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Sound Effects for Children's Temporal Integration of Fast-Paced Television Content

Sandra L. Calvert and M. Catherine Scott

Children's visual orientation to and recognition of events presented in a fast-paced and a slow-paced television program was examined as a function of sound effects. Sixty-four children were randomly assigned to one of four viewing conditions which crossed two levels of sound effects with two levels of pace. As expected, sound effects increased children's visual orientation to program events which had been marked by sound effects, but only in the fast-paced program.

Fast-paced television programs, in which the scenes shift frequently from one setting to another, are typically designed for a young viewing audience (Huston et al., 1981), but the impact of such pacing on comprehension has been questioned. While some argue that fast-paced programs disrupt children's comprehension by denying them the opportunity to rehearse and think about the information (Singer & Singer, 1983), others argue that fast-paced programs may call upon a child to process material actively because the program tempo is challenging (Wright et al., 1984).

Humorous inserts interspersed in educational television programs have enhanced children's attention to, and understanding of, content presented in fast-paced programs (Zillmann, Williams, Bryant, Boynton, & Wolf, 1980). Presumably, the humor leads to attentional orienting responses from

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Sandra L. Calvert *(Ph.D., University of Kansas, 1982) is Assistant Professor of Psychology at Georgetown University. Her research interests focus on the impact of television and computers on children's attention to, and comprehension of, content.* ***M. Catherine Scott*** *(M.A., University of Maryland, 1988) is Research Assistant for the Institute of Child Study at the University of Maryland. Her research interests focus on the effects of day care on children's social development.* *This research was supported by a grant from the Home Economics Grant Foundation at the University of North Carolina at Greensboro. The authors thank the staff, parents and children of the UNCG Child Care Education Center and of General Greene Elementary School in the Greensboro School System. We also thank the Center for Research on the Influences of Television on Children (CRITC), Paul Whitener, Katherine Clark, Rebecca Mahaley, Robert Nida, Tammy Wilkes Burchette, and Nancy Foltz for their assistance. This manuscript was accepted for publication May 1989.*

children, thereby momentarily increasing information processing activity. The major thesis here is that sound effects, an auditory production feature, can also be used to increase children's recognition of content presented in a fast-paced televised story.

Comprehension and Attention Processes

Comprehension of television content is a multifaceted process which includes an understanding of information that is explicitly or implicitly presented in the program (Collins, 1983). Explicit information involves concretely presented content that is either central or incidental to the story plot. Implicit information, which is necessary for understanding a plot, requires viewers to make inferences which go beyond the information given; character feelings, motivations, and interscene connections are various types of implicit content.

Children's comprehension of television content has been assessed through verbal recall measures (Lorch, Anderson, & Levin, 1979; Welch & Watt, 1982), multiple-choice questions (Calvert, Huston, Watkins, & Wright, 1982; Collins, 1983), and recognition of picture sequences (Wright et al., 1984). Measures are assumed to tap different modes of information processing. Recall measures, for example, rely on verbal skills whereas picture sequencing measures rely on visual skills. Because young children have difficulty in producing verbal information (Flavell, 1985), strictly verbal tasks may well underestimate children's knowledge of program content. For this reason, we selected picture sequencing as a way to simplify the comprehension task for young viewers.

While picture sequencing involves recognition of visual content, it also involves an understanding of order and the temporal relations among scenes (Calvert, Huston, & Wright, 1987). Picture sequencing, then, taps children's visual recognition of explicitly presented program events and requires them to integrate temporal information across scenes, a component of implicit comprehension.

Like comprehension, attention to television programs has also been measured in varying ways. One common theme is to score visual attention when a child looks at the television screen (Anderson & Lorch, 1983; Calvert et al., 1982; Krull, 1983; Welch & Watt, 1982; Wright et al., 1984). These looking indices are then examined at macro or micro levels. Macro levels of attention typically index *how much* attention a child pays to a television program. By contrast, micro levels of attention index *which parts* of the program a child sees (Huston & Wright, 1983). While both types of attentional measures are related to children's understanding of television content (Calvert & Gersh, 1987), our focus here was on visual orientation to television, a microattention score indexing the number of times that a child looked at

specific program points. In particular, we were interested in attracting children's visual orientation at specific program points in order to enhance their temporal integration of story content.

Sound Effects as Markers of Important Television Content

Across a wide range of studies, sound effects are consistently associated with visual orienting responses from children who are not looking at the television screen and with visual maintenance responses from children who are looking at the television screen (Alwitt, Anderson, Lorch, & Levin, 1980; Anderson & Levin, 1976; Bryant & Zillmann, 1981; Calvert et al., 1982; Calvert & Gersh, 1987).

Wright and Huston (1983) describe these attentional effects as a function of perceptual salience, which are attributes that embody the stimulus characteristics of change, incongruity, novelty, movement and the like (Berlyne, 1960). Perceptually salient characteristics are likely to elicit attention from young viewers because these features are attention-getters. Applied to the television literature, Wright and Huston (1983) argue that sound effects embody the characteristic of novelty, and therefore are likely to elicit attention from even the youngest viewers. As part of development and experience with the media, children learn that features sometimes mark content for further processing. That is, the repeated use of a feature like sound effects with interesting, comprehensible, and informative content makes it likely that children will learn to attend to the screen when sound effects are presented. Regardless of the reason for attending, be it perceptual salience or marking, the implication of the research is that sound effects are features which reliably ensure that children will see content that is targeted for them.

Once attention is gained, sound effects can serve comprehension by association with contiguously presented content (Calvert et al., 1982). Specifically, attention may momentarily enhance information processing activity, thereby increasing the probability that the information which immediately follows a sound effect will be processed (Bryant, Zillmann, & Brown, 1983; Watt & Welch, 1983). For example, using sound effects to mark story content led to improved recognition of central, plot-relevant content, particularly for young viewers (Calvert & Gersh, 1987). Similarly, attention-getting techniques such as unusual noises attracted children's attention and facilitated their acquisition of information from an educational television program, particularly at young ages (Bryant & Zillmann, 1981). Taken together, these findings suggest that sound effects can guide children's attention to specific program points, thereby mediating improvements in understanding a television program.

Attention to specific program points may be as important for compre-

hension as is attending during most of a television program. Lorch et al. (1979) found that children who viewed twice as much of an episode of *Sesame Street* did not differ in comprehension from children who viewed much less of the program; however, attention to specific program points was associated with their comprehension of that particular content. Similarly, Calvert and Gersh (1987) found that overall levels of visual attention were related to children's understanding of incidental, irrelevant program details, but attention at three targeted program points was associated with understanding of the central content. Attention to specific program points, then, may be crucial for children's understanding of television messages.

Effects of Program Pacing on Learning

While attention is necessary, it is not sufficient for effective comprehension of a televised story (Welch & Watt, 1982; Wright & Huston, 1983. Watt and Welch (1983) argue that form has both indirect effects on children's comprehension, which are mediated through visual attention, and direct effects on comprehension, which are independent of visual attention.

Pace, the rate of scene and character changes in a television program (Huston et al., 1981), influences children's attention to, and comprehension of television content. The more rapidly the scenes change, presumably the more difficult it is for children to attend to important program points and to integrate information over time. Even so, the perceptual salience of rapid pace may make the feature attention-worthy for young children. For example, interspersed humorous episodes that are fast-paced enhance attention to program material more quickly than do the same humorous inserts clustered in the program to make it slow-paced (Zillmann et al., 1980).

The components of pace may be related to set complexity, the degree of randomness or change in the physical locations of a television program (Krull, 1983). Complexity, like pace, involves the information processing demands of a task. As the complexity increases, so do the demands made on the individual for processing the content. Young children attend longer to short than to long bits (Krull, 1983). Older children, by contrast, react to rhythms of set complexity, and they attend to content in cycles which suggests that they can anticipate change.

Watt and Welch (1983) proposed a similar construct called dynamic visual complexity, which measures change over time in the luminance of the television screen. The more change that occurs, the more dynamic complexity there is. This definition suggests that as pace increases, so does visual dynamic complexity. Welch and Watt (1982) found that as visual change on the screen increased, children's visual attention also increased. Taken together, the studies indicate that fast-pace is attention-worthy to young children.

The effects of pace on comprehension are less clear. Fast-pace has been

associated with increased and decreased comprehension of program content. In the study by Zillmann et al. (1980), the fast-paced program facilitated information acquisition more than the slow-paced program. Visual dynamic complexity is also associated with enhanced recognition of content (Welch & Watt, 1982). However, younger children temporally sequenced events from the slow-paced programs better than from the fast-paced program in the Wright et al. (1984) study.

One must consider, though, that the same program content was studied in the Zillmann et al. (1980) study while different programs were examined in the Wright et al. (1984) study. Altering pace by interspersing humorous inserts may not be the same thing as studying programs in which there are different rates of novel scenes. Moreover, pace may operate differently when information is presented in a magazine format, in which the bits can be understood independently of one another (e.g., Welch & Watt, 1982), than in a story format, in which integrating information across scenes is required for thorough comprehension (Wright et al., 1984).

Developmental Differences in Attention and Comprehension

Older children are more likely to attend to, and to understand the central, plot-relevant content in a television program than are younger children (Calvert & Gersh, 1987; Collins, Wellman, Keniston, & Westby, 1978). These findings are attributed to increases in children's ability to deploy attention effectively to significant content as well as to improvements in their cognitive skills (Collins et al., 1978).

Wright and Huston (1983) argue that children at young ages may be more interested in fast-paced than in slow-paced television programs because they tend to focus on perceptually salient attributes of television programs. With development, children search for meaning, independent of the salience of attributes. Older children also develop schemas which allow them to anticipate the flow of program information (Krull, 1983). For example, Krull and Husson (1979) found that older children could guide their visual attention to program content by anticipating changes in form complexity while younger children could not. The data base about sound effects suggests that marking key program points might facilitate information acquisition, particularly for young viewers who are watching a fast-paced program.

The Present Study

The purpose of this study was to examine the potential impact of sound effects for children's temporal integration of television programs which varied in the rate of proggam pace. We expected sound effects to improve visual attention to, and temporal integration of television content, particu-

larly for the fast-paced program. Older children were expected to sequence program material better than the younger children; thus, younger children's sequencing of the program content was expected to benefit from sound effects more so than older children's. While older children were expected to attend to the marked program points more so than younger children, no differences in attention were expected as a function of sound effects.

Method

Subjects were 64 children, equally distributed by gender and by grades preschool and fourth (M = 4 years, 11 months vs. 10 years, 2 months), who attended one of two schools in a moderately-sized Southeastern city. Within grade and gender groups, children were randomly assigned to one of four treatments.

Two 15-minute, live children's television programs which varied in pace, were selected from the Wright et al. (1984) study for further examination. These two programs were examined because young children had more difficulty sequencing the events from the fast-paced than from the slow-paced programs (Wright et al., 1984). Programs were originally selected from a library of 137 children's television programs which had been scored for formal features, including pace.[1] The two programs selected for study here were at opposite ends of the distribution for pace (i.e., the rate of scene and character change). The rate of scene and character change was 2.38 for the slow-paced program and 9.20 for the fast-paced program.

While programs were selected by pace, content was kept as similar as possible. In *Thunder: The Adventures of a Super Horse,* the slow-paced program, a horse helps save a dog who has been poisoned by drinking from a polluted stream. In *Search and Rescue,* the fast-paced program, a team of trained animals rescues a father and son who have been in a car accident. Both programs were prosocial stories about children, family members and animals who were involved in some type of rescue mission. In both plots, animals played key roles in helping humans to accomplish the rescue operation. Programs contained little violence.

In all four treatment conditions the program plot was retained. The treatment conditions crossed two levels of sound effects with two levels of program pace. One-second sound effects of a slide whistle were used to mark significant story events. The marking procedure was implemented as follows.

First, two sets of key visual program events that were central to each program plot were selected and photographed. These four sets of program events had been selected by a team of five researchers. Approximately 50 pictures were initially taken from each program. The research team then

selected and constructed two sets of central visual events from which the story could be told for each of the two programs.

Based on previous research (Wright et al., 1984), five events were then selected for each picture set. At least 80.0% of the judges agreed on each picture retained and 100.0% consensus was reached for each of the final four picture sets.

Finally, one of the two picture sets from each program was randomly selected for marking. The two stimulus programs were later edited so that sound effects preceded each of those five program events in the marker conditions.

Children participated individually in one 30-minute session in a vacant room in or near their school. Each child was seated at a table that had small toys and comic books on it. An experimenter told each child to read, play, and watch television just like at home and that some questions about the story would be asked after the program ended. She told the child that she had some work to do, but would stay in the room. With remote control buttons, the experimenter activated a hidden camera which videotaped the viewing session and a videotape recorder which played one of the four edited program versions. The experimenter then went to another area of the room and appeared to work on some papers.

Visual Orientation to Marked Content

Videotapes of children's visual attention to the television program were later scored to derive three microattention scores. Visual attention was scored "on" when a child looked at the television screen and "off" when a child looked away. Elicit attention scores measured the probability that children who were not looking at the television program immediately before the five targeted program points would look back at the program within 5 seconds after the onset of the sound effect treatment. Maintain attention scores measured the probability that children who were already looking at the onset of each of the five program points would continue to look for at least 5 seconds after the onset of the sound effect treatment. Elicit and maintain scores were summed to compute visual orientation scores, the number of times that children looked (i.e., their eyes were directed at the television screen) at the five targeted program events.

Interobserver reliability for elicit and maintain scores (i.e., the visual orientation scores), based on eight randomly selected viewing sessions, was 92.5%, calculated as 2 times the number of agreements divided by the total number of scores for both observers. Agreement occurred when both observers scored an onset or offset of attention within 5 seconds after a sound effect occurred or during that same program time frame in no sound effect conditions.

Recognition of Temporal Sequences

After viewing, each child ordered the two sets of five events that had been photographed from the television program in order to assess temporal integration of the plot line. For each program, one set of events had been marked in the television program by sound effects while the other had not been marked.

For each temporal sequencing set, the experimenter randomly arranged the photographs in two rows and gave the following instructions: "Here are some pictures of things that happened in the story. I'd like you to put these pictures in order from the first thing that happened in the story to the last — in a line right in front of you." After a child had sequenced each set, the experimenter recorded the child's response order from numbers on the backside of the photographs.

Following procedures developed by Wright et al. (1984), temporal sequence scores were calculated for each child by comparing the child's picture order to its correct absolute position and to the number of correctly sequenced adjacent pairs of pictures. The absolute correct order resembles a rank order correlation (rho) between the correct and the actual orders of pictures. To calculate this score, the pictures were correctly ordered from the first to last event. For each picture, one point was awarded for every picture that had been correctly placed to its left. This type of measure alone, however, fails to give credit for pictures that are correctly placed beside one another. For that reason, one point was given for each pair of pictures which were correctly paired together. For a set of five items, 10 points are possible for the absolute correct order, and 4 points are possible for the adjacent pairs of pictures. The temporal sequence scores were calculated by adding the two parts, resulting in a maximum score of 14 for each set.

Results

Visual Orientation to Marked Program Points

Sound effects were expected to increase children's visual orientation to key program points, particularly in the fast-paced television program. Visual orientation scores, ranging from 0-5, indexed the number of times that children looked at the five targeted program points. Visual orientation scores were submitted to a 2 (Sound Effect) × 2 (Pace) × 2 (Grade) × 2 (Gender) between-subjects analysis of variance.

The four factor ANOVA computed on visual orientation scores ($R^2 = .24$) yielded a main effect of sound effect condition [$F(1,48) = 7.57$, $p < .01$]; which was qualified by a sound effect by pace interaction

Table 1
Mean Visual Orientations Scores to Marked Story Events as a Function of Sound Effects and Pace

	Sound Effect Treatment	
	Off	On
Pace Level		
Slow	3.31[b]	3.25[b]
Fast	2.38[c]	4.08[a]

Means with different letter superscripts are significantly different at $p < .05$. Each cell mean is based on 16 subjects.

[$F(1,48) = 8.78$, $p < .01$]. As seen in Table 1, children who viewed the fast-paced program were more likely to see the marked program points when sound effects were present rather than absent, but children who viewed the slow-paced program did not benefit from sound effects. Within the sound effect treatment conditions, children were more likely to see the key program points when sound effects marked the fast-paced than the slow-paced program. By contrast, children who viewed the no sound effect conditions were more likely to see the key program points in the slow-paced than in the fast-paced program. As expected, there was also a main effect of grade [$F(1,48) = 12.94$, $p < .001$]; older children attended to the five program points more frequently than did younger children (3.78 vs. 2.72).

The Relation between Visual Orientation and Temporal Integration

Visual orientation scores were expected to mediate temporal sequencing scores. That is, children who looked during the five program points were expected to sequence program events better than children who did not look during those five events.

Temporal sequence scores, ranging from 2–14, were computed for the marked and the unmarked temporal sequencing sets. These two sets of scores were submitted, in turn, to a 2 (Pace) × 2 (Sound Effect) × 2 (Grade) × 2 (Gender) analysis of covariance with visual orientation scores as the covariate. Pace, sound effect, grade, and gender were between-subjects factors.

The four-factor ANCOVA computed on the marked sequencing set ($R^2 = .57$) yielded a main effect of the visual orientation covariate, [$F(1,47) = 40.13$, $p < .001$]; and a main effect of grade [$F(1,47) = 32.64$, $p < .001$]. As predicted, visual orientation during these five program points was positively related to performing this task well. Not surprisingly, older children temporally sequenced more of the program information correctly than did younger children (Adjusted $M = 14.00$ vs. 5.27).

The 4-factor ANCOVA computed on the unmarked sequencing set ($R^2 = .45$) yielded a main effect of the visual orientation covariate, [$F(1,47) = 30.40$, $p < .001$]; and a main effect of grade [$F(1,47) = 22.94$, $p < .001$], qualified by a pace by grade interaction, [$F(1,47) = 14.69$, $p < .001$]. Visual orientation during the five marked program points was positively related to ordering the unmarked sequencing set correctly, suggesting general as well as specific effects of the marking treatment. As seen in Table 2, older children temporally sequenced the slow-paced program better than the fast-paced program, but the opposite pattern was true for the younger age group. Not surprisingly, older children sequenced more events correctly than did younger children (Adjusted $M = 13.70$ vs. 6.58).

Table 2
Adjusted Mean Number of Items Sequenced Correctly as a Function of Grade and Program Pace

	Pace Level	
	Slow	Fast
Preschool	5.74^{d}	7.52^{c}
Fourth	15.11^{a}	12.29^{b}

Means with different level superscripts are significantly different at $p < .05$. Each cell mean is based on 16 subjects.

The lack of effect for sound effects in both temporal sequencing analyses suggests that its impact on comprehension is mediated through visual attention. Moreover, the interaction of pace and grade in the unmarked sequencing task suggests direct effects of pace for temporal sequencing in addition to the indirect effects which were mediated through visual attention.

Discussion

The purpose of this study was to examine the impact of sound effects for children's temporal integration of fast-paced television programs. As expected, sound effects increased children's visual orientation to the fast-paced television program. Visual orientation scores, in turn, were associated with improvements in temporal sequencing of both sets of program events, thereby suggesting general as well as specific effects of the marking procedure. The results are in keeping with previous research which links sound effects with visual orientation to (Alwitt et al., 1980; Anderson &

Levin, 1976; Bryant & Zillmann, 1981; Calvert et al., 1982) and with enhanced recognition of contiguously presented content (Calvert & Gersh, 1987).

Although visual orientation scores mediated improvements in the fast-paced program, pace had effects on temporal sequencing of the unmarked sequencing task that were independent of visual orientation. These effects fit well within a framework proposed by Watt & Welch (1983). In that model, form can have either direct or indirect effect on children's comprehension. Indirect effects are mediated by visual attention. In this study, sound effects indirectly increased children's recognition of temporal sequences by enhancing children's visual orientation to the marked program points, but sound effects had no direct link with temporal sequencing. Pace, on the other hand, had both indirect and direct effects on temporal sequencing. Visual orientation scores were associated with improved temporal sequencing of both picture sets, suggesting indirect links between pace and temporal sequencing through visual attention. While pace had no direct effect on children's sequencing of the marked picture set, a direct effect remained in their sequencing of the unmarked set. In fact, pace affected older and younger children's sequencing of the unmarked set in opposite ways.

Interestingly, younger children sequenced unmarked events from the fast-paced television program better than unmarked events from the slow-paced television program, while the opposite pattern was true of older children. These findings support the hypothesis that the younger viewer will be more affected by perceptual salience than will the older viewer (Wright & Huston, 1983). Specifically, the rapid change of scenes created more interest for younger viewers to understand the program than did the slow change of scenes, but with development, the older children were less affected by salience. Older children, in fact, sequenced events from the slow-paced program very well.

Similarly, Welch and Watt (1982) found that dynamic visual complexity, which measures the change in the visual field over time, was positively related to children's attention and recognition scores. As found for fast pace in the present study, dynamic visual complexity had both direct and indirect links with recognition of program content. Taken together, these studies suggest that the element of change is needed to create an interesting television program. The argument that fast-paced programs are incomprehensible to young viewers (Singer & Singer, 1983) is not supported here. On the contrary, fast-paced programs interest young viewers more than slow-paced programs.

Limited attentional processing capacity (Kahneman, 1973) might also explain the interaction of pace and sound effects. That is, in fast-paced programs more processing capacity is required than most young children have

available. The viewer must quickly sample and temporally integrate content. In such a situation, sound effects can isolate events and direct attention, and thus direct processing effort to important program points while minimizing effort directed to less essential points. In a slow-paced program, by contrast, additional processing capacity remains available after children have temporally integrated the program. In the latter case, direction of attention and the allocation of processing space has no effect.[2]

Not surprisingly, developmental differences occurred in both children's visual orientation and temporal recognition scores. As found in previous research (Calvert & Gersh, 1987), older children attended to targeted content more often than did younger children. Similarly, as found by others (Wright et al., 1984), older children correctly sequenced more program events than did younger children.

While only one type of sound effect was used in the present study, the literature suggests that beneficial effects occur regardless of whether one type of sound effect is used (Calvert & Gersh, 1987) or if different sound effects are used (Bryant & Zillmann, 1981; Calvert et al., 1982). Taken together, these findings suggest that sound effects are a cost-effective way to improve the comprehensibility of children's television programs.

Even so, the failure of sound to work effectively in a slow-paced program suggests that there are limits to the usefulness of the feature. The results suggest that one must consider the ecological fit between a feature and its placement within the television program. That is, sound effects belong in fast-paced programs, but not in slow-paced programs (Huston et al., 1981) which may then influence how a child perceives and uses a feature. As suggested by Bryant et al. (1983), there might even be instances where sound effects could distract children from comprehending a message (e.g., if the sounds are so interesting that the child focuses on the feature and ignores the content).

Another limitation of this study is the generalizability of the findings. Because only two programs were used, beneficial effects of sound effects may or may not generalize to a larger sample of television programs which vary in pace.

In conclusion, using sound effects to mark important story events in a fast-paced television story can facilitate children's temporal integration of the plot line. While the effects of sound are mediated by visual attention, the effects of pace on recognition of temporal sequences are both mediated by visual attention and are independent of visual attention. By marking significant story events with production techniques like sound effects, the comprehensibility of fast-paced television programs can be increased for young viewers. Even so, the effects of complex visual variables like pace suggest that getting children to look at the screen is but one facet of getting them to recognize the content of what they view.

Notes

[1]All 137 television programs were part of a library scored for formal features including molar features like pace and action as well as specific auditory and visual features like dialogue, sound effects, narration, music, and specific camera techniques (e.g., zooms, dissolves). A detailed description of these programs and their formal features are described elsewhere (see Huston et al., 1981). Distributions for each feature were then made across the entire sample so that television programs could be examined as a function of particular formal features. In the study reported here, the rate of program pace was the feature by which programs were selected.

[2]The authors thank one of the reviewers for this point.

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