that serves to represent only defining or typical features of the word. Presentation of the word serves to lower the threshold of that abstract representation. thereby reducing the amount of information that must later be collected for the subject to decide that the word has occurred. To account for the lack of transfer between auditory presentation of a word and its later

visual perceptual identification, Morton (1979) has postulated separate visual and auditory logogen systems. The present finding of effects of the context in which a word was read on its later perceptual identification poses a more serious problem for the logogen model. The difficulty is that the activation of a logogen that is said to be gained by reading a word is a historic in that the source of that activation is not preserved; the threshold of a logogen does not reflect the amount of data-driven processing separately from that of conceptually driven processing involved in the prior reading of a word. The lowering of the threshold of a logogen depends only on a sufficient total amount of information having been obtained to allow the prior reading of the word. Regardless of the context in which a word was read, it must have been the visual logogen system that was involved so equal effects on later perceptual identification must be predicted.

One way of accounting for the present results is to assume that the level of the "unit" that is represented is determined by context. Osgood and Hoosain (1974) report that presenting wordlike nominal compounds such as "peanut butter" does not enhance later perceptual identification of the individual words in the compound, and argue that this is because the meaning of the individual words is lost in the larger unit, and perceptual identification utilizes feedback from central mediational processes concerned with meaning. Drewnowski and Healy (1977) used a letter search task to attempt to specify units that are at a higher level than the individual word but emphasized effects on the processing of visual information rather than appealing to an effect of feedback from meaning. They found a disproportionately large number of detection errors when subjects were searching for letters that appear in the common function words "the" and "and." The number of errors on these function words was reduced if the words were placed in an inappropriate syntactic

context or if word identification was interfered with by presenting words in a mixed typecase. Drewnowski and Healy argue that letters are embedded in words when subjects attend to units at the word level and that words, in turn, can be embedded in larger units when subjects attend to those higher levels. To account for the present results, it could be suggested that context determines the level of the unit that is processed. Possibly, when a word is read in the context of an antonym, the word and its antonym comprise a larger unit that fails to match with the single word unit that is later presented for perceptual identification; as a consequence, performance suffers. By this view, reading a word in an incongruent context requires that subjects attend to the individual letters of the word, and it is information at that level that is most useful for later perceptual identification of words presented in isolation.

This notion of units at different levels could be used to retain the spirit of the logogen model by claiming that potential units of perception are represented at different levels and that units at each of the levels have corresponding thresholds that can be temporarily lowered by their prior use. Memory for an event would be distributed among a number of representations at different levels of abstraction and be recorded by lowering the threshold of units at some of those levels. By postulating units at a number of different levels, one would have to greatly increase the number of representations that are postulated and decrease the generality of at least some of those representations, decreasing the attractive simplicity of the model. One also encounters difficulties associated with postulating the temporary lowering of thresholds. Rather than being temporary, the effects of a prior presentation are so persistent as to cause problems for a logogen model (Jacoby. 1983). Further, details of the visual appearance of a word that is read are remembered and influence later perceptual identification (Jacoby & Witherspoon, 1982). Since a word can assume an essentially infinite number of different appearances, effects of this sort are potentially damaging for a threshold model. Prior to the presentation of a word there is potentially no representation of its word shape whose threshold can be lowered.

The conclusion I prefer is that perceptual identification reflects memory for the processing of episodes. The choice between representations is similar to that considered by Glushko (1979) and Brooks (1978) when they advocate activation of whole words rather than abstract spelling to sound rules as a basis for pronunciation. They argue that an account in terms of abstract spelling to sound rules requires a proliferation of rules in the hundreds or thousands and that a sizable number of these rules would have to be so specific to particular words as to no longer be abstract across word identity. McClelland and Rumelhart (1981) incorporate these suggestions by postulating whole words as being the unit of representation and accounting for word perception in terms of the number of "friends" and "enemies" that are recruited on the basis of similarity when a particular word is presented. The form of model I prefer is similar to that proposed by McClelland and Rumelhart but utilizes memory for the processing of a word during particular encounters with that word rather than some abstract representation of the word. The level of activation that is postulated by McClelland and Rumelhart as being a property of an abstract representation of a word can be seen as being a summary statistic that reflects the number and similarity of remembered prior episodes that represent occasions on which the particular word was read. Predictions made in terms of differences in memory for episodes will often not differ from those that could be derived by postulating abstract representations that differed in their level of activation. The primary difference is that the episodic view of perception predicts more specific and persistent effects of a prior experience (Jacoby, 1983; Jacoby & Witherspoon, 1982). Further, the episodic view dictates that similarity must be specified in terms of the similarity of processing of events rather than, as is often done, in terms of the similarity of literal representations of words.

If the episodic view of perception is adopted, the distinction between episodic and semantic memory (Tulving, 1972) largely disappears, as does the distinction between perception and memory (Jacoby & Witherspoon, 1982). Whether a word fragment, for example, is called a retrieval cue (Nelson & McEvoy, 1979) or is treated as a perceptual stimulus (Broadbent & Broadbent, 1975) becomes largely arbitrary. For both memory and perception, the interaction between constraints provided by the stimulus (cues provided by the test) and those coming from memory for prior episodes, determines performance. The primary difference between a test of memory and one of perception is likely to be in the type and amount of constraint imposed by the cues provided at test. For a test of recognition memory, fewer prior episodes are potentially relevant than would be relevant for a test of perception. Memory and perception can also differ in the aspects of prior episodes that they rely on most heavily. In the present experiments, effects in perception reflected prior data-driven processing while recognition memory reflected prior conceptually driven processing. The memory underlying perception, as well as that underlying performance on recognition or recall tasks, however, is apparently distributed across memory for prior episodes rather than being fully centralized in abstract representations. Models of the form proposed by Ratcliff (1978) provide a promising lead toward specifying how assumptions about a distributed memory system can be linked to performance in a manner that makes quantitative predictions possible.

The issues here are identical to those involved in a choice between "instances" and "abstractionist" views of concept formation (Brooks, 1978; Medin & Shaffer, 1978). A logogen model corresponds to an

abstractionist view, whereas a model that emphasizes memory for prior episodes corresponds to an instances view of concept formation. The relationship between theories of concept formation and those of perception and memory is more fully discussed by Jacoby and Witherspoon (1982). The data from the present experiments can be interpreted as being in line with an instances view of concept formation. That data supporting an instances view can be gained in a word perception task is impressive since the great deal of experience that subjects have had reading would seem to favor the abstraction and consistent use of a general (abstract) representation of words.

Generating as compared to reading a word does not produce a better memory but, rather, produces a difference in what is remembered. If only the recognition memory results were examined, one would agree with others (e.g., Craik & Lockhart, 1972: Sachs, 1967) that it is primarily meaning, the semantic interpretation of an event, that is remembered over the long term. By this view, perceptual data are used only to arrive at the interpretation of an event and are rapidly forgotten. Results produced by the perceptual identification test, however, provide evidence that the perceptual data are remembered also. Memory for the perceptual data was revealed by presentation of a word enhancing its subsequent perceptual identification. The results of the present experiment support the claim that the cues provided for retrieval by a test, or the operations employed to process an item during a test, must be compatible with the prior processing of that item for evidence of memory to be obtained (e.g., Jacoby, Craik, & Begg, 1979; Kolers, 1979; Tulving & Thomson, 1973). The effects of encoding conditions on recognition memory were the opposite of those on perceptual identification so that conclusions drawn about memory depended on the form of test that was examined.

Effects that partially reflect memory for prior perceptual processing have also been

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found using a variety of other tasks. The prior presentation of a word enhances performance when subjects are later asked to read an inverted version of the word (Kolers, 1976), make a lexical decision by judging that a repetition of the item is a word (Forbach, Stanners, & Hochaus, 1974; Scarborough, Cortese, & Scarborough, 1977), complete a word fragment that requires the previously presented word as a solution (Tulving, Schacter, & Stark, 1982), or use a word fragment (ending cue) as an explicit cue for recall (Nelson & Mc-Evoy, 1979). That the effect of a prior presentation in each of these tasks relies, at least partially, on memory for prior perceptual processing is evidenced by the effect of changing the modality of presentation between study and test. As has been found for the perceptual identification task employed in the present experiments, hearing a word or generating that word is less effective than is reading the word for either a later visual test that requires lexical decisions (Kirsner & Smith, 1974; Scarborough, Gerard, & Cortese, 1979), or for a later test that involves visual presentation of a word fragment as a cue for recall (Nelson & McEvoy, 1979). As well as an effect of modality, Kolers and his colleagues have found effects of changes in the visual appearance of items (e.g., changing typeface) on the amount of transfer gained from prior practice in reading an inverted text (e.g., Kolers & Perkins, 1975; Kolers, Palef, & Stelmach, 1980).

That the effects of generating a word are specific to the form of test that is used weighs on the interpretation of experiments that have been designed to determine why generating as compared to reading a word enhances its memory (e.g., Donaldson & Bass, 1980: Graf, 1980: McElroy & Slamecka, 1982). A popular account of the "generation" effect is that generating produces better memory by forcing subjects to deal with the meaning of the to-be-remembered material. In contrast, the present results lead to the conclusion that generating does not produce better memory but rather

produces a difference in what is remembered. The benefits of generating a word for recognition memory in the present experiments can be described in terms of an increase in conceptually driven processing; however, those benefits were offset by a reduction in benefits for later perceptual identification. Graf (1980) offered similar comments on the specificity of the generation effect by employing a distinction between interword and intraword organization proposed by Mandler (1980). Interword organization can be seen as corresponding to conceptually driven processing. Intraword organization (integration) is described as reflecting memory for the perceptual characteristics of a word, data-driven processing, and was proposed by Mandler as serving as one basis for recognition memory. Graf used a recognition memory test to measure effects on memory for perceptual characteristics. The present perceptual identification measure seems to more truly reflect differences in prior perceptual processing than does a test of recognition memory, and has the additional advantage of encouraging greater contact with the perception literature than does the notion of intraword organization.

Rather than reflecting the operation of different memory systems, perceptual identification and recognition memory can utilize different types of information. Finding variables that have opposite effects on the performance of two tasks is a standard criterion for asserting the independence of the tasks. By this criterion, perceptual identification and recognition memory are independent of one another; increasing data-driven processing had an opposite effect on the two tasks. Other experiments have also revealed evidence that the effect of prior experience on the performance of a perceptual task can be independent of recognition memory (Jacoby & Dallas, 1981; Jacoby & Witherspoon, 1982; Kolers, 1976; Tulving, Schacter, & Stark, 1982). Tulving et al. (1982) interpreted their results as evidence of the existence of two independent

memory systems: a perceptual or performance based memory system and a separate episodic memory system upon which recognition memory is based. Rather than concluding that there are two memory systems, each identified with a type of task, I want to emphasize the difference in the type of information employed by the two types of task. The test of recognition memory used information for which prior conceptually driven processing was important, whereas perceptual identification used information for which data-driven processing was more important.

By concentrating on the type of information used by a task, highly variable relations among the tasks can be predicted, a result that would be awkward for a theory that identified the types of task with independent memory systems. It is likely that the independence of effects on perceptual identification and recognition memory can be removed by altering the details of the testing procedures so that both tests rely on the same type of information. In the present experiments, words were presented without context for the test of perceptual identification so only prior data-driven processing was important. Experiments that have reinstated study context at the time of test have found that performance on a perceptual task relies on prior conceptually driven processing (Franks, Plybon, & Auble, 1982). Similar effects of reproviding context can probably be found for visual perceptual identification, making it possible to remove the independence of recognition memory and perceptual identification by allowing both tasks to use memory for prior conceptually driven processing. Conversely, recognition memory can rely either on memory for perceptual characteristics (familiarity) or on memory gained by processing meaning (e.g., Jacoby & Dallas, 1981; Mandler, 1980). There is evidence that the independence of perceptual identification and recognition memory can be removed by insuring that both forms of test use memory gained from data-driven processing (Jacoby & Witherspoon, 1982). Given that perceptual identification and recognition memory can be made dependent or independent of one another by manipulating factors that influence the type of information that they employ, it seems unwise to identify the tasks with independent memory systems.

Postulating separate memory systems would be justified if perceptual identification and recognition memory employed representations that differed in the amount of detail that they preserved about a prior experience. As discussed earlier, a common assumption is that perception relies on an abstract representation that does not preserve the details of any particular processing episode, whereas recognition memory relies on memory for episodes. Alternatively, it could be claimed that the forms of memory underlying the two types of task differ in that the memory revealed by perceptual tasks is gained in a more passive, automatic fashion and preserves all of the perceptual details of the prior event. Results of the present experiments provide no support for either of these alternatives. Both perceptual identification and recognition memory were influenced by the encoding conditions of the prior presentation of a word. Other experiments (Jacoby, 1983) have revealed that variables influencing retrieval of memory for episodes have effects on both types of task. Although perceptual identification and recognition memory can differ in terms of the type of information that they use, it seems that both types of task rely on memory for prior processing episodes.

Effects on perceptual identification are useful for analyzing interactive processing. In the present experiments, items were presented out of context in the perceptual identification test to provide evidence of differences in data-driven processing. The results are similar in some ways to those obtained in investigations of memory for pictures. Friedman (1979) reported effects of subjects' expectations on both the visual

processing and memory of objects pictured in a scene. For example, if a refrigerator was pictured in a familiar context such as a kitchen scene, fewer eye fixations were localized on the refrigerator and memory for it was poorer than if the object had been incongruous in the context in which it was pictured. When an object had appeared in a familiar context, subjects were less able to discriminate between the object that had actually appeared in the picture and other objects of the same class. Memory for pictured objects reflected differences in datadriven processing so that if an object was expected, less processing of visual information was required to allow its identification and this reduction in processing was reflected in later memory performance. In this study, as in perceptual identification in the present paper, increasing conceptually driven processing reduced performance on a later "data-oriented" measure of memory.

Studies of reading have also employed on-line measures of processing such as eye movements to investigate interactive processes but have lacked a measure of memory to provide converging evidence of effects of context on visual processing (e.g., Ehrlich & Rayner, 1981). The lack of converging evidence has been problematic since it is difficult to specify the locus of effects by using on-line measures. A reduction in processing time that comes from providing context can reflect a reduction in the amount of time required to gain a syntactic or semantic interpretation of a word rather than a reduction in the reader's reliance on visual information (McConkie & Zola, 1981). However, total reliance on online measures has been encouraged by the view that reading uses abstract representations, making memory data useless for revealing differences in data-driven processing.

The use of effects on perceptual identification as a converging measure of differences in prior processing rests on the same rationale as does Kolers' (e.g., 1976) work

on reading inverted text, but removes the worry that due to the task being an unusual one, reading inverted text might reveal practice effects that are more specific than those that could be found in normal reading. Words were presented in a normal orientation at a leisurely rate in the first phase of the present experiments. Effects on later perceptual identification revealed converging evidence for the claim that providing context reduces the reader's reliance on the analysis of visual information (e.g., Ehrlich & Rayner, 1981) rather than having its effect totally through a reduction in the time required for higher level processing such as dealing with the meaning of a word (McConkie & Zola, 1981). The results are also potentially relevant to theories describing the effects of context on lexical decisions. Rather than emphasizing effects on data-driven processing, Becker (Becker, 1980; Eisenberg & Becker, 1982) has suggested that the effects of context on the speed of lexical decisions is largely attributable to a reduction in the size of the verification set that subjects search through to explicitly identify a stimulus. The general notion is that rudimentary visual information is gained from a word that is to be read, and that the reader then searches through a verification set of variable length for a representation of a word that matches the visual information. The procedure for presenting stimuli in the first phase of the present experiments is similar to that employed in experiments investigating the effects of context on lexical decision. However. effects on later perceptual identification revealed that context can have a substantial influence on the amount of data-driven processing.

The present results are most easily summarized by claiming that the effect of context is to determine the amount of visual evidence that a reader requires to be confident in his or her reading of a word. The amount of evidence that is required is reduced when the word is read in a congruent context, particularly when the overall va-

lidity of context is high, and is increased when the word is read in an incongruent context. Of course, to prove the utility of the perceptual identification measure as a means of analyzing interactive processing in reading it must be shown that the measure is sensitive enough to reveal differences in the reading of connected discourse at normal rates. An encouraging note in this regard is that the present effects were obtained with words that appear with a high frequency in the natural language and the effects of a prior presentation are larger for low frequency than for high frequency words (e.g., Jacoby & Dallas, 1981). There are, at least, means by which the magnitude of the effects can be increased.

Concluding comments. Among the claims that have served as cornerstones of the cognitive revolution are the claims that it is primarily meaning that is remembered over the long term, and that much of behavior is rule-governed or guided by abstract concepts. As an example, Bruner (1966) was so impressed by what has come to be called conceptually driven or top-down processing that he recommended "discovery learning" as a primary procedure for education. Discovery learning requires that the learner generate a solution to a problem rather than its being presented in a more intact form and is said to, thereby, enhance memory. Results of the present experiments revealed that "conceptually driven" processing enhanced recognition memory but actually reduced memory performance when a test of perceptual identification was employed. Performance on perceptual tasks is probably equally important to that on other tasks but relevant to different educational objectives than those considered by Bruner. Rather than a procedure producing good or poor memory, it depends critically on how memory is tested or utilized. Further, the claim that performance is governed by abstract concepts or rules has come under attack. It has been suggested that concept formation may utilize memory for particular instances of the con-

cept rather than a representation that is at a higher level of abstraction and that encompasses all of the instances of the concept (e.g., Brooks, 1978; Medin & Schaffer, 1978; Vokey & Brooks, in press). In the present experiments, it was the processing of an item on its particular prior presentation, rather than some abstract representation that remained invariant across situations, that was important for later performance. Perceptual identification relied on memory for the processing of a prior presentation, as did recognition memory, although the two forms of test employed different types of information. As research progresses, it seems likely that distinctions between memory and perception will continue to blur (Jacoby & Witherspoon, 1982). Both perception and memory seem to rely on memory for prior episodes, and, consequently, the two types of tests can be described within the confines of a single model. In any case, comparisons of effects on recall or recognition memory with those on performance of perceptual tasks may prove useful for further analyzing the reading process as well as for analyzing processing in a variety of other situations.

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