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Effect of Prior Knowledge on Good and Poor Readers' Memory of Text

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We investigated how prior knowledge influences the amount of short-term nonverbal and verbal memory and long-term retention in students of high and low ability in reading comprehension. Sixty-four junior high students were divided into four equal-sized groups on the basis of preassessed reading ability (high and low) and preassessed amount of existing prior knowledge about baseball (high and low). Each subject silently read an account of a half inning of a baseball game. After reading, each subject recalled the account nonverbally by moving figures and verbally by retelling the story. After an interpolated task, they summarized the game and sorted passage sentences for idea importance. There was a significant main effect for prior knowledge on all measures. No interactions between prior knowledge and ability were found. These results delineate the powerful effect of prior knowledge.

Two topics of interest to educational researchers are the effect of reader prior knowledge on recall and the disparity in the comprehension of good and poor readers. Our purpose was to examine whether prior knowledge or reading expertise had more effect on recall.

The results of reading research indicates that prior knowledge of a topic increases the amount of information that adults (Chiesi, Spilich & Voss, 1979; Steffensen, Joag-Dev, & Anderson, 1979) and children (Pearson, Hansen, & Gordon, 1979; Taft & Leslie, 1985) recall from text on that topic. In these studies, readers are typically asked to recall material or to answer comprehension questions immediately after reading; thus quantitative short-term memory is measured. However, the few researchers who have assessed the qualitative nature of memory over longer intervals have found similar effects of prior knowledge (Lipson, 1983). When the reader has knowledge about the subject to be read, comprehension is better and there are fewer errors in recall. We hypothesize that this results from an active interplay between the reader's cognitive structures that are relevant to the topic and the presentation of the topic in text (Anderson & Pearson, 1984).

Results of comparisons of good and poor readers indicate that good readers have better recall than do poor readers (Ryan, 1981). One might be tempted to conclude that poor readers have poorer memory for what they read than do good readers. However, researchers who have *simultaneously* compared good and poor readers and manipulated text familiarity have found that good and poor readers have similar levels of short-term recall when the text is familiar. Taylor (1979) found no difference between good and poor third-grade readers' recall of familiar text, but the poor readers were significantly less able to recall unfamiliar text. McConaughy (1985) found no difference between good and poor sixth-grade readers' ability to summarize stories with easy predictable text structure. These studies suggest that prior knowledge facilitates recall in both good and poor readers and that the recall of good and poor readers is similar after reading decodable, familiar text. The qualitative nature of their recall has not been examined.

In contrast to the quantitative measures of recall that dominate reading research, researchers studying the performance of subjects with differing levels of expertise have typically measured the quality of memory. The initial research on recall was done with the game of chess, and the results, that the amount and quality of semantic organization of information increase with expertise, have been substantiated on tasks as diverse as bridge (Charness, 1979), computer programming (Adelson, 1981), electronics (Egan & Schwartz, 1979), and baseball (Chiesi et al., 1979). These findings support evidence from reading research that suggests that high prior knowledge about the content to be read facilitates the quantity and quality of recall. When adults of equal reading ability and of high or low prior knowledge of baseball listened to a half inning of a baseball game, subjects with high prior knowledge recalled more than did subjects with low prior knowledge (Chiesi et al., 1979), and their knowledge closely resembled the semantic organization of the game itself.

In this study we had two purposes. First, we extended research on prior knowledge to children for examination of qualitative and quantitative differences in the memory of children with high versus low knowledge in a domain. In most studies of the effects of prior knowledge on comprehension, researchers have used adult subjects. In only one study was the qualitative nature of a child expert's long-term memory examined, but comprehension of text was not required, and only one child was investigated (Chi & Koeske, 1983). We examined the quality of recall by high-knowledge versus low-knowledge children by comparing their recall with that of experts.

Second, and most important, we simultaneously examined prior knowledge and amount of reading expertise. Good and

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poor readers were asked to read a passage for which they had differential (high or low) prior knowledge. Their recall was scored quantitatively (amount of recall) and qualitatively to ascertain how their recall compared with that of experts in order to determine whether poor readers with high prior knowledge would show recall similar to that of good readers with high prior knowledge.

Both nonverbal and verbal measures were chosen to measure recall. Although not as frequent as verbal memory measures, nonverbal recall has been measured in several studies on prior knowledge. The studies on expert/novice chess performance suggest that experts differ substantially from novices when asked to view the middle of a chess game for 5 s and to reconstruct the game pieces on an empty board (Chase & Simon, 1973). This suggests that high prior knowledge facilitates nonverbal reenactment of the chess game. In addition, Feagans and Short (1984) found that normal and reading-disabled children demonstrated equal understanding of a story as measured via nonverbal reenactment, in which they demonstrated the action of the story. However, the reading-disabled children recalled fewer verbal action units, complex sentences, and words. Because of the different results for the poor readers on verbal and nonverbal measures, both types of measures were used in our study.

In this study, verbal short-term memory was assessed via subject recall immediately after reading, and long-term memory was subsequently assessed through summarization and rating of passage sentences for idea importance. Research on summarization suggests that poor readers in middle grades can summarize easy, predictable text (McConaughy, 1985), but not longer, expository text (Winograd, 1984), as effectively as good readers can. Also, poor readers are not as effective as good readers in choosing the most important (by fluent adult standards) ideas in text, which is an essential facet of summarization (Winograd, 1984). However, in research on summarization and judgment of importance, how prior knowledge affects these measures has not been examined.

Method

Subjects

The subjects were 32 seventh- and 32 eighth-grade students from a metropolitan-area middle school. Good (high-ability) readers were children who scored above the 70th percentile, and poor (low-ability) readers scored below the 30th percentile on the Scientific Research Associates (SRA) achievement comprehension subtest. We selected low-ability subjects who scored above the 30th percentile in vocabulary to avoid word-recognition problems. High-knowledge subjects scored above the 70th percentile and low-knowledge subjects scored below the 30th percentile on the baseball knowledge pretest. The high-ability/high-knowledge cell had 10 boys and 6 girls; the high-ability/low-knowledge cell had 3 boys and 13 girls; the low-ability/high-knowledge cell had 12 boys and 4 girls; and the low-ability/low-knowledge cell had 7 boys and 9 girls. There were 8 seventh graders and 8 eighth graders per cell.

Materials

Pretest of baseball knowledge. A 42-item multiple choice pretest on baseball knowledge was based on questions of varying difficulty submitted by 3 semiprofessional baseball players. Reliability of the baseball pretest was established through a pilot study of 475 seventh and eighth graders in two inner-city schools, two suburban schools, and one rural school. The internal consistency reliability estimate was .77. On the basis of item discrimination statistics, three items were removed, and reanalysis of the pilot test results yielded an alpha reliability of .81.

Experimental passage. We chose baseball as the topic to be read because we felt that junior high students' knowledge of baseball might be independent of their reading ability. A sequential exposition passage describing a half inning of a baseball game was adapted from a similar text (Spilich, Vesonder, Chiesi, & Voss, 1979). The passage was shortened from 776 words to 625 words, sentence structures were made less complex, and the team names and player names were changed to reflect a game between the Milwaukee Brewers and the Detroit Tigers. The average readability level was early fifth grade, according to the Dale Chall readability formula.

Procedure

All 624 seventh- and eighth-grade students enrolled in the middle school took the baseball knowledge pretest in their English classes. It was read orally by their teacher in order to ensure that students with low reading ability would not be unfairly penalized. Students who met the reading ability and prior knowledge criteria were randomly chosen for inclusion in the study.

Subjects were tested on an individual basis in a quiet room of their school by the same examiner. Each subject was first given a practice passage. Subjects read a short episode about a track race in two parts. After each section, they moved the figures of the two racers around a board to reenact the action described in the passage, verbally described the action, and listened to the examiner read a concluding summary of the race.

After the practice, each subject was asked to silently read the story of a half inning of a baseball game in five parts. The examiner emphasized that this was not a reading test, so the subject was encouraged to ask the examiner for help with any unfamiliar words. After each part, the subject was presented with an 18 × 20 in. replica of a baseball field with 4-in. wooden baseball players, painted to represent their appropriate team and placed at their designated positions. The subject was asked to move the figures around the board to reenact the action described in the text. He or she also verbally described what happened. Afterwards, the student was asked about school, an interpolated task designed to interfere with storage of the baseball passage in working memory. Last, the student was asked to summarize the selection and to sort 22 sentences, chosen randomly from the passage, on the basis of importance of ideas to the text.

Scoring

Quantitative. Each subject's reenactment, verbal retelling, summary, and rating of idea importance was scored quantitatively for amount of correct information recalled. We scored the reenactment task by assessing the number of correct moves and errors. Verbal retelling was the number of propositions (segments of text involving a single idea and defined as a verb and an accompanying noun) recalled after each of the five passage parts. The text was partialed into a total of 197 propositions, in accordance with Clark and Clark's (1977) procedure. The propositional analysis was done separately by 2 independent judges. Pearson correlation coefficients, computed for propositions scored by the judges, were .97 on the verbal quantitative measure and .95 on the summarization quantitative measure. The number of propositions recalled by each student was totaled for all five sections of the story, and that number represented the verbal

quantitative measure of short-term memory. Each student's summary was scored via propositional analysis, and the total number of correct propositions represented the quantitative measure of verbal long-term memory for the whole passage.

Qualitative. Each subject's reenactment, verbal retelling, summarization performance, and rating of idea importance were also analyzed qualitatively. Qualitative scoring involved recall of information that was important to the text; importance was defined according to the performance of experts. Seven experts, men who had played 2 or more years of semiprofessional baseball, were asked to read the baseball text in five sections, to reenact the action by using the baseball figures, to recall the story segment verbally after each part, to summarize the text, and to rate the 22 sentences for idea importance. We constructed a composite (qualitative measure) for the reenactment, retelling, summary, and idea importance rating by using agreement from 5 of the 7 experts.

We compared each student's performance with the expert composite performance to derive qualitative measures. All ideas that were in common with the expert composite received a score of 1, and the scores were summed. Each student had reenactment, retelling, summarization, and idea importance scores that reflected how much of their score was in common with the recall of the experts.

Results

The results were analyzed in equal-*N*s multivariate analyses of variance (MANOVAS). The independent variables for the preliminary analysis were reader ability (good and poor), prior knowledge (high and low), and grade (seventh grade and eighth grade). The dependent variables were quantitative and qualitative nonverbal reenactment, amount of error in reenactment, quantitative and qualitative retelling measures, quantitative and qualitative summarization, and judgment of idea importance. The preliminary analysis revealed neither a main effect of grade, $F(8, 49) = 0.90$, $p < .523$, nor any interactions with grade (Fs < 1). Therefore, this factor was dropped from the main analysis and was not considered further. The major analysis was conducted on all dependent measures; the independent variables were ability and prior knowledge as defined earlier. The multivariate main effect of prior knowledge was significant, $F(8, 53) = 20.8$, $p < .001$. The multivariate main effect of ability was not significant, $F(8, 53) = 1.94$, $p > .05$; thus the univariate F ratios of ability are not reported. There was no significant interaction between knowledge and ability, $F(8, 53) = 0.43$, $p > .05$, and, again, no univariate F ratios are reported.

Reenactment Measures

In Table 1 we present the means and standard deviations of reenactment quantitative and qualitative recall and errors as a function of level of prior knowledge and ability. The memories of high-knowledge readers were significantly greater than the memories of low-knowledge readers, as measured via the number of correctly placed movements, absence of errors, and congruence to the expert composite. Significant univariate effects of prior knowledge were found for the number of correctly placed movements, $F(1, 60) = 85.00$, $MS_E = 32.11$, $p < .001$, the quality measure of those moves, which reflected a comparison of the subjects' movements with those of the experts, $F(1, 60) = 95.42$, $MS_E = 12.29$, $p < .001$, and errors in movement, $F(1, 60) = 33.30$, $MS_E = 2.93$, $p < .001$. Students with high knowledge of baseball made more correct movements than did those with low knowledge, and their movements were more like the movements made by baseball experts. In addition, they made fewer errors.

Table 1
Quantity, Quality, and Errors of Reenactment as a Function of Prior Knowledge and Ability

Ability	Total possible	Prior knowledge: High *M*	High *SD*	Low *M*	Low *SD*
High					
Quantity	40	31.4	3.9	18.8	7.4
Quality	24	20.7	1.8	12.7	4.5
Error	∞	0.1	0.3	2.2	1.9
Low					
Quantity	40	27.5	5.1	13.9	5.7
Quality	24	19.4	2.7	10.3	4.3
Error	∞	0.7	0.9	3.6	2.7

Note. $n = 16$ per cell.

Verbal Retelling

In Table 2 we present the means and standard deviations of verbal quantitative and qualitative recall as a function of level of prior knowledge and ability. Significant univariate effects of knowledge were found on verbal recall, both quantitative measures, $F(1, 60) = 83.45$, $MS_E = 791.51$, $p < .001$, and qualitative measures, $F(1, 60) = 133.47$, $MS_E = 15.51$, $p < .001$. Students with background knowledge for baseball were able to recall more information after reading, and their recall was more like the recall of experts than was the recall of students with less knowledge about baseball.

Summarization Measures

In Table 3 we present the means and standard deviations of the summarization quantitative and qualitative recall and judgment of idea importance as a function of level of prior knowledge and ability. A significant univariate effect of prior

Table 2
Quantity and Quality of Verbal Recall as a Function of Prior Knowledge and Ability

Ability	Total possible	Prior knowledge: High *M*	High *SD*	Low *M*	Low *SD*
High					
Quantity	197	131.5	31.1	68.4	31.1
Quality	72	26.3	2.4	14.7	4.7
Low					
Quantity	197	113.8	29.9	48.4	18.4
Quality	72	23.0	3.7	11.9	4.6

Note. $n = 16$ per cell.

Table 3
Quantity and Quality of Summarization and Judgment of Idea Importance as a Function of Prior Knowledge and Ability

Ability	Total possible	Prior knowledge: High *M*	High *SD*	Low *M*	Low *SD*
High					
Quantity of summarization	197	35.3	17.2	14.5	9.0
Quality of summarization	19	10.9	3.2	3.9	2.9
Idea importance	16	7.6	1.5	6.4	1.9
Low					
Quantity of summarization	197	30.4	15.6	12.8	6.9
Quality of summarization	19	9.1	4.6	3.4	2.2
Idea importance	16	7.6	1.8	6.3	1.3

Note. $n = 16$ per cell.

knowledge was found on the summarization quantitative measure, $F(1, 60) = 35.2$, $MS_E = 167.33$, $p < .001$, and qualitative measure, $F(1, 60) = 56.64$, $MS_E = 11.26$, $p < .001$. Students with more knowledge about baseball produced summaries that contained more correct information from the text than did readers with less knowledge. In addition, the summaries of high-knowledge readers were more like the summaries of baseball experts.

Idea Importance Measure

A significant univariate effect of prior knowledge was found on the idea importance measure, $F(1, 60) = 9.22$, $MS_E = 2.71$, $p < .01$. Readers with high prior knowledge were more able to sort sentences into categories of high, medium, and low importance that were like the sorting decisions of the experts than were readers with little knowledge about baseball.

Discussion

Our findings replicated the vast majority of research on the effect of prior knowledge on memory. On all measures, children with greater knowledge of baseball recalled more than did children with less knowledge, and what they recalled was more similar to what the experts recalled. Greater knowledge also resulted in better recognition of important ideas in text and the incorporation of those ideas into a summary of the important goal-based action. These conclusions are warranted independently of reading ability because the Knowledge × Reading Ability interaction was not significant. Students with high reading ability but low knowledge of baseball were no more capable of recall or summarization than were students with low reading ability and low knowledge of baseball. This finding appears to contradict previous research (Taylor, 1979) in which good readers, when as equally *unfamiliar* with the content of a passage as were poor readers, were more able to recall it than were poor readers. It is possible that differences in content between the studies is responsible for the differences in results. It is likely that baseball is generally more familiar than the expository information used in prior research. Thus having superior general reading ability was not as advantageous as when materials were less familiar.

The lack of benefit of superior reading ability coupled with high knowledge is also interesting: Students with high reading ability and high knowledge did not recall better or summarize more than did students with low reading ability and high knowledge. It appears therefore that knowledge of a content domain is a powerful determinant of the amount and quality of information recalled, powerful enough for poor readers to compensate for their generally low reading ability.

The findings of no differences between good and poor readers on summarization support those of McConaughy (1985) with sixth graders who read a short, well-formed story. However, our results with students who read expository text are at odds with those of Winograd (1984). Winograd did not control level of prior knowledge, and so the differences between good and poor readers may have been attributable to a confounding of ability with knowledge. This same confounding may also cloud interpretation of his finding that good readers are better able to identify ideas important to the text. The findings that good and poor readers can identify important ideas similarly if they have high prior knowledge of the subject may indicate that the important information that is selected for summarization depends on prior knowledge. Prior knowledge creates a scaffolding for information in memory; "knowledge builds up an internal context that the individual is able to utilize when new inputs of domain-related information occur" (Voss, 1978, p. 17). For poor readers the scaffolding effect of prior knowledge allows them to compensate for their generally inefficient recognition of important ideas and summarization. The finding that summarization of poor readers with high knowledge of baseball was far superior to that of good readers without such knowledge demonstrates the powerful effect of knowledge on memory.

Implications for Instruction

In the last few years, there has been an emphasis on teaching students strategies for comprehending text. Our results suggest that prior knowledge is essential in prereading activities. With adequate prior knowledge, those students who are comprehending below the 30th percentile on the SRA are comparable with those above the 30th percentile in reenactment, verbal recall, and the ability to summarize text. Time and care taken to create an adequate schematic scaffolding in memory for the newly introduced material may well pay off in increased student recall and the creation of appropriate schemata in memory.

Recent emphasis has focused on providing direct instruction in strategies to help the student to consciously use the learned strategies in different contexts. However, the emphasis has been placed on direct instruction and the practice of strategies. Although direct strategy instruction makes a needed contribution, it is not enough to consider strategies without consideration of the subjects' knowledge base (Chi, Glaser, & Rees, 1982). In light of the importance of adequate prior knowledge, strategy instruction and the knowledge base should be equally considered in the design of instruction.

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