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ABSTRACT

A study on children's recall of words presented on a computer was assessed as a function of action and verbal labels. Subjects, 80 public school children in a southeastern city, equally distributed between kindergarten and second grade and between high and low reading ability levels, interacted with different versions of a computer presentation. Within versions, words were presented with varying levels of visual action and verbal labels. Not surprisingly, older children recalled more words than did younger children. For the second graders, action presentation increased the poor readers' verbal recall to the level of their better reading peers. Results suggested that older children who have difficulty reading may well benefit from visual action emphasis of computer content. (One table of data and one figure are included; 27 references are attached.) (RAE)

Computer Presentational Features for Poor Readers' Recall of Information

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Running Head: COMPUTER PRESENTATIONAL FEATURES

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Abstract

Children's recall of words presented on a computer was assessed as a function of action and verbal labels. Eighty children, equally distributed by grades kindergarten and second and by high and low reading ability levels, interacted with different versions of a computer presentation. Within versions, words were presented with varying levels of visual action and verbal labels. Older children recalled more words than did younger children. For the second graders, action presentation increased the poor readers' verbal recall to the level of their better readng peers. The findings suggest that older children who have difficulty reading may well benefit from visual emphasis of computer content.

Computer Presentational Features for Poor Readers' Recall of Information

Computers are increasingly used in educational settings to teach basic skills (Lepper, 1985), but little is known about how children decode the symbol systems that present the content. More specifically, computer presentational features, the audio-visual symbol system that is used to present computer software, must be understood in order for children to understand the electronically-packaged messages. This study examines the potential role of computer presentational features for children's recall of verbally presented content.

Presentational Features as Representational Codes

The features that are used to present computer content are similar to those that are used to present television content (Silvern & Williamson, 1987). For example, visual features like animation, action, and camera dissolves and auditory features like sound effects and narration can convey information in both television and computer contexts.

Presentational features affect children's recall of both television and computer content. In the television area, slowly-paced programs are easier to understand than are rapidly-paced programs (Wright, Huston, Ross, Calvert, Rollandelli, Weeks, Raessi, & Potts, 1984); content presented with action is better understood than is content presented without action (Calvert, Huston, Watkins, & Wright, 1982); content presented with sound effects is better understood than is content presented without

sound effects (Calvert & Gersh, 1987); and flashbacks in time are better understood when represented with dreamy camera dissolves rather than camera cuts (Calvert, in press). Some initial work in the computer area suggests that feature effects may generalize to this new technology. For example, preschoolers selected and recalled computer content presented with action better than content presented in still frame (Calvert, Watson, Brinkley, & Bordeaux, in press).

One reason that features affect children's memory may be their ability to provide modes which children can use to represent content (Huston & Wright, 1983). Action, for example, provides an iconic mode which can be used to represent visually presented content while language provides a symbolic mode to represent verbally presented content.

Developmental Differences in Children's Use of Visual and Verbal Symbol Systems

Children vary in the ease with which they process these visual and verbal symbol systems. Young children, who have difficulty processing abstract verbal information, may be particularly likely to benefit from visual presentation (Wright & Huston, 1983). Presumably, visual presentation assists the young child by matching his dominant mode of iconic thinking (Bruner, Olver, & Greenfield, 1968). Actions, in fact, are more memorable to young children than are utterances (Gibbons, Anderson, Smith, Field, & Fischer, 1986). For example, actions are better recalled than are utterances even when a story is presented only

in an auditory mode (Beagles-Roos & Gat, 1983; Gibbons et al., 1986). With development, however, the older child becomes increasingly abstract in thought and better able to encode information when only a verbal symbol system is provided (Wright & Huston, 1981).

When verbal information is presented alone, young children have difficulty in recalling that information. However, young children can remember more of that information when taught to rehearse (Keeney, Cannizzo, & Flavell, 1967). Flavell (1970) described this behavior as a production deficiency. The child is able to use, but he does not spontaneously produce, the strategy that is necessary for effective recall skills. Older children, by contrast, do spontaneously rehearse; their tendency to rehearse partly accounts for their superior recall performance over younger children (Flavell, Beach, & Chinsky, 1966).

One type of verbal rehearsal strategy is to label objects. Television researchers have successfully used verbal rehearsal procedures in which an adult labels significant story content for children; when information is provided that children do not spontaneously produce, recall improves (Collins, Sobol, & Westby, 1981; Friedrich & Stein, 1975; Watkins, Calvert, Huston-Stein, & Wright, 1980). Such procedures might also benefit young children who are interacting with computers.

Another way to enhance young children's recall of verbal information is to provide supplementary visual information. When visual presentation is combined with verbal labels, the child has

been given two distinct but complimentary ways to think about, and to encode, content. For example, children were more likely to understand central televised story content presented with both action and language than to understand content presented in only a verbal mode (Calvert et al., 1982) and to recall utterances that were accompanied by visual presentation than utterances presented only in an auditory mode (Gibbons et al., 1986). Young children are especially likely to benefit from complimentary and redundant visual and auditory presentation of information (Field & Anderson, 1985).

Using two symbol systems to assist information processing can also be observed in beginning reading programs for young children. In reading books, pictures are often paired with words to help young children learn the symbol system of written language. For example, a picture of a drum is presented with the word "drum." This pictorial symbol system simplifies the task of decoding the comparatively abstract symbol system of language for the child. That is, visual images should aid a child who is learning a vocabulary of nouns because a particular object is paired with the arbitrary verbal label (Bruner et al., 1966). Simultaneous presentation of visual and verbal symbols provides dual modes which can be used to represent content (Paivio, 1969). As children begin to master written language, their books contain fewer and fewer pictorial aids. Thus, visual presentation may benefit younger more so than older children.

Poor and Good Readers' Recall Skills

Children within the same age group also differ in their skill at processing verbal information. For example, good readers consistently perform better on short-term recall tasks than do poor readers (Brady, Mann & Schmidt, 1987; Katz, Shankweiler & Liberman, 1981). Although poor and good readers recall visual drawings of doodles equally well, pictures that can be named are better recalled by the good readers (Katz et al., 1981). This finding suggests that good readers may be more likely to supply their own verbal labels when objects can be named than are the poor readers; this verbal code, in turn, assists recall efforts.

When a child does not perform a skill well, one intervention option is to supplant or provide the skill for him (Salomon, 1979). Poor readers may process verbal information differently than good readers (Katz et al., 1981), or they may just be delayed in their ability to use linguistic codes. If poor readers are simply delayed, then perhaps they might benefit from features that are useful for a younger age group. In particular, activites which require verbal skills might be made easier for a poor reader if verbal labels and visual action are provided to support information processing.

The Present Study

The purpose of this study was to examine the effects of action and verbal labels (i.e, naming the object) on children's recall of words presented in a computer learning context. We

expected 1) older children to recall more words than younger children; 2) good readers to recall more words than poor readers; 3) younger children to recall more words presented with than without action; 4) younger children to recall more words presented with than without verbal labels; and 5) older children who were poor readers to recall as many words as older children who were good readers when action was present rather than absent.

Method

Subjects

The sample consisted of 80 children who attended one of two public schools in a moderately-sized Southeastern city. Children were equally distributed by grades kindergarten and second (M = 6 years, 2 months vs. 8 years, 3 months) and by high and low reading ability level. Children in the high and low reading ability levels were in the upper quartile of their respective reading groups at school. These reading level judgments were made by the children's teachers. Within grade and reading level groups, children were randomly assigned to one of four versions of a computer presentation.

Computer Treatment Conditions

The computer presentation was the same "talkworld" across all treatment conditions. On the color monitor, a computer screen depicted a park scene which had a green grassy area, a blue lake, a blue sky, a black train track, and a brown road. Twenty four sprites, i.e., programmable cursor points depicted as objects, could appear in talkworld by keying in (i.e, typing) the

word for the sprite object. The sprites looked like objects which belonged to one of the following six categories: people (mom, dad, boy, girl); water animals (frog, duck, fish, turtle); land animals (cat, dog, horse, bird); vehicles (car, truck, train, plane); nature (cloud, sun, flower, tree); and toys (boat, kite, ball, wagon).

Four versions of talkworld were created. Within each version, the four objects within each of the six categories (i.e., people, water animals, land animals, vehicles, nature, and toys) had been randomly assigned properties of action and verbal labels. The design was counterbalanced so that across the four versions, each object assumed all possible combinations of action and verbal labels. This allowed assessment of the properties of objects, independent of the attractiveness of a particular object. Properties of the objects within the four versions are presented in Table 1.

Insert Table 1 about here

After each word was typed, a verbal label was either presented or not presented as the objects either appeared with action (i.e., motion) or without action (i.e, in still frame). A Votrax voice syntehsizer was programmed to label the objects. After the word was typed, the computer said the name of the object.

Movement was always moderate, approximating the speed of a walk. Objects performed the actions appropriate for the designated sprites. For example, the frog hopped across the pond, and the truck drove along the road. Talkworld, programmed in Sprite Logo, requires a Sprite Logo board and a Votrax voice synthesizer. Specific documentation is reported elsewhere (see Watson, Calvert, & Popkin, 1987).

Procedure

Each child participated individually in one 10 minute session. In order to familiarize children with the properties of objects within their particular version of talkworld, the objects were presented by an experimenter as she read a brief story about an afternoon in a park. As she came to a targeted word, she typed it into the computer. After each word was typed, the object appeared on the computer screen in talkworld.

After presenting the objects, the experimenter cleared the computer screen, leaving only the talkworld background. She then engaged the child in a 30 second distraction task to prevent the child from rehearsing the names of the objects. In order to do so, the experimenter told the child that they were going to play a guessing game. The child was asked to close his eyes, and then the experimenter hid a colored block behind her back. When the child opened his eyes, he guessed which hand held the block and identified its color.

Comprehension: Free Recall Scores

The experimenter then pointed at the computer screen and asked each child to name all the objects that he could remember. As the child spoke, the experimenter recorded the first to last response on an answer sheet which had all the words listed in alphabetical order. Then the experimenter said: "That's good. Can you think of any other objects?" If the child named any other objects, those objects were recorded by the experimenter in consecutive order, beginning with the last number previously recorded. Each time that the child paused for more than 5 seconds, the experienter asked if he could remember any other objects. When the child said, "No," the experimenter moved to the next phase of the study.

At this phase, each child was asked to type in the words that he had remembered, beginning with the first word recalled and continuing through the last. Typing skills were aided by 5" x 7" index cards which showed each word, a picture of that object, and a representation of the computer keyboard with the appropriate letters for that word highlighted in yellow. As each word was typed, the object appeared in talkworld. The experimenter helped the child key in the word if needed. This last phase was provided as a reinforcer for children's participation in the study.

Results

Free Recall Scores

Free recall scores were computed for each child by summiing all objects that were remembered representing each of the 2 x 2 factorial cells of action and verbal labels. Six was the maximum possible score for each of the four within-subject cells; scores ranged from 0-6. Summed across the four action and verbal label conditions, 24 was the maximum possible recall score; scores ranged from 8-24.

Children's recall scores were submitted to a 2 (action) x 2 (verbal label) x 2 (grade) x 2 (reading level) mixed analysis of variance. Grade and reading level were between-subjects factors; action and verbal labels were within-subjects factors.

The four factor ANOVA yielded a main effect for grade, $F(1,76) = 45.55$, $p < .0001$. Second graders recalled an average of 4.56 words while kindergartners recalled an average of 3.38 words. Summed across the four action and verbal label treatment conditions, second graders recalled a total of 18.24 words and kindergartners recalled a total of 13.52 words. Contrary to prediction, there was no main effect for reading level, nor did young children perform significantly better when action and verbal labels were present rather than absent.

As predicted, a planned comparison yielded an action by reading level by grade interaction, $F(1,118) = 6.28$, $p < .01$. As seen in Figure 1, second graders who were poor readers recalled

Insert Figure 1 about here

more words when objects were presented with, than without, action; by contrast, there was little difference in recall for second graders who were good readers when objects were presented with or without action. For the second graders, then, action presentation increased the poor readers' verbal recall to the level of their better reading peers. There were no significant differences within the kindergarten age group, but both poor and good readers recalled slightly more words that had been presented with, than without, action.

Discussion

The purpose of this study was to examine children's recall of information that had been presented with varying levels of visual action and verbal labels. The results suggest that features like action differentially support recall of information, depending on the characteristics that a child brings to the computer learning situation.

Not surprisingly, older children recalled more words that did younger children. Age effects in recall favoring older over younger children have long been documented in both the basic memory literature (Flavell et al., 1966) and in the television literature (Collins, 1970).

What is interesting in this study is that recall differences between second graders who were good and poor readers were

eliminated when the verbal, linguistic content was presented with action. Although poor readers are typically deficient in coding information linguistically (Katz et al., 1981), poor readers who saw moving objects recalled as many words as their better reading second-grade peers. Action may serve recall by providing a visual mode to represent verbal, linguistic content (Calvert et al., 1982); such aids may be less needed by older children who can read well. Computer presentations which use action seem promising as an educational approach.

While previous research has demonstrated positive effects of action for preschoolers' recall of computer content (Calvert et al., in press), action did not improve kindergartners' recall. Perhaps kindergartners are less dependent on action for information processing than are preschoolers. However, it seems more likely that developmental differences were not found because second graders continued to benefit from action. Future research should clarify the relation between various child characteristics and learning processes so that computer presentations can be tailored to suit individual needs.

The lack of findings for verbal labels may best be explained by a procedural flaw. Specifically, all words were labeled for children by the experimenter when she read the story to them. The verbal label condition, then, actually involved a repetition of certain labels by the voice synthesizer. Because previous research demonstrates beneficial effects of verbal rehearsal procedures for young children (Collins et al., 1981; Flavell,

1977; Friedrich & Stein, 1975; Watkins et al., 1980), we recommend additional research before drawing any conclusions about its potential effectiveness in computer presentations.

In conclusion, while previous research demonstrates that preschoolers' recall benefits from action in computer presentations, this study demonstrates that second graders who are poor readers also benefit from action. The results suggest that second graders who are developmentally behind their peers in reading can benefit if action emphasizes the verbal, linguistic content. New technologies like computers can enhance children's recall when there is a match between the way that a child thinks and the symbol system that he must decode.

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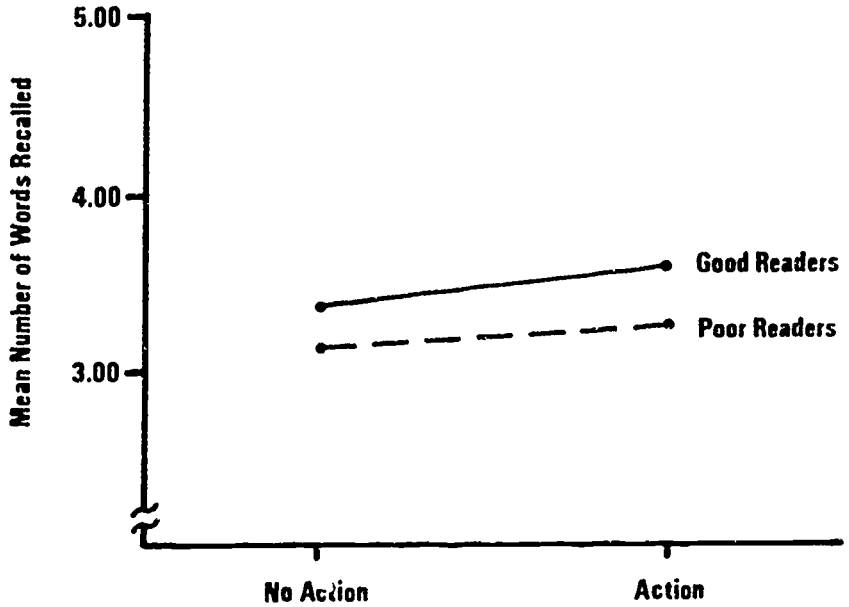
Table 1. Counterbalancing of object characteristics

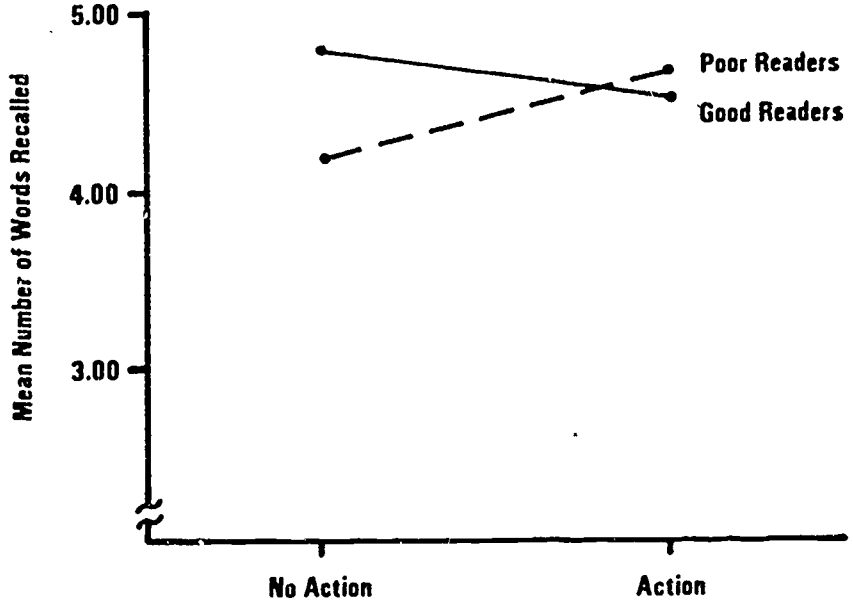
	NO ACTION NO LABEL	ACTION NO LABEL	NO ACTION LABEL	ACTION LABEL
	Dog	Horse	Bird	Cat
	Fish	Duck	Turtle	Frog
	Wagon	Boat	Kite	Ball
VERSION 1	Mom	Boy	Dad	Girl
	Cloud	Tree	Sun	Flower
	Train	Truck	Plane	Car
	Cat	Dog	Horse	Bird
	Frog	Fish	Duck	Turtle
	Ball	Wagon	Boat	Kite
VERSION 2	Girl	Mom	Boy	Dad
	Flower	Cloud	Tree	Sun
	Car	Train	Truck	Plane
	Bird	Cat	Dog	Horse
	Turtle	Frog	Fish	Duck
	Kite	Ball	Wagon	Boat
VERSION 3	Dad	Girl	Mom	Boy
	Sun	Flower	Cloud	Tree
	Plane	Car	Train	Truck
	Horse	Bird	Cat	Dog
	Duck	Turtle	Frog	Fish
	Boat	Kite	Ball	Wagon
VERSION 4	Boy	Dad	Girl	Mom
	Tree	Sun	Flower	Cloud
	Truck	Plane	Car	Train

Figure 1.

Mean number of words recalled as a function of grade, action, and reading level



KINDERGARTEN



SECOND GRADE