

Formal Features in Children's Science Television: Sound Effects, Visual Pace, and Topic Shifts

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This study analyzes the auditory, visual, and information-presentation pace of children's science television programs. These half-hour programs averaged more than 19 sound effects per minute, 14 visual changes (cuts, wipes, and fades/dissolves) per minute, and more than 27 topic shifts per program. These results indicate that the current crop of programs presents content at a pace that may reduce their effectiveness.

One prime factor influencing children's attention to television is the nature of the formal features used in producing a television program. Formal features are non-content elements of TV programs—such as cuts, wipes, fades, dissolves, zooms, and sound effects—that are used to help viewers follow the narrative and to convey concepts like change of location or passage of time (Calvert, Huston, Watkins, & Wright, 1982; Huston & Wright, 1983). Re-

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search has shown that certain formal features—sound effects, women's voices, animation, and rapid pace—reliably draw children's attention to the TV screen (Huston & Wright, 1983; Wakshlag, Day, & Zillmann, 1981).

The explanation for why some formal features draw children's attention to the TV screen resides in how children process television (Anderson & Burns, 1991; Anderson & Lorch, 1983; Huston & Wright, 1983; Pingree & Hawkins, 1982). Initially, when children watch television, their attention to the screen is essentially random. They attend to the television when perceptual salience (e.g., loud noises, bright lights, or motion) captures their attention by causing an orienting response (Huston & Wright, 1983; Ohman, 1979). However, as children get older (around 2½ to 3 years), the impact of the orienting response is greatly reduced. Instead, older children have learned through experience that some formal features signal content that is appropriate or interesting to them, and they turn their eyes to the screen when such formal features appear (Anderson & Burns, 1991; Anderson & Lorch, 1983; Pingree & Hawkins, 1982).

Research suggests that increased attention to the screen is associated with learning of program content (Calvert & Gersh, 1987; Calvert, Huston, Watkins, & Wright, 1982; Calvert & Scott, 1989; Campbell, Wright, & Huston, 1987; Wright, Huston, Ross, Calvert, Rolandelli, Weeks, Raeissi, & Potts, 1984). The more attention children pay to the screen, the more they learn. Thus, the presence of some formal features can enhance learning.

However, while some formal features seem to draw attention to and increase learning from television, other formal features may interfere with learning, depending on the task and the content (Anderson & Burns, 1991). For example, rapid scene changes, rapid character changes, and rapid presentation of humor enhance learning of TV content (Calvert & Scott, 1989; Wakshlag et al., 1981; Zillmann, Williams, Bryant, Boynton, & Wolf, 1980). In contrast, rapid presentation of information seems to degrade learning (Campbell et al., 1987). That is, rapid visual or auditory change can increase attention to the program, but rapidly switching from topic to topic may cause children to lose interest or simply be unable to understand the content.

The foregoing discussion suggests that the formal features of a television program (e.g., cuts, wipes, fades/dissolves, sound effects, and content pacing) are key to that program's effects. Unfortunately, while many studies indicate the importance of formal features to learning (e.g., Calvert et al., 1982; Wright et al., 1984; Zillmann et al., 1980) little work has been done to characterize these features in children's educational programs. Perhaps most important, the seminal content analysis characterizing formal features in children's television was conducted on programs produced more than 20 years ago (Huston & Wright, 1994; Huston, Wright, Wartella, Rice, Watkins, Campbell, & Potts, 1981). That work found that children's entertainment programs primarily presented formal features designed to gain attention (e.g., rapid action, music, and visual change), while educational programs presented many features designed to encourage thoughtful processing of content (e.g., long zooms, moderate action, and singing). The question is, has this pattern changed? Do educational programs still present formal features that encourage thoughtful processing?

The goal of this paper is to present an analysis of formal features in children's science education programs. To that end, a sample of children's science education programs was analyzed for the number of cuts, wipes, fades/dissolves, sound effects, and also for content

pace. This analysis allows speculation regarding the potential impact of children's science education programs on learning and sets the stage for future effects studies. It also updates our understanding of the use of formal features in children's programming.

METHOD

Program Descriptions

To characterize the pacing in children's educational science programs, four half-hour programs were analyzed. These programs were chosen to capture the diversity in science education programs today—they represent network and PBS offerings, animated and non-animated programs, and topical and question/answer formats.

Bill Nye The Science Guy (Buena Vista Television/PBS). Each episode of this program has a theme, such as marine mammals, rivers and oceans, or respiration. Each episode has several segments, including at-home experiments, on-location interviews with scientists, and demonstrations of scientific principles. Bill Nye, a standup comic and former mechanical engineer, shares the stage with several children, and celebrities occasionally stop by. The central location for the show is Nye Labs, which resembles a warehouse crammed with scientific paraphernalia. The target market for *Bill Nye* is grade school children, especially children ages 8 to 12.

Magic School Bus (PBS). In this animated program based on the popular children's book series, a school teacher (voice by Lily Tomlin) helps her students learn about scientific principles by taking them on field trips in their magic school bus. Typical field trips include going to a carnival, a bee hive, and a water treatment plant. The target market for *Magic School Bus* is preschool and early grade school children, typically ages four to seven.

Newton's Apple (PBS). In this magazine-format program, five hosts find the answers to viewer questions about scientific topics. To answer the questions, the hosts interview experts such as hematologists, physics teachers, pediatricians, and dieticians. *Newton's Apple* targets family viewers of all ages. It is designed to reach as broad an audience as possible, but usually attracts viewers older than 10.

Beakman's World (Sony Entertainment). In this program, Beakman (portrayed by performance artist Paul Zaloom) and his two assistants (an adult female and an adult male dressed in a rat suit) answer viewer questions about diverse science topics, including biology, physiology, physics, technology, medicine, and psychology. The setting for this program is a large, two-story stage cluttered with a mix of scientific and non-scientific paraphernalia. The target market for *Beakman's World* is grade school children, especially children ages 8 to 12.

Sample Selection

With the exceptions of *Beakman's World* and *Magic School Bus*, the program sample was drawn from the 1995-96 season. We analyzed all 13 episodes, the full season, of *Newton's Apple*. Of the 38 episodes of *Bill Nye The Science Guy*, we coded a random sample of 12 episodes to avoid biasing the data toward this program. Of the 13 episodes of *Magic School Bus* that were in the study, 12 episodes were from the 1995-96 season and one episode was from the 1996-97 season.¹ Of the 12 episodes of *Beakman's World* we analyzed in this study, four episodes came from season one (1992-93), four came from season two (1993-94), two came from season three (1994-95), and two came from season four (1995-96).²

Program Attribute Coding

Program characteristics coded in this study included number of topic shifts, sound effects, and visual pacing. To assess reliability on all program attributes, two independent coders coded a randomly selected episode of each program. Because the programs varied significantly in their use of production techniques and their content, reliability was assessed on a program-by-program basis.

Content pacing. Content pacing was assessed because previous research (e.g., Campbell et al., 1987) has shown that faster-paced content is harder for children to learn than slower-paced content. In this study, pacing of program content was assessed by counting the number of homogeneous segments in an episode. A homogeneous segment was defined as a unit within the program that was bounded on both ends by a shift in topic. In other words, it covered a single topic and was bounded on both ends by a transition to a new topic. Thus, a segment conveyed essentially a single idea. However, the segment did not have to cover a *complete* topic. When one topic was interrupted by another topic, this was considered a shift in topic and, therefore, a segment boundary.

Reliability for topic shifts was assessed by counting the number of times both coders found a topic shift. If one coder found a topic shift and the other did not, it was considered a mismatch; if both coders found a topic shift, it was considered a match. Reliability, as assessed by Cohen's kappa, ranged from 0.77 to 0.87.

Sound effects. Previous research has shown that sound effects elicit attention to the screen and result in greater learning from the program (e.g., Wright et al., 1984). For this study, a sound effect was considered to be any sound added to the sound track for effect (i.e., for comic effect or for emphasis). This did not include sounds that would normally be expected from what was occurring on screen, such as street noise (e.g., cars honking or construction noise) or background conversation. It included sounds that were exaggerated for effect (such as volcanoes erupting or wind that was louder than was warranted by what was occurring on screen). It also included short bits of music like drum rolls or fanfares. For sound effects that were a series of discrete sounds (e.g., clocks ticking, alarms whooping, or crickets chirping), coders counted every instance of the sound (every tick, every alarm whoop, etc.). Sound effects that were a series of sounds that couldn't be distinguished from each other (such as comic running noises or insect wings beating) were counted as a single effect.

Reliability was assessed by breaking an episode into one-minute segments and counting the number of sound effects in each segment. Reliability, as assessed by Pearson correlation, ranged from 0.83 to 0.97³.

Visual pacing. As noted previously, research has shown that visual change elicits attention to the screen and, thus, increases learning of program content. Because cuts, wipes, and fades/dissolves are obvious visual changes and because other studies have examined them (e.g., Huston et al., 1981), coders counted the number each of these features in each episode in the sample.

Reliability was assessed by counting the number of cuts, wipes, and fades/dissolves in each homogeneous topic segment of an episode. Reliability, as assessed by Pearson correlation, was acceptable, ranging from 0.85 to 1.0⁴.

RESULTS

In general, the programs in this study were fast paced. They used frequent sound effects and cuts, and switched from topic to topic quite rapidly.

Sound Effects Pacing

Research suggests that sound effects can elicit children's attention to the TV screen, improving comprehension (Calvert & Gersh, 1987). If this is the case, most of the programs in the study should frequently elicit viewer's attention. On average, the programs used more than 19 sound effects per minute, with some episodes exceeding 1000 sound effects in just 21 minutes.

However, there were significant differences among the programs ($F(3, 46) = 80.42, p < .05$). *Beakman's World* by far outstripped other programs in its use of sound effects, largely because of all the sirens, ticking clocks, and whooping alarms it used. At the other extreme was *Newton's Apple*, which used only two sound effects per minute, on average (Table 1).

TABLE 1
Average Number of Formal Features per Episode by Program

Program	Sound Effects per Minute	Cuts per Minute	Fades/ Dissolves per Minute	Wipes per Minute	Topic Shifts per Episode
Beakman's World	41.88	10.73	0.85	0.20	22.83
Bill Nye The Science Guy	13.96	17.46	1.02	0.11	37.50
Magic School Bus	20.73	13.44	0.49	0.10	19.62
Newton's Apple	2.03	11.81	0.70	0.23	29.08
Average Across Programs	19.32	13.33	0.76	0.16	27.14

Visual Pacing

Although research suggests that the use of fades/dissolves and wipes enhances reflective thinking about program content (Huston et al., 1981), the programs in this study used very few of these visual effects, averaging fewer than one per minute. Rather, the predominant form of visual change was cuts, averaging more than 13 per minute.

Cuts. While cuts were the most used visual-pacing effect across all programs, the programs differed significantly in the number of cuts per minute ($F(3, 46) = 24.96, p < .05$), with *Bill Nye The Science Guy* having, by far, the greatest rate of cuts (Table 1). It used nearly 50% more cuts than the average of the other three programs.

Fades/dissolves. While fades/dissolves were used sparingly in the four programs, averaging just under one fade/dissolve per minute, their use did differ significantly by program ($F(3, 46) = 3.44, p < .05$). *Magic School Bus* had the lowest rate of fades/dissolves and *Bill Nye* the greatest (Table 1).

Wipes. The programs also differed significantly in the number of wipes per minute ($F(3, 46) = 3.05, p < .05$), with the greatest number of wipes occurring in *Beakman's World* and *Newton's Apple* (Table 1). However, an inspection of Table 1 reveals that none of the programs used wipes very frequently, averaging only one wipe every 6 minutes.

Content Pacing

Research indicates that rapidly presenting information can decrease learning (Campbell et al., 1987). Yet, the pace of topic presentation in the educational programs in this study was generally quite high (see Table 1), averaging 27 topic shifts per episode. Again, there were

significant differences by program ($F(3, 46) = 34.55, p < .05$). *Bill Nye The Science Guy* led with an average of 37.5 shifts per episode; *Magic School Bus* lagged behind the rest of the programs, averaging approximately 19.5 topic shifts per episode.

DISCUSSION

The purpose of this study was twofold: (1) to add to the limited body of literature characterizing the use of formal features in children's educational programming by updating the work in this area, and (2) to determine whether the use of formal features in children's educational programming had changed over time, by comparing these results to the some of the findings from Huston et al. (1981). This latter purpose is particularly important given the push toward "edutainment" in children's programming.

Results indicated that, as in past work, the four programs in the study frequently used visual and auditory formal features. On the high end was *Beakman's World*, with an average of 13 visual and auditory features per minute. *Bill Nye The Science Guy* and *Magic School Bus* had 8 and 9 of these features, respectively. *Newton's Apple* had the fewest production features with approximately 4 features per minute. The differences among the programs may be due to differences in targeted audiences. Unlike the other three, which bill themselves as children's programs, *Newton's Apple* considers itself a family program. As a result, *Newton's Apple* may not be using as many attention-getting formal features because producers may assume that older adolescents and adults do not need these cues as much as children do.

While the programs contained numerous attention-getting features, they contained few formal features that would encourage thoughtful processing of content such as fades/dissolves and wipes. On average, the programs contained fewer than one of each per episode. And, while there were significant differences among the programs, these differences have little practical significance; all of the programs had an average of one or fewer fades/dissolves and wipes per minute. The dearth of features encouraging reflective thought in these programs differs from Huston et al. (1981). Given that one mission of educational programs is to encourage learning, producers might wish to decrease the number of cuts per episode and increase the number of fades/dissolves and wipes.

While most of the programs contained multiple formal features that would elicit attention to the screen, it is unclear whether attention to the screen will result in learning. Another important formal feature to assess in this respect is the rate of topic shifting. This rate is important because research indicates that children may learn less when information is presented too rapidly (Campbell et al., 1987). All four programs in this study changed topics rapidly, averaging 27 changes per episode. This high number of topic shifts becomes even more impressive when you consider that these half-hour programs in reality presented between 21 and 25 minutes of content per episode.

There were differences among programs in topic shifting. These differences can be explained in part by differences in target audiences. *Magic School Bus*, which is predominantly aimed at 4- to 7-year-old children, had the lowest number of topic shifts (averaging 19.5 per episode). The other three programs, which target older children and adults in addition to young children, averaged 23 to 37.5 topic shifts per episode. Overall, based on previous research, the high number of topic shifts in these three children's educational programs suggests that children may have trouble learning program content.

However, the question of effects will hinge upon whether it is the rate of presentation of information—topic churn—or the volume of information that is important. In this study, one program, *Bill Nye The Science Guy*, had the highest topic churn at 37.5 topic shifts per episode, yet each episode presented a limited number of topics, repeating them frequently throughout the episode. At the other end of the spectrum was *Magic School Bus*, which presented fewer than 20 topic shifts per episode, but had little repetition of information.

Taken together, the high number of attention-gaining formal features and the rapid pace of program content may work against one another. That is, based on previous audience studies, we would predict that while these programs may gain children's attention, the rapid pace of the programs could cause children to learn less of the content. This prediction, of course, depends on the differential effects of topic churn and information volume on learning.

In some ways, it is not surprising that these educational programs for children are fast paced, both from an auditory/visual standpoint and from a topic-shift standpoint. Educational programs are in a difficult position—they have to compete head-to-head with children's entertainment programs for viewers. As a result, these educational programs may be adopting more entertainment characteristics to attract audiences. An analysis of a sample of current children's entertainment programming, similar to that conducted by Huston et al. (1981), would provide a good comparison point.

Future research should include not only further content analyses, but also a series of effects studies to ascertain the effect on learning of the high number of both attention-eliciting formal features and topic shifts. Such studies would be particularly helpful to producers in determining the optimal ratio of attention-eliciting features to topic shifts, thus increasing the learning potential of educational programs for children.

NOTES

¹ Because of inventory problems, the producers of *Magic School Bus* were missing episode 209. They substituted episode 301 to provide the equivalent of a full season.

² Because *Beakman's World* is produced solely for commercial distribution, the producers were reluctant to provide an entire season's worth of episodes. Instead, they sent what they considered to be a representative collection of episodes from all four seasons. To ensure cooperation from the producers and to avoid copyright infringement, only the 12 programs provided were coded. Although the episodes were not chosen randomly, they appeared to be representative of the series.

³ Because of the density of sound effects, it was often impossible to determine whether coders were examining the same sound effect. Therefore, it was not possible to count matches and mismatches. For this reason, coders counted the number of effects in each minute of the program. We ran Pearson correlations on this data, rather than Cohen's kappa.

⁴ As with sound effects, the density of visual effects made it impossible to determine whether coders were examining the same visual effects. Therefore, it was not possible to count matches and mismatches. For this reason, coders counted the number of visual effects in each homogeneous content segment of the program. We ran Pearson correlations on this data, rather than Cohen's kappa.

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