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Improving Native American children's listening comprehension through concrete representations ☆

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Abstract

The primary purpose of the present study was to determine whether recent findings documenting the benefits of text-related motor activity on young children's memory for reading passages [Glenberg, A. M., Gutierrez, T., Levin, J. R., Japuntich, S., & Kaschak, M. (2004). Activity and imagined activity can enhance young readers' reading comprehension. *Journal of Educational Psychology, 96*, 424–436.] could be extended to the text processing of Native American children. Forty-five third through seventh-grade students with academic learning difficulties listened to four narrative passages under one of three instructional conditions: manipulate, where students moved toy objects to represent the story's content; visual, where students observed the results of an experimenter's toy manipulations; and free-study, where students thought about the content of the presented story sentences. Findings were consistent with the literature documenting the comprehension and memory benefits of text-relevant concrete representations, with students in the manipulate and visual conditions

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statistically outrecalling students in the free-study condition. In contrast to the results of the Glenberg et al. (2004) reading study, no conditions-related differences were observed on a final passage where students were instructed to generate internal visual images of story events in the absence of external visual support (i.e., when no toys were present).

Keywords: Text-processing strategies; Embodiment theory; Indexical hypothesis; Listening comprehension; Native American students

1. Introduction

Throughout the history of studying human cognitive development, psychologists have hypothesized the existence of multiple modes of representation. Jerome Bruner (1964), for example, theorized that humans make sense of their environment through three modalities: action, imagery, and language, which he labeled enactive representation, iconic representation, and symbolic representation, respectively. Similar perspectives were offered by Piaget and Inhelder (1971) and Paivio (1971), among others. At the same time, a consistent empirical finding is that promoting relevant motor activity during study improves participants' memory for target stimuli in a variety of learning contexts (e.g., Engelkamp & Zimmer, 1989; Kormi-Nouri, Nyberg, & Nilsson, 1994; Mangels & Heinberg, 2006; Noice & Noice, 2001; Thompson & Paivio, 1994). Research extending these notions to text processing is not as prevalent, but has again uncovered learning benefits. For example, a few studies that have involved participants either drawing or manipulating plastic cutouts have yielded positive effects of text-relevant motor activity (e.g., Lesgold, Levin, Shimron, & Guttmann, 1975; Rubman & Waters, 2000; Van Meter, 2001).

Glenberg has recently proposed the indexical hypothesis as an explanation of language comprehension, and which accords well with the just-mentioned research findings (e.g., Glenberg, 1997; Glenberg & Robertson, 2000). According to Glenberg, indexing (i.e., mapping) symbols, such as words, to objects is a necessary step in language comprehension. In the context of text comprehension, predictions derived from both the early associative-learning findings (e.g., Varley, Levin, Severson, & Wolff, 1974; Wolff & Levin, 1972) and the indexical hypothesis are that text-relevant motor activity—in the form of a student manipulating objects to represent the events described in a narrative passage—enhance the indexing process, improve the student's ability to generate visual images to represent the passage's events, and in turn have positive cognitive consequences. A recent series of reading comprehension experiments with typically developing first- and second graders from a midwestern community produced empirical evidence consistent with these expectations (Glenberg, Gutierrez, Levin, Japuntich, & Kaschak, 2004).

The primary purpose of the present study was to determine whether Glenberg et al.'s (2004) findings could be extended to the text processing of Native American children who were at risk academically. Native American students suffer disproportionately from high rates of academic failure. For example, in Arizona, a state with a very large Native American population, the 2003–2004 dropout rates were 10.4% and 9.6% for males and females, respectively. These figures are well above those of any other ethnic group represented by the state (Arizona Department of Education, 2005). It is likely that many Native American students drop out of school because of difficulties associated with learning

prerequisite skills (e.g., second-language comprehension) that are necessary to participate in classroom environments. Therefore, capitalizing on the cognitive benefits produced by learning-strategy research is of critical importance to Native students.

Numerous observational studies of Native American populations provide details and suggestions for educational interventions (see, for example, Brenner, 1998; Dehyle & Swisher, 1997, for relevant reviews). Yet, there have been only a few investigations in which various classroom- and school-based interventions have been implemented with Native American students (Kratochwill, McDonald, Levin, Youngbear-Tibbetts, & Demaray, 2004; Rossier & Farella, 1976; Tharp, 1982). For example, in 2003, the Northwest Regional Educational Laboratory (NREL) released a review of culturally based educational strategies (Demmert & Towner, 2003), and in the preface of the review the authors' state:

> The availability of quantitative research literature on culturally based education programs for Native American children is severely limited. (p iii).

With specific regard to the present study's focus, although Marley and Levin (2006) recently reported that enactive/visual learning modes are prevalent and preferred among North American Native children (e.g., Berry, 1969; More, 1989; Rohner, 1965; Shubert & Cropley, 1972), Kleinfeld and Nelson (1991) had previously identified only three empirical instructional intervention efforts. In one, with a Yupík (Eskimo) population, Erikson (1972) found that fourth- through eighth graders who studied the food chain with pictorial support outperformed (on a cued recall task) their peers who studied solely verbal representations. In a second study, Shears (1970) compared "visual" (in the form of print) with auditory study of basal sight words in a sample of kindergarten children living on a Minnesota reservation. Although the main effect of strategy was not statistically significant, the interaction of reading level by condition was, with the visual strategy's advantage being relatively greater for lower-level readers than for higher-level readers. The final study compared three instructional strategies, as applied to a lesson on cities, with a sample of third- through eighth-grade reservation children (McCartin & Schill, 1977). The conditions were printed text with pictures, oral presentation with the same pictures as in the preceding condition [1], and oral presentation with large pictures presented via an overhead projector. No statistically significant differences were found among the three conditions. Unfortunately, a no-pictures comparison condition was not included in the study, which precludes interpretation of a pictorial vs. verbal effect.

Thus, for the most part, evidence from available observational and nonrandomized intervention studies indicates that Native Americans have inherent strengths in performing visual/pictorial- and performance-oriented tasks. Pending more scientifically rigorous experimental support, this might suggest that teachers of Native children should exploit such children's strengths with educational strategies that employ visual and "hands on" tasks. However, when students are sent to public schools, instruction emphasizes learning through oral and written modalities. It is therefore plausible that the preference of teachers to provide verbal instruction does not take full advantage of Native American students'

[1] It appears that the same pictures were provided in the first two conditions but it is not completely clear from the authors' description.

strengths (nor, according to the aforementioned indexical hypothesis, of the strengths of all students).

A second, more general purpose of the present study was to ascertain whether the text-processing benefits of concrete representations of text *per se* (namely, without accompanying motor activity) that have been repeatedly reported in the literature (e.g., Carney & Levin, 2002; Levin, Anglin, & Carney, 1987; Levin & Mayer, 1993) would be similarly manifested in a Native American student population. A final purpose of the study was to determine whether providing students with text-relevant motor activity and concretizations would be helpful in promoting transfer to passages where the students were instructed to generate their own internal text representations (i.e., as visual images), paralleling what was found in the earlier Glenberg et al. (2004) study.

2. Method

2.1. Participants and design

Forty-five Native American third- through seventh-grade students from a reservation in the southwestern United States participated in the study, with students targeted for inclusion on the basis of their having manifested a variety of academic learning difficulties. Students were randomly assigned in equal numbers to listen to narrative passages while applying one of three individually administered instructional strategies: manipulate, where students moved toy objects to represent the story's content; visual, where students observed the results of an experimenter's toy manipulations; and free study, where students were instructed to think about the content of each story sentence as it was presented. A second between-subjects factor (character type, to be described next) consisted of the type of story character associated with students' instructed actions. The vast majority of participating students (87%) were in the 4th, 5th, and 6th grades, with five students in the 3rd grade and only one in the 7th grade.[2] Coincidentally, there were seven girls and eight boys in each condition.

2.2. Materials and procedure

Four 12-sentence stories were created with alternating primary character sentences (focusing on a single main character of the story) and secondary character sentences (focusing on all other story characters), with half of the students in each condition randomly assigned to each character type (for an example of story content, see Appendix A). Of interest was whether the anticipated effects of manipulation and concrete representations would be similarly manifested on: (a) story events associated with a single main character engaged in numerous activities (primary); and (b) story events associated with other characters engaged in only one or a few activities (secondary). Story topics related to events that occurred in either a farm (two stories) or zoo (two stories) setting. Partici-

[2] In the manipulate condition, one student was a third grader, five were fourth graders, four were fifth graders, four were sixth graders, and one was a seventh grader. In the visual condition, the respective numbers were 2, 4, 5, 4, and 0; and in the free-study condition, the respective numbers were 2, 4, 4, 5, and 0. Analyses of the primary outcome measures based on just 4th through 6th grade students yielded statistical results that were the same as those that are reported here for the full sample.

pants listened to the stories in one of four partially counterbalanced orders (the "partial" constraint being that the first two stories were from one setting and the second two stories were from the other setting), with approximately one quarter of the students in each strategy condition assigned to each story order. Because many of the students had basic reading problems (i.e., decoding and word recognition difficulties), the story passages were presented orally. The total amount of study time was equalized for all students, with each experimental session lasting approximately 35 min. The procedures followed in each strategy condition are summarized in Table 1.

Participants in all conditions were presented an initial story (Story 1) to provide a pre-strategy measure of students' recall of text information, which served as a variance-reducing covariate in the statistical analyses that were conducted. After reading the passage aloud, the experimenter administered a filler task, a free-recall task, and a cued-recall task, respectively. These same tasks followed each of the three remaining experimental stories (Stories 2–4) and are described later.

2.2.1. Strategy practice

Following Story 1, a six-sentence practice story about a grocery store was then used to introduce students in each condition to the strategy that they would be applying for Story 2. In the free-study condition, for the practice passage, following each sentence students were instructed to think about what was happening in the story. In the manipulate condition, students were shown a set of Playmobil toys that represented the settings, characters, and objects mentioned in the story. For alternating sentences, the students either moved the toys to correspond with the story's content (when a particular cue card was displayed, and referred to hereafter as "critical" sentences) or covered their eyes and thought about what was happening in the story while the investigator moved the toys to their appropriate story locations (when a different cue card was displayed, hereafter referred to as "other" sentences). In the visual condition, students also were shown the Playmobil toy set. However, the students were required to cover their eyes following every sentence and think about what was happening in the story while the investigator moved the toys in accordance with the story content.

After the practice passage, students in all conditions were familiarized with a different Playmobil toy setting, along with the important toy characters and objects that would be mentioned in the upcoming story. This was followed by the presentation of Story 2 and its three associated tasks. One of the farm stories, with a designation of its 22 broadly defined free-recall propositions (p_i), to be described later, is presented in Appendix A. Then, students were shown a new Playmobil setting and toys representing the characters and objects that would appear in Stories 3 and 4, with each story followed by its associated three tasks.

2.2.2. Free-study condition

In this condition, for the subsequent experimental passages (Stories 2–4) the toy settings and toys were covered with a blanket. On the first two experimental passages (Stories 2 and 3), students listened to the story and were instructed to think about the relevant story events during a three-second pause that followed each sentence.

2.2.3. Manipulate condition

For Story 2, manipulate participants listened to the story and alternated with respect to the type of activity they were to engage in (for critical or other sentences, in conjunction

Table 1
Experimental procedures in each strategy condition

	Free study	Visual	Manipulate
Story 1 (Baseline)	Participants in all conditions listened to one of four stories, were given a two-minute distractor task, and were administered free- and cued-recall tasks		
Strategy practice (Practice toys visible in manipulate and visual conditions)	Students were instructed to "think about" what they heard during the pause that followed each sentence	Every sentence was followed by a cue card. The card signaled students to "close your eyes and think about what is happening in the story" while the experimenter manipulated the toys	Alternating sentences were followed by critical- and other-sentence cue cards. The cards signaled students to manipulate the toys (critical-sentence cue cards) or to "close your eyes and think about what is happening in the story" while the experimenter manipulated the toys (other-sentence cue cards)
	Students practiced with grocery store story	Students practiced with the grocery store story and toys	Students practiced with the grocery store story and toys
Setting familiarization	Participants in all conditions were familiarized with toys representing Story 2's setting, characters, animals, and objects		
Story 2 (Toys visible in manipulate and visual conditions)	The toys were covered Students listened to Story 2 according to the manner in which they practiced	The toys were visible Students listened to Story 2 according to the manner in which they practiced	The toys were visible Students listened to Story 2 according to the manner in which they practiced
Setting familiarization	Participants in all conditions were familiarized with a new setting. If Stories 1 and 2 took place on the farm, Stories 3 and 4 took place at the zoo, and vice versa		
Story 3 (Toys visible in manipulate and visual conditions)	After familiarization with the new setting, students followed the same procedures that were used for Story 2	After familiarization with the new setting, students followed the same procedures that were used for Story 2, with one exception: Students were instructed to "close your eyes and make pictures in your head" of story events when the cue card was presented	After familiarization with the new setting, students followed the same procedures that were used for Story 2, with one exception: Students were instructed to "close your eyes and make pictures in your head of story events when an other-sentence cue card was presented
Story 4 (Toys covered in all conditions)	Students were instructed to "close your eyes and make pictures in your head" when presented with a critical-sentence cue card on alternate sentences	Students were instructed to "close your eyes and make pictures in your head" when presented with a critical-sentence cue card on alternate sentences	Students were instructed to "close your eyes and make pictures in your head" when presented with a critical-sentence cue card on alternate sentences

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

with either primary or secondary characters), as they had previously practiced. For Story 3, students performed the same actions as in Story 2, accompanied by instructions to "close your eyes and make pictures in your head about what is happening in the story" when the toys were being manipulated by the experimenter.

2.2.4. Visual condition

For Story 2, visual condition students were required to close their eyes following each sentence and think about what was happening in the story while the experimenter moved the toys to represent the story content. For Story 3, students performed the same actions as in Story 2, accompanied by instructions to "close your eyes and make pictures in your head about what is happening in the story" when the toys were being manipulated by the experimenter.

2.2.5. All conditions

Students in the three conditions listened to the final story (Story 4) without the toys. On alternate sentences, students in all conditions were instructed to close their eyes and make pictures in their heads of the story events.

Following presentation of each story, students were given a two-minute filler task ("Simon," an electronic pattern game) to help mitigate short-term memory effects. Students were then asked by the experimenter to "tell me everything you can remember about the story" (free recall). Students were prompted up to three times with questions such as "Is there anything else you remember?" to increase the completeness of their recall. This was followed by a set of 12 cued-recall questions that focused on story events and locations (e.g., "Where did the farmer leave the bucket of water?"). For cued recall on Stories 2–4, six of the questions referred to content associated with a primary character and six questions referred to content associated with secondary characters. A complete set of cued-recall questions for one of the farm stories may be found in Appendix B, where it may be seen that the questions alternate between primary-character content (here, the farmer on even-numbered questions) and secondary content (animals and the two children on odd-numbered questions).

2.2.6. Scoring

All protocols were scored "blindly" with respect to students' identities and experimental conditions. Cued-recall responses were scored as incorrect (0 points), partially correct (half a point), and correct (1 point). For example, the first question in Appendix B, "Where did the rooster fly?", targets the first sentence in Appendix A, "Early in the morning the rooster with the red head flew to the very top of the barn and sang 'cock-a-doodle-doo' to wake everyone up." The response "somewhere" would be awarded 0 points, "up top" half a point, and "on the roof of the barn" a full point.

After calibrating their scoring criteria with several examples, two independent scorers scored the free-recall responses for students' memory of propositions, objects (which included characters and animals), actions, and locations. Full- and half-point credit was awarded for items recalled in each of these story categories. Consider, for example, the just-discussed first sentence of Appendix A. If a student were to state that "the rooster flew to the top of the barn," the response was awarded a full point for the proposition p_1. In addition, a point for "rooster" would be given in the object recall category, a point for "flew" would be given in the action recall category, and a point for "top of the barn" would be given

in the location recall category. Alternatively, if a student said that "the rooster flew up," (s)he would be awarded half a point for the proposition, a point for "rooster" as an object, a point for "flew" as an action, and no points for location. A student who recalled "the rooster" would be awarded no points for the proposition, action, or location. However, a point for "rooster" as an object would be credited. Each sentence was scored this way and tallied across all the propositions, objects, actions, and locations for a total story score in each category for both primary and secondary sentences. When disagreements occurred between the raters, areas of difference were discussed until a consensus was reached.

3. Results

Strategy (manipulate, visual, free study) and character-type (primary, secondary) effects were assessed as between-subjects factors through analyses of covariance separately conducted on students' performance on sentence content for Stories 2–4, with the covariates consisting of students' standardized (z-score) performance on Story 1 (propositions recalled and correct responses for the free- and cued-recall measures, respectively) and a four-level factor representing the particular story version that the student received.[3] Statistically significant omnibus tests of strategy condition effects were followed by Fisher LSD comparisons based on a controlled familywise Type I error probability of .05 (Levin, Serlin, & Seaman, 1994).

Character-type main effects were statistically significant on almost all of the measures analyzed, with students remembering secondary-character sentences better than primary-character sentences. Recall that for the experimental stories, the six primary-character sentences all revolved around a single main actor (the zookeeper or the farmer) whereas the six secondary-character sentences revolved around many different actors (e.g., in the zoo scenarios, members of a three-person family and several animals each performed actions). The uniqueness or novelty of each actor in the secondary-character sentences may have enhanced students' recall of the associated story events (see, for example, Garner & Gillingham, 1989). Despite these character-type main effects, no interactions between character type and strategy condition were found, a previously mentioned question of interest in the present experiment. In addition, supplementary analyses revealed that students' grade level (defined either as a 5-level factor or a dichotomous, higher/lower level factor) was not statistically related to their performance on the selected outcome measures.[4] Students' adjusted performance outcomes, by experimental condition, are summarized in Table 2.

3.1. Free recall

Only the proposition outcomes are detailed in the next paragraph. Students' free recall of story objects and actions resulted in statistical patterns that were virtually identical to

[3] Sentence type (critical vs. other sentences) constituted a within-subjects variable in these analyses. With few exceptions, however, statistically significant interactions between strategy and sentence type were not detected. Consequently, for simplicity purposes here, the tables and analyses reported are based on all sentences (i.e., critical plus other), with the exceptions noted.

[4] As a reviewer points out, however, the statistically nonsignificant grade-level effects must be interpreted with respect to the relatively smaller (and unbalanced by condition) sample sizes and lower power associated with grade levels here—see Footnote 2.

Table 2
Adjusted mean number of items recalled and cued recall percentages, by strategy condition, for each experimental story

	Story 2			Story 3			Story 4		
	Free study	Visual	Manipulate	Free study	Visual	Manipulate	Free study	Visual	Manipulate
Free recall									
Propositions	5.46[a]	8.92[b]	7.97[b]	5.55[a]	8.34[b]	8.34[b]	5.21	3.33	4.30
		$MS_e = 9.69$			$MS_e = 7.55$			$MS_e = 8.78$	
Objects	9.49[a]	16.88[b]	13.84[b]	9.77[a]	13.97[b]	14.45[b]	9.15	5.97	8.21
		$MS_e = 20.02$			$MS_e = 17.67$			$MS_e = 23.54$	
Actions	6.60[a]	10.81[b]	8.93[ab]	6.49[a]	10.64[b]	10.82[b]	6.21	4.27	5.79
		$MS_e = 14.13$			$MS_e = 11.98$			$MS_e = 14.49$	
Locations	2.74	4.37	4.26	3.04	4.09	4.24	2.05	1.37	2.07
		$MS_e = 4.32$			$MS_e = 4.32$			$MS_e = 2.73$	
Cued Recall	53.0[a]	77.2[b]	86.2[b]	53.8[a]	78.8[b]	87.0[b]	41.2	38.9	40.9
		$MS_e = 359.7$			$MS_e = 391.1$			$MS_e = 387.5$	

Note: $N = 15$ in each experimental condition. The average (across story versions) maximum scores possible for free recall of propositions, objects, actions, and locations are 24, 31, 24, and 21, respectively. During presentation of Story 2, toys were visible in the manipulate and visual conditions. During presentation of Story 3, toys were visible and imagery instructions were given in the manipulate and visual conditions. During presentation of Story 4, toys were covered and imagery instructions were given on alternate sentences in all strategy conditions. All means are adjusted for students' Story 1 *z*-scores and outcome story version. For each measure, means with different superscripts are statistically different from one another, based on a familywise Type I error probability of .05.

those found for propositions. An important exception, however, was that on Stories 2 and 3, students in the activity and visual conditions recalled relatively more story objects than did students in the free-study condition for critical sentences (where either the student or the experimenter manipulated the toys) than for other (nonmanipulation) sentences, all ps $< .05$. No strategy-related differences were obtained on the locations free-recall measure (see Table 2).

Students' adjusted mean recall of Story 2–4 propositions is presented in the first row of figures in Table 2. With the toys visible in the activity and visual conditions on Story 2, there were statistical differences among strategy conditions, $F(2, 35) = 9.82$, $p < .001$. Controlled post hoc Fisher comparisons revealed that both activity and visual participants substantially outperformed those in the free-study condition, respective ds $= 1.23$ and 1.55, with no statistical difference between the former two conditions. The same was true on Story 3, $F(2, 35) = 7.63$, $p < .002$, respective ds $= 1.42$ and 1.04. The main effect of strategy condition was not statistically significant on Story 4, where activity with, and visual feedback from, the toys were replaced by student-generated visual imagery on the critical sentences, $F(2, 35) = 2.35$, $p = .11$. On that same story, the interaction of strategy and sentence type was statistically significant, however, $F(2, 35) = 3.37$, $p = .04$. Follow-up interaction contrasts revealed a statistically greater difference between the activity and visual conditions (favoring the former) when imagery was prompted than when it was not, $t(35) = 2.09$, $p = .04$, d or estimated ψ_σ for a between-factor, within-factor interaction (Levin, 1997, p. 104) $= .32$. Interaction contrasts investigating the same difference between

either activity or visual participants and their free-study counterparts were found not to be statistically significant, $t(35) = 1.16$ and $-.93$, respectively, both $ps > .20$.[5]

3.2. Cued recall

Students' adjusted mean percentage correct on Story 2–4 questions is presented in the last row of figures in Table 2. The statistical results paralleled each of those just reported for the proposition-recall data. Specifically, there were differences among strategy conditions on both Story 2 and Story 3, $F(2, 35) = 11.89$ and 11.19, respectively, both $ps < .001$, with Fisher comparisons indicating that the performance of activity and visual students was statistically comparable and considerably higher than the performance of students in the free-study condition, respective $ds = 1.75$ and 1.28 (Story 2) and 1.68 and 1.27 (Story 3). Again the strategy condition main effect was not statistically significant on Story 4, where only student-generated imagery was permitted, $F < 1$.

4. Discussion

Three major conclusions result from the present study. First, academically at-risk Native American students' recall of orally presented text passages was greatly enhanced by concurrent text-relevant "hands on" activity. Statistically significant effects were observed for children in the manipulate condition relative to those in the free-study condition, with students who manipulated toy objects outperforming their free-study peers by well over a standard deviation on the major text-recall measures. As a follow-up to this study, the present authors are currently exploring the benefits of students' manipulations in an actual reading (rather than listening) context with young Native American students.

Second, even though physical manipulation of story characters greatly improved students' text processing, a comparable degree of facilitation was produced by the provision of concrete visual representations of story events. That there was little or no difference in the benefits of performing story actions and observing the outcomes of those actions is consistent with previous findings in the children's associative-learning literature, as well as with the results of two recent children's text-processing studies (Glenberg, Brown, & Levin, in press; Theodosiou, 2005). That "equivalence" outcome is also currently being followed up by the present authors.

A few comments should be offered in regard to the outcome equivalence of physical manipulation and the provision of analogous visual representations. Note that the present visual representations were, in some sense, dynamic—that is, they changed as the story was read, rather than remaining as a single static picture. The comparability of students' performance in the manipulate and visual conditions may also reflect the fact that the toys were relatively common objects, and hence literal manipulation may not have revealed much more than visual inspection.[6]

The third conclusion resulting from the present study is that after brief experience with either physical manipulation or visual representations, students were not able to

[5] The same statistical interaction patterns were also found for students' recall of Story 4 verbs.

[6] It should also be pointed out that unlike the procedures followed in the typical participant-versus experimenter-generated activity research, in the present visual condition students observed only the results of the experimenter's manipulations and not the manipulations themselves.

experience facilitative strategy transfer when required to produce their own internal visual representations for Story 4. There are several possible explanations for this strategy-transfer failure. First, the participating Native American students had academic learning difficulties, which may have resulted in an inability for them to generate beneficial text-relevant visual imagery. Second, English was a second language for many of the students and it is possible that they did not fully understand the directions to "close your eyes and make pictures in your head" that accompanied Stories 3 and 4. Third, by the time students were presented the final imagery-transfer passage (Story 4), approximately 25 min had elapsed, which may have exceeded the present students' attention, interest, and effort levels. Fourth, unlike the stories used by Glenberg et al. (2004), which all took place in the same setting, for the present Story 3 the setting changed from a zoo to a farm (or vice versa). This may have resulted in students not having the degree of familiarity with the setting, characters, and objects required to produce story-enhancing visual imagery. Finally, it has been documented that transferring from externally provided concrete representations to internally generated visual imagery is not easily accomplished in young students without ample practice and metacognitive support (see, for example, Levin et al., 1987; Levin & Mayer, 1993). Unfortunately, very little explicit support or training was provided here.[7] For all of these reasons, it would be premature to dismiss the indexical hypothesis on the basis of the present study.

A reviewer of an earlier version of the manuscript asks specifically: "To what extent do the authors feel that including children with academic learning difficulties in the study actually mitigated the overall test of the theoretical model?" Our primary interest was in generalizing the text manipulation phenomenon demonstrated by Glenberg et al. (2004) in a majority population of typically developing school children to a Native American population of school children. Glenberg et al. included first and second graders in their study. Because many, if not most, of the Native American children in our reservation school were experiencing academic learning difficulties to some degree, as well as English-as-a-second-language challenges afforded by the constructed passages, we elected: (a) to include older children (primarily 4th through 6th graders) than those studied by Glenberg et al.; and (b) to present the passages orally. Both of these decisions were made as partial compensations for the developmental and reading-proficiency differences in the two respective populations. The reviewer's concern is therefore acknowledged in that in our making these decisions, a valid test of Glenberg's (1997) theoretical notions was likely compromised.

In summary, this study may be the first scientifically credible investigation of a learning strategy with a Native American population. Within that context, the study's outcomes have particular educational importance. Students who had either physical or visual access to story-relevant manipulatives enjoyed a marked improvement (greater than $1-1/2$ within-conditions standard deviations) on cued- and free-recall outcomes when compared to students who listened to the stories in a standard verbal format. Such findings add to the long history of evidence supporting the efficacy of activity- and imagery-based learning strategies and suggest that the additional effort required to include concrete representations during text processing is well worth the effort with low-achieving Native American

[7] In that regard, it is important to remember that students in the visual condition received more practice with imagery generation on Story 3 (i.e., for each sentence of the story) than did students in the manipulate condition (only for every other sentence).

students. As a unifying theoretical framework, Glenberg's indexical hypothesis (Glenberg & Robertson, 2000; Glenberg et al., 2004) provides multiple directions for future research inquiry. If fruitful, such inquiry could result in powerful methods for improving Native American children's processing of oral and written text. With carefully controlled programmatic investigations addressing these topics, we are hopeful that learning-strategy researchers will not continue to neglect the educational needs of America's first people.

Appendix A. Sentences and free-recall propositions (p_i) for one of the stories[a]

A Day on the Farm

1. Early in the morning the rooster with the red head flew to the very top of the barn (p_1) and sang "cock-a-doodle-doo" to wake everyone up (p_2).
2. The farmer picked up the bucket of water next to the cart (p_3) and went around the barn to the big pig (p_4).
3. The hen came out of her nest (p_5) and pecked at her two baby chicks (p_6).
4. The farmer left the bucket of water for the pig to drink (p_7) and went out front to get something from the cart (p_8).
5. The dog in the back yard chased the baby pig once in a circle around the sunflower (p_9).
6. The farmer climbed up the ladder to the upstairs part of the barn (p_{10}) and looked around for the pitchfork (p_{11}).
7. The bird in the tree flew to the side roof of the barn (p_{12}), but it was slippery when it landed and so it fell to the ground (p_{13}).
8. The pitchfork was not upstairs and so the farmer climbed down the ladder (p_{14}) and looked under the cart (p_{15}).
9. Outside the barn, the little girl went to the hen's nest (p_{16}) and put her eggs in the basket to take home later (p_{17}).
10. The farmer found the pitchfork behind the door next to the bench (p_{18}) and put it in the cart (p_{19}).
11. The little boy took a basket of vegetables to the rabbits (p_{20}) and fed them the lettuce and carrots (p_{21}).
12. The farmer was tired and went and sat on the bench (p_{22}).

Appendix B. Cued recall questions for the farm story of Appendix A

A Day on the Farm

1. Where did the rooster fly? (To the top of the barn)
2. Where did the farmer pick up the bucket of water? (Next to the cart)
3. Where did the hen come from to peck at her baby chicks? (The nest)
4. Where did the farmer leave the bucket of water? (Next to the pig)

[a] In this story the farmer is the primary character (even-numbered sentences) and the children and animals are secondary characters (odd-numbered sentences).

5. Where did the dog chase the baby pig? (Around the sunflower)
6. What did the farmer use the ladder for? (To go upstairs)
7. What happened when the bird tried to land on the side of the barn? (It fell to the ground)
8. Where did the farmer look for his pitchfork after he climbed down the ladder? (Under the cart)
9. Where did the girl put the hen's eggs? (In her basket)
10. Where did the farmer find his pitchfork? (Behind the door)
11. Where did the boy take the basket of vegetables? (To the rabbits)
12. What did the farmer do at the end of the story? (He sat on the bench).

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