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Technical Report No. 140

AN INVESTIGATION OF LOOKBACKS DURING STUDYING

Stephen M. Alessi, Thomas H. Anderson
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University of Illinois at Urbana-Champaign

September 1979

Center for the Study of Reading

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Abstract

Looking back at relevant sections of previously read text is proposed as a useful fixup strategy when comprehension fails while studying a text. Subjects read 24 pages of text and answered inserted questions which assessed their comprehension of the text. About half of the subjects were branched back to reread prerequisite information when it was later needed but had not been fully understood by those subjects. Subjects receiving lookbacks showed better comprehension of later information dependent upon the prerequisite information. In the light of these results, the training of natural lookbacks during study holds promise as a means of improving students' study behaviors.

An Investigation of Lookbacks During Studying

Studying has been characterized as having three main phases: before, during, and after reading (Anderson, 1979). The during reading phase, which is our main interest at this time, can in turn be characterized as having three aspects: those activities appropriate when the reader succeeds in comprehending parts of the text, those activities appropriate when the reader fails to comprehend parts of the text, and the monitoring processes which the reader undertakes to distinguish success or failure of comprehension. Comprehension monitoring (see Brown, 1978) determines to which of the two previous classes of activities the reader should direct his efforts.

Appropriate activities to use when sections of text are understood include: organizing the information (e.g., outlining), increasing the amount of text processing (e.g., imaging, paraphrasing, discussing), and record keeping for review (e.g., note taking and underlining).

"Fixup" activities appropriate when comprehension fails might include going back to learn prerequisite material missed, misunderstood, or forgotten (e.g., looking back in the text, rereading, or referring to previously taken notes), more carefully inspecting the confusing sections of text (e.g., careful parsing of sentences, slow reading, trying to picture the material mentally), and consulting outside sources (e.g., other books or persons who might be knowledgeable on the subject).

The prime objective of this study is to investigate those behaviors used during studying which are appropriate when comprehension of the text

fails. Based on questionnaire data from correspondence students (Anderson, Alessi, & Standiford, 1976), it would appear that students engage fairly commonly in the activities appropriate to understanding, but not in those appropriate to comprehension failures. They probably engage in activities appropriate to understanding both when they are and when they are not understanding what they are reading. This may largely be due to a failure to engage in monitoring activities, or to an inadequate repertoire of fixup strategies. To be sure, people employ all three activities to some extent. Every reader will, at times, recognize that he or she has not understood a segment of text, and, having recognized this, will sometimes engage in rereading or other fixup activities. But the questionnaire responses suggest that comprehension monitoring and fixup skills of even skilled adult readers may be far from optimal. To improve readers' fixup strategies, i.e., to remedy comprehension failures, would seem to have great promise as a way of improving overall comprehension.

At least two reasons why a segment of text may not be comprehended are (a) the reader has not read it carefully enough, failing to engage in deep, meaningful processing (Craik & Lockhart, 1972); and (b) the reader does not have knowledge of prerequisite information necessary to understand the information now at hand. The latter may include not knowing a word definition or usage in the present context, having incomplete or incorrect knowledge of necessary information which has already appeared in the text, or having incomplete or incorrect knowledge of necessary information outside the text.

In the present study, we have focused on comprehension failure caused by inadequate knowledge of prerequisite information previously presented in the text. This may be due to either an initial failure to comprehend prerequisite information or to the forgetting of prerequisite information which was initially comprehended.

What evidence is there that the absence of prerequisite knowledge causes subsequent problems in comprehension? Instructional research on learning structure, sequence, and hierarchy (e.g., Gagne, 1965; Merrill, 1965; Merrill & Stolurow, 1966; Lee, 1965) has addressed the subject of hierarchical relationships between segments of text and questioned how the sequencing of text segments affects the reader's comprehension of the text. There is evidence (e.g., Gagne, 1962, 1965; Merrill & Stolurow, 1966) that, if information A is subordinate to information B, then A should occur in the text before B for the text to be comprehended adequately. Applying this to studying, let us say a principle f(A) utilizes a definition A. Then the prior comprehension of A should be prerequisite to the comprehension of the principle f(A). That is, comprehension of f(A) will be difficult or impossible unless the reader comprehends A prior to reading f(A) and unless knowledge of A is still available at the time the reader encounters f(A).

More recent research (e.g., Meyer & McConkie, 1973; Meyer, 1977) provides evidence that most texts can be analyzed into hierarchical information structures, that position in the hierarchy is a crucial factor in

determining what is learned from a text, and that it is important for a reader to learn and remember prerequisite information. In one experiment (Meyer & McConkie, 1973, page 114) while readers' overall recall of idea units was only 23%, in those cases in which a particular idea unit was recalled, there was a 70% chance that the idea unit directly above it (superordinate to it) would be recalled. While the authors take this as evidence that superordinate information cues subordinate information at the time of recall, it might equally well be taken as indicating that knowledge of subordinate information makes comprehension of superordinate information more likely.

Although text structure research has focused on complex hierarchies, in many texts important prerequisite relationships may be characterized by a linear cumulative hierarchy. Presumably, authors order information as they do because some things "logically come first." One point builds up to a later more complex point, which in turn often leads up to another point. In the notation used previously, point A leads up to point f(A). This common feature of texts is likely to have the same effect on the reader as the more complex hierarchies. The reader will comprehend later information better when earlier information is comprehended and remembered. In summary, cumulative relationships in texts, coupled with both comprehension and memory failures, may lead to more comprehension failures in later parts of the same text. It is easy to picture a problem of pyramiding comprehension failures as the reader progresses through the text. One or two things not understood or forgotten lead to later misunderstandings

and confusions. Of course, most readers usually do understand texts to some extent, rather than being hopelessly confused at the end of every chapter. One reason is that most texts contain a substantial amount of redundancy, which allows for some missed concepts to be learned later. Another is that readers probably do engage in some activities to remedy failures, such as note taking, looking back, and quite often rereading the entire text.

Fixups for comprehension failures. What then, are readers to do when comprehension fails due to the lack of prerequisite knowledge? There are three steps the reader probably should take: (a) Recognize that a failure has occurred. (b) Decide whether or not to do something about the failure at that time. (c) Engage (conditional upon step six) in fixup activities which supply the prerequisite information.

The first step, recognizing that a failure has occurred, is a consequence of comprehension monitoring activities. In the reported investigation, we externalized and optimized comprehension monitoring by questioning the reader.

The second step is deciding whether it is necessary to engage in fixup activities at the given time. It is assumed that some failures may be cleared up by continued reading, and some may not be important considering the task demand. The text may later explain a new word or concept or a particular segment of the text may be an unimportant aside. Deciding if something is important is a complex process which must take account of the

nature both of the text and of the task to be performed. For the sake of simplicity, the current experiments did not investigate whether or not subjects can make good decisions about engaging in fixups.

Finally, the reader should in many instances perform a fixup. A number of possible reasons for comprehension failure were previously mentioned, and these may dictate different fixup strategies. For example, if the reader was not reading carefully enough or not paying attention to important relationships, a logical fixup strategy would be to reread the sentence or paragraph, perhaps engaging in careful analysis activities such as thinking about the meaning, paraphrasing, drawing diagrams, or using mental imagery. Comprehension failure may also result from a deficit in prerequisite knowledge found outside the text, such as not knowing the meaning of a word or lacking general world knowledge. Consulting outside sources such as dictionaries or more knowledgeable persons should help remediate this type of failure. Finally, comprehension failure may be due to a deficit in prerequisite knowledge found earlier in the text being read. Properly directed lookbacks to reread relevant prerequisite information should remediate this last kind of comprehension failure.

There are, however, a number of reasons why knowledge of prerequisite information present earlier in the text might be lacking at a later time, not all of which may be remediated by lookbacks. Three likely reasons are: (a) The prerequisite information was comprehended but is currently unretrievable. (b) The prerequisite information was not carefully attended

to and never comprehended, perhaps because the reader didnot think it was important. (c) The prerequisite information was too difficult for the reader to comprehend.

Failures corresponding to the first two of the above reasons are likely to be remediated by lookbacks. The third situation might require something instead of, or in addition to, lookbacks. It is conceivable that most failures involving prerequisite knowledge are of the third type, in which case lookbacks alone might not prove useful. But more likely all three reasons for comprehension failure occur in combination, and the first two will generally be remediated by lookbacks. In short, lookbacks make sense as a method of fixing up certain types of comprehension failures due to the lack of prerequisite knowledge, but, because we donot know which types of problems account for most instances of comprehension failure, the overall usefulness of lookbacks is by no means certain.

Our hypothesis is that lookbacks to prerequisite information may enhance comprehension of target information when the reader has either forgotton or failed to comprehend the prerequisite information. In the reported study, comprehension was determined by correctness of answers to inserted questions about the prerequisite and target information. Lookbacks were initiated automatically. That is, subjects who received lookbacks were forced to look back when answers to inserted questions indicated that a comprehension failure due to the lack of prerequisite knowledge was likely to occur. If lookbacks facilitate learning, the subjects who looked back to prerequisite material upon missing a prerequisite question should

have been better able to answer a subsequent target question than those who were not permitted to look back.

Success with experimenter-imposed lookbacks would indicate that certain comprehension failures can be remediated by lookbacks. Further research would be needed to determine if readers can be taught to correctly initiate and direct lookbacks themselves, and to determine if increases in achievement are found in field tests with students studying natural texts in school.

Method

Subjects. Subjects were 106 first semester freshman from the University of Illinois at Urbana-Champaign. One subject was dropped from the analysis for failing to take the task seriously. He was observed to skim the text, spending about twenty minutes compared to over an hour on the average for other subjects, and answered very few questions correctly. Thirteen subjects were dropped from the analysis because they reported being very familiar with the text. In all, the data from 92 subjects was analyzed.

Materials. The text was a 4926 word discussion of physiological psychology developed from the chapter summaries of a physiological psychology textbook. It occupied 24 pages, each 24 lines long. The text was conceptually rich and laden with hierarchical relationships. Twenty prerequisite-target pairs were identified. An example of a prerequisite segment of text is:

> A single neuron cannot excite another neuron enough to cause an impulse. One end of a neuron comes near the ends of many other neurons, and many neurons must send impulses to a single neuron to start an impulse in it.

and an example of a target segment of text corresponding to this prerequisite segment is:

> The dendrites are at the front end of the neuron where impulses are produced. A dendrite receives information from another neuron at a synapse. Each neuron must have many dendrites (in order to receive and add up impulses from many neurons). Information received by dendrites is excitatory or inhibitory. Excitatory signals from other neurons tend to increase impulse flow. Inhibitory signals decrease impulse flow.

Both prerequisite and target segments varied in length from 4 to 8 lines. Prerequisite and target information could occur on any part of a page (to prevent shaping the subject's attention to certain favored locations). Prerequisite clusters occurred from one to three pages prior to target elements, with the exception of one pair separated by five pages. Most 15 pairs were separated by one page of text, or about 24 lines. The rest of the text consisted of related information not necessary to understand either prerequisite or target information.

Prerequisite-target pairs overlapped so as to decrease ease of recall of the prerequisite information and decrease the subjects' ability to guess the pattern of questions and lookbacks being employed. Overlapping should decrease ease of recall by increasing the amount of important information

and the number of inserted questions between prerequisite and target segments of text.

Multiple choice questions were constructed for each of the prerequisite and target clusters. An example of a question testing comprehension of the previously shown prerequisite segment of text is:

A neuron will relay information if

1) the correct signal is transmitted to it.
2) information is sent to it from another neuron.
3) information is sent to it by a large number of different neurons.
4) information is sent to it in the form of a very strong impulse.
5) information is sent to it as one strong or two weak impulses.
6) I don't know.

correct answer is 3

and an example of a question testing comprehension of the corresponding target segment of text is:

The function of dendrites on a neuron is

1) to transmit a signal from one end of the neuron to the other.
2) to prevent a neuron from firing when an inhibitory signal is sent to it from another neuron.
3) to provide nourishment for the cell.
4) to receive a signal from one neuron, and pass it along to many other neurons.

5) to collect signals coming into a neuron from many other neurons, and sum them together.

6) I don't know.

correct answer is 5

The questions were designed to assess comprehension of the text. Most were of the paraphrase and new application type (Anderson, 1972). Questions about prerequisite information were inserted immediately before corresponding target information. Questions about target information were inserted approximately 8 lines after the corresponding target information.

The materials were normed with two studies. In the first study, 18 subjects read a version of the text just described while 20 subjects read the text with the prerequisite text segments replaced by non-prerequisite information. All subjects received the same inserted questions. The text and questions were revised before the second norming study. In the second study, 21 subjects read the normal text with inserted questions.

After the norming studies, it appeared that the materials possessed the desired characteristics. (a) Prerequisite information was tested by prerequisite questions. Subjects who received prerequisite information performed significantly better on prerequisite questions than subjects who did not receive prerequisite information. (b) Prerequisite clusters were the main places where prerequisite information was presented. This too was demonstrated by subjects who received prerequisite information performing better on prerequisite questions than subjects who did not

receive prerequisite information. (c) Enough prerequisite questions were answered incorrectly to result in an adequate number of lookbacks for most subjects. Pilot subjects who received prerequisite information answered 60% of the questions correctly, indicating that, on the average, they would receive 8 out of 20 possible lookbacks. (d) Correctly answering prerequisite questions increased the probability of correctly answering corresponding target questions. A dependent t-test showed that the conditional probability of correctly answering a target question after having correctly answered the prerequisite question was significantly higher than the conditional probability of correctly answering a target question after having incorrectly answered the prerequisite question.

Procedure. The passage was presented on a computer terminal in the following manner. The text was divided into pages of 24 lines each, from 50 to 60 characters wide. The subject did not see entire pages of text, but groups of lines (line clusters) of four lines at a time. At the beginning of each page, the first four lines appeared. By pressing the key labeled NEXT the subject received the next line cluster. No more than 2 line clusters were ever displayed, the new line cluster and the immediately preceeding one. For example, assume the top 8 lines are displayed. Requesting the next four lines causes the top four lines to disappear. Only lines five through twelve are left displayed. Thus, a maxiumum of eight lines were displayed at one time. The subject could go forward or backward on a page. By pressing the key labeled BACK, the

subject received the previous line cluster. Subjects could not return to previous pages.

At selected points throughout the text (immediately before and eight lines after target clusters), the screen was erased and a question appeared. The subject was required to type in a response. The subject was immediately informed whether his response was correct or incorrect. The correct answer was not indicated after incorrect responses. Questions sometimes came in groups of two.

Forty-five subjects received lookbacks. If they incorrectly answered a prerequisite question, they were branched back to the cluster containing the prerequisite information, and, after reading it, were branched forward to a point directly after that where the prerequisite question occurred. Directions encouraged subjects not to guess when answering the questions. To further discourage guessing, the response option "I don't know" appeared with every question. In order to prevent subjects who knew the answer from answering incorrectly because they wanted to receive the lookback, correct answers were followed by an option to look back if the subject wished to. Few subjects took advantage of this option to any great extent. Most subjects did not use it at all.

Forty-seven subjects did not receive lookbacks. They were presented with the same text and questions but always went to the next line cluster following the questions, regardless of the correctness of their answers.

Subjects were shown how to sign on the computer by the experimenter. All other procedures were computer administered. When a subject first

signed on, the program randomly assigned the subject to the No Lookback or Lookback condition. Before reading the experimental material, the subject read three pages of directions and practice text to learn how to move about in the text. When the subject indicated understanding of the procedure, the program began displaying the text and questions. The program automatically stored time and sequence data on the subject's movement through the text and answers to the inserted questions. A short interview was conducted with each subject after the reading was completed.

Results

The main questions addressed in the analysis were (a) did the No Lookback subjects demonstrate a deficiency in target performance attributable to the lack of prerequisite knowledge and (b) was such a deficiency significantly reduced for the Lookback subjects? Because subjects varied greatly in their need for lookbacks, an anlysis of variance was conducted on the basis of Condition (Lookbacks versus No Lookbacks), Measure [(probability of answering the target correctly after the prerequisite had been correctly answered, denoted by $\underline{p}(\underline{R}_T|\underline{R}_p)$, versus the probability of answering the target correctly after the prerequisite had been incorrectly answered, denoted by $\underline{p}(\underline{R}_T|\underline{W}_p)$], and Need (few versus many lookbacks needed). Condition and Need were between-subject factors, while Measure was a within-subject factor. Subjects who missed three to seven prerequisite questions were classified as needing few lookbacks, while those who missed

eight to fifteen prerequisite questions were classified as needing many lookbacks. Four subjects missed two or fewer prerequisite questions and were dropped from the analysis.

Figure 1 depicts the results when subjects' data were computed based on all 20 question pairs. The main result our hypothesis predicts is a Condition by Measure interaction with means indicating that No Lookback

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Insert Figure 1 about here.

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subjects show a deficit due to their lack of prerequisite knowledge but that Lookback subjects do not show such a deficit. No overall Condition by Measure interaction was found in this analysis. But the three-way interaction (Condition by Measure by Need) is fairly strong, $F(1,84) = 3.1$, $p = .08$. Although not significant at the .05 level, the three-way interaction is strong enough to warrant looking at the Condition by Measure interaction for separate levels of Need. The procedures for looking at the simple interactions and simple main effects for this design are based on Kirk (1968, pp. 284-294). Because there were suitable numbers of subjects for each level of Need to produce reliable error terms, the calculations of simple effects for each level of Need was done with error terms based on just those subjects in the level of Need under consideration.

There is no interaction of Condition by Measure for subjects needing few lookbacks. This is as we would suspect for two reasons. First, not needing many lookbacks, these Lookback and No Lookback subjects were, in fact, not very different. Secondly, needing few lookbacks, the denominators of their conditional probabilities are very small so that the distribution

of the conditional probabilities for these subjects contains a substantial degree of error variance.

For subjects needing many lookbacks, the interaction, though still not significant, is much stronger, $F(1,41) = 2.7$, $p = .1$, and the means are in the predicted direction. Although this is not a very significant interaction, it is still worthwhile looking further at the simple main effects within this level of Need. There are four contrasts to be considered: (a) the difference between conditions for $p(R_T|R_p)$, which we would expect to be small; (b) the difference between conditions for $p(R_T|W_p)$, which we would expect to be large; (c) the difference between $p(R_T|R_p)$ and $p(R_T|W_p)$ (which represents the deficit due to a lack of prerequisite knowledge) for No Lookback subjects, which we would expect to be large; and (d) the difference between $p(R_T|R_p)$ and $p(R_T|W_p)$ for Lookback subjects, which we would expect to be small.

The results of all four of these contrasts were as predicted. There is no difference between conditions for $p(R_T|R_p)$, $F(1,41) = .01$, but the difference between conditions for $p(R_T|W_p)$ is significant, $F(1,41) = 4.6$, $p < .05$. There is no reason to expect a difference in the first contrast because for both conditions prerequisite knowledge was adequate, and no lookbacks occurred. The second contrast indicates that when prerequisite knowledge is inadequate, lookbacks increase the probability of comprehending target information. There is a large difference between $p(R_T|R_p)$ and $p(R_T|W_p)$ for No Lookback subjects, $F(1,41) = 15$, $p < .01$, but a non-significant difference between the conditional probabilities for Lookback

subjects, $F(1,41) = 1.9$. This indicates that No Lookback subjects have a deficit attributable to their lack of prerequisite knowledge, and that lookbacks largely remediate the deficit.

Although these simple main effects are as predicted, the lack of significance for the interaction indicates we must be cautious in taking them as confirmation of our hypothesis. We have interpreted the data as indicating a weak effect as predicted for lookbacks. The next analysis to be described increases the sensitivity of our test of lookbacks by basing the analysis on those parts of the materials which the second norming study indicated to be most sensitive in detecting differences in conditional probabilities.

Conditional probabilities were calculated using 10 of the original 20 question pairs selected on the basis of how similar the two question difficulties were in the second norming study. The 10 pairs with the most similar question difficulties were chosen.

The reason for this selection is that a large difference between the two question difficulties of a question pair biases the results toward the null hypothesis. Consider why. $p(R_T|R_P)$ is computed by the formula RR/(RR + RW), where RR represents the number of times both questions were answered correctly, and RW the number of times only the prerequisite question was answered correctly. $p(R_T\ W_P)$ is computed by WR/(WR + WW), where WR represents the number of times only the target question was answered correctly, and WW the number of times neither question was answered correctly.

A prerequisite relationship is demonstrated when the first conditional probability is larger than the second. Assume the prerequisite question to be much easier than the target question. This leads to an inflation of the RW term. Since that term occurs only in the denominator of $p(R_T|R_P)$, that figure is increased, thereby reducing the difference between the two conditional probabilities. Now assume the target question to be much easier. In this situation the WR term is inflated. Since that term is found in both the numerator and denominator of $p(R_T|W_P)$, that probability is spuriously increased. Because it is expected to be smaller than $p(R_T|R_P)$, an increase in its value again serves to decrease the difference between the two conditional probabilities.

Figure 2 depicts the results of a condition by subject analysis for the items selected. Subjects were included in the analysis if they had at least three errors on prerequisite questions out of the possible ten. There were 34 No Lookback and 29 Lookback subjects in the analysis.

Insert Figure 2 about here.

For the No Lookback group, performance on target questions dropped 21% when prerequisite questions were answered incorrectly, but, for the Lookback group, performance dropped only 3%. The difference between conditional probabilities is almost completely eliminated in the Lookback group. The interaction is significant, $F(1,61) = 5.15$, $p < .05$.

The procedures described in Winer (1962, p. 311) were used to test which simple main effects are significant. As predicted, the difference between $p(R_T|R_p)$ and $p(R_T|W_p)$ for the No Lookback group is significant, $F(1,61) = 16.10$, $p < .001$, and the difference between $p(R_T|R_p)$ and $p(R_T|W_p)$ for the Lookback group is not significant, $F(1,61) = .37$.

Also as predicted, the two groups do not differ significantly for $p(R_T|R_p)$, $F(1,61) = .46$. The difference between groups for $p(R_T|W_p)$ is not significant either, $F(1,61) = 1.28$, $p > .25$.

Discussion

Degree of facilitation due to lookbacks. There were two main results. First, when the analysis utilized all of the materials and focused on subjects who needed a large number of lookbacks (because they made many errors on prerequisite questions), the deficit due to a lack of prerequisite knowledge was partially eliminated due to lookbacks. Second, when the analysis focused on all subjects but utilized only the more reliable parts of the materials, the deficit due to a lack of prerequisite knowledge was almost totally eliminated for those subjects utilizing lookbacks.

These results definitely indicate facilitation of learning due to lookbacks. But in the case of the first analysis, utilizing all materials, the results were not as strong as expected. The two obvious reasons are (a) not all subjects needed lookbacks because they were learning well without them, and (b) some of the materials were not sensitive enough to measure facilitation due to lookbacks.

Other factors were present which probably reduced the power of our test of lookbacks. First, the test of lookbacks was in one sense a very conservative one. The frequent adjunct questioning of subjects probably facilitated overall learning (Anderson & Biddle, 1975), perhaps to the point of washing out some of the differences that might have been produced by the use of lookbacks. Supporting this contention, 80% of the subjects reported in the post-experimental interview that the questions helped them learn the material quite a lot.

Moreover, questions probably had other more specific effects in addition to a general facilitation of comprehension. Reading a question about prerequisite information may be much like looking back and rereading, encouraging the subjects to mentally review the material. Furthermore, subjects were given immediate feedback as to whether or not they answered questions correctly. In many cases this probably helped the subjects determine the correct answer. In post-experimental interviews, many subjects reported that, when answering a question, they often had reduced the answer to one of two alternatives, and, after getting feedback, knew the correct answer whether or not they had answered correctly.

Questions may also have reduced the effect due to lookbacks because of the tendency of questions to focus attention. After a reader encounters an inserted question, his attention to the immediately following text is usually increased (Reynolds, Standiford, & Anderson, in press). In our experiment that meant that, after a prerequisite question error, No

Lookback subjects would have had their attention focused on target information, while Lookback subjects would have had theirs focused on the prerequisite information. This probably gave some advantage to the No Lookback subjects on the target questions and increased the value of $\underline{p}(\underline{R_T}|\underline{W_P})$ for them in contrast to the Lookback subjects. Despite this bias, the Lookback subjects had a higher value for that conditional probability, giving added weight to the facilitation that was found due to lookbacks.

Overall, questions acted in a number of ways to reduce the appearance of a facilitative effect due to lookbacks. More sensitive experiments might be designed to minimize such interference, by either eliminating questions or the feedback following them, or by more carefully sequencing subjects to ensure that the focusing of attention does not bias the results in favor of any particular hypothesis.

Another potential reason for weak facilitation due to lookbacks goes back to the proposed causes of comprehension failure. We discussed above three possible reasons for lacking prerequisite knowledge at the time of reading target information. These were: (a) the subject's forgetting of prerequisite information, (b) the subject's not attending to prerequisite information, and (c) prerequisite information being too hard for the subject to comprehend. We had hypothesized that the first two would probably be remediated by lookbacks alone, while the last reason probably would require something more. In the post-experimental interviews, 32% of the subjects reported that their incorrect answers to questions were due to having

forgotten prerequisite information. Thirty-nine percent of the subjects reported that the main reason for incorrect answers was that the material was too difficult and that they had not understood it completely when they first read it. The remaining subjects attributed errors to both forgetting and failure to initially comprehend, to question difficulty, and to a variety of other factors.

According to the subjects, many errors were due to their initially failing to comprehend target information because it was very difficult. We had hypothesized that lookbacks might not be sufficient to remediate this kind of error. But the results indicated that either lookbacks do remediate even these errors, or, and this in spite of what the subjects said, that few such errors occurred. Although the weak effect in the analysis of subjects for all materials could be explained on this basis (i.e., prerequisite material was too hard for subjects to comprehend even after lookbacks), we would then expect a similar weak effect for the analysis based on half of the materials. We would not expect almost total remediation of the deficit, as was found. The material selection criterion was based solely on similar question difficulties, and there is no reason to suspect that this criterion is related to reasons why subjects lack prerequisite knowledge at a later time.

Concluding remarks--the next steps. As predicted, lookbacks were shown to facilitate learning by remediating (or preventing) comprehension failures attributable to a lack of prerequisite knowledge. What are the next few steps towards more natural tests of the effectiveness of lookbacks?

In this regard there are two main questions. First, can subjects be trained to look back to the correct places at the correct times? Second, will the facilitation we have found for lookbacks in an artificially constructed text also occur in natural texts?

Knowing when to look back, let alone training when, still needs research. Should lookbacks occur only when previous prerequisite information is not comprehended? Perhaps occasional "reminder and review" lookbacks are helpful at other times. An important training problem must be overcome as well. Even if a reader is monitoring his comprehension well and is thus able to detect a comprehension failure, how can he know that the failure is related to a particular segment of prerequisite text if he does not recall that prerequisite information or did not understand it to begin with?

There is evidence that readers have fairly good memory for location of information in text (Christie & Just, 1976). Therefore, if they know what to look back for, and when, it appears likely that they will be able to find it. Recent research indicates that monitoring is trainable and with mature learners even generalizes to new situations (see Brown & Barclay, 1976; & Brown, Campione, & Barclay, 1978). So we should also be able to teach readers to recognize when to look back.

Nonetheless, we are expecting the reader to develop a number of complex skills and bring them together during the study process. (a) The reader must learn to recognize when comprehension is failing. (b) The reader must learn to recognize when the trouble is attributable to a deficit in

prerequisite knowledge presented earlier in the text and therefore can be remediated by looking back. (c) The reader must learn to determine what and where the relevant prerequisite information is.

This is a lot for the reader to learn to do on top of all the other study skills generally required. Before we undertake the task of training students to do this, we must field test the use of lookbacks with natural texts in natural study situations. Laboratory effects often do not hold up in the real world where we cannot control other factors. Only if we can show that looking back really improves study of natural text would we be warranted in suggesting that students take the effort to learn to engage in lookbacks.

If the effects we have found are trainable and hold up in the real world, students should enjoy substantial increases in their capacity to comprehend difficult text material.

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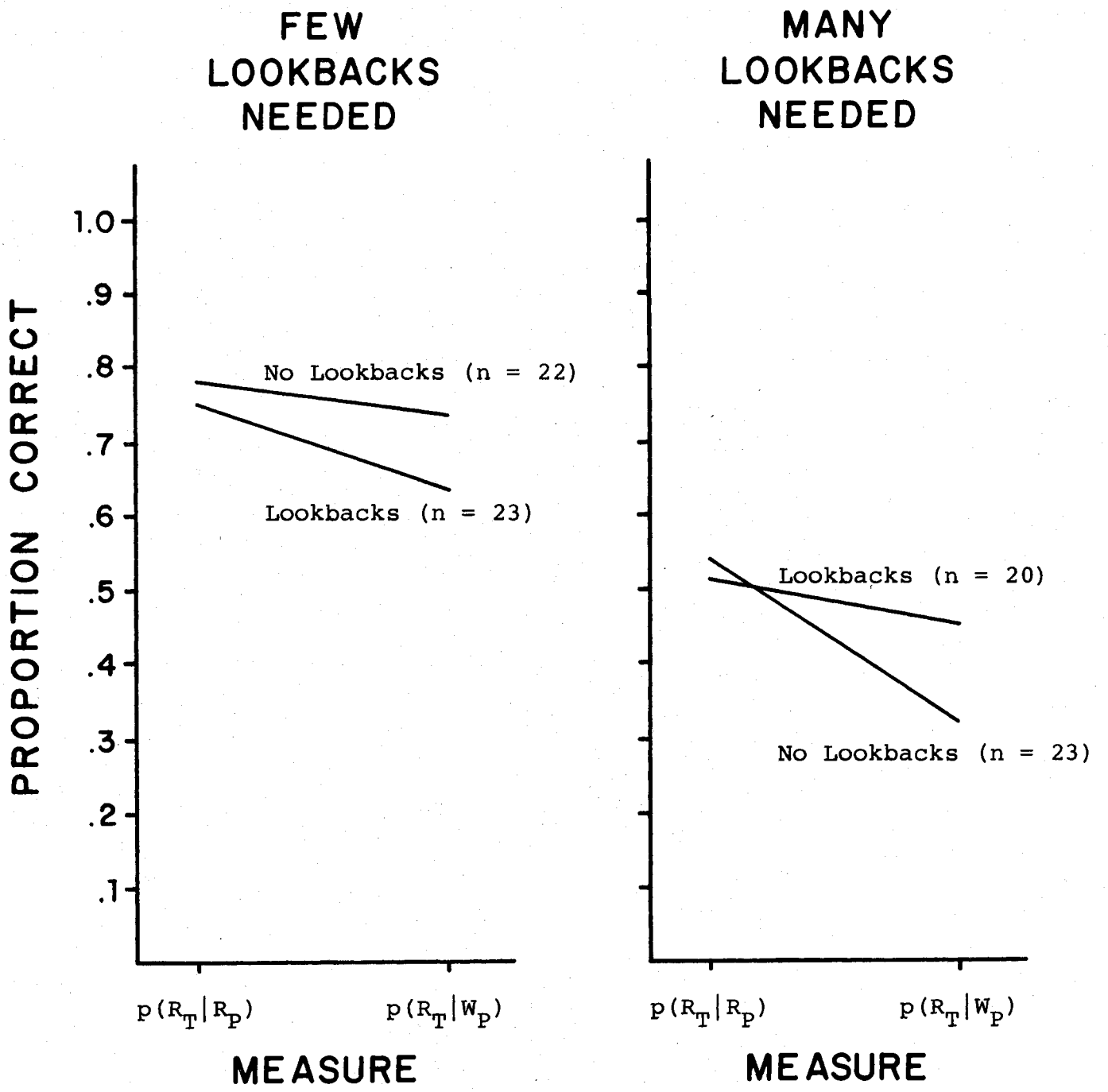
Figure Captions

Figure 1. Interaction of Condition, Measure, and Need

Figure 2. Interaction of Condition and Measure based on subject responses to question pairs with equivalent difficulties.


FEW LOOKBACKS NEEDED
MANY LOOKBACKS NEEDED
PROPORTION CORRECT
1.0
.9
.8
.7
.6
.5
.4
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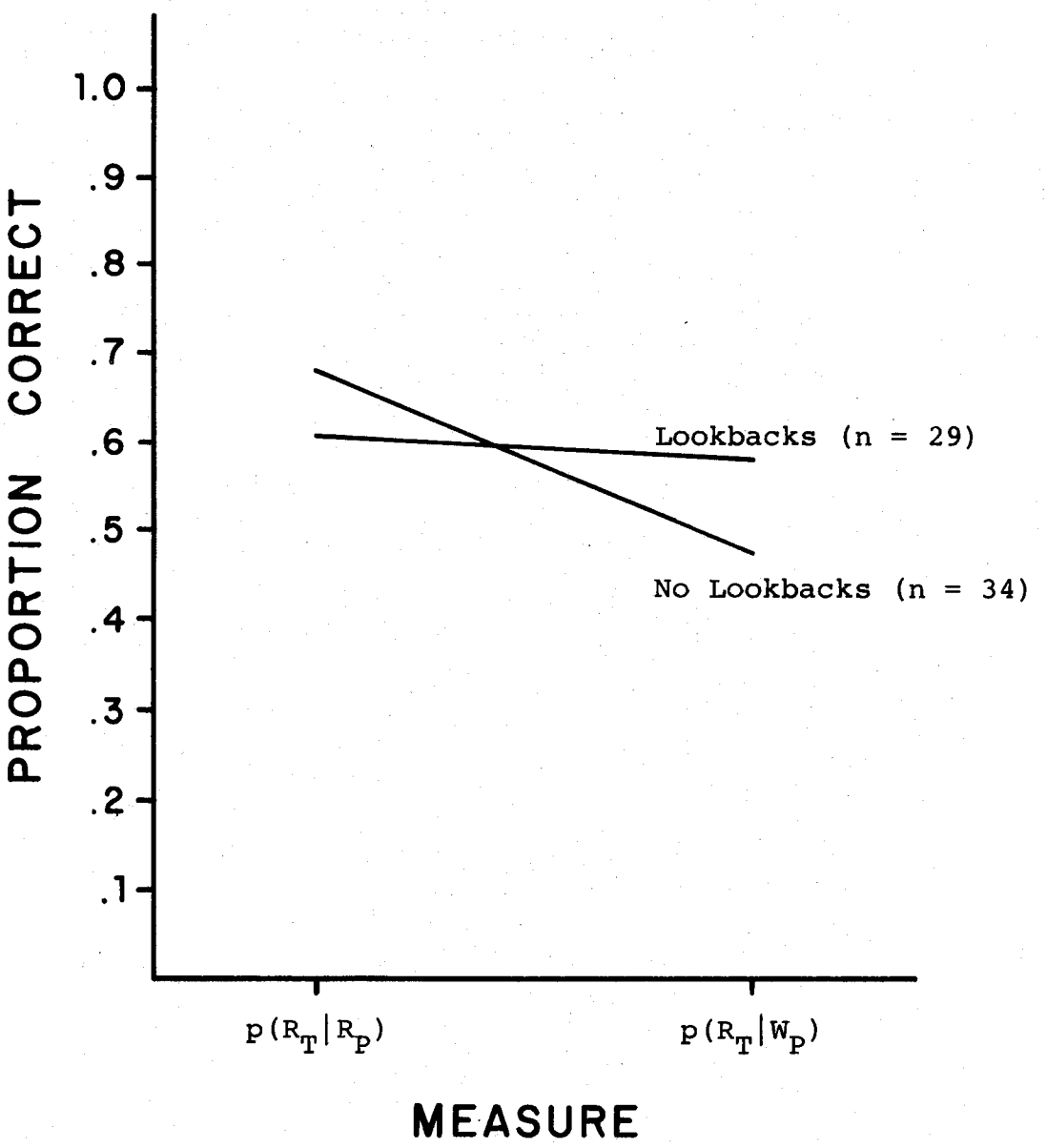
.2
.1
No Lookbacks (n = 22)
Lookbacks (n = 23)
Lookbacks (n = 20)
No Lookbacks (n = 23)
p(RT|RP)
p(RT|WP)
p(RT|RP)
p(RT|WP)
MEASURE
MEASURE


PROPORTION CORRECT
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
Lookbacks (n = 29)
No Lookbacks (n = 34)
p(R_T|R_P)
p(R_T|W_P)
MEASURE

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