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The Effect of Interactive Media on Children's Story Memory

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The authors examined the influence of interactive media on children's story memory. First-grade children (6–7-year-olds) experienced a computer-based story in 1 of 4 presentation modes: One group heard only the narration, analogous to radio. A 2nd group saw an audiovisual presentation, analogous to television. A 3rd group viewed the story and interacted with animated areas of the screen. A 4th group was yoked to the interaction group such that they observed but did not control the interaction. The audio-only group consistently recalled and comprehended poorly, but there were no differences among the other media groups. In the interaction groups, there was also no relation between the amount of interaction with the story and subsequent memory. Overall, the results for interactive media were similar to the findings for the television-like presentation.

Children today have the opportunity to learn through a range of different media, including audiotapes and radio, television and videotapes, and computer-based activities. In particular, computer access and use by children is becoming increasingly important, both at home and in school settings (Calvert, 1999; Jennings, 2001). As computers become more integrated into the classroom, new questions arise about the potential impact of interactive media on children's ability to comprehend and remember information. Specifically, most computer programs allow children to control the activity and to interact with the content in a way that is quite different from other forms of presentation, such as radio and television. It is important to investigate whether interactivity might influence children's learning and memory.

The question of whether children's learning might be shaped by the type of media through which the information is presented is not new. For example, researchers compared the impact of radio and television presentations. One theory had it that the highly salient visual information available through a televised presentation would interfere with children's processing of the auditory information and thus reduce learning or at least shift children's attention away from the narration toward the visually depicted information. Support for this "visual superiority" hypothesis was found when children who viewed television recalled more actions than children who heard an audio-only presentation. The latter were more likely to remember dialogue and to make inferences about "outside the story" material (Beagles-Roos & Gat, 1983; Calvert, 1999; Greenfield, Farrar, & Beagles-Roos, 1986; Meringoff, 1980).

An alternative theoretical framework had it that the availability of both visual and auditory information in televised presentations should increase children's overall memory and comprehension, when compared with audio alone. Support for this possibility was found in several studies (Hayes, Kelly, & Mandel, 1986; Pezdek, Lehrer, & Simon, 1984; Walma van der Molen & van der Voort, 1997). For example, Gibbons, Anderson, Smith, Field, and Fischer (1986) matched audio and audiovisual television presentations for character utterances and actions (visually depicted or verbally narrated). Children who watched the television presentation recalled more utterances than children who heard the audio-only presentation. Thus, the addition of visual information to narration seems to facilitate children's overall recall.

Children's increased exposure to computers has raised a new question about the impact of media on learning. Specifically, computer-based programs offer children the opportunity to interact with the content and to direct their own exploration of the material, for example, by selecting what to look at and controlling how long the image remains on the screen. One possibility is that interactivity would enhance children's engagement and motivation and, in turn, their retention of the material (Cordova & Lepper, 1996). In fact, attention to the screen does predict learning (Anderson & Levin, 1976; Bryant, Zillmann, & Brown, 1983; Calvert & Gersh, 1987; Rice, Huston, & Wright, 1983; Watkins, Huston-Stein, & Wright, 1980). For example, Zillmann, Williams, Bryant, Boynton, and Wolf (1980) found that the addition of irrelevant humorous inserts to a children's educational program increased children's visual attention and their memory for the program.

An alternative possibility is that certain characteristics of interactive media might undermine children's learning rather than enhance it. An example is found in the case of computer-based interactive books, which are now widely available and often used in Head Start and other early literacy programs (Chomsky, 1990). Interactive books appear quite similar to a paper-based book: Each page of a story is reproduced with the text and illustration on the computer screen. The text is accompanied by an audio narration, as if the book is being read aloud to the child, and the child can watch

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the story like a television program. For example, in the interactive book version of *The Ugly Duckling* (1993), one screen is the text and an illustration of the mother duck sitting on her eggs. As the text is narrated, the illustration on the screen becomes animated: The eggs hatch, the ducklings emerge, and the mother looks surprised and distressed at the appearance of the ugly duckling.

The interactive book format offers many more potential detours and distractions away from the main story line than other forms of media. On each screen, the child can click on nearly any object to see an animation with accompanying sound effect (a "hotspot"), which is generally not part of the story. For example, on the *The Ugly Ducking* (1993) page in which the duckling is hatched, the child can click on a pond reed in the background and see a parade of costumed ants march across the foreground accompanied by music. It seems possible that interacting with these animated areas of the screen might disrupt children's attention and interfere with their ability to connect scenes, make inferences, and follow the story line, particularly as each page can contain dozens of hotspots (Wright, Shade, Thouvenelle, & Davidson, 1989).

Support for the possibility that interaction with hotspots might disrupt learning is found in research with adult learners. The addition of interesting but irrelevant information to a passage ("seductive details") can significantly impede learning (Hidi & Baird, 1986; Renninger, Hidi, & Krapp, 1992; Schraw, Lehman, & Hartley, 2001). When the learner's attention is distracted by seductive details embedded in the text, there are correspondingly fewer cognitive resources devoted to processing the central content. Seductive details may take several forms, including the addition of bits of irrelevant but interesting text, diagrams and illustrations, and video segments added to multimedia presentations (Harp & Mayer, 1997). Hotspots may be similar to seductive details in that they are designed to be interesting and to attract attention but do not have a logical or causal link to the story line.

There has been one previous investigation of the role of interaction with elements of a story on children's recall. Derley and Wright (1995) compared three electronic presentations of a story: interactive computer, passive computer (no input device), and a video presentation. First-grade children recalled the most story information in the passive computer condition, next in the interactive condition, and least in the video. Interactivity seemed to undermine children's story recall. However, the video was not animated and was a lower quality presentation than the computer version, making it difficult to compare performance directly across the different media.

The present study is designed as an initial investigation into the impact of interactive media on children's story memory. Following Derley and Wright (1995), one group of first-grade children viewed a story presented on the computer screen in the passive audiovisual mode, analogous to a television presentation. Children in a second group were presented with the same story in the interactive mode and were allowed to explore the hotspots. We predicted that children who interacted with the story would show lower comprehension and recall. Children in a third group heard only the story narration, analogous to a radio presentation. This condition was included as a replication of previous radio–television comparisons; the prediction was that children in the audiovisual viewing condition would perform better than those in the audio-only condition.

A fourth condition was included to examine the role of the child's control over the interaction with the story, for two reasons: First, it is possible that children only activate hotspots when they understand the story and have additional cognitive resources available to explore the screen. That is, interaction may reflect comprehension. If so, then watching hotspots activated by someone else should be more disruptive to memory than having control over the interaction. Second, as a practical matter, it seemed important to compare the experiences of the child controlling the computer with that of observers, because in the classroom, children frequently use the computer in pairs or small groups. Therefore, children in the fourth condition were yoked to children in the interactive condition such that they saw exactly the same material (e.g., hotspots activated by the other child) presented at the same time on a separate computer monitor, but did not have control over the interaction. We predicted that interactive observer children would perform less well than children who controlled the interaction.

After exposure to the story, children's memory was assessed with a battery of tasks, including free recall, memory for story facts, ability to make inferences, and a picture-sequencing task. Children's hotspot explorations in the interactive condition were recorded to learn if there was a relation between extent of interaction and memory for the participants in this condition. All children participated in an exit interview about their preferences for learning with different media.

Method

Participants

The study included 66 first-grade children: 35 boys and 31 girls (mean age = 81 months, SD = 5.51 months). Written parental permission was obtained for each child as well as verbal assent from the child at the start of the session. The children attended an elementary school located in an affluent, rural area near the University of Massachusetts at Amherst; almost all were White, and none received special-education services. The site was chosen specifically because of its excellent computer laboratory; all students used computers on a daily basis and were already familiar with the operating system and the hardware used in the study. In addition, 77% of the participants indicated that they had access to a computer in their homes and were familiar with various games and educational software packages. However, no child in the study had seen *The Ugly Duckling* (1993) interactive book before.

Experimental Design

Children were randomly assigned to one of four story presentation conditions: audio only (N = 17), audiovisual (N = 17), interactive participant (N = 16), and interactive observer (N = 16). Each child in the interactive observer condition was yoked to a peer in the interactive participant condition.

Materials and Equipment

The interactive story used in the study was *The Ugly Duckling* (1993). This story was selected because it was appropriate for the target age group, was a manageable length (16 pages) for use in one experimental session, included hotspots (500 total), did not include highly gender-stereotyped themes or characters, would run on the available computer equipment, included both the interactive and passive play modes needed for the experimental design, and conformed to a classic story grammar so that

patterns of memory could be compared with established findings in story-recall research. Episodes in the story were assigned to their corresponding story grammar categories. For example, in the opening episode, the mother duck appeared sitting on her nest in the marsh near the farmhouse (setting), the eggs hatched (initiating event), the mother counted the chicks (reponse), and the mother discovered that one was missing (outcome). An outline of the entire story with corresponding story grammar categories may be obtained from Carole R. Beal.

The interactive story was presented via a CD-ROM disk on a Performa 636 CD Macintosh computer with a separate 14-in. color monitor. In addition, a micropresenter (Focus Entertainments) was used to convert the computer's digital output to video signals displayed on a 14-in. Panasonic color television and recorded by a Panasonic videocassette recorder. All children wore headphones attached to the computer during the story presentation. Portable audiocassette recorders were used to record all of the interview sessions.

An interactive playground game, Dandy Dinosaurs (1993), was also used briefly in the interactive participant condition. For the picture-sequencing task, small color copies of 8 of the 16 scenes from *The Ugly Duckling* (1993) were prepared from screen shots.

Procedure

Children were invited to come with an experimenter to a large room at the school used for an after-school activity program. One side of the room contained a large, round conference table. The computer and monitor were set up on one end of the conference table, and the attached television and video recorder were set up on the other side. Two separate interview stations were set up behind room-divider screens at the far ends of the room.

At the beginning of the session, the experimenter and child sat at one of the interview stations. The experimenter asked the child his or her name, age, grade in school, and asked for verbal consent to participate in the project. Children's initial familiarity with the story *The Ugly Duckling* (1993) was assessed by asking them if they had ever heard the story before. If they said they knew the story, the experimenter asked the child to describe what happened in the story. Children who said they were not familiar with the story were asked to tell what they thought the story might be about. Children were then told to listen carefully to the story as they would be asked a few questions about the story when it was finished.

The procedure varied at this point for children in the four conditions. Children in the audio-only condition were seated in front of the computer or television monitor. They listened to the story narration played through their headphones; however, the monitor's screen resolution was turned down so that no images appeared on the display. Children in the audiovisual viewing condition also wore headphones and watched as *The Ugly Duckling* (1993) story was played in the passive mode on the computer or television screen. These conditions lasted about 15 min.

Children in the interactive participant condition were seated in front of the computer and asked to play the Dandy Dinosaur (1993) game for 3 min, which involved pointing and clicking on objects on the screen as directed by the experimenter, to ensure that children were comfortable using the mouse. Then, the children viewed *The Ugly Ducking* (1993) in the interactive mode on the computer and were told that they could click the screen arrow to move to the next page and on objects on each page to see additional special effects. Children's progression through the story and their interactions with the 500 hotspots were automatically recorded on videotape and subsequently coded by the experimenter and a research assistant. Percentage of agreement regarding the number and order of hotspots activated by each child was 99%. The 16 children in this condition received interaction scores representing the average number of hotspots activated on each page.

Meanwhile, the yoked interactive observer child was taken by a second experimenter to the television monitor at the other end of the table, also attached to the computer. The observer child then saw the interaction of the participant child with the story on the television monitor, but was not able to control the interaction. To reduce distraction, both children wore headphones, the monitors were arranged so that children did not have a clear view of one another, and an experimenter sat near each child. These interactive sessions lasted about 25 min on average, and up to 40 min in a few cases, because of the additional time required for children in the interactive condition to explore the story hotspots.

After the story presentation, each child was escorted to an interview station by one of the experimenters. Children first completed a 5-min verbal task in which they were asked to generate names of items from various categories (e.g., fruit; Horowitz & Mendelsohn, 1994). The primary purpose of this task was to ensure that children were not rehearsing story elements. This task has also been used in child eyewitness-memory research as an indirect measure of children's willingness to talk in an interview, which can predict the amount of information reported in free recall (Ricci, Beal, & Dekle, 1996).

After the verbal task, children were asked a free recall question about the story ("Can you tell me what happened in the story that you just heard?"). Children's free recall was measured by counting the number of different correct components mentioned in response to this question. In addition, the components recalled by each child were classified according to classic story grammar categories (setting, initiating event, response, and conclusion–resolution).

Children then responded to 20 specific questions about the story. These included 13 fact questions assessing children's memory for information explicitly presented in the story. Of these, 7 questions addressed information presented in the narration, whereas the remaining 6 questions focused on visual information. Children were also asked 7 inference questions about aspects of the story that were not explicitly stated (character affect, attributes of story events) but had to be inferred in order to understand the story. The specific questions are included in the Appendix.

Because some answers to the specific questions could be considered more accurate than others (e.g., a child might say somewhat vaguely that the kitchen girl made the duckling leave, whereas another might specifically say that she kicked him right out the door and that his wings flapped wildly as he soared through the doorway and landed in a puff of dust), a scoring system was devised in which each of the 20 questions was worth a possible 3 points. Thus, each child received a total memory score ranging from 0–60. Two research assistants independently evaluated and scored all of the memory questions for every participant. Reliability between scorers was calculated as the percentage of agreement in the scoring of each question for each child. Scores obtained reliability ratings of 87%. All disagreements were discussed, and a final decision was made by Christine M. Ricci.

Two additional tasks focused on children's comprehension of the story. In one task, children were asked what they thought the main point was of the story. Correct responses were defined as reporting the theme emphasized in the conclusion: "Things change as they grow." In the second comprehension task, children were asked to put eight small color copies of the story pages into the correct order. Each child received a score ranging from 0–8, reflecting the number of pictures placed in the correct order.

After the memory and comprehension portion of the interview, children's views on different media were assessed by asking them to rate on a 5-point Likert scale how much they liked the story, how much they liked different media, and how much they felt they learned from different media. The session concluded by asking the child to name a favorite book, computer program, television show, and radio program or audiotape. The purpose of these questions was primarily to ensure that each child left the interview feeling positive about his or her performance.

Results

At the start of the session, children were asked what happened in the story of the ugly duckling. Children reported very few

Table 1
Mean Number of Story Components Reported Before and After Story Presentation

Condition	*N*	Prestory test	Poststory test
Audio only	17	0.59 (0.94)	2.29 (2.28)
Audiovisual	17	1.00 (1.06)	3.82 (2.60)
Interactive participant	16	0.88 (1.02)	2.87 (2.13)
Interactive observer	16	1.00 (1.26)	3.62 (3.16)

Note. Standard deviations are in parentheses. Maximum number of story components is 55.

correct components ($M = 0.10$, $SD = 0.31$), and this did not vary with gender or media condition.

Mean free-recall scores may be seen in the right column of Table 1. An analysis of covariance was conducted to examine the effects of gender (boy–girl) and media condition (audio only, audiovisual, interactive participant, interactive observer) on free-recall scores, with the number of correct story components reported before the story presentation as the covariate. There was no effect of gender and no effect of media condition on free recall. There was a significant correlation between the number of items children mentioned in free recall and the number of items mentioned in the verbal naming game, $r(62) = 0.32$, $p < .01$.

Although media condition did not affect overall free-recall scores, it was possible that children in different conditions might have remembered different aspects of the story. Items mentioned in free recall were categorized as referring to setting, initiating event, response, or outcome and were analyzed in a gender (boy, girl), media condition (audio only, audiovisual, interactive participant, interactive observer), and story component (setting, initiating event, response, outcome) analysis of variance (ANOVA), with story component as a within-subjects factor. There was a main effect of story category, $F(3, 174) = 18.57$, $p < .01$. With Tukey's honestly significant difference post hoc comparisons (.05 significance level; also used in all subsequent post hoc comparisons), children recalled fewer setting elements ($M = 0.24$, $SD = 0.53$) than initiating events ($M = 0.09$, $SD = 1.08$), responses ($M = 0.64$, $SD = 0.69$), or outcomes ($M = 1.05$, $SD = 0.90$).

Children's total correct-response scores in response to the 20 specific questions were initially analyzed in a two-way ANOVA to examine the effects of gender (boy, girl) and interviewer (Experimenter 1, Experimenter 2). There was no effect of gender, $F(1, 62) = 0.18$, $p = .67$, and no overall difference in performance across interviewers, $F(1, 62) = 0.55$, $p = .46$. However, there was an Interviewer × Gender interaction, $F(1, 62) = 10.60$, $p < .01$. Performance of girls interviewed by Experimenter 1 ($M = 38.97$, $SD = 7.99$) was better than that of girls interviewed by Experimenter 2 ($M = 30.04$, $SD = 9.06$), but there was no difference for boys. This interaction did not appear interpretable; there were no analogous experimenter effects on the other tasks, experimenters were counterbalanced across conditions, and interviewer did not interact with media condition. Therefore, because of the limited sample size, the data were collapsed across interviewer in subsequent analyses. However, because in previous research there have been gender differences in computer interest and use by young children, the gender variable was retained in most of the analyses.

Children's scores in response to the specific memory questions (scores ranged from 0–60) were analyzed in a two-way ANOVA examining media condition (audio only, audiovisual, interactive participant, interactive observer) and gender (boy, girl). There was a main effect of media condition, $F(3, 58) = 10.91$, $p < .01$. Children in the audio-only condition ($M = 25.76$, $SD = 8.24$) performed significantly worse than children in the audiovisual ($M = 38.35$, $SD = 8.18$), interactive participant ($M = 37.09$, $SD = 7.34$), and interactive observer ($M = 39.72$, $SD = 7.34$) conditions.

Children in the audio-only condition might have been at a disadvantage on some questions that addressed information available in the story illustrations. Therefore, a second media condition by gender ANOVA was conducted on children's summed correct responses to the questions that could be answered from the narration (see Appendix B for breakdown of question types). Again, there was a main effect of media condition, $F(3, 58) = 10.31$, $p < .01$. Children in the audio-only condition performed worse on the narration questions ($M = 20.06$, $SD = 7.32$) than children in the audiovisual ($M = 29.82$, $SD = 6.04$), interactive participant ($M = 28.09$, $SD = 5.91$), and interactive observer ($M = 30.72$, $SD = 4.85$) media conditions.

The specific questions included both factual and inference items. In Table 2, the mean number of correct responses to narrated fact (7) and inference (7) questions are shown separately for each media condition. Scores ranged from 0–21 for each question type (narrated fact and inference). These scores were analyzed in a gender (boy, girl), media condition (audio only, audiovisual, interactive participant, interactive observer), and question type (narrated fact, inference) ANOVA, with the latter as a within-subjects factor. There was a main effect of media condition, $F(3, 58) = 8.23$, $p < .01$; children in the audio-only group performed significantly worse than children in the other conditions. In addition, there was a main effect of question type, $F(1, 58) = 7.60$, $p < .05$. Children performed better on the inference questions ($M = 13.64$, $SD = 4.36$) than narrated fact questions ($M = 11.76$, $SD = 3.80$).

When asked about the main point of the story, only 6 children (2 audio-only, 1 interactive participant, 3 interactive observers) reported the theme mentioned in the story ending (things change as they grow). There were many other answers, including 14 "I don't know" responses, 13 of the "be nice to people who are different" theme, and a host of other creative replies including "purple ducks are swans, chickens and ducks, colors, to read, never believe you are going to be ugly, and people shouldn't be ugly."

Table 2
Mean Number of Correct Responses to Narrated Fact and Inference Questions

Condition	Narrated fact questions	Inference questions
Audio only	9.03 (2.86)	10.70 (4.86)
Audiovisual	13.06 (4.28)	14.65 (3.66)
Interactive participant	12.25 (3.20)	13.78 (4.14)
Interactive observer	12.78 (3.54)	15.56 (3.33)

Note. Standard deviations are in parentheses. Maximum score is 21 for each question type (fact and inference).

Children's scores on the picture-sequencing task were analyzed by a gender (boy, girl) and media condition (audio only, audiovisual, interactive participant, interactive observer) ANOVA. There was a main effect of condition, $F(3, 60) = 12.44$, $p < .01$. Children in the audio-only condition scored lower ($M = 4.59$, $SD = 1.97$) than children in the audiovisual ($M = 7.24$, $SD = 0.83$), interactive participant ($M = 6.59$, $SD = 1.77$), and interactive observer ($M = 7.29$, $SD = 0.92$) conditions.

Additional analyses were conducted to examine the effects of interaction on memory for both the interactive participants ($N = 16$) and the yoked interactive observer children ($N = 16$). There was considerable individual variation, ranging from 1 child who only clicked on 18 hotspots in the entire story to another child who clicked on 331. Only 53% of children's first clicks on a page were on a central character or object. Interaction scores (average number of clicks per page) were not significantly related to interactive participant children's correct responses to the specific memory questions, $r(16) = 0.10$, *n.s.*, or to the interactive observer children's memory, $r(16) = 0.49$, *n.s.*.

Children's ratings of their enjoyment of the story were generally high ($M = 4.42$, $SD = 0.80$, on a 5-point scale), and these ratings did not vary with gender or media condition. Children's ratings of how much they enjoyed different media were analyzed in a media condition (audio only, audiovisual, interactive participant, interactive observer), gender (boy, girl), and media type (computer, television, radio, tapes) ANOVA, with media type as a within-subjects factor. There was a main effect of media type, $F(3, 174) = 12.05$, $p < .01$. Children liked radio ($M = 3.44$, $SD = 1.49$) less than the computer ($M = 4.65$, $SD = 0.69$), and the computer more than television ($M = 4.00$, $SD = 1.32$) or tapes ($M = 4.12$, $SD = 1.14$). Children also rated the computer as the most effective learning tool ($M = 4.46$, $SD = 0.85$), followed by tapes ($M = 3.42$, $SD = 1.43$), radio ($M = 3.06$, $SD = 1.42$), and television ($M = 2.56$, $SD = 1.59$). When asked how they learned best, 52% chose books, 39% chose the computer, 8% chose television, and 1% chose radio and audiotapes.

General Discussion

In this study, we examined the influence of interactive media on children's story memory, compared with traditional media presentations (audio only and audiovisual). We replicated that children in an audio-only condition remembered a story poorly, including memory for story facts, ability to make inferences, and ability to sequence pictures from the story. The audio-only children performed worse than children in the other conditions, even when only questions about narrated information were considered. Thus, contrary to the visual-superiority hypothesis, processing visual information did not interfere with children's attention to the narration or their overall understanding of the story.

Although the addition of visual information to the story narration clearly aided children's memory in this study, interaction with the story did not impede memory. Contrary to expectations, interaction with hotspots in the story did not affect children's memory for story facts, their ability to make inferences, or their performance on the picture-sequencing task. Children's free recall of the story clearly conformed to patterns observed in much prior research on story memory, with lower recall of setting information than other components, but the patterns were similar across media conditions. Interactive participant children explored dozens or in some cases hundreds of hotspots that were completely irrelevant to the story line. Yet they and their partners in the interactive observer condition performed as well as children in the audiovisual condition on the battery of memory tasks. In the two interaction conditions (participant and observer), there was also no relation between the extent of hotspot exploration and individual children's memory performance.

Also contrary to predictions, interactive observer children who did not have control over the interaction performed as well as those who selected what to activate and when to move on in the story. At least half the time a new page appeared on the screen for an observer child, the first object clicked on by the interactive participant child was not relevant to the story line. Yet this apparently did not interfere with the yoked observer child's ability to follow and remember the story. Because choice can enhance children's motivation (Cordova & Lepper, 1996), it is important to investigate this factor more extensively in future work. It may be that children were already so engaged with the story that any effects of choice and control were masked in the present study. In fact, the observer children were clearly interested in and attentive to the interactive choices of the other child; many were observed to follow the cursor with a finger as it moved around the screen.

There also was no indication that interaction with the story was beneficial to memory. Because additional time was required for interactive participant and observer children to explore the story, these sessions were necessarily longer than those in the audio-only and audiovisual conditions. However, more time with the material did not lead to better memory for these children.

The conclusion that interactive media did not influence children's memory is necessarily preliminary because only one well-structured story was used in this initial study. The results may have been different with a more difficult story or with other types of material such as expository text. On the other hand, there is some reason to believe that the failure to find an effect of interaction with the story may be meaningful. First, it does not appear that the task was simply too easy for children. Children could not report much about the story at the start of the interview. Thus, they were not reasoning on the basis of prior knowledge. Their performance on the battery of memory tasks was not close to ceiling. Second, in contrast to previous studies, the materials and procedures were identical across media conditions. All children were seated at a monitor display station and heard the story through headphones, and exactly the same story was used in all four conditions; the only difference was the presentation option selected (soundtrack, passive, or interactive mode). Third, confidence in the negative findings regarding interaction is strengthened by the replication of other well-established findings, including the relatively poor performance of the audio-only group, the relation of performance on the verbal naming game to free recall, and lower recall of setting information than other story components. Fourth, these results are generally consistent with earlier conclusions regarding distance education and other instructional technologies that have previously been introduced for older students. In general, educational content is a greater influence on learning than the medium of presentation (Clark, 1983).

During the exit interview, children generally felt that the computer was an effective and enjoyable learning medium, even though participants in the interaction conditions did not actually

perform any better in the study. It was also apparent that children in the study had a high level of exposure to computer-based media. The majority of the children used computers at home as well as at school and had favorite software programs. In fact, computer use appeared to be at least as pervasive as television viewing for this relatively advantaged sample, a finding that has been reported in recent surveys of media use and access (Annenberg Public Policy Center, 1999; Jennings, 2001; Wright et al., in press).

A tentative conclusion from this initial study is that interactive stories appear to function similarly to television viewing in terms of children's memory. Interestingly, the interactivity of television programming for children is increasing steadily; for example, characters in the popular children's television programs *Blue's Clues* and *Dora the Explorer* invite the child to respond to questions and to help the characters choose between activities. The rapidly approaching convergence of digital television and computer media will allow children to direct their own exploration of the content both at home and at school (Calvert, 1999). It will be important for educators and researchers to play a role in the design of interactive media in the future to ensure that interaction facilitates children's learning.

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(*Appendix follows*)

Appendix

Story Memory Interview

Free-Recall Question

1. Can you tell me what happened in the story you just heard? Anything else?

Narration-Based Fact Questions

2. Where did the story take place?
3. What was the mother duck doing at the beginning of the story?
4. What did the mother duck think was missing?
5. How was the ugly duckling different from the other ducklings?
6. What did the kitchen girl do to the ugly duckling?
7. Who did the ugly duckling meet in the cottage?
8. What could the cat do?

Visually Dependent Fact Questions (Inference for Audio)

9. What color was the ugly duckling?
10. Who did the ducklings meet when mother duck brought them to the barnyard?
11. The ugly duckling wanted to be like the "beautiful birds" that he saw; what kind of birds were they?
12. Why did the ugly duckling leave the farmer's house?
13. What do the kids at the park say and do to the ugly duckling?
14. Who did the ugly duckling meet at the end of the story?

Inference Questions

15. Was the egg that the mother duck found really one of her eggs?
16. How did the mother duck feel when she saw the ugly duckling?
17. Why was the ugly duckling able to paddle more beautifully than the other ducklings?
18. Why wasn't anyone nice to the ugly duckling?
19. The ugly duckling met geese who invited him to a nicer swamp; why didn't he go with them?
20. What kind of bird was the ugly duckling?
21. At the end of the story why didn't any of the other ducklings or kids recognize the ugly duckling?

Main-Point Question

22. What do you think the story was trying to teach you?

Picture-Sequencing Task

Given eight pictures from the story in a random order, the child is asked to put them in the correct order.

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