The Impact of Television, Print, and Audio on Children’s Recall of the News
A Study of Three Alternative Explanations for the Dual-Coding Hypothesis

JULIETTE H. WALMA VAN DER MOLEN
University of Amsterdam
TOM H. A. VAN DER VOORT
Leiden University, the Netherlands

Recent research has shown that children remember more from television news than from print news, a finding that has been explained by the extra mnemonic support offered by redundant television pictures (the dual-coding hypothesis). The present study was designed to examine three alternative explanations, which attribute children’s superior recall of television news to (a) underutilization of the print medium, (b) a recall advantage of listening compared with reading, and (c) imperfect reading ability. A sample of 192 fourth and sixth graders was presented with children’s news stories, either in (a) their original television form, (b) a bare print version, (c) a print version supplemented with photo material, or in (d) an audio version. Results indicated that the television presentation was remembered better than any of the other three versions. The results of the study were consistent with the dual-coding hypothesis, whereas no support was found for the alternative explanations tested in the study.

Children rely on television as their main source of news information. Most children in the highest grades of elementary school frequently watch news programs on television (Children Now, 1994) but rarely read newspapers or listen to radio news, and they seldom discuss the news with others (Comstock & Paik, 1991). Because children scarcely use alternative news sources, the emergence of television has increased their access to the news. In the United
States, children now have access to television news around-the-clock, which may only enhance their reliance on it.

Until recently, little research had been conducted into children’s recall of the news presented via different media. Recently, however, three media comparison studies have been conducted that suggest that it is advantageous to children that they depend predominantly on television as their source of news about the world because television emerged as the medium that may serve them most effectively. Both a quasi-experimental study (Beentjes, Vooijs, & van der Voort, 1993) and two experimental media comparison studies (Walma van der Molen & van der Voort, 1997, 1998) indicated that children remember more from children’s news stories watched on television than from reading print versions of the same news stories consisting of literal transcripts of the television commentary.

According to Walma van der Molen and van der Voort (1997, 1998), the superiority of television news observed in their experimental media comparison studies was the result of the close correspondence between the verbal and visual content of the television stories employed. On the basis of Paivio’s (1969, 1971) dual-coding hypothesis, they argued that television can facilitate information transfer by adding relevant visual information to the verbal message. The dual-coding hypothesis posits that audiovisual information is stored in memory in two separate but associated codes—one verbal and one visual—whereas text-only information is stored in one verbal code only. During recall, the visual memory code serves as an extra retrieval cue, which could account for the superior recall of television stories compared to stories without pictures. However, dual coding may enhance recall only when the verbal information is supplemented with redundant pictures—that is, pictures that convey the same basic propositional meaning as that conveyed by the text (e.g., Drew & Grimes, 1987; Graber, 1990; Levin & Mayer, 1993; Nugent, 1982; Reese, 1984). When verbal and visual information do not correspond, limited-attentional-capacity theories suggest that the viewer’s attentional capacity is exceeded, with the result that the viewer is distracted from the verbal message (e.g., Drew & Grimes, 1987; Grimes, 1990, 1991).

The two experimental media comparison studies conducted by Walma van der Molen and van der Voort (1997, 1998) indeed provided evidence to suggest that the dual-coding hypothesis offered the most plausible explanation for the observed superiority of television news. The recall advantage of television compared with print news was found to apply mainly to verbal information elements that were effectively visualized on television, whereas no recall difference (Walma van der Molen & van der Voort, 1997), or a considerably smaller recall advantage of television (Walma van der Molen & van der Voort, 1998), was
found for information elements that were presented only verbally, without the use of redundant pictures.

The experimental comparison study to be presented here again examined the validity of the dual-coding hypothesis. However, the main purpose of our study was to examine the validity of three alternative explanations for the observed superiority of television news.

The first rival explanation attributes the recall advantage of television found in previous television-print comparison experiments to underutilization of the print medium. The comparison experiments may have underutilized the potential advantages of print in two respects. First, the print stories used consisted of literal transcripts of the television narratives and therefore were not originally written as newspaper stories. Second, bare-text stories were used that were not accompanied by a newspaper photo. To examine the first possible source of underutilization of the print medium, Walma van der Molen and van der Voort (1998) included in their experiment not only literal transcripts of the television narratives but also two extra print conditions that presented children with “real” newspaper coverage of the same topics written by two journalists from a children’s newspaper. However, there were no indications that the inferior recall of printed news was due to the use of literal transcripts, because no recall differences were found between the various print conditions. The second possible source of underutilization has not yet been examined. Therefore, one of the goals of the present study was to examine whether recall of the printed news would be enhanced by the addition of a newspaper photo. To that end, the study included not only a print condition in which children read bare text versions of the news stories but also a print condition in which the same printed news was supplemented with a photo.

The television news stories used in the comparison experiments differed from the print stories not only because the television stories contained pictures but also because the text was read aloud to children rather than read by the children themselves. A second rival explanation for the observed recall advantage of television therefore is that children tend to process textual information better when they listen to it than when they have to read it themselves. To examine the validity of this explanation, in the present study, the television and print conditions were supplemented with an audio condition in which the news was read aloud to children.

The third rival explanation attributes the observed superior recall of television news to children’s imperfect reading ability. Children may learn less from printed news stories than from television stories because they have not yet developed sufficient reading proficiency and therefore are insufficiently able to extract information from print. This alternative explanation was tested by Walma van der Molen and van
der Voort (1997, 1998) by investigating whether the recall difference between television and print was smaller among more proficient readers than among less proficient readers. However, no significant interaction was found between level of reading proficiency and medium in either of the studies. Although the two studies did not provide evidence that the recall advantage of television was due to children’s imperfect reading proficiency, for the sake of completeness, this explanation was again checked in the present study.

In sum, in the present study, an experimental comparison was made between four conditions: (a) television news stories, (b) print stories (literal transcripts), (c) print stories accompanied by a photo, and (d) audio stories (soundtrack of the television stories). The study encompassed a partial replication of the two previous studies conducted by Walma van der Molen and van der Voort (1997, 1998). To enhance comparability with the two previous studies, the same stimulus materials and age range were used.

**HYPOTHESES**

**Dual-Coding Hypothesis**

The dual-coding hypothesis gives reason to assume that children will remember more from television than from print news because television can facilitate information transfer by adding relevant visual information to the verbal message. This assumption was confirmed by the above-mentioned media comparison studies conducted with children that employed news as stimulus material (Beentjes et al., 1993; Walma van der Molen & van der Voort, 1997, 1998). A recall advantage of television was also found in media comparison studies conducted with children that employed fictional stories as stimulus material (Beentjes & van der Voort, 1991a, 1991b, 1993). In the present study, we therefore expected to find the following:

H1: Children remember more from television news stories than from the same stories presented in print.

However, confirmation of H1 provides insufficient evidence that dual coding is indeed responsible for the observed recall advantage of television. There is more reason to assume that dual coding explains why television is remembered best if the recall advantage of television applies mainly or exclusively to verbal information that was effectively visualized on television. As discussed previously, this was exactly what was found by Walma van der Molen and van der Voort (1997, 1998). On
the basis of the dual-coding explanation, in the present study, we therefore again expected to find the following:

H2: The recall advantage of television compared with print is most pronounced for verbal information supplemented with redundant pictures.

The dual-coding hypothesis induced us to suspect not only that television news stories will be remembered better than print stories but also that television news stories will be remembered better than audio (radio) stories. In fact, a comparison of television and audio news provides a purer test of the effect of adding pictures to the verbal message than the previous television-print news comparisons did, because television and audio differ only in the addition or omission of television pictures. To our knowledge, children’s recall of television and audio news has only been examined in Barrow and Westley’s (1959) study, which found that television was remembered best. This finding is, however, difficult to interpret because the authors did not use the sound track of the television stories as the audio condition but a separately produced radio broadcast. More clear indications that children tend to remember more from television than from audio follow from television-audio comparisons involving fictional stories. These experiments showed that, relative to children who listened to the audio story, children who watched the television story recalled more central information (Greenfield & Beagles-Roos, 1988), more detailed story information (Beagles-Roos & Gat, 1983; Greenfield & Beagles-Roos, 1988), and more actions (Gibbons, Anderson, Smith, Field, & Fischer, 1986; Hayes, Kelly, & Mandel, 1986; Meringoff, 1980). In the present study, we therefore expected to find the following:

H3: Children remember more from television news stories than from an audio version of the same news.

Finally, on the basis of the dual-coding hypothesis, we expected to find the following:

H4: The recall advantage of television compared with an audio version is most pronounced for verbal information supplemented with redundant pictures.

Underutilization of Print

Educational research has shown that the addition of a picture that is related to a printed text can enhance children’s learning (e.g., Levin & Berry, 1980; Levin & Mayer, 1993), a finding that may be explained in
terms of the dual-coding hypothesis. It should be noted, however, that
the pictures used in these studies were line drawings depicting various
essential information elements of each text. The photos used in newspa-
papers, however, are generally meant to attract the reader’s attention
rather than to convey the story’s main ideas. To enhance ecological va-

dility, the present study also used photos instead of line drawings to
supplement the print stories. It may well be that the print versions with
photos are recalled better than the bare print versions. However, be-
cause a photo can only offer a limited amount of visual information, we
considered it unlikely that the recall advantage of television would dis-
appear completely in a comparison of television news stories with print
stories that are accompanied by a photo. We therefore expected to find
the following:

H5: Children remember more from television news stories than from a print
version of the same news supplemented with a photo.
H6: Children remember printed texts supplemented with a photo better
than bare text versions.

Listening Versus Reading

The alternative explanation for the superior recall of television which
argues that listening might be easier for children than reading suggests
that children remember audio news better than print news. In the pres-
ent study, however, we did not expect to find a difference in recall be-
tween children who listened to the news stories and children who read
the stories. Several studies suggest that children rely on the same skills
when processing orally presented and printed information (e.g., Per-
fetti, 1987; Pezdek, Lehrer, & Simon, 1984; Sinatra, 1990; Smiley, Oakley,
Worthen, Campione, & Brown, 1977), because children’s listening and
reading skills were found to be fairly highly correlated. In general,
good readers were found to be good listeners as well, whereas poor
readers were found to be poor listeners too. Although listeners have an
advantage in that each word is already decoded, whereas readers have
to decode each word themselves, decoding only poses an obstacle to
the processing of information for the young child who is starting to
read (Perfetti, 1987). From about the age of 10 (Grade 4), children have
achieved an automated level of decoding (Chall, 1983) and may be ex-
pected to rely on the same skills to process and recall audio and printed
information. Studies investigating the recall of orally presented versus
printed information indeed showed that children between 9 and 12
years of age remembered as much from the audio information as from
the printed information (e.g., Levin & Divine-Hawkins, 1974; Nugent,
1982; Rohwer & Harris, 1975; Smiley et al., 1977). Because the age of the
children who participated in the present study also varied between 9 and 12 years, we expected to find the following:

H7: Children remember printed news stories equally well as an audio version of the same news.

Reading Ability

In theory, it seems very plausible that the recall advantage of television compared with print is largest among the poorer readers, because they have more difficulty extracting information from print. Nevertheless, Walma van der Molen and van der Voort (1997, 1998) found that the recall advantage of television was about equally large for both less and more proficient readers, a finding that was attributed to the fact that the news stories employed were easy to understand for children. It could be that children’s reading proficiency does affect the relative effectiveness of television and print news when the verbal information is less easy to understand. However, because the present study used the same news stories as in Walma van der Molen and van der Voort’s previous studies, we again expected to find the following:

H8: The recall advantage of television compared with print is about equally large for more and less proficient readers.

METHOD

Participants

The study was conducted with a sample of 101 girls and 91 boys from Grades 4 ($n = 96$, $M$ age = 10 years 2 months) and 6 ($n = 96$, $M$ age = 12 years 2 months) from six primary schools in the urban district of Leiden, the Netherlands. Fourth and sixth graders were included in the present study (as well as in the studies replicated) for two reasons: (a) The children’s television news stories we used were meant for children in Grades 4-6, and (b) the use of the younger (Grade 4) and somewhat older (Grade 6) children enabled us to examine whether developmental differences in reading ability interact with the relative effectiveness of the media involved.

The participants came from both lower- and middle-class families and did not have any learning, visual, speech, or hearing disorders. The six primary schools that participated in the experiment were comparable in socioeconomic makeup with the various schools that participated in Walma van der Molen and van der Voort’s (1997, 1998) earlier
studies. Participation in the study was part of the children’s normal school routine. As in the studies being replicated, children were excluded from the sample if their score on a standardized test of reading comprehension (National Institute for Education and Measurement, 1981, 1991) was more than two standard deviations below the group mean found within each grade. Using this criterion, less than 3% of the children were excluded from the sample. The assumption was that inclusion of this subgroup of very poor readers would obstruct procedures in the print conditions and could lead to a disproportionate reduction of performance in the print conditions.

Design

Children were randomly assigned to one of four experimental medium conditions: (a) a television condition in which children watched children’s television news stories; (b) a “print” condition in which children read literal transcripts of the television narratives; (c) a “print-with-photo” condition in which children read literal transcripts of the television narratives, each illustrated with a photo; and (d) an audio condition in which children listened to an audiotape of the television narratives.

A 2 (Grade 4 vs. Grade 6) × 2 (less vs. more proficient readers) × 4 (television vs. print vs. print with photo vs. audio) design was used. To reduce error variance, a randomized block factorial design (Kirk, 1968) was used. Reading proficiency was used as a matching variable to form blocks. Within each grade, children were matched into blocks of four children with identical or almost equal scores on the reading comprehension test. Subsequently, within each block children were randomly assigned to one of the four experimental medium conditions. Because the children were placed in blocks of four participants with a comparable level of reading proficiency, the factor medium was used in the analyses as a within-subjects, or rather, “within-blocks” factor; the two other factors were between-subjects factors. A distinction between less proficient and more proficient readers was made within each grade, using the median of scores on the reading comprehension test as the cutoff score. Hence, half of the children in the experiment belonged to the category of less proficient readers; the other children were regarded as more proficient readers. To control for possible experimenter effects, the participation of two experimenters was systematically varied across the four experimental medium conditions.

Stimulus Materials

In each of the four experimental conditions children were presented with five news stories. The news stories were identical to those used by
Walma van der Molen and van der Voort (1997, 1998). The five news stories had been taken from the Jeugdjournaal (Children's News), a daily news program in the Netherlands designed specifically to make the news comprehensible to children of about 10 to 12 years of age. The news stories had been broadcast at least 1 1/2 years prior to the experiment and involved isolated news events that had not attracted repeated media attention. Therefore, the chance that children would have advance knowledge of the news stories was minimal. In selecting the five television news stories, care was taken that the spoken commentary in the news stories was perfectly comprehensible without the accompanying pictures. Hence, the television narrative could be used in the print and audio conditions.

The five news stories were representative of the issues typically covered by the Dutch Children's News program, including topics of special interest to children as well as “adult” topics. The stories selected covered the following events: “Bear set free in sanctuary after years of captivity,” “Bullied Japanese pupils play hooky,” “Queen Beatrix opens new railway tunnel,” “Rhinoceros wrongfully sold to circus,” and “New U.S. law restricts purchase of firearms.” Each television news story began with a short summary delivered by an anchorperson and continued with film footage accompanied by spoken commentary. Table 1 presents some significant features of the five news stories used.

Although the Children's News makes an effort to use pictures that are redundant with the spoken commentary, only part of the verbally conveyed information in the television items was supplemented with

<table>
<thead>
<tr>
<th>Feature</th>
<th>Bear Set Free</th>
<th>Japanese Pupils</th>
<th>Railway Tunnel</th>
<th>Rhinoceros</th>
<th>Law on Firearms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of wordsa</td>
<td>538</td>
<td>250</td>
<td>307</td>
<td>373</td>
<td>540</td>
</tr>
<tr>
<td>Number of sentencesa</td>
<td>34</td>
<td>19</td>
<td>20</td>
<td>25</td>
<td>43</td>
</tr>
<tr>
<td>Number of seconds</td>
<td>169</td>
<td>78</td>
<td>107</td>
<td>134</td>
<td>190</td>
</tr>
<tr>
<td>Talking heads (in seconds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newsreader</td>
<td>10</td>
<td>25</td>
<td>21</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Interviewee(s)</td>
<td>63</td>
<td>—</td>
<td>13</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Reporter</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Film footage (in seconds)</td>
<td>96</td>
<td>53</td>
<td>73</td>
<td>66</td>
<td>141</td>
</tr>
<tr>
<td>Number of speakers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Male</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

a. This feature also applies to the print version of the news stories.
redundant pictures because it is difficult to illustrate abstract information with pictures. The verbal information elements that were most frequently visualized with redundant film footage involved people (e.g., Queen Beatrix; U.S. cowboys carrying firearms), animals (e.g., a bear and a rhinoceros), and objects (e.g., a train and a railway tunnel). Other verbal information elements that were frequently pictured involved the actions of both people (e.g., Queen Beatrix opening the new railway tunnel) and animals (e.g., a bear doing tricks while in captivity) as well as objects in motion (e.g., a train running through the new tunnel). Finally, the television stories frequently provided redundant verbal and visual information about places. In some cases the places mentioned in the spoken commentary were pictured with real-life film footage (e.g., a circus and a school), whereas in other cases schematic visualizations were used (e.g., a city plan or a map of Europe showing the country where the bear was set free).

For the television condition, the five news items were combined into the format of a regular children’s newscast, including the Children's News leader and credit titles. The total duration of the newscast was 11 minutes, about the same as that of a regular Children’s News broadcast.

In the print condition, the literal transcripts of the five news stories were presented in a newspaper format. The television titles that served to announce each television news story were used as headlines for the printed stories. The introductory commentary, delivered by an anchor-person in the early part of each of the television stories, was transformed into a bold printed lead in the print versions. The remaining text of the television stories was printed in two columns. Thus, an attempt was made to approximate the natural format of newspapers as closely as possible, while keeping the information conveyed by the printed transcripts identical to the verbal information conveyed by the television stories. In one television news story a short interview with a Spanish-speaking man was included, whereas another story included a short passage of someone speaking English. In the television version these parts were subtitled. In the printed transcripts these subtitles were adopted literally.

The texts in the print-with-photo condition were given the same format as those in the print condition except for the photo, which was placed at the beginning of the second column of each news story. For each news story, a photo journalist from a large national newspaper selected one photo from a range of still photographs taken from the film footage of the children’s television news stories. Each photo depicted the main event or the main objects or participants described in the news story. The story about a bear that was set free in a sanctuary was accompanied by a photo of the bear climbing out of its cage in the
woods. The story about Japanese pupils playing hooky was accompanied by a photo of a classroom with Japanese pupils. The story about the new railway tunnel was illustrated with a photo of a train running through the new tunnel, whereas the story about a rhinoceros that was sold to a circus was accompanied by a photo of the rhinoceros performing in the circus. Finally, the story about a new U.S. law restricting the purchase of firearms was illustrated by a photo of a man looking at weapons in a gun store.

The audiotape in the audio condition was identical to the television narrative except for the two parts that involved Spanish- and English-speaking people. In constructing the audiotape, the original foreign language was replaced by a Dutch translation. The spoken text was identical to the Dutch subtitles used in the television version.

Procedure

To reduce the possibility of classroom effects, children from each classroom were randomly assigned to each of the four experimental medium conditions. In each class, the experiment was conducted simultaneously in two vacant rooms in the school building. This way, two conditions were administered per test session. To prevent children from telling each other what was expected of them in the experiment, the other two conditions were completed the same morning or afternoon in a second session immediately following the first. To reduce the possibility of session-order effects, the four medium conditions were systematically varied during the first and second test sessions. Each session lasted about 40 minutes.

Sixteen children from each class participated in the experiment. Children were called from their classroom in groups of 8. Half of these children were taken to one of the rooms by one experimenter; the other children were taken to the other room by a second experimenter. To enhance ecological validity, the children did not participate in the experiment individually but were tested in small groups of 4, as was done in the previous studies by Walma van der Molen and van der Voort (1997, 1998). At home, children generally learn about the news in the presence of others. Moreover, the children were expected to be more relaxed in the presence of peers, rather than alone with a strange experimenter.

In each of the four experimental medium conditions, the children were seated at tables separated by a distance of about four feet (1.20 m). Each child was sitting at a separate table. In the television condition, the children sat at a distance of about seven feet (2.15 m) from a 16-inch (40 cm) color television placed at eye level. In the audio condition, the children sat at a distance of about five feet (1.50 m) from a cassette player that was placed on a table in front of them.
The first experiment conducted by Walma van der Molen and van der Voort (1997), in which an experimental distinction was made between children who did and children who did not expect to be tested, showed that knowledge of an impending memory test did not affect the relative effectiveness of television and print news. As was done in Walma van der Molen and van der Voort's (1998) second study, all children were therefore subjected to experimental treatments that led them not to expect a memory test. The assumption was that an instruction aimed at preventing expectation of a memory test would increase the ecological validity of the experiment, because children do not expect to be questioned about the news in the home situation either. Children were prevented from expecting a test by suggesting that their watching or reading of the news was only intended as a way to pass the time the experimenter needed to prepare the actual experiment. In each of the four medium conditions the children were told the following: “We are going to do something special and different today. However, I still have some preparations to complete for you, which I can only do now, because I have just learned all your names.” In the television condition the experimenter then proceeded to say: “In the meantime, you can watch some television. I have here a videotape of an episode of the Children’s News. You can watch that while I’m busy working.” In the two print conditions the experimenter said, “In the meantime, you can read something. I have here some stories from a children’s newspaper. You can read that while I’m busy working.” In the audio condition the experimenter said, “In the meantime you can listen to an audiotape. I have here an audiotape of the Children’s News. You can listen to that while I’m busy working.” Casually, the children were asked not to talk to each other. They were told that talking would make it difficult for the experimenter to concentrate.

The children in the television and audio condition were exposed to the news for 11 minutes. The children in the two print conditions, however, were allowed to read the news stories at their own tempo. The decision was made not to hold exposure time constant across the four medium conditions, because Walma van der Molen and van der Voort’s (1997, 1998) studies had shown that most children needed more than 11 minutes to read the five news stories. Constant exposure times would therefore put children in the print conditions at a disadvantage and prevent a meaningful media comparison. The average reading time in the two print conditions was 12 minutes and 15 seconds. There was no statistically significant difference in reading time between the two print conditions.

Immediately after presentation of the five news items, the children in the television and audio condition were presented with a memory test. The children in the print conditions had been asked to raise their
hands when they finished reading, at which time they were presented with the recall measure. The memory test was preceded by written instructions. The children’s reading proficiency had been established 3 weeks prior to the experiment.

Measures

Reading proficiency. Reading proficiency was assessed by means of standardized reading comprehension tests developed by the National Institute for Education and Measurement (1981, 1991). Two different test versions were used to measure reading comprehension in the fourth graders and sixth graders. Each test contained five texts with a total of 25 corresponding multiple-choice questions. The questions asked the children to identify the central theme of a text, to link different parts of a text, and to draw inferences from the information provided in the texts. Cronbach’s alpha (K-R 20) was .85 (Grade 4) and .80 (Grade 6).

Recall. Memory for the five news stories was measured by means of a paper-and-pencil test developed by Walma van der Molen and van der Voort (1997). The memory test contained 56 open-ended questions (the number of questions varied between 10 and 12 questions per news story). For each of the five news stories, questions were generated about each of the five components most news stories are composed of: event, place, principal(s), cause, and consequence (Findahl & Höijer, 1985). In addition, questions about story details were generated. Examples of questions are the following: “One of the news stories was about a bear that was set free. In which country was the bear set free?” “What was the first thing that the bear did when it was set free?” “Write down the name of another country where more bears are going to be set free in the near future.” The memory test contained only questions about information that was present in the spoken commentary of the television stories—and thus in the text of the printed news stories and in the audio version. Hence, the test did not include questions on visual information that was not conveyed verbally. Cronbach’s alpha (K-R 20) was .90 in the present experiment; in their previous studies, Walma van der Molen and van der Voort (1997, 1998) found alphas of .93 and .92, respectively.

As discussed earlier, in the television news stories some of the information conveyed verbally was supplemented with pictures conveying more or less the same information, whereas other information was not. To enable the analysis of the contribution of redundant pictorial information to children’s story recall, Walma van der Molen and van der Voort (1997) had two independent judges classify the questions in the memory test into two types: (a) questions about information that
was conveyed only verbally, in print, and in the television narrative ("verbal-only" information); and (b) questions about verbal information that, either partly or completely, was also presented visually on television ("visual" information). Interrater agreement as measured by Cohen's kappa was .96. Thirty-five questions from the memory test were categorized as "verbal only" (Cronbach's alpha = .89), and 21 questions as "visual" (Cronbach's alpha = .84).

RESULTS

Initial data checks showed that the distribution of recall scores satisfied the assumptions regarding normality and homogeneity of variance that underlie the analysis of variance. There were no statistically significant differences in recall scores between children who participated in the first test sessions and children who participated in the second sessions. In the analysis of variance, the children included in each block of four, who had been matched on reading proficiency, were treated as if they were one person who had been treated with repeated measures (Kirk, 1968; Tabachnick & Fidell, 1989). All effects were assessed at the .05 level.

A 2 (Grade 4 vs. Grade 6) × 2 (less vs. more proficient readers) × 4 (television vs. print vs. print with photo vs. audio) × 2 (verbal-only vs. visual information) analysis of variance was performed on children's total scores on the memory test, with medium condition and type of information as within-subjects factors and grade and level of reading proficiency as between-subjects factors. Table 2 presents the mean proportions of correct answers for the four medium conditions as a function of grade. There was a statistically significant main effect for medium condition, \( F(3, 132) = 7.78, MSE = 0.038, p < .001 \). The proportion of variance accounted for was \( \eta^2 = .15 \), using \( \eta^2 = \frac{SS_{\text{effect}}}{SS_{\text{effect}} + SS_{\text{error}}} \) (Cohen, 1973, 1988; Tabachnick & Fidell, 1989). To determine which medium conditions differed significantly, six paired \( t \) tests were performed, using an alpha level of .008 based on a Bonferroni correction (Pedhazur & Pedhazur Schmelkin, 1991). As predicted in H1, the television news stories were recalled better than the printed stories, \( t(47) = 4.11, p < .001 \). As anticipated in H3, the television news stories were also remembered better than the audio stories, \( t(47) = 4.58, p < .001 \), and in line with H5, the television stories were remembered better than the printed stories accompanied by a photo, \( t(47) = 3.41, p < .002 \). Contrary to H6, however, there was no statistically significant difference in recall between the two print conditions (\( p > .46 \)). In accordance with H7, there was no significant difference between the print and the audio conditions (\( p > .95 \)).
There was a statistically significant interaction between the four medium conditions and the categories “verbal-only” and “visual” information, $F(3, 132) = 5.52$, $MSE = 0.006$, $p < .002$, $\eta^2 = .11$. This interaction is depicted in Figure 1. As predicted in H2 and H4, the superior recall of television compared with print and audio was especially pronounced when the news information had been effectively visualized on television. For questions about information that was conveyed both verbally and visually on television, mean recall scores (with standard deviations in parentheses) were .66 (.12), .52 (.22), .53 (.18), and .51 (.17) for the television, print, print with photo, and the audio condition, respectively, whereas mean recall scores for verbal-only information were .58 (.14), .49 (.22), .52 (.19), and .50 (.17), respectively. Follow-up tests showed that children in the television condition indeed scored significantly higher on the “visual” measure than children who received (a) the printed stories, $t(47) = 5.21$, $p < .001$; (b) the printed stories accompanied by a photo, $t(47) = 5.36$, $p < .001$; and (c) the audio stories, $t(47) = 6.28$, $p < .001$. There were no significant differences between the two print conditions and the audio condition on the “visual” measure (all $p$’s were >.40). Although the recall advantage of television compared with the other medium conditions was most pronounced for information that was conveyed both verbally and visually on television, there was also a difference in retention between verbal-only information presented on television and the same information presented in the print and audio condition. Follow-up tests showed that children remembered more from verbal-only information presented on television than from the same information presented in (a) the printed stories, $t(47) = 2.93$, $p < .006$; and (b) the audio stories, $t(47) = 2.92$, $p < .006$. The latter two $p$-values were also significant when a Bonferroni correction was applied, leading to a corrected alpha level of .008. There was no statistically significant difference in

### Table 2

Mean Recall Scores for the Television, Print, Print-With-Photo, and Audio Versions as a Function of Grade

<table>
<thead>
<tr>
<th>Medium</th>
<th>TV M SD</th>
<th>Print M SD</th>
<th>Print-With-Photo M SD</th>
<th>Audio M SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 4</td>
<td>.57 .12</td>
<td>.43 .19</td>
<td>.47 .17</td>
<td>.47 .18</td>
</tr>
<tr>
<td>Grade 6</td>
<td>.65 .10</td>
<td>.58 .21</td>
<td>.58 .18</td>
<td>.53 .14</td>
</tr>
<tr>
<td>M</td>
<td>.61 .12</td>
<td>.50 .21</td>
<td>.53 .18</td>
<td>.50 .16</td>
</tr>
</tbody>
</table>

NOTE: Scores represent mean proportions of correct answers. Total $N = 192$. 
recall between verbal-only information presented on television and the same information presented in the print-with-photo condition, \( t(47) = 1.90, p > .06 \). No significant differences were found between the two print conditions and the audio condition on the "verbal-only" measure (all \( p \)'s were >.30).

Sixth graders (\( M = .59, SD = .17 \)) remembered significantly more of the news stories than fourth graders (\( M = .49, SD = .17 \)), \( F(1, 44) = 15.29, MSE = 0.058, p < .001, \eta^2 = .26 \). There was no statistically significant interaction between grade and medium condition: Both fourth and sixth graders remembered more from the television news stories than from the other medium conditions and this medium effect was about the same size in both grades.

Table 3 presents the mean proportions of correct answers for the four medium conditions as a function of reading proficiency. Overall,
more proficient readers \((M = .61, SD = .15)\) remembered the news stories better than less proficient readers \((M = .47, SD = .17)\), \(F(1, 44) = 32.84, MSE = 0.058, p < .001, \eta^2 = .43\). There was no statistically significant interaction between reading proficiency and the medium condition, which indicates that, as predicted in H8, the recall advantage in the television condition as compared with the three other conditions was about equally large for both less proficient and more proficient readers. The analysis of variance showed no other statistically significant main or interaction effects.

The interaction depicted in Figure 1 already suggested that the visual information presented in the photos did not contribute to better recall in the print-with-photo condition compared with the conditions without visual information (print and audio). A supplementary analysis also failed to show a recall advantage for information depicted in the photos. Analogous to the distinction between “verbal-only” and “visual” television information, two independent judges classified the questions in the memory test into two types: (a) questions about information that was not depicted in the photos (“verbal-only” information), and (b) questions about verbal information that was also presented visually in the photos (“in photo” information). Interrater agreement as measured by Cohen’s kappa was 1.00. Only 5 of the 56 questions from the memory test could be categorized as pertaining to “in photo” information. A 2 (“verbal-only” vs. “in photo” information) \(\times 4\) (television vs. print vs. print with photo vs. audio) analysis of variance was performed on children’s total scores on the memory test, with both factors as within-subjects factors. The results of this analysis are depicted in Figure 2. For questions about information that was conveyed both in the texts and in the photos, mean recall scores (with standard deviations in parentheses) were .75 (.14), .61 (.24), .64 (.20), and .66 (.19) for the television, print, print-with-photo, and the audio condition,

### Table 3

Mean Recall Scores for the Television, Print, Print-With-Photo, and Audio Versions as a Function of Reading Proficiency

<table>
<thead>
<tr>
<th>Medium</th>
<th>TV</th>
<th>Print</th>
<th>Print-With-Photo</th>
<th>Audio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Proficiency</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>More proficient readers</td>
<td>.66</td>
<td>.10</td>
<td>.60</td>
<td>.19</td>
</tr>
<tr>
<td>Less proficient readers</td>
<td>.56</td>
<td>.12</td>
<td>.41</td>
<td>.19</td>
</tr>
</tbody>
</table>

NOTE: Scores represent mean proportions of correct answers. Total \(N = 192\).
respectively; mean recall scores for information that was not presented in the photos were .60 (.12), .49 (.22), .52 (.18), and .49 (.17). There was a statistically significant main effect for type of information, $F(1, 47) = 87.35$, $MSE = 0.023$, $p < .001$, $\eta^2 = .65$, but no interaction between type of information and the four medium conditions, $F(3, 141) = 1.30$, $p > .27$. In all four conditions, the information that was also depicted in the photos ($M = .68$, $SD = .20$) was remembered better than the information that was not depicted ($M = .52$, $SD = .18$).

**DISCUSSION**

The results of the present study support and extend the findings from Walma van der Molen and van der Voort's (1997, 1998) previous
studies. Again, television was found to be the most effective transmitter of news information. As anticipated in H1, the television news stories were remembered better than the printed stories, and consistent with H2, the superior recall of television compared with print news occurred mainly when verbal information elements were supplemented with redundant television pictures. In addition, as anticipated in H3, the television stories were recalled better than the audio versions, and consistent with H4, the recall advantage of television was found to be particularly pronounced in the case of information that was presented both verbally and visually on television. These findings, and especially the confirmation of H2 and H4, suggest that the observed superior recall of television may indeed be best explained in terms of an advantage of dual-memory codes offered by redundant audiovisual information.

In the present study, we have done our utmost to dispute the validity of the dual-coding explanation for the observed superiority of television news. However, none of the rival explanations investigated were found to be valid. As anticipated in H5, the television news stories were not only recalled better than the printed stories but also better than the printed stories accompanied by a photo, indicating that the observed superior recall of television was not attributable to an underutilization of the print medium in previous studies (Beentjes et al., 1993; Walma van der Molen and van der Voort, 1997, 1998). Although we anticipated in H6 that the texts with photo would be recalled better than the bare text versions, no statistically significant difference in recall was found. The latter finding may be due to the fact that the photos offered a limited amount of visual information. Only 5 of the 56 questions in the memory test pertained to verbal information that was also depicted in the photos, which proved to be insufficient to bring about a recall advantage in the print-with-photo condition. In fact, children in the print-with-photo condition did not even score better on the five recall questions about information presented in the photos than did children in the print and audio condition. In all medium conditions, the information that was also presented in the photos was recalled better than the information that was not depicted, probably because the photos depicted the most salient information from the news stories, information that was well remembered in all medium conditions.

A second alternative explanation for the recall advantage of television argued that children remember more from orally presented information than from the same information presented in print. However, as anticipated in H7, we did not find a recall difference between the audio and print conditions, indicating that the superior recall of television news was not attributable to the fact that children in the television condition were able to listen to the verbally presented information,
whereas children in the print conditions had to read all the information themselves.

The present study also failed to lend support to a third alternative explanation, which attributed the observed superior recall of television compared with print news to children's imperfect reading proficiency. In accordance with H8, both more and less proficient readers remembered most from the television news presentation, and the recall advantage of television compared with the other medium conditions was about equally large for both groups of readers.

However, there is a fourth rival explanation that the present study did not address. This explanation argues that the observed recall advantage of television may be due to the fact that most children find watching television more attractive than reading, with the possible result that the television news stories generate a greater amount of attention than the print versions. However, in a previous study that used the same stimulus materials, Walma van der Molen and van der Voort (1998) found no evidence to suggest that children found the television news stories more attractive than the print stories. Moreover, television’s great appeal to children does not necessarily result in a higher level of attention. A recent study of British families watching television in their homes (Gunter, Furnham, & Lineton, 1995) showed that both children’s and adults’ level of attention to television newscasts was far from optimal. Television’s great appeal to children neither implies that children invest more effort in learning from television than in learning from print. On the contrary, according to Salomon (1984), children tend to invest more mental effort in learning from print than in watching television, because children experience print as a “tough” medium and television as an “easy” medium.

Although the results of the present study suggest that the observed recall advantage of television may be explained best in terms of the dual-coding hypothesis, and no support was found for a number of alternative explanations, there is one finding that cannot be accounted for by the dual-coding explanation. As was found previously by Walma van der Molen and van der Voort (1998), the present study showed that the recall advantage of television compared with print news applied not only to verbal information supplemented with redundant television pictures but also, although to a lesser extent, to information that had only been presented verbally on television. Verbal-only (only orally presented) television information differs from printed information in three respects: (a) It is read aloud to the viewers, whereas readers must decode each word themselves; (b) verbal-only television information contains additional nonverbal oral cues (e.g., inflection); as well as (c) additional nonverbal, nonoral cues (e.g., gestures and smiling), that is, insofar as the verbal information is presented by an on-screen speaker.
If the observed superior recall of verbal-only television material was caused by the channel differences mentioned under (a) and (b), then one would expect that children in the audio condition would have remembered more than children in the print condition, which was not the case. There is a possibility, however, that the recall advantage of verbal-only television information was due to the fact that the television viewers received such nonoral cues as gestures and smiling. It is, however, equally possible that the superior recall of verbal-only television information is due to a “radiation effect” (Walma van der Molen & van der Voort, 1998). This explanation assumes that because the viewers of the children’s news are better acquainted with those parts of the news story in which the verbal message is supported by redundant pictures, they may also be more capable of processing the remaining information elements that are conveyed only verbally. Further research is required to determine the best explanation for the observed recall advantage of verbal-only television information.

Whereas the present study and previous comparisons of television and print news conducted with children (Beentjes et al., 1993; Walma van der Molen & van der Voort, 1997, 1998) showed that television was remembered better than print, the reverse was found in studies conducted with adults. With the exception of one study in which no media difference was found (Stauffer, Frost, & Rybolt, 1981), media comparison experiments conducted with adults (college or university students) consistently showed that print news was remembered better than television news (DeFleur, Davenport, Cronin, & DeFleur, 1992; Facorro & DeFleur, 1993; Furnham & Gunter, 1985; Gunter & Furnham, 1986; Gunter, Furnham, & Gietsos, 1984; Gunter, Furnham, & Leese, 1986; Wicks & Drew, 1991; Wilson, 1974). The opposite outcomes obtained with adults and children may have resulted from the fact that the studies conducted with the two age-groups employed different types of television news programs. The studies conducted with children used children’s television news stories marked by high audiovisual redundancy. The studies conducted with adults, on the other hand, employed regular “adult” television newscasts that are usually characterized by a small amount of semantic overlap between text and pictures (e.g., Robinson & Levy, 1986). As a result, the adult viewers may have been unable to profit from the extra mnemonic support offered by redundant television pictures and may even have been distracted from the verbal message (e.g., Drew & Grimes, 1987; Grimes, 1990, 1991). It therefore remains to be seen whether the superior recall of television news found with children also applies to their memory for “adult” news. On the other hand, it is equally questionable whether the superior recall of print news that has been found with adults also applies to their memory for children’s news. In another experiment in progress,
these questions are investigated by subjecting both children and adults to television and print stories in both children’s and “adult” news formats.

Finally, what are the implications of the present study for theory and practice regarding children’s learning from news media? The study lends further support to the hypothesis that information conveyed both verbally and visually is recalled better than text-only information, provided that there is considerable semantic overlap between the content of the verbal and visual channels. Therefore, it is important that producers of children’s television news, as well as designers of instructional and educational television programs for children, ensure that verbal and visual content are closely related. However, producers of “adult” newscasts should also be more careful in their selection of television pictures, because it may well be that audiovisual redundancy affects adults’ memory for the news as much as that of children.

REFERENCES


