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What Cognitive Benefits Does an Activity-Based Reading Strategy Afford Young Native American Readers?

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The authors conducted 2 experiments with children from a reservation community. In Experiment 1, 45 third-grade children were randomly assigned to the following reading strategies: (a) "reread," in which participants read each sentence of a story and then reread it; (b) "observe," in which participants read sentences and then observed an experimenter move manipulatives as directed by the story; and (c) "activity," in which participants read sentences and then moved manipulatives as directed by the story. In Experiment 2, 40 second-grade children were randomly assigned to either the reread or activity strategy. In both experiments, activity participants remembered more story content than did reread participants. In Experiment 1, the authors identified no memory differences between observe and activity strategies. When imagery instructions replaced the original strategies, Experiment 1 third-grade activity (and observe) participants recalled more story content than did reread participants, but Experiment 2 second-grade activity participants did not. The authors discuss the instructional benefits of activity-based reading strategies, along with developmental implications.

Keywords: activity, embodiment, imagery, Native American, reading, strategy

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IN 2006, RAMPEY, LUTKUS, AND WEINER reported that the average reading scores of fourth- and eighth-grade Native American children were the relatively lowest on the National Assessment of Educational Progress. This circumstance suggests that effective reading strategies need to be developed and tested with Native American learners. However, scientific studies investigating reading strategies with exclusively Native American samples are uncommon (Marley & Levin, 2005).

The present study attempts to address the lack of scientifically based evidence with these populations through the experimental study of a reading strategy that emphasizes active encoding with second- and third-grade students from a Native American reservation community in the Southwestern United States.[1] On the basis of contemporary theories of cognitive development and empirical studies from related areas of cognitive research, we expected that a learning strategy that capitalizes on active encoding would result in enhanced memory for a narrative passage.

Cognitive Development

Theoretical explanations of cognitive development provided by Bruner (1964) and Piaget (1962) emphasize the importance of activity, imagery, and symbolic reasoning. Bruner proposed that humans mentally represent their environment using action, imagery, and language, which he labeled as *enactive*, *iconic*, and *symbolic* modalities, respectively. According to Bruner, there are age-related differences in modality usage, with younger children deriving greater cognitive benefits when enactive representations are present. According to this view, as children develop, they become more adept at representing their environments through iconic and symbolic modalities. Piaget put forward a similar sequence of events with humans progressing from preoperational to formal operations. In Piaget's model of cognitive development, concrete operational children (6–12 years of age) are anticipated to struggle with tasks that require abstract thought. A prediction based on both theories of cognitive development is that young children should benefit more so from the provision of manipulatives during learning experiences relative to older children.

Activity-Based Learning Strategies

The previously cited developmental theories suggest that the efficacy of activity-based learning strategies with young children results from the presence of enactive representations. Empirical investigations of activity-based learning strategies have consistently found improved memory for target information when activity is present. These findings have two potential theoretical explanations. The first explanation is that the benefits of activity-based learning strategies are due to motoric encoding (Engelkamp & Zimmer, 1989). This is to say that a motor memory system is present that provides an additional pathway for the encoding and retrieval of target information to and from long-term memory. The second explanation is that activity-based learning strategies result in distinct events that are contained within episodic memory (Tulving, 1983). According to this view, memories for activities that one has engaged in are contained in person-relevant autobiographical memories.

A considerable amount of basic research exists examining activity-based learning, which has also been labeled self-performed tasks (SPTs; Cohen, 1981; Kormi-Nouri, Nyberg, & Nilsson, 1994). A typical SPT study compares college-age participants' memories for target information after pretending to perform actions on a list to rote memorization of the list. In these studies, participants who perform actions at the time of encoding consistently recall more content from the lists than from rote-memorization conditions. Studies with young children of activity-based learning strategies have also found comparable memory benefits on associative-learning tasks and recall of novel events (Salmon, Bidrose, & Pipe, 1995; Salmon, Yao, Bernsten, & Pipe, 2007; Saltz & Donnenwerth-Nolan, 1981; Wolff & Levin, 1972).

Visual and Imaginal-Learning Strategies

The combination of pictures with text has resulted in robust memory effects in many empirical investigations. These effects can be explained using dual-coding theory (Paivio, 1971; Sadoski & Paivio, 2001; Thompson & Paivio, 1994). According to dual-coding theory, cognitive representation consists of verbal and nonverbal systems, with the two systems linked through referential connections. Therefore, when a verbal representation (a word) of a concrete concept is presented, the nonverbal representation (an image) is expected to be activated in memory via the referential connections.

Over the past 4 decades, several studies have found large memory benefits in favor of pictures and text relative to text-only presentation in adult populations (e.g., Carney & Levin, 2002; Levin, Anglin, & Carney, 1987; Levin & Mayer, 1993). Comparable results with young children have also been identified (Levin & Berry, 1980; Pressley, Levin, Pigott, LeComte, & Hope, 1983). For example, a recent study by Greenhoot and Semb (2007) found that when elementary-age children listened to a story with pictures present, they recalled more story content than did children who listened to the story alone.

Combination of Activity-Based and Visual/Imaginal Learning Strategies

In the context of an activity-based reading strategy, all three of Bruner's (1964) modalities of mental representation are present. In other words, physically interacting with manipulatives while reading can be considered a combination of enactive, iconic, and symbolic representations. On the basis of the assumption that three forms of mental representation are better than two, learning strategies that incorporate enactive and visual modalities of encoding should result in greater memory benefits for text relative to learning strategies that emphasize one supporting modality (usually visual) or text alone.

Research examining manipulatives in applied contexts is generally supportive of the efficacy of activity-based learning strategies. For example, in the domains of mathematics and science, meta-analyses have identified medium-sized effects on achievement measures for activity-based strategies relative to traditional learning strategies (Schroeder, Scott, Tolson, Huang, & Lee, 2007; Sowell, 1989). However, studies investigating the efficacy of activity-based reading and listening strategies with young children are less common. On the basis of the aforementioned research, the combination of active and visual encoding modalities is expected to be an efficacious learning strategy.

A recent theoretical explanation for why learning strategies that combine active and visual modalities in support of text learning are expected to be effective is offered by the indexical hypothesis (Glenberg & Robertson, 1999, 2000). According to the indexical hypothesis, the addition of active encoding should facilitate the formation of dual-coding theory's referential connections between words and concrete representations. In brief, the indexical hypothesis predicts that children who manipulate text-relevant objects will exhibit improved memory for narrative events relative to children who view pictures.

Two recent studies that are directly relevant to the present study have investigated indexical hypothesis predictions in applied listening and reading contexts. In one reading-comprehension study with first- and third-grade children, Glenberg, Gutierrez, Levin, Japuntich, & Kaschak (2004) found that children's manipulation of toy objects as directed by a narrative improved their story recall relative to reading alone. In addition, it was found that after a brief training period, the manipulation strategy could be replaced by an imagined manipulation strategy.

Marley, Levin, and Glenberg (2007) extended the results of Glenberg et al. (2004) to academically at-risk Native American students listening to narrative passages and found similar improvements on measures of free recall and cued recall in favor of an activity-based strategy relative to a listening-only strategy. In addition, Marley et al. (2007) included a nonactivity visual learning strategy, namely, one in which the children observed the experimenter manipulating toys to represent the story content. The results indicated that students in both activity and visual listening strategies performed comparably on all learning outcomes. However, the previously observed benefits of an imagined manipulation training strategy were not apparent.

The Present Study

Marley et al. (2007) focused on the listening comprehension skills of academically at-risk students (viz., Native American students with learning difficulties). The primary objective of the present two-experiment study was to determine whether an activity-based reading strategy would improve memory for a narrative relative to visual and text-only reading strategies with second-grade (i.e., Experiment 2) and third-grade (i.e., Experiment 1) children from the same Native American population. In addition, two secondary objectives of the study were (a) to reexamine the issue of whether children who initially manipulated objects would exhibit better story memory (relative to nonactivity participants) when the manipulatives were removed and replaced by imagery instructions and (b) to determine whether manipulations that were targeted at unusual (atypical) story events would yield relatively greater memory benefits than manipulations targeted at more likely (typical) story events (e.g., see Rubman & Waters, 2000). The logic associated with this latter issue is simply that more typical (predictable) story events might be well remembered, or reconstructed, even without the potential benefits of accompanying physical enactment.

EXPERIMENT 1

METHOD

Participants and Design

Forty-five regular education third-grade students (25 boys, 20 girls) from three elementary schools on a rural southwestern United States Indian reservation participated in the study. Participants were recruited in accordance with American Psychological Association standards. All participants had been identified by their teachers as limited English proficient and as tribal members. The school district serving the children in this sample had not made adequate yearly progress, as defined by the No Child Left Behind Act of 2001, since its enactment. In addition, 88% of the children in the three elementary schools received free or reduced-price lunch.

Treatments were administered individually, with students randomly assigned in equal numbers to receive one of three instructional strategies: “activity,” in which students read each sentence and moved the toys in accordance with story events on selected action sentences; “observe,” in which students read each sentence and watched the experimenter move the toys; and “reread,” in which students read each sentence twice.[2] In addition, typicality (typical action statements vs. atypical action statements) represented a within-subjects factor. To prevent participants from missing their regular classroom instruction, all treatment sessions were held during noninstructional periods that had been arranged in conjunction with the classroom teachers.

Materials

Six nine-sentence stories (three with a farm setting and three with a zoo setting) were created, with each story containing three nonaction (setting-related and filler) sentences and six action sentences. All story settings were physically represented with commercially manufactured toys (Playmobil). For the three experimental stories (Stories 1–3) read by the students, three of the six action sentences contained typical statements in which characters interacted with objects in a common manner. For example, a sentence describing a typical action was "The farmer picked up the rake and cleaned the ground with it"; a sentence describing an atypical action was "The farmer picked up the rake and closed the door with it." Within each story, sentences alternated between typical and atypical action statements. These alternations were assigned randomly to each story in blocks of two, resulting in two versions of each story. (See Appendix 1 for an example of story content and alternations.) The pretest story's six action sentences contained only typical action statements.

Instruments

To assess memory for story content, the children were asked to recall as much of the story as they could remember (free recall). Up to three experimenter prompts were provided whenever a child stopped responding. Free recall was followed by three questions apiece that targeted information in the typical and atypical action statement sentences (cued recall). The free- and cued-recall measures were designed to assess participants' memory for story events and action typicality. (See Appendix 2 for an example of a cued-recall measure.)

Scoring. To prevent bias in scoring, all protocols were scored by a rater who was unaware of individuals' identities and experimental conditions. Cued-recall responses were scored as incorrect (0 points), partially correct (1/2 point), and correct (1 point), with 3 points possible for both the typical- and atypical-action statement questions. For example, the first question in Appendix 2—"What did the girl put in the brown basket?"—targets the second sentence in Appendix 1, "The girl took the brown basket to the nest and put the eggs in the basket." If a child's response was "stuff," the response would be awarded zero points, "something she got from the nest" would be awarded half a point, and "she put the eggs in the basket" would be awarded a full point.

Free-recall responses were scored for the following proposition types: typical (labeled *tp*), atypical (labeled *ap*), and nonaction (labeled *np*) propositions. As an example of scoring, Sentence 2 of Appendix 1 was divided into two propositions, "The girl took the brown basket to the nest" (p_2) and "[she] put the eggs in the basket" (tp_3). A participant who responded "The girl put eggs in a basket" would be awarded a full point for tp_3. Typical and atypical propositions were independently summed which resulted in two proposition type subscores. The subscores were then added together for a total proposition score. The nonaction sentences were broken into propositions and scored the same way. The pretest story was scored solely for total number of propositions recalled and was used as a covariate in all of the analyses.

Procedure

The total amount of study time was equalized for all students, with each experimental session lasting approximately 30 min. (See Table 1 for an overview of study procedures for each strategy condition.)

Pretest. All participants read one of two versions of the pretest story aloud to obtain a measure of students' recall of text information in the absence of any explicit text-processing strategy instruction. After the student had finished reading the passage, the experimenter administered the filler task (Simon, an electronic pattern game), then the free-recall task.

Strategy practice. A six-sentence practice story about a grocery store was used to introduce students in each condition to the strategy that they would be applying for Story 1. For this practice story, at the end of the three action sentences, participants in the reread condition were instructed to read the just-presented sentence one more time. In the activity condition, students were shown a set of toys (Playmobil) representing the characters and objects in the story. Students were instructed to move the toys as directed by the story's sentence when they encountered a green sign at the end of action sentences. In the observe condition, students also had visual access to the Playmobil toy set but were instructed to watch as the experimenter moved the toys to represent the events occurring in the story.

Story 1. After the practice passage, all students viewed toys that corresponded to the characters and objects in the three subsequent (zoo or farm) experimental stories. Students were familiarized with significant characters and objects from that story setting. This was followed by the student reading Story 1 aloud. In the reread condition, the toys were covered with a blanket and the student reread

TABLE 1
Experimental Events in Each Strategy Condition

	Reread	*Observe*	*Activity*
Pretest	Participants in all conditions read one of two stories (Farm 1 typical or Zoo 1 typical), were given a 1-min distractor task, and were assessed on free recall and cued recall.		
Strategy practice (toys present in visual and manipulate conditions)	1. Students trained to reread what they had read when they saw a green sign. 2. Students practiced with grocery store story.	1. Students trained to watch the experimenter manipulate the toys when they saw a green sign. 2. Students practiced with grocery store story and toys.	1. Students trained to manipulate the toys when they saw a green sign. 2. Students practiced with grocery store story and toys.
Familiarization	Participants in all conditions were familiarized with toys representing Story 1–3's characters, objects, and setting. If Story 1 took place on the farm, Stories 1–3 took place at the zoo, and vice versa.		
Story 1 (toys present in visual and activity conditions)	1. The toys were covered. 2. Students read Story 1 as trained.	1. The toys were not covered. 2. Students read Story 1as trained.	1. The toys were not covered. 2. Students read Story 1 as trained.
Story 2 (toys present in visual and activity conditions)	1. Students read Story 2 as trained.	1. Procedures at this time were the same as Story 1 with one exception, the students were instructed close their eyes and "make pictures in their head" when they came to a green sign. Then, they were instructed to open their eyes and observe the experimenter manipulate the toys.	1. Procedures at this time were the same as Story 1 with one exception, the students were instructed close their eyes and "make pictures in their head" when they came to a green sign. Then, they were instructed to open their eyes and manipulate the toys.
Story 3 (toys absent in all conditions)	1. Students were instructed to "make pictures in their head" when they saw the green sign.	1. Students were instructed to "make pictures in their head" when they saw the green sign.	1. Students were instructed to "make pictures in their head" when they saw the green sign.

Note. All stories were followed with a 2-min distractor task ("Simon," an electronic memory game), and free- and cued-recall measures.

sentences with a green sign a second time. In the activity condition, students read the story and manipulated the toys when they came to a green sign. In the observe condition, students were required to stop reading at each green sign and watch while the experimenter moved the toys as directed by the text. After the student finished reading the passage, the experimenter administered the filler task, the free-recall task, and the cued-recall task, respectively. (These same tasks followed each of the two remaining experimental stories and so they will not be mentioned again.)

Story 2. All students read a third story. Procedures were the same for reread participants as they were for Story 1. Children in the activity and observe conditions received instructions to "close your eyes and make pictures in your head" before observing or performing the activity described by the story.

Story 3. Students in all conditions read the final story without the toys present. Following every action sentence, the children were instructed to close their eyes and "make pictures in your head" of story events.

Hypotheses

We expected the following:

1. Children who applied an activity-based reading strategy would exhibit greater memory for narrative events relative to children who applied visual and text-only reading strategies.
2. Children who initially applied the activity reading strategy would subsequently benefit more from imagery instructions relative to children who initially applied visual and text-only reading strategies.
3. A strategy-by-typicality (typical vs. atypical) interaction was expected so that there would be a greater strategy-related difference favoring the activity strategy on children's recall of atypical story events than on their recall of typical story events.

RESULTS

As would be expected from the random assignment process, mean proposition recall on the pretest story was statistically equivalent in the three experimental conditions, $F < 1$. For Stories 1–3, strategy (activity, observe, reread) represented a between-subjects factor in analyses of covariance separately conducted on free- and cued recall of sentence content, with the covariates consisting of students' standardized performance on the pretest (propositions recalled during free recall) and a six-level factor representing the story version that the student received.[3]

In addition, a two-level within-subjects factor, action typicality, was included. However, with only two exceptions (indicated later), no effects associated with the typicality factor were statistically significant with a Type I error probability (α) of .05 and so they will not be mentioned in the analyses that follow. Statistically significant omnibus tests of strategy were followed by Fisher Least Significant Difference (LSD) comparisons on the basis of a controlled familywise α of .05 (Levin, Serlin, & Seaman, 1994).

Story 1: Application of the Assigned Reading Strategy

Free recall. Table 2 summarizes the analysis of typical action, atypical action, and nonaction proposition recall. The main effect of strategy was statistically significant, $F(2, 31) = 8.44, p < .01$. Participants in both the activity and observe conditions recalled more story propositions than did participants in the reread condition, *d*s = 1.45 and 1.36, respectively, with no statistical difference between the former two conditions. Furthermore, we observed no mean recall differences among conditions on the nonaction propositions measure, $F(2, 31) = 1.92$, $p = .16$.

TABLE 2
Mean Free Recall of Typical, Atypical, and Nonaction Propositions by Strategy Condition (Experiment 1)

		Reread	*Observe*	*Activity*
Story 1 (Toys Present)				
Typical		1.24	1.74	2.02
Atypical		0.97	2.10	1.92
Total	$MS_e = 1.44$	**2.20**[a]	**3.84**[b]	**3.94**[b]
Nonaction	$MS_e = 0.47$	0.95	0.62	1.19
Story 2 (Toys Present)				
Typical		1.21	2.27	2.21
Atypical		1.45	2.25	2.14
Total	$MS_e = 1.33$	**2.66**[a]	**4.52**[b]	**4.36**[b]
Nonaction	$MS_e = 0.63$	1.67[a]	0.92[b]	1.22[ab]
Story 3 (Toys Absent)				
Typical		0.95	1.52	1.63
Atypical		0.94	1.24	1.34
Total	$MS_e = 1.00$	**1.89**[a]	**2.76**[b]	**2.97**[b]
Nonaction	$MS_e = 0.943$	1.30	1.00	1.52

Note. Story means are adjusted for pretest standardized scores and outcome story identification. Means in bold are marginal means. For each measure, condition means with different superscripts are statistically different from one another based on a familywise Type I error probability of.05. The reduced sample sizes for Reread, Observe, and Activity were, respectively: Story 1, 15, 11, and 13; Story 2, 15, 15, and 15; and Story 3, 15, 12, and 13 (see Footnote 3).

TABLE 3
Mean Cued Recall of Typical and Atypical Sentences, Out of 3 Possible, by Strategy Condition (Experiment 1)

		Reread	*Observe*	*Activity*
Story 1 (Toys Present)				
Typical		2.54	2.57	2.73
Atypical		2.09	2.53	2.30
Total	$MS_e = 0.90$	**4.62**	**5.09**	**5.03**
Story 2 (Toys Present)				
Typical		2.44	2.83	2.78
Atypical		1.90	2.63	2.31
Total	$MS_e = 0.83$	**4.34**[a]	**5.46**[b]	**5.08**[b]
Story 3 (Toys Absent)				
Typical		2.35	2.27	2.49
Atypical		1.42	1.75	1.95
Total	$MS_e = 1.52$	**3.77**	**4.02**	**4.43**

Note. Story means are adjusted for pretest standardized scores and outcome story identification. Means in bold are marginal means. For each measure, condition means with different superscripts are statistically different from one another based on a familywise Type I error probability of.05. The reduced sample sizes for Reread, Observe, and Activity were, respectively: Story 1, 15, 11, and 13; Story 2, 15, 15, and 15; and Story 3, 15, 12, and 13 (see Footnote 3).

Cued recall. Table 3 provides statement typicality (typical and atypical) and total score cued-recall means for each story. In contrast to the Story 1 free-recall findings, the main effect of strategy was not statistically significant, $F < 1$.

Story 2: Application of the Assigned Reading Strategy With Imagery Instructions

Free recall. For the typical and atypical action propositions analysis, the main effect of strategy was statistically significant, $F(2, 36) = 11.50$, $p < .001$, with comparisons again revealing that participants in both the activity and observe conditions remembered more propositions in comparison to their reread counterparts, respective ds = 1.47 and 1.61, with no statistical difference between the former two conditions. Contrary to the first story results, we found between-conditions differences on the nonaction measure, $F(2, 36) = 3.27$, $p = .05$, with students in the reread condition statistically outperforming those in the observe condition, $d = .94$.

Cued recall. For Story 2, the main effect of strategy was statistically significant, $F(2, 36) = 5.77$, $p = .007$. Pairwise comparisons revealed that students in both the activity and observe conditions outperformed those in the reread condition, respective ds = .82 and 1.23, with no statistical difference between the former two strategies. Here, the main effect of typicality was statistically significant, $F(1, 36) = 11.33, p = .002$, with typical-statement questions better answered than atypical-statement questions, respective Ms = 2.68 and 2.28, $MSe = 0.31$, $d = .73$. Consistent with the earlier-reported findings, however, the interaction of strategy with typicality was not statistically significant, $F < 1$.

Story 3: Imagery Instructions in All Reading-Strategy Conditions

Free recall. With the toys removed and all participants instructed to create visual images of story events, we detected between-conditions differences in the free recall of propositions, and the main effect of strategy was once again statistically significant, $F(2, 32) = 4.36$, $p = .02$. As with the previous two stories, students in both the activity and observe conditions remembered more story content than did those in the reread condition, respective ds = 1.09 and 0.87, with no statistical difference between the former two conditions.

Cued recall. The main effect of condition was not statistically significant, $F < 1$. As with Story 2, however, the main effect of typicality was statistically significant $F(1, 32) = 14.19, p < .001$, with typical story events better remembered than atypical ones (respective Ms = 2.37 and 1.70, $MSe = 0.58$), $d = .88$.

EXPERIMENT 1 DISCUSSION

Experiment 1 provides limited support for the hypothesis that participant manipulation during a reading task improves memory for story content. In particular, on both free- and cued-recall measures, we detected statistical differences among strategies, with activity and observe participants remembering more story content compared with reread participants. As an interesting discriminant validity counterpart, on the nonaction free-recall measure, (a) there were no statistical differences among conditions for two of the three stories; and (b) on the story for which strategy-related difference were detected (Story 2), the reread students statistically outperformed the observe students. This suggests that although reread students were generally at a disadvantage in recalling the stories' critical events, they were not at a disadvantage in recalling other, less critical story information.

The results of Experiment 1 are not compelling with respect to the hypothesis that dynamic visual representations (in the form of either participant manipulation or observation during a reading task) will differentially improve memory for atypical story events. In particular, on all free- and cued-recall outcomes, the critical strategy-by-typicality interaction was statistically nonsignificant.

The free-recall results also provide modest support for the hypothesis that text-relevant motor activity training fosters young children's internal imagery generation (e.g., Glenberg et al., 2004). In particular, on the free-recall measure, students who had previously manipulated the toys themselves statistically recalled more text-relevant content than did reread students. However, it should be noted that the observe strategy exhibited a comparable advantage to the reread strategy.

EXPERIMENT 2

In addition to an attempted replication of the effectiveness of the activity-based strategy relative to rereading, there were two major purposes of Experiment 2. The first was to determine whether the benefits of imagery training would be experienced similarly by second-grade children (Experiment 2) as they were by third graders (Experiment 1). On the basis of Bruner (1964) and Piaget's (1962) cognitive theories of development, we anticipated that second-grade children might not benefit from imagery training in contrast to what was observed for third-grade children. The second purpose was to reexamine through a more precise assessment the prediction that students who physically manipulate toy characters and objects will be relatively more adept at accommodating unlikely story events relative to a text-only strategy. Assessment precision was increased by creating stories that were more thematic and increasing the number of typical and atypical statements in each story.

METHOD

The three hypotheses examined in Experiment 2 paralleled those of Experiment 1, namely, those related to initial strategy effects, to subsequent imagery effects, and to a strategy-by-typicality interaction.

Participants

Forty second-grade students (18 boys, 22 girls) from the same Southwestern reservation community as in Experiment 1 participated in the study.

Design and Materials

Treatments were administered individually, with students randomly assigned in equal numbers to receive one of two instructional strategies (activity or reread). As in Experiment 1, typicality (typical vs. atypical statements) was a within-subjects factor.

Three nine-sentence stories (each taking place in a farm setting) were created. Two of the stories contained one nonaction setting-related sentence and eight action sentences (see Appendix 3 for an example of story content). In addition, four of the eight action sentences described typical actions in which characters interacted with objects in an expected manner; the other four described atypical actions in which characters interacted with objects in a less common manner. Typical and atypical actions were created for each of the four respective sentences, resulting in two versions of each story that were randomly assigned to participants. Story 3's nine action sentences contained only typical actions.

For the first two stories, participants' cued recall of story information was assessed using 12 questions, 4 each that targeted information in the typical and atypical action sentences as well as 4 that targeted story locations. For the third story, students were asked to recall as much of the story as they could remember (free recall). This was followed by eight questions that targeted location information in the action sentences (cued recall).

Procedure

With three exceptions, the procedures for Experiment 2 were the same as those in Experiment 1. The differences are that participants were not given a pretest, the observe condition was not included, and for the first two stories free recall was not measured. These differences were primarily due to constraints associated with performing experiments in educational settings. The instructions provided to participants were the same as those provided in Experiment 1 and will not be further described.

Scoring

Scoring procedures for measures of free recall and cued recall were the same as were described in Experiment 1.

Results

For all stories, we conducted analyses of variance on each measure of interest (with story topic statistically controlled for in Story 1 and Story 2 outcomes) on the basis of an alpha of .05. Table 4 presents a summary of cued-recall scores for each strategy.

TABLE 4
Mean Cued Recall of Typical and Atypical Actions, and of Locations, by Strategy Condition (Experiment 2)

		Reread (N = 20)	*Activity (N = 20)*
Story 1 (Toys Present)			
Typical		2.71	3.50
Atypical		2.78	3.15
Total	$MS_e = 1.82$	**5.49**[a]	**6.64**[b]
Locations	$MS_e = 0.86$	2.47[a]	3.12[b]
Story 2 (Toys Present)			
Typical		2.95	3.56
Atypical		2.61	3.05
Total	$MS_e = 1.54$	**5.56**[a]	**6.61**[b]
Locations	$MS_e = 0.82$	2.45[a]	3.33[b]
Story 3 (Toys Absent)			
Locations	$MS_e = 2.01$	4.78	5.35

Note. Story means are adjusted for outcome story identification and typicality version. Means in bold are marginal means. For Stories 1 and 2, the maximum score possible for typical and atypical action questions, as well as for locations, was 4; for Story 3, the maximum score possible was 9. For each measure, condition means with different superscripts are statistically different from one another based on a Type I error probability of.05.

Story 1: Application of the Assigned Reading Strategy

For Story 1, activity participants moved the toys in accordance with the story events following each action sentence. A repeated-measures analysis that included only the eight action questions (typical vs. atypical) revealed a statistically significant difference between conditions $F(1, 36) = 7.31$, $p < .01$, with students in the activity condition outperforming students in the reread condition, $d = .86$. However, neither the typicality main effect nor the typicality by condition interaction was statistically significant, $F < 1$ and $F(1, 36) = 1.40$, ps = .43 and .24, respectively. Statistical differences between conditions were also found on the four-item location measure, $F(1, 36) = 4.90$, $p = .03$, with children in the activity condition outperforming their reread counterparts, $d = .70$.

Story 2: Application of the Assigned Reading Strategy With Imagery Instructions

For Story 2, activity students were instructed to picture the story event in each sentence before moving the toys. As with Story 1, there was a statistically significant difference between conditions on the eight action questions, $F(1, 36) = 6.97$,

$p = .01$, with students in the activity condition outperforming students in the reread condition, $d = .84$. In addition, the main effect of typicality was statistically significant, $F(1, 36) = 5.86$, $MSe = 0.60$, $p = .02$, with typical actions (adjusted $M = 3.25$) better recalled than atypical actions ($M = 2.83$), $d = .54$. However, the interaction of condition and typicality was not statistically significant, $F < 1$. In addition, activity participants statistically surpassed reread participants on the location measure, $F(1, 36) = 9.05$, $p < .005$, and $d = .96$.

Story 3: Imagery Instructions in Both Reading-Strategy Conditions

For Story 3, activity students did not move the toys but were instructed to make pictures in their heads. As in Experiment 1, there was no mean difference between activity and reread participants on their cued recall of story locations, $F(1, 38) = 1.65$, $MSe = 2.01$, $p = .21$. In contrast with the Experiment 1 free-recall results, neither were there statistical differences between the activity ($M = 3.78$) and reread ($M = 4.10$) strategies in students' free recall of propositions $F(1, 38) = .10$, $MSe = 10.43$, $p = .75$.

EXPERIMENT 2 DISCUSSION

Three major conclusions result from Experiment 2. First, as evidenced on the cued-recall and locations measures, the reading performance of the second-grade students was substantially enhanced by the students' concurrent manipulation of objects to represent passage events.

Second, in contrast with what was observed in Experiment 1 with third-grade students, after experience with physical manipulation, second-grade students did not outperform their reread counterparts when they were required to generate their own internal visual representations of story events during Story 3. The younger age of the children in Experiment 2 relative to those in Experiment 1 is a tentative explanation for the lack of an imagery effect (e.g., see Levin & Pressley, 1978), but one that needs to be investigated more thoroughly.[4]

Third, even though typicality was statistically significant for one of the two stories where that factor was investigated (with students remembering typical actions better than atypical ones), the hypothesized interaction of condition and typicality was not statistically significant for either story.

GENERAL DISCUSSION

Community members of a southwestern Indian reservation located in the United States were participants in two experiments. In Experiment 1, predictions derived from Glenberg's indexical hypothesis were tested with regular education third-grade children on a reading task, and in Experiment 2, we evaluated similar predictions with regular education second-grade students. The results from the two experiments are of particular theoretical interest.

Theoretical Implications

Dual-coding theory. The present study's findings generally correspond with those from studies exploring the efficacy of text and pictures versus text alone (e.g., Carney & Levin, 2002; Levin et al., 1987; Levin & Mayer, 1993). The results of such studies are consistent with Paivio's (1971) dual-coding theory, which hypothesizes that two forms of cognitive representation exist: verbal and nonverbal. With concrete objects, nonverbal and verbal codes unite through referential connections. These referential connections between representations are enhanced by concurrent presentation of both codes. Although not explicitly stated, the indexical hypothesis would suggest that—especially with young children—referential connections can be forced (or "imposed," using Levin's, 1973, p. 20, terminology) on the learner through physical manipulation, which, in turn, should improve the learner's subsequent performance on memory tasks relative to visual presentation alone. The failure of the present study to find statistically significant strategy differences between the activity and observe strategies suggests that the theory requires some revision.

Activity improves imagery production. In Experiment1, the third graders' memory for narrative events was greatly enhanced by text-relevant motor activity. After the manipulatives on Story 3 were removed, a positive effect of imagined manipulation was observed on the free-recall measure in the activity condition, relative to the reread condition. However, it should be noted that observed manipulation improved free recall of actions and typical/atypical actions to a similar degree when children in that condition were prompted to make images.

Second graders' memory for story events was also improved by the presence of text-relevant activity in Experiment 2. However, unlike Experiment 1, when the manipulatives were removed free-recall differences between conditions were no longer present. This indicates that the imagery instructions were not effective for the group of younger students. Several plausible explanations exist for the absence of an imagery effect in second-grade students' following training. Of particular relevance are the possibilities that the present instructions and training time were not sufficient for younger children. It is known that transferring from externally provided concrete representations to internally generated visual imagery is not readily accomplished in young children without ample practice and metacognitive support (e.g., see Levin et al. [1987] and Levin & Mayer [1993] as well as the presumably more effective imagery-induction procedures adopted by Glenberg et al. [2004], as described earlier).

Activity differentially improves memory for atypical actions. Experiments 1 and 2 do not support the prediction that dynamic visual representations (here, manipulation or observation) during a reading task differentially improve students' memory for atypical actions compared with typical actions. It is possible that readers often expect unlikely events in fictional stories. In fact, unlikely events are often what make stories entertaining to read—something that also relates to the "seductive details" literature (e.g., Wade, Schraw, Buxton, & Hayes, 1993, p. 93). At the same time, one might question the validity of the typicality construct that was operationalized here. Note, however, that the main effect of typicality was statistically significant on the cued-recall outcomes of Stories 3 and 4 of Experiment 1 and on Story 2 of Experiment 2, and so the present typicality manipulation might be considered a reasonably good one.

Educational Implications

From a classroom perspective, the present study provides evidence for the effectiveness of two learning strategies with regular education Native American children in tutoring contexts: student manipulation and observed manipulation. In both experiments, memory benefits were observed when either manipulation or observed manipulation was present. In addition, third-grade regular education students exhibited strategy maintenance when the manipulatives were removed, which indicates that providing external supports is a powerful method for improving children's ability to generate imagery. The large effects observed here hint at promising educational interventions. These interventions would provide students with external support by providing physical or visual access to objects described by a story followed by instructing the learner to imagine story events. By familiarizing students with story characters and settings before and during a narrative in this manner, it is expected students' understanding and recall of story events will improve.

With benefits gained from both forms of dynamic visual representation, a large number of inexpensive classroom activities (the manipulatives cost around $100 per setting) are available that could take advantage of the underlying cognitive processes identified in this study. For example, a classroom teacher involved in student or small-group tutoring sessions could instruct students to play with objects that represent the characters and setting of a story about which they are to read or hear. After a period of play, the teacher would arrange the objects in positions that they would be in at the start of the story segment. Then, during the reading or listening activity, the students would update the position of the objects to reflect the events in the story. With time, the teacher would teach the students to close their eyes and imagine the toys engaging in story events as they occur. After imagining the toys moving, the students would take turns moving the toys, or one student would be designated as the one to do all of the manipulations. Eventually, the toys would be removed, and the students would receive instructions to close their eyes and imagine moving the toys as directed by the text. On the basis of the results of this study, it might be expected that students taught to generate imagery during reading and listening tasks in this manner would be more likely to improve their performance on subsequent text-memory assessments. Alternatively, manipulating images on a computer screen seems to provide benefits equivalent to that of manipulating the physical toys (Glenberg, Goldberg, & Zhu, 2009).

Conclusions

A reliable finding of the study is that an activity-based reading strategy does improve memory for target passages. However, an observed activity reading strategy resulted in similar cognitive benefits. Of considerable interest in light of related past research was that our activity-based reading strategy fostered subsequent imagery generation and facilitated the free recall of third-grade students, yet did not produce similar benefits with younger children. Finally, our investigation failed to support the prediction that relative to a simple rereading strategy, an activity-based reading strategy would differentially improve encoding and retrieval of atypical story events.

NOTES

1. Readers should be aware that there are 564 federally recognized tribes in the United States (United States Department of Interior, 2010). Caution should be exercised, therefore, in generalizing the results of any particular study beyond the specific tribal members on whom the study was based.
2. It is important to mention that operationalization of Marley et al.'s (2007) visual condition and the present observe condition differed. In the former study, the children were screened from watching the experimenter move the toy objects and only saw the outcomes of those manipulations, whereas in the present study, the children both watched the experimenter move the toys and saw the outcomes.
3. Because of a procedural miscue, story version was not properly counterbalanced across experimental conditions in the participant assignment process. Consequently, for two of the stories (Stories 1 and 3), one of the conditions ended up with no students receiving a particular story version. To remove that source of confounding in the analysis, all students in the two other conditions who received that story version were excluded. The resulting total sample size was 39, 45, and 40 for Stories 1, 2, and 3, respectively; and for Stories 1 and 3, the original six-level story-version factor was reduced to five levels.
4. A second tentative explanation arises from the specific version of the instructions used in Story 3, namely, to "make pictures in your head." In Glenberg et al.'s (2004) study, children

were instructed to imagine how they would move the toys, and they were given practice reading sentences, imagining how they would move the toys, and then describing what they imagined. Thus, Glenberg et al.'s procedures differ from those in the present study in both the degree to which the instructions elicited a type of self-referential imagery and the amount of imagery practice provided.

AUTHOR NOTES

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APPENDIX 1

Experiment 1 Story Content

Having Fun on the Farm
(np1) A girl and her older brother were almost finished with the day's work.
(p2) The girl took the brown basket to the nest/(tp3) and put the eggs in the basket.
(ap4) The girl put the basket behind the soccer goal for the night.
(p5) The boy got on his bike/(ap6) and then got off it and turned it over on its handlebars.
(np7) The girl yelled at her brother/(np8) for playing while she was still working.
(p9) The little pig went to the ball/(tp10) and pushed it into the soccer goal.
(p11) The girl took the skateboard/(tp12) and rolled it under the bench.
(np13) There was still a bag of flour/(np14) that needed to be put away.
(p15) The girl wanted to put the bag of flour away/(ap16) and so she looked inside the opening of the bag.

np = nonaction proposition
p = action proposition
tp = typical action proposition
ap = atypical action proposition

APPENDIX 2

Experiment 1 Cued Recall Questions

1. What did the girl put in the brown basket?
2. Where did the girl put the basket for the night?
3. What did the boy do with his bike?
4. What did the pig do with the ball?
5. What did the girl do with the skateboard?
6. What did the girl do with the bag of flour?

APPENDIX 3

Experiment 2 Story Content

(np1) A farmer and his two children were taking care of the farm.
(tp1) The girl grabbed the brown brush off the blue feeder and brushed the horse.
(ap1) Then the girl put the red bucket in the blue feeder for the horse.

(tp2) The cart was dirty and so the farmer took the bucket of soapy water and poured it on the cart.
(ap2) The farmer needed his rake and so he crawled through the window to see if the rake was in the pigpen.
(tp3) The farmer found the rake behind the barn door and he cleaned the ground with it.
(ap3) The little pig climbed over the fence and went to the rabbit house.
(tp4) The little boy saw the pig and picked up the rabbit and put it in the rabbit house.
(ap4) Then the little boy took the lettuce off the ground and ate it.

np = nonaction proposition
tp = typical action proposition
ap = atypical action proposition