Effects of Task on the Activation of Predictive Inferences

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ABSTRACT

Research on the activation of predictive inferences has provided inconsistent
results that may be explained within a contextual view of reading. The present
study tested whether the type of test for explicit memory would affect the activation
of knowledge-based predictive inferences. The information necessary for the activation
of a predictive inference was provided to readers in four different conditions
(no inference, local processing, global processing, coherence). Manipulation was accomplished
by varying the type of question asked after reading the passage (verbatim,
factual, or inference). Analysis suggests predictive inferences are automatically activated
and nor affected by contextual factors such as the question. Consequently, the
current data do nor provide clear support for a contextual view of comprehension.
These conclusions are supported by a two-stage view of elaborative processing.

The effects of a reader's prior knowledge has been a central issue for theories of text comprehension (Kintsch, 1988; Kintsch, Welsch, Schmalhofer, & Zimney, 1990; Whitney & Waring, 1991). A critical part of this issue is that the interaction of background knowledge and text-based information may lead to the formation of elaborative inferences (Bransford & Johnson, 1972; Johnson-Laird, 1983, 1989). Predictions about the consequences of actions represent one form of elaborative inference that has received considerable recent attention (e.g., Fincher-Kiefer, 1993; McKoon & Ratcliff, 1986; Whitney, Ritchie, & Crane, 1992). Predictive inferences represent a clear example of the type of expectation-driven processing that relies heavily on a reader's prior knowledge. For example, if a reader is presented the sentence "The actress fell off the 14-story building," the reader may use prior knowledge of such situations to infer that the actress is "dead." These types of inferences are important if they occur during comprehension because they may affect how the reader comprehends later text (Whitney, *et al., 1992).*

Previous researchers have disagreed on whether predictive inferences are activated during processing for comprehension. Some research has suggested that predictive inferences are rarely generated during processing (McKoon & Ratcliff, 1986, 1992; Potts, Keenan, & Golding, 1988) while other studies have suggested that readers generate predictive inferences in a variety of situations (Fincher-Keifer, 1993; Waring, 1996; Whitney, *et al., 1992).* Whitney and colleagues (Whitney & Waring, 1991; Whitney & Williams-Whitney, 1990) have suggested that the context of the reading situation may explain some of the variation in the occurrence of elaborative inferences. The current study was designed to assess whether variations in the type of reading task affect the activation of predictive inferences during processing for comprehension.

Past research has relied on a variety of tests, such as free recall, recognition of probes, answering questions, summarization, naming, making lexical decisions, and thinking out loud. However, numerous researchers have expressed concern that the task employed may affect the reader's goal orientation, with the potential of either encouraging or suppressing inferential activity (Van den Broek, Fletcher, & Risden, 1993; Whitney, *et al., 1992;* Whitney & Williams-Whitney, 1990). For example, Whitney and Waring (1991) and Van den Broek, *et al.* (1993) have argued that the speeded-item recognition task may discourage the on-line generation of predictive inferences. The speeded-item recognition task requires the reader to recognize within 300 msec. whether a word appeared in some previously read text. Requiring the reader to focus on simple word recognition may orient the reader toward a shallow, verbatim representation designed to store only the words from the text. In this situation the production of elaborative inferences would be counter-productive to completing the task at hand (Van den Broek, *et al.,* 1993; Whitney, *et al., 1992).*

In contrast to most studies of elaborative processing, several recent studies have used constrained word-stem completion to test readers' implicit memory of text. In particular, constrained word-stem completion has been used to show that predictive inferences are activated when the inference event is the current focus of a story (Whitney, *et at.,* 1992) and when the

inference might resolve a stated goal of the main character (Waring, 1996). A constrained word-stem is a word fragment the reader is asked to complete with the first word that comes to mind. For example, a possible constrained word-stem for the sentence "The actress fell off the 14-story building" would be "d ___." If the reader generated the target inference, then the reader would be more likely to complete the constrained word-stem with the target word "dead." Unlike most other tasks, constrained word-stems are presented as a distractor prior to an explicit test of memory. The explicit memory test is used to disguise the true nature of the constrained word-stem task and to ensure that readers are actually reading the text for comprehension. Because constrained word-stem completion is designed to test a reader's memory without his awareness, it is considered to be much less intrusive in reading.

Waring (1996) provided a good example of constrained word-stem completion. He had participants read extended passages in which the outcome of an event could fulfill a goal of the story's main character if the reader formed a predictive inference. The passages were designed such that information about a character's goal was either one or five sentences away from the critical event. This allowed inferential activity to be assessed under both local and global processing conditions. After each passage, participants completed a set of constrained word-stems. The critical word-stems were designed to be completed with a target inference only if that term had been activated in memory. Following the word-stems, participants answered a true-false question that was presented as the critical task.

Waring (1996) found that the constrained word-stems were completed with the target inferences significantly more often in both the local and global processing conditions, relative to a no-inference control condition. These findings suggest that readers activate predictive inferences under conditions of both local and global processing, if the inference fulfills the story character's unresolved goal.

The current study used constrained word-stem completion to test for the activation of both local and global predictive inferences under different question type conditions. The materials for this study were the character-goal passages developed by Waring (1996). However, Waring used an explicit memory test that only required the participant to determine whether a specific fact had been stated in the passage. In the current study, the level of elaborative processing necessary to answer the explicit memory questions was manipulated between subjects. Consequently, the current study replicated Waring's procedures with the additional variable of question type (verbatim, factual, or inference). Dependent on whether the type of question affects the activation of an inference, we would expect one of two possible outcomes for this study.

If the type of question *does not affect* the activation of predictive inferences, we would only expect to find a main effect of passage type, replicating Waring's (1996) results. If, however, the type of question *does affect* the activation of predictive inferences, we would expect constrained word-stem completion rates to reflect an interaction between passage type and

question type_ Specifically, constrained word-stem completion rates would
be expected to vary as a function of the extent to which elaborative processing
is required to answer successfully the explicit memory questions.

METHOD

Participants
Participants were 120 general psychology students from Appalachian
State University and were native speakers of English. They received credit
toward a course requirement for their participation.

Design
This study involved a 4 x 3 mixed factorial design. Passage type (local
priming, global priming, coherence, and no inference) was manipulated within
subjects, while question type (verbatim, factual, and inference) was manipulated
between subjects. The dependent measure was constrained word-stem
completion.

Materials
The stimulus materials for this study were 16 sets of passage taken from
Waring's (1996) study. Each passage set contained versions of a passage inducing
local processing, global processing, coherence, or no inference. Every
passage was seven sentences long and described a situation in which the
!11ain character attempts to resolve a stated goal. Information about the character's
goal and the event that could resolve that goal were contained in
separate sentences. Previous pilot studies have demonstrated that information
about both the goal and event are required for a predictive inference to
be formed (Waring, 1996). The remaining five sentences in each passage
were neutral filler sentences that were used to manipulate the location of the
two sentences explaining the goal and event. Examples of passages inducing
local and global processing are provided in Table 1.

TABLE 1
Sample Passages For Target Predictive Inference "Break"

Local Priming Condition

Dave had been an executive with the company for 12 years.

He went into his boss's office but his boss was not there.

He considered leaving a note but decided against it.

He looked around the office as he prepared to leave.

Dave had been fired and wanted to get back at his boss. (Goal)

He walked over and picked up an ancient porcelain vase. (Event)

The vase had always been his boss's most prized possession.

Global Priming Condition

Dave had been fired and wanted to get back at his boss. (Goal)

He had been an executive with the company for 12 years.

He went into his boss's office but his boss was not there.

He considered leaving a note but decided against it.

Dave looked around the office as he prepared to leave.

He walked over and picked up an ancient porcelain vase. (Event)

The vase had always been his boss's most prized possession.

The four versions of each passage varied either on sentence location or content. Within each passage the sentence explaining the critical event was always the sixth sentence. For the induction of local priming, the sentence indicating the goal was the fifth sentence, immediately preceding the Event Sentence. For the induction of global priming, the Goal Sentence was the first sentence, five sentences before the Event Sentence. The Coherence Passage was designed to force the activation of an inference by requiring it for passage coherence. The Coherence Passage was the same as the Global Priming Passage except for the final sentence. For example, the last sentence for the Global Priming Passage in Table 1 was changed to "He watched the tiny pieces scatter across the floor." A previous pilot study demonstrated that the coherence sentence alone was not enough to cause the activation of the target inference (Waring, 1996). The Coherence Passage was necessary to ensure that the inference could be generated when necessary. Finally, the passage designed to induce no inference was the same as the Global Priming Passage except that the Event Sentence was modified so that the inference was not suggested. For example, the Event Sentence for the No-inference passage was "He walked over and admired an ancient porcelain vase."

A Latin square design was used to create four stimulus lists that contained one version of each passage. Thus, each stimulus list contained four versions of each passage type (Local, Global, Coherence, or No Inference). In addition to the 16 experimental passages, 22 filler passages were also taken from Waring's (1996) study. The filler passages were consistent with the general form of the experimental passages in that they were 7-sentence narrative passages that described some event. Six of the filler passages were placed at the beginning of each stimulus list to serve as practice passages. This allowed participants to become familiar with requirements of the task prior to the actual experiment. The other 16 filler passages were randomly interspersed among the experimental passages. This was done to help keep participants naive to the experimental manipulation.

Each passage in each list was followed by two constrained word-stems_ The target constrained word-stems were taken from Waring's (1996) study and have been effective measures of activation of inference. The target constrained word-stems were created by providing the first letter of 4-letter words and the first rwo letters of longer words_ For example, the constrained word-stem for the target words "fall" and "break" would be "C __ " and "be __ ," respectively. Distractor-constrained word-stems were constructed using the same method. The distractor-constrained word-stems were used for the second constrained word-stem occurring after each experimental passage and for both constrained word-stems occurring after the filler passages_ Care was taken to ensure that the distractor-constrained word-stems did not resemble the experimental-constrained word-stems either semantically or orthographically. Each experimental passage was paired with the appropriate target-constrained word-stem and a filler constrained word-stem, with the target-constrained word-stem always occurring first.

Manipulation of the task was accomplished by creating three different true-false questions for each passage. The question types used were verba-tim, factual, and inferential. The verbatim question asked whether a word had occurred in the passage. For example, the verbatim question for the passage in Table 1 was "The word *office* appeared in the passage." The factual question asked about factual content from the passage. The factual true-false question for the Table 1 passage was "Dave had been fired from his job." Finally, the inferential questions required some low level inferential processing to answer the question correctly. For example, the inference question for the passage in Table 1 was "Dave blamed his boss for being fired." Note, the text did not explicitly state that Dave blamed his boss, but with normal comprehension this can be inferred to be true. To avoid response strategies, 50% of the questions within each list were true and 50% were false. Crossing the three question type conditions with the four passage lists resulted in twelve stimulus lists, four within each question type.

Procedure

Participants were told that the purpose of this study was to test some of the basic memory processes involved in comprehending narrative text. All materials were presented to the participants by computer using Micro-Experimental Laboratory software to control the presentation of materials and to record responses to the true-false questions. Instructions were presented on the computer for each participant to read. Once the participant read the instructions, the main points were reiterated verbally. Participants were told that on each trial they would read a passage one sentence at a time and answer a single true-false question related to the passage. They were also informed that a simple intervening task would occur between the passage and the question. The intervening task would be to complete two word fragments with the first word that comes to mind. Participants were asked to read the passages as they normally would for comprehension.

Each participant began by working through the practice set of six passages. Each passage was read one sentence at a time with only one sentence occurring on the screen at a time. Participants hit the space bar to control sentence presentation, which allowed them to read at their own pace. Once

the last sentence of a passage was completed, the constrained word-stems were presented one at a time. The participant had seven seconds to complete verbally each constrained word-stem. The experimenter recorded participants' responses. If a response was not given within the allotted 7 sec., the experimenter noted a "no response." Following the constrained word-stems, the true-false question was presented. Participants responded to the question by pressing "1" for true and "2" for false on the computer keyboard. The computer recorded responses with no time restrictions. Once the practice passages were completed, presentation of the experimental passages began and followed the same sequence. The passage lists were broken down into four blocks with eight passages in each block. The computer randomly determined the order of block presentations.

RESULTS

Seven participants who scored less than 70% on the true-false comprehension questions were replaced. The mean proportion of constrained words-tem targets completed by each participant in each condition was analyzed using a 4 (passage type) X 3 (question type) mixed analysis of variance. In addition, the mean proportion of targets completed m each condition were collapsed across participants and analyzed by item m a mixed analysis of variance. This was done to ensure that the results were generalizable across both participants and materials. Because the pattern of results was the same across both analyses, only the analysis conducted on the participants' data is reported. The mean proportions of constrained word-stem targets completed with the target-inference term in each condition are presented in Table 2.

TABLE 2
MEAN PROPORTIONS AND STANDARD DEVIATIONS FOR TARGETS WITH CONSTRAINED
WORD-STEMS COMPLETED WITH TARGET-INFERENCE TERM FOR EACH
PASSAGE TYPE BY QUESTION TYPE CONDITION

	No Inference		Local		Global		Coherence	
	M	SD	M	SD	M	SD	M	SD
Verbatim	0.15	0.17	0.28	0.23	0.26	0.18	0.42	0.26
Factual	0.19	0.17	0.29	0.23	0.31	0.19	0.44	0.23
Inference	0.19	0.18	0.33	0.24	0.28	0.19	0.43	0.25

The only significant finding was a main effect of passage type $(F_{3,351} = 36\%, Mse=0.04, p<.05)$. The mean proportion of constrained word-stem targets completed with the target inference term for each passage type was for No Inference = 0.18, Local Priming = 0.30, Global Priming = 0.28, Coherence = 0.43. Pairwise comparisons of mean constrained word-stem completion rates for each passage type condition were made using Tukey's *HSD.* Results indicated that constrained word-stem targets were completed with the target-inference term significantly more often for the Coherence Passages than for all other passage types. In addition, constrained word-stems were

completed with the correct inference terms significantly more often for the Local Priming and Global Priming Passages when compared to the No Inference passages. The responses to the Local and Global Priming Passages were not significantly different.

DISCUSSION

Because the type of questions asked might affect the activation of predictive inferences, participants in this study were expected to vary the type of representation formed during reading. Readers who had the task of recognizing whether a word had appeared in the text were expected to focus on the individual words in the passage and activate few, if any, inferences based on prior knowledge. Readers who had the task of recognizing factual information from the text were expected to focus on developing a text-based representation. Consequently, some evidence of the activation of inferences was predicted, but it was expected to be moderated by the fact that such activation was unnecessary to answer a factual question. Finally, readers given a task that required them to verify the validity of statements that went beyond what the text explicitly stated (inferences) were expected to focus heavily on the development of a richly elaborated representation of events in the text and demonstrate relatively high inferential activation. Clearly, the current data do not support predictions based on differences between tasks. There was no evidence to suggest any variation in the amount of inferential activation, relative to the variations of question type. While it would be easy to conclude that the current data argue against a contextual view of the reading process, such an argument would be premature.

There are at least two possible explanations for the failure to find a main effect of question type consistent with contextual predictions. First, it is possible that the manipulation used was too subtle to yield significant variation in inferential activation. For the factual and inferential questions there appears to be a great deal of similarity in the nature of the questions that participants were asked to complete. Participants in each case were asked to verify the truth of a complete proposition that was clearly true or false with regard to the passage; however, this argument seems unlikely when the differences berween the verbatim (word recognition) condition and the other two conditions are considered. In contrast to the factual and inferential conditions, the verbatim condition simply required the participants to assess whether a single word had appeared in the passage. Criterial differences between tasks of exactly this type have been used as an explanation for conflicting results in past research (Van den Broek, *et at.,* 1993; Whitney & Waring, 1991). Consequently, even if the factual and inferential conditions were not sufficiently different, the constrained word-stem completion rates should have been lower in the verbatim condition.

A more plausible explanation for the failure to find a main effect of question type is based on the idea that elaborative processing involves more than just inference activation. Numerous researchers have suggested that elaborative inferences are the product of a two-stage process (e.g., Johnson-Laird, 1983; Kintsch, 1988). From this point of view the activation of an inference

is only the first stage. In the second stage, the inference must be actively integrated into the reader's developing representation of events.

Within a 2-stage view it has also been suggested that the activation of a reader's prior knowledge may be an automatic process (Kintsch, 1988). It is a noncontroversial point that automatic processes are not affected by situational or contextual variables (see Kintsch, 1988, for a review). It should be noted that constrained word-stem completion was designed to be a sensitive measure of whether information in memory has been activated above some baseline level. Such priming can result from associative activation of related concepts. As a result, measures of priming like constrained word-stems may provide evidence for inferential activity even when the amount of activation is not sufficient for the concept to enter the reader's working memory. Associative priming of this type is expected to diminish if the reader does not actively process the information in working memory. Such active processing is required for the information to be incorporated into a representation of the events described in text.

These data support the idea that, when the information necessary for a predictive inference is present, activation of the inference term will occur automatically. This conclusion is supported by the replication of Waring's (1996) results across each question-type condition. However, the current data do not preclude the possibility that contextual variations in the reading situation playa role in the second stage of elaborative processing, integration. So long as the inference has been activated in memory, contextual variables such as type of task may influence whether a reader engages in active processing of the inference. While inferences may be automatically activated, subsequent integration may be a strategic process.

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