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Pace and Continuity of Television Programs: Effects on Children's Attention and Comprehension

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Children's tv programs can be distinguished by the processing demands of their format and the pace with which changes occur. High-continuity programs are stories requiring temporal integration of successive scenes for full comprehension. Low-continuity programs are in "magazine" format: Successive bits are independent of one another, and temporal integration across bits is not required for comprehension. Pace is defined as rate of scene and character change in stories and rate of bit change in magazine shows. Sixteen children's tv programs varying in continuity (high vs. low), pace (high vs low), and animation (cartoon vs. live production) were made from broadcast material. Each lasted 15 minutes. Children (N = 160), half in grades K–1 and half in grades 3–4, viewed two of the programs and were then tested for recall. The recall task required sequential seriation of still photos taken from the program. Older children attended longer and reconstructed sequences better than younger children. High-continuity (story) programs led to greater attention and better recall than low-continuity (magazine) programs. Low-paced shows were recalled better than high-paced shows. Older children recalled best when shown either low pace or story format or both. Young children showed additive increments in recall due to low pace and high continuity: Either alone was better than none, and both was better than either alone. Younger children attended somewhat more to high- than to low-paced shows if they were in magazine format, a weak effect of perceptual salience. Older children attended to high-continuity programs in synchrony with their pace: longer looks to low-paced and shorter looks to high-paced programs. This effect was attributed to schematic and strategic processing by older children when the format justified it. Regression analyses indicated higher correlations between attention and recall for animated stories than for other types of programs, an effect attributed to their relatively high stereotypy in the medium. Age, continuity, and pace effects on recall were not fully accounted for by their effects on attention. Results were interpreted as indicating evidence for development of active, schematic processing of television by children and for strategic attending by older children, based on perceived processing demands.

Rapid pace is often used in both commercial and educational television to attract and hold children's attention. Cartoons and other commercial children's programs are short and are characterized by very rapid rates of change (Huston et al., 1981). Many educational programs, such as *Sesame Street* and *The Electric Company,* have also adopted rapidly paced formats comprised of short "bits" on the assumption that young children have brief attention spans and need frequent change to maintain their interest. Indeed many of the criticisms of these programs are based on the premise that such formats encourage shallow or passive processing, reduced mental effort, short attention span, and a taste for perceptual gimmickry, all of which may be inimical to thoughtful processing and constructive learning.

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The effects of pace on cognitive processing are of theoretical as well as applied interest. We have proposed earlier (Wright & Huston, 1981) that very young children's attention to television is governed more by the perceptual salience of the audiovisual events than by the viewer's agenda for information search and meaningful interpretation of messages. Perceptual salience refers to such properties as Berlyne's (1960) "collative properties"—intensity, contrast, change, movement, novelty, or incongruity—which are exemplified in children's television by such features as rapid pace (rate of scene and character change), high rate of action (physical movement of characters through space), frequent use of special effects, auditory and visual embellishment, and the like. The perceptual salience model suggests that for young children at least, high pace, with its short bits and frequent changes, directly elicits and maintains children's attention more effectively than low pace. The salience hypothesis is meant to describe initial perceptually based determinants of attention, and is expected to account for less attentional variance as the child's cognitive level and viewing experience come to play more important roles in sustaining attention and interest (Huston & Wright, 1983; Wright & Huston, 1983).

Although there is empirical support for the effects of many salient television features on attention, existing data do not provide strong support for the effects of rapid pace, per se, on attention. Anderson and Levin (1976) initially found that children paid more visual attention to short bits than to long bits while watching *Sesame Street,* a magazine format program consisting mostly of unconnected bits. However Lorch, Anderson, and Levin (1979) found no such differences when they compared specially constructed *Sesame Street* programs composed of long versus short bits (equivalent to low and high pace, respectively).

In a pilot study (Wright, Calvert, Huston-Stein, & Watkins, 1980), children attended to high-paced cartoons more than to low-paced cartoons, but when the content was changed to a magazine format, segments taken from *The Electric Company,* pace had no effect on visual attention. Moreover, children in middle elementary school were more attentive to the high-paced cartoons than were preschoolers, an age trend opposite to that predicted.

One reason for the inconsistent effects of pace on attention is suggested by more microscopic analysis. Pace is actually composed of changes to a new scene (not previously shown in the program), changes to a familiar scene, and changes in the cast of characters present. These changes are often marked by visual features, such as fades, dissolves, zooms, or pans, or by auditory features, such as changes in music, sound effects, or speech. Thus changes of scene sometimes elicit attention from a child who is not looking, but for a viewer who is attending, scene and character changes can sometimes prompt a temporary interruption of looking (Alwitt, Anderson, Lorch, & Levin, 1980; Wright et al., 1980). Older children, presumably better able to parse the flow of a program, used scene-change points as the occasion for both starting and stopping a look more regularly than did younger children in one of these studies, suggesting that they were more aware of the formal feature cues marking a breaking point in the program. It appears that at least for school-age children, scene and character changes are attentional decision points. Therefore, for them, rapid pace may lead to frequent shifts in attention, rather than to longer durations of looking (Huston & Wright, 1983).

One formulation (Huston-Stein & Wright, 1979), proposed a developmental shift from perceptual salience as a basis for attentional decisions toward search for information based on processing the content of the program. That is, the cognitive-processing requirements of the program should become increasingly important for attention as children become older, more cognitively sophisticated, and more experienced with television.

Two other theoretical models concerning the relation of cognitive processing to attention have been proposed. Krull and Husson (1979) suggested that high pace and unpredictability of content would increase the processing demands of the program, resulting in cognitive arousal, a prediction they confirmed with respect to autonomic activity while viewing by adolescents. They predicted and found greater attention to high- than to low-paced programs, an effect they attributed to the higher levels of arousal induced by the former.

Anderson and his colleagues (1981) have proposed an alternative model in which attention is determined by the perceived comprehensibility of the content being presented.

Both the content itself and certain accompanying features can serve to signal whether a program is intended for children and thus whether a child is likely to be able to understand it. If the scenes and characters in a program change rapidly, a child may not be able to make the connections and inferences necessary for temporal integration and logical comprehension of the narrative. If it is all happening too fast there may be a corresponding reduction in comprehensibility, with a consequent loss of attention relative to a lower paced program of otherwise equal difficulty. The comprehensibility hypothesis appears to predict exactly the opposite of the salience and arousal hypotheses regarding the effects of pace on attention: that low-paced programs, being easier in general to understand, should receive more attention than high-paced programs, as the latter prove to be less comprehensible, especially for younger children. It is likely that salience and cognitive-processing requirements both play a role in determining attention, for as Salomon (1981) has shown, these same attributes in concert with the child's expectations can determine the level of mental effort invested in processing television.

In the present study, we investigate the hypothesis that certain aspects of a program determine the kind and depth of processing that a child invests in understanding it. When the content is not cumulative, that is, when little logico-temporal integration of content messages appears to be required, then children's attention and recall should be more influenced by superficial perceptual attributes of the program. But when more cumulative processing is called for, signaled by cues that events seen and heard are interconnected and require logico-temporal integration, then attention and subsequent processing should be governed more by the informational needs of the child as he or she makes an effort to understand (cognitive arousal), and more by the success she or he experiences in so doing (comprehensibility), but less by the superficial perceptual attributes. High pace should enhance attention in the former case (low continuity of content), but whether high or low pace would lead to greater attention in the latter case (high continuity) is not clear, as reasonable predictions can be made in both directions.

The two kinds of processing just described correspond to Mandler's (1979) distinction between schematic and categorical organization. A magazine format program, that is, one containing separate bits that are essentially self-contained and could logically be presented in any order, does not lend itself to organization by a schema based on temporal or logical connections among its parts. It probably elicits discrete or noncumulative processing of bits, each enjoyed for its self-contained attributes, but not integrated into a larger meaningful message. To be sure, each bit may require its own internal integrative processing, but with each bit change there is a fresh start.

However, much of television consists of high-continuity stories that do lend themselves to schematic processing (Collins, 1982). Understanding a television story is inherently a matter of processing sequenced, connected, time-locked event structures and narratives (Wright, Watkins, & Huston, 1978). The connected narrative or story format both demands effort for children to achieve temporal integration of its plot and offers them an opportunity to exercise existing schemes and scripts drawn from their real-world and television knowledge bases to help them prestructure, anticipate, rehearse, and organize the content into a coherent tale.

Collins and his associates have delineated many of the cognitive processes children use to understand narrative, portrayed on television (Collins, 1982; Collins, Sobol, & Westby, 1981). They have suggested that children under age 8 or 9 do not readily achieve logico-temporal integration of televised stories. Young children do not make inferences that serve to connect explicitly presented bits of information with content that is implied but not shown. Nor do they make appropriate inferences about characters' feelings and motives as explanations for their behavior. Although Collins and his colleagues have identified many of the cognitive processes involved in understanding televised stories, it seems likely that they have underestimated young children's abilities by conducting their research with adult programs. Not only are the story scripts complex (e.g., they have extensive subplots), but they also require real-world knowledge that young children do not have (e.g., understanding the interpersonal implications of testifying against someone in court).

In the present study, we investigated the possibility that the effects of pace on attention

are different in stories than in magazine format programs. That is, rapid versus slow pace should have different effects when children are engaging in processing that is noncumulative. Within each type of program, pace could influence attention and processing on the basis of its perceptual salience or on the basis of the processing demands it makes on the viewer. But it is likely that salience should have stronger effects for magazines (low continuity) than for stories (high continuity). In addition, we hypothesized that older children (9 and 10) are likely to be less responsive to salience than younger children (5 to 7). Older children, of course, may also be better able to discriminate the two formats and their differential processing demands. Thus, the formats may have more distinctive effects on their attention than on that of younger children.

Children's attention to programs varying in pace (rate of scene and character change) and continuity (story vs. magazine format) was measured. In addition, recall of the temporal sequence of program events was measured as a test of the amount of schematic processing the child had done. If children organized story material schematically as they viewed, then recall of the temporal sequence should be better for stories than for magazine formats, as the latter cannot as readily be organized into temporal schemes. If children did not use schematic processing, then recall for the two types of programs should not differ. Two age groups (kindergarten and first grade vs. third and fourth grades) were compared to assess developmental differences.

Method

Subjects

Participants were 160 children who attended a public school in a small midwestern city They were equally divided by age (kindergarten and first grade vs. third and fourth grades) and by sex.

Television Programs

Sixteen programs were selected from a library of approximately 150 broadcast children's television programs that had been scored for formal features Eight high-continuity programs were stories designed for children. Each had a relatively well-developed plot, no programs consisting of simple chase plots or disconnected sight gags were included. All stories were originally made for commercial television and lasted 20 to 25 min in their broadcast version (one lasted 50 minutes). Each was edited so that it lasted approximately 15 minutes, and so that each story plot was meaningfully developed and resolved within the 15-min edited version, including titles and credits.

Table 1
Rates Per Minute of Scene and Character Changes for Programs Varying in Pace, Continuity, and Animation

Continuity	Bit* change	Scene change	Character change	Total
		Low pace		
Low				
Animated	.34	2.27	3.12	5.39
Live	.45	.65	1.37	2.02
High				
Animated		1.25	3.23	4.48
Live		.95	1.31	2.26
		High pace		
Low				
Animated	1.25	3.29	5.15	8.44
Live	1 30	3.23	3.56	6.79
High				
Animated		5.16	5 45	10.61
Live		5.01	5.36	10.37

* only applies to magazine (low-continuity) format

Of the eight high-continuity programs, four were high paced and four were low paced Pace was defined as the rate of scene and character changes. Half the programs at each pace level were animated and half were live. Because animated programs have a higher average level of pace than live programs, the absolute levels of pace for the animated and live programs differed. Nevertheless there were marked differences between the high- and low-paced programs. Moreover, editing was used to further increase or reduce pace for the high- and low-paced programs, respectively. The mean rates of scene and character change for each level are shown in Table 1.

The low-continuity programs were magazine format shows in which the individual "bits" had no causal relationship to one another and no logical sequence. Four of the original programs from which they were taken were originally made for commercial broadcast and four for public television. High and low pace were defined by the length of bits. For the high-paced shows a series of short bits was edited together; for the low-paced shows a series of long bits was assembled. As much as possible, selections were made that contained relatively few or no scene changes within bits. Again, half the shows within each level of pace were animated and half were live. Each show lasted approximately 15 min in its edited version, including beginning and ending titles and credits. The rates of scene and character change and the rates of bit change are also shown in Table 1.

Experimental Design

The 16 programs formed four cells of a design that crossed high–low continuity (story vs. magazine) with high–low pace. Within each cell two programs were animated (Programs A and B) and two were live (Programs C and D). Each child was assigned to see two programs (one animated and one live) from one of the four cells of the pace by continuity design. Within each continuity by pace cell, half the subjects saw Programs A and C; the other half saw Programs B and D. Thus the complete experimental design included Age (2) × Sex (2) × Continuity (2) × Pace (2) × Pairs (5) as between-subjects variables, and animation (2) as a within-subjects variable. Program set (A–C vs B–D) was nested within continuity and pace.

Procedure

Children were brought to a two-room mobile laboratory, parked on school grounds, in same-sex pairs. When they entered the viewing room, they were told that they would see some television. They were seated facing each other at a small table, arranged so that each child's chair was at a 90° angle to the color tv monitor (though the chairs could easily be turned by the children, and often were) Paper, crayons, magic markers, and a variety of small toys were on the table. The participants were told that they could play with any of the materials, talk, or watch TV, but they were asked to remain seated at the table The purpose of the toys and of viewing in pairs was to provide enough alternative activities so that attention would vary and to make the situation similar in some respects to natural home viewing. Children were told that they would be asked some questions about the programs later. The adult experimenter announced that he or she would be in the next room if needed and went into the control room.

Shortly after the adult left the room, the first program began. When the first program ended, the adult entered the viewing room very briefly to ask if they were comfortable or needed anything. She or he then explained that another program would start soon and returned to the control room. The second program was then shown Within each cell of the design the order in which the two programs were shown was counterbalanced across pairs of subjects

Children's visual orientation to the monitor was scored continuously as off or on by two observers (one assigned to each child) on a Datamyte recorder. The one-way mirror through which the observer watched was located directly behind, and just above the tv monitor The time of each onset and offset of looking at the screen was recorded automatically. Videotapes of all sessions were made In a few cases, attention was rescored from the tapes because live scoring had been disrupted or because data were lost from the Datamyte. Observer agreement was assessed by having two observers score videotaped records independently. Agreement occurred when both observers coded an onset or an offset within 4.8 s of one another Agreement was 96%, using the following formula. number of agreements × 2, divided by the total number of scores by both observers. Subsequent reliability checks on live scoring have yielded 97% agreement.

The following three attention scores were calculated for each child: (a) duration—the total looking time divided by the length of the program. The score can be thought of as percentage of time spent looking, (b) frequency—the total frequency of looking (number of looks) per minute, (c) duration per look—the average length of looks, defined as the total looking time divided by total frequency

Comprehension of Temporal Sequences

At the end of the second program, tests of comprehension were administered to each child individually. The seriation task was to arrange photos in the order in which they appeared in the program. Seriation measures of comprehension were selected because the main theoretical focus of the study was the child's recall of logical and temporal sequences within programs. Seriation measures also have the advantage of not requiring verbal description by the experimenter or by the child. Two levels of seriation were tested· whole-program seriation and segment seriation.

Whole-program seriation For each of the 16 programs, five still photographs were made representing scenes sampled from throughout the program. The scenes were chosen to be distinctive and to represent central (as contrasted with incidental) program events For the low-continuity programs, each photograph was taken from a different bit. For the high-continuity programs, each depicted a different scene in the story.

Segment seriation One segment, 1 to 3 min long, was selected from each of the 16 programs for a mini-seriation item. Five photographs were taken from within this segment For low-continuity programs, the segment-seriation items were taken from a single bit.[1] For the high-continuity programs, they were taken from one portion of the story, comprising one or two contiguous scenes.

Administration All seriation sets were administered after children had viewed both programs, because testing after the first program might have influenced attention to the second program One of the children was invited into the control room for an interview with one adult, while a second adult interviewed the other child in the viewing room

Six seriation sets were administered to each child. The first two were the whole program and segment-seriation sets, respectively, from the *last* program the child had seen during the viewing session Hence, they represented fairly immediate recall Next the whole-program and segment-seriation sets from the *first* program shown in the viewing session were administered Thus, they measured delayed recall, with possible interference from the intervening television viewing and testing For each set the child was shown the pictures in scrambled order and asked to arrange them in the same order in which they occurred within the television programs. Children were encouraged to verbalize the basis for their picture-arrangement decisions.

Finally, each child responded to the whole-program and segment-seriation sets for one additional program that he or she had *not* seen The purpose of this procedure was to determine the effects of cues in the pictures, previous familiarity with the program, or other factors extraneous to the experimental viewing experience These scores were used to control for possible differences in difficulty among the seriation sets for different programs The "unseen" program was always selected from the same pace and continuity cell of the design, as were the programs that the

[1] Except for one animated and one live program in the low-continuity, high-paced cell, where they were taken from adjacent bits.

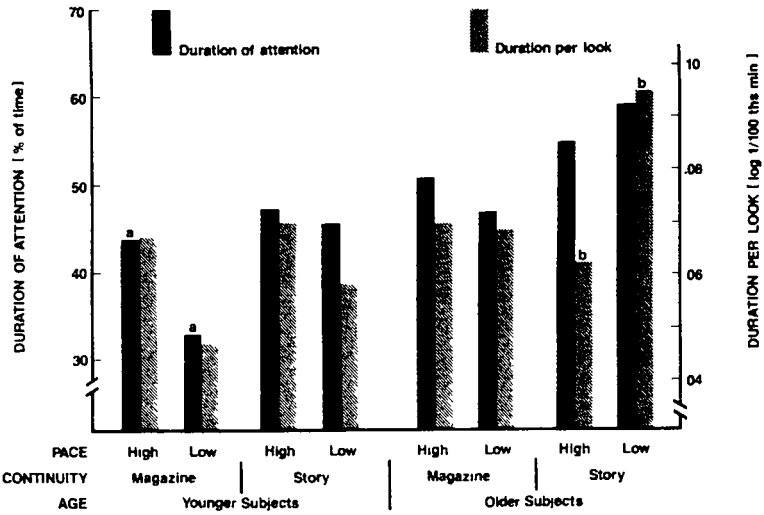

Figure 1 Attention to programs as a function of age, pace, and continuity. (Difference between means marked "a" is of borderline significance, $p < .10$ Difference between means marked "b" is significant, $p < .05$.)

child had seen When children were given these final "unseen" seriation items, the adult explained that they came from a program the child had not seen but that the child should try to arrange them as she or he thought they would occur in a television program.

Scoring The seriation score for each set was calculated by comparing the temporal sequence of the pictures with the correct sequence on two criteria: how close each picture was to its correct absolute position and how many pictures were sequenced correctly, regardless of absolute position. For this purpose, the pictures were correctly numbered from 1 to 5. Then the seriation score was calculated as follows. (a) For each picture in turn, one point was given for every picture with a lower number that was placed to the left of it The maximum number of possible points was 10. This part of the score correlates very highly (.98) across all possible sequences, with scores derived by calculating the rank-order correlation (rho) between each order and the correct one. Such an index, however, based solely on the absolute position of each picture, fails to give sufficient credit for correct partial sequences that are misplaced For example, the response sequence 23451 receives a rho of 0, whereas the sequence 13254 receives a rho of .80. Therefore a second component of the seriation score was devised. (b) The second part of the score consisted of one point for each pair that was placed in correct adjacent order, regardless of overall position. The maximum number of points on this part was 4. The correlation of this part with rho across all possible sequences is only moderate— 45.

The total seriation scores were calculated by adding the two parts. Although the maximum number of possible points is 14, all 14s were reduced to 12, because obtained scores of 12 and 13 are numerically impossible. The final total scores were normally distributed. The total score for the sample sequence 23451 is 9, and for the sample sequence 13254 it is 8. The correlation of total seriation score with rho across all possible sequences is .89.

Results

Attention to Programs

Initial analyses indicated that frequency and duration of looking were normally distributed, but duration per look was positively skewed. Accordingly, duration per look scores were submitted to a log transformation, which normalized their distribution. Initial analyses also indicated no important effects of the order in which programs were seen, and so orders were ignored in all subsequent analyses.

Each measure of attention was submitted to an analysis of variance (ANOVA) in which between-subjects effects were Age (2) × Sex (2) × Pace (2) × Continuity (2) × Pairs (5), and the within-subjects effect was animation (2). Pairs entered as a random variable; therefore error terms for all other effects were based on pair scores. Within each level of the Pace × Continuity × Animation classification, the two programs (A vs. B, or C vs. D) were not distinguished. Hence, any differences attributable to the content of particular programs within cells contributed to error variance.

Duration of looking. The proportion of time spent looking at the monitor is shown in Figure 1. Children spent more time looking at high-continuity programs than at low-continuity programs, $F(1, 64) = 6.24$, $p < .05$. They looked 52% of the time during the high-

continuity programs and 44% of the time during the low-continuity programs. There were no significant main effects or interactions associated with program pace, but a planned contrast between attention to high- and low-paced magazine programs for younger children approached significance ($p < .10$). For them, high-paced magazine shows got more attention than low-paced magazine shows. Older children spent more time looking than younger children, $F(1, 64) = 9.86$, $p < .01$. The mean proportions of time spent looking were 53% and 42%, respectively. There were no significant interactions of age with program characteristics.

Boys spent more time looking than girls, $F(1, 64) = 5.43$, $p < .05$. A borderline interaction of Sex × Animation, $F(1, 64) = 3.69$, $p < .06$, signified that the sex difference occurred primarily on the animated programs. For the animated programs boys attended 56% of the time, whereas girls looked 43% of the time. The corresponding figures for live programs were 47% and 45%, respectively.

Duration per look. The two age groups differed in their mean log duration per look during high- and low-paced programs, as indicated by the significant interaction of Age × Pace, $F(1, 64) = 4.42$, $p < .05$. Older children had longer looks during low-paced programs (.081) than during high-paced programs (.066). Younger children showed the reverse pattern: Their looks were shorter during low-paced programs (.051) than during high-paced programs (.068). Subgroup comparisons indicated that older children looked significantly longer per look at low-paced than at high-paced story programs ($p < .05$). There were no other significant main effects or interactions for duration per look. The means appear in Figure 1.

Frequency of looking. Looking frequency was submitted to an analysis of covariance (ANCOVA) in which the covariate was duration of looking. In previous studies, including the pilot studies for this one, frequency was negatively correlated with duration, perhaps because children who spend most of their time looking do not look toward and away from the screen as often as those who spend less total time oriented to the screen. In any case, looking frequency is of interest only as an index of the pattern of looking. It, of course, duplicates in reverse some of the variance contained in the duration-per-look index.

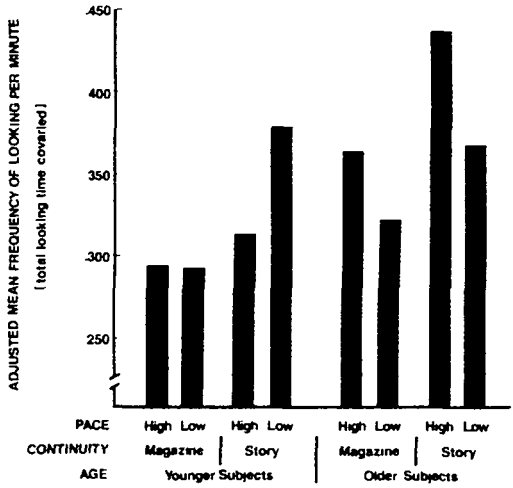

Figure 2 Adjusted mean frequency of looking (per minute), with duration of looking covaried, as a function of age, pace, and continuity

With duration controlled, children shifted gaze more often during high-continuity than during low-continuity programs, $F(1, 63) = 11.46$, $p < .01$. Older children shifted gaze more often than younger children, $F(1, 63) = 8.69$, $p < .01$. There was a significant interaction of pace by age, $F(1, 63) = 5.43$, $p < .05$, which replicated in reverse the pattern found for duration per look. During low-paced programs younger and older children shifted gaze about equally often. However, younger children shifted less often during high-paced than during low-paced programs, whereas older children shifted more often during high-paced than during low-paced programs. The adjusted means are shown in Figure 2.

Similarity of children viewing together. Children had patterns of attention that were more similar to those of their partner in the same pair than to those of other children. For total duration of looking and duration per look, there was a significant effect of pairs in the ANCOVA, $F(64, 80) = 5.23$, $p < .001$, and $F(64, 80) = 2.90$, $p < .001$, respectively.

Comprehension of Temporal Sequences

Whole-program seriation. The total program-seriation scores were submitted to ANCOVAs in which age (2), sex (2), pace (2), con-

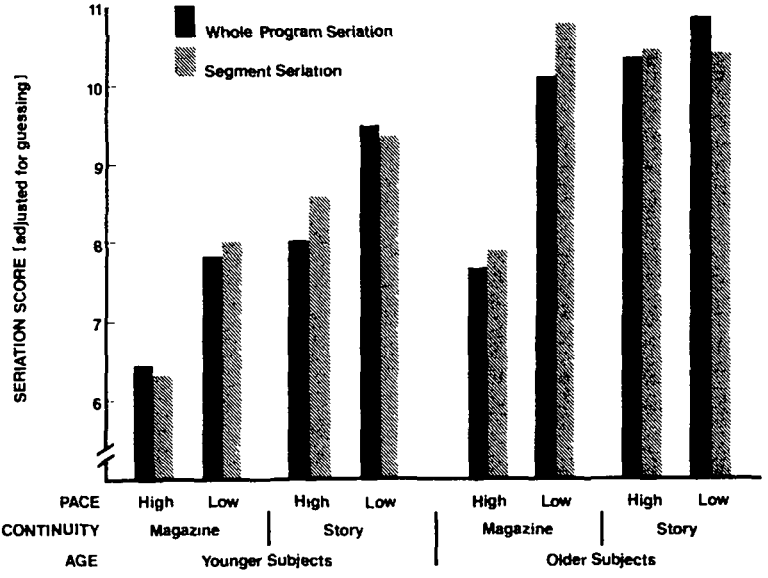

Figure 3 Comprehension of programs indexed by seriation scores as a function of age, pace, and continuity.

tinuity (2), pairs (5), and animation (2) were independent variables. The covariate for each television program was the mean "unseen" seriation score obtained by the control group of children who had not seen that program.[2] The seriation performance data are shown in Figure 3.

Children performed whole-program seriation better on the low-paced than on the high-paced programs, $F(1, 62) = 27.70$, $p < .001$, and they performed better on the high-continuity than on the low-continuity programs, $F(1, 62) = 36.18$, $p < .001$. Older children performed better than younger ones, $F(1, 62) = 44.20$, $p < .001$. Of borderline significance was the interaction of pace by continuity by age, $F(1, 62) = 3.76$, $p < .06$.

Although both age groups performed better on high- than low-continuity shows and on low- than high-paced programs, the pattern of intermediate scores was somewhat different. For older children, either of the "favorable" attributes—high continuity or low pace—led to performance that was almost as good as when both favorable attributes were combined. For younger children, by contrast, there was an additive effect: Low-paced stories were sequenced best; high-paced stories or low-paced magazine programs were intermediate; and high-paced magazines were sequenced very poorly. There were no other significant effects on whole-program seriation scores.

Segment seriation scores. Parallel analyses were performed on the segment seriation scores shown in Figure 3. Again children performed better on low-paced than on high-paced programs, $F(1, 62) = 18.39$, $p < .001$; and they performed better on high-continuity than on low-continuity programs, $F(1, 62) = 30.08$, $p < .001$. There was a significant interaction of pace by continuity, $F(1, 62) = 47.51$, $p < .001$, and a borderline three-way interaction of pace by continuity by age $F(1, 62) = 3.85$, $p < .06$. The pattern of findings is similar to that for whole-program seriation.

Unlike the whole-program scores, however, there were differences in seriation of segments associated with animation. The means are shown in Table 2. There was a significant main effect of animation, $F(1, 62) = 14.14$, $p < .001$, and significant interactions of Anima-

[2] It is obviously impossible to obtain such a control score from a child who has seen the program. Accordingly, the mean for other children who had not seen the program was considered to be the most appropriate estimate of the score that might be obtained by use of the cues in the still pictures and general world and media knowledge. There were no effects of age, sex, pace, or continuity on the "unseen" scores.

Table 2
Adjusted Segment Seriation Scores for Programs Varying in Pace, Continuity, and Animation

	Continuity			
	Animated		Live	
Pace	Low	High	Low	High
Low	8.95	8.05	9.81	11 78
High	8.18	8.89	6 06	10 09

tion × Pace, $F(1, 62) = 24.60$, $p < .001$, and Animation × Continuity, $F(1, 62) = 26.41$, $p < .001$. Children performed better on live than animated programs for all combinations of pace and continuity, *except* those with high pace and low continuity. For those rapidly paced magazine shows, children were able to recall the serial order within a short segment better for animated than for live shows. Because there were only two television programs in each cell, this result may reflect idiosyncratic properties of particular programs.

Order effects. An ANOVA of age (2) × order (2) × pace (2) × continuity (2) × pairs (5) × animation (2) was performed for each type of seriation score. Order was coded 1 when the animated program was shown first and 2 when the live program was shown first. In the analysis, therefore, the interaction of Animation × Order reflects the real effects of order of presentation for particular programs. No covariates were entered because the comparison of two orders of administration always involved comparing scores for the same programs.

There were no effects of order for whole-program seriation, but there were some significant effects for segment seriation scores. The relevant means appear in Table 3. There was a significant interaction of Continuity × Order × Animation, $F(1, 64) = 5.63$, $p < .05$, and a five-way interaction of Age × Pace × Continuity × Order × Animation, $F(1, 64) = 4.33$, $p < .05$. For magazine programs only, segment seriation scores were better for the program seen last and tested immediately after viewing than for the program seen first and tested after a delay. This recency effect for magazine programs only was confined to cells where performance was intermediate. That is, it appeared for younger children in low-paced programs and for older children in high-paced programs. It did not appear either for younger children in high-paced programs, where scores were consistently low, nor for older children in low-paced programs, where scores were consistently high.

For high-continuity programs (stories), order of presentation and testing had no significant effects on either whole-program or segment seriation performance.

Similarity of children viewing together. Although comprehension was tested individually for each child in a separate room from the pair-mate, pairs of children viewing together could not be assumed to have independent scores. If, for example, attention during viewing influenced comprehension, then the mutual influence of two children on each other's attention during viewing could lead to their having similar patterns of comprehension. The two children in a pair were also free to discuss and rehearse program content during viewing. In the ANOVAs of whole-program and segment seriation scores, the main effect of pairs was significant for whole-program seriation, $F(64, 80) = 1.84$, $p < .01$, but not for segment seriation scores. Even for whole programs, however, pairs accounted for a relatively small proportion of variance.

Relation Between Attention and Comprehension

The relation between individual patterns of attention and comprehension scores were examined in a series of multiple regression analyses formatted in two different ways: predicting

Table 3
Mean Segment Seriation Scores by Order of Testing/Viewing

	Order of viewing			
	Low continuity		High continuity	
Pace	First	Second	First	Second
Low				
Younger	6.95	8 75	9.35	8.90
Older	10.55	10 65	9.90	10.35
High				
Younger	6.55	6.90	8.75	8.45
Older	7 35	9.25	10.70	10.25
All subjects	7.85	8.89	9.68	9.49

Table 4
Multiple Regression of Whole-Program Seriation Scores

Predictor	Live programs			Animated programs		
	Beta	Increment in R^2	F to enter	Beta	Increment in R^2	F to enter
1. Duration	.10	.06	4.60*	.38	.18	17.49**
2. Frequency	.21	.08	7.75**	.26	.14	16.16**
3. Age group	.29	.07	6.42*	.28	.07	7.83*
4. Continuity	.28	.08	8 36**	.22	.04	5.55*
5. Pace	−.37	.13	17.35**	−.17	.03	3.88
Overall F		(5, 74) 10.87**			(5, 74) 12.53**	
Overall multiple R^2		.42			.46	

* $p < .05$ ** $p < .01$.

comprehension from attention and predicting attention from comprehension, in each case using age and treatment as additional predictors. Because there was some relationship between the attention and whole-program comprehension scores of pairs of children who viewed together, pair means were used as entries in the multiple regressions. Analyses were performed separately for animated and live programs because each child saw one program of each type.

Prediction of comprehension from attention. In the prediction of comprehension scores, the attention measures, duration and frequency of looking, were forced to enter first, followed by age, continuity, and pace. This procedure was designed to determine the extent to which the effects of age and treatments might be mediated by attention.

The regressions for predicting whole-program seriation in live and animated programs are shown in Table 4. Both attention duration and attention frequency predicted significant proportions of the variance in both types of programs. Even with attention statistically controlled, older children performed better than younger ones; seriation scores were higher for high-continuity than for low-continuity programs; and, for live programs, children recalled low-pace better than high-pace programs. That is, the effects of age and treatments on comprehension were not entirely accounted for by their effects on attention.

The major difference between the regressions for animated and live programs was that attention accounted for twice as much variation in comprehension of animated, as compared to live programs (32% vs. 14%). For animated programs, duration of attention was a somewhat stronger predictor than frequency, whereas the reverse was true for live programs. In live programs, low pace was associated with much better seriation than high pace, even with all other variables controlled. In animated programs, pace did not account for comprehension after the effects of other variables were removed.

Subanalyses were carried out for high- and low-continuity programs separately. The results appear in Table 5. The effects of attention on comprehension were in general stronger for story than for magazine formats. By contrast, the independent effects of pace on comprehension occurred primarily in live magazine formats.

Subanalyses were also performed for older and younger children separately. They appear in Table 5. Both attention and treatments accounted for more variance in older than in younger children's seriation scores.

In summary, these analyses show that attention, age, continuity, and pace accounted for just under half the variance in the whole-program seriation scores.

When segment seriation was the dependent variable, fewer effects reached significance than when whole-program seriation was analyzed. Attention was not a significant predictor of comprehension even when entered first, but the patterns of relationship were similar. Accordingly, they are not reported here.

Prediction of Attention From Comprehension

The second set of multiple regressions were designed to predict attention as a dependent variable. On the grounds that actual compre-

Table 5
Multiple Regression of Whole-Program Seriation Scores for High- and Low-Continuity Programs and for Older and Younger Children

	Live programs						Animated programs					
	High continuity			Low continuity			High continuity			Low continuity		
Predictor	Beta	Increment in R^2	F to enter	Beta	Increment in R^2	F to enter	Beta	Increment in R^2	F to enter	Beta	Increment in R^2	F to enter
1. Duration	.20	.07	3.07	.04	.00	0.01	.57	.30	16.28**	.17	.07	2.76
2. Frequency	.24	.13	5.54*	.26	.07	2.71	.39	.19	14.14**	.08	.02	0.89
3. Age group	.42	.14	7.90**	.20	.05	2 17	.21	.04	3.14	.44	.17	8.57**
4. Pace	−.12	.01	0.80	−.63	.37	25.49	−.04	.01	0.13	−.26	.07	3.34
Overall F	(4, 35)		4.81*	(4, 35)		8.46**	(4, 35)		10 10**	(4, 35)		4.29**
Overall multiple R^2	.35			.49			.54			.33		
	Younger children			Older children			Younger children			Older children		
1. Duration	.23	.03	1.25	.01	.02	0.80	.26	.11	4 61*	.57	.19	8.74**
2. Frequency	.01	.04	1.64	.40	.08	3.39	.30	.13	6.42*	.34	.14	7.65**
3. Continuity	.22	.04	1.64	.40	.19	9 49**	26	.06	3.03	.23	.07	2.98
4 Pace	−.40	.13	5.69*	−.56	.27	21.38**	−.12	.01	0.68	−.26	.04	4.17*
Overall F	(4, 35)		2.72*	(4, 35)		11.10**	(4, 35)		3 97**	(4, 35)		6.97**
Overall multiple R^2	.24			.56			.31			.44		

* $p < .05$. ** $p < .01$.

hension scores may serve as one index of comprehensibility, and that such differential comprehensibility might be perceived early in a program and thus have an opportunity to influence attention to the remainder of the program, the comprehension scores were entered as predictors of attention, along with age, continuity, and pace, in two different forced orders: comprehension first and comprehension last. None of the analyses significantly predicted frequency of looking. Accordingly, only the analyses of duration of attention are reported. The results appear in Table 6.

For live programs, even when comprehension was forced to enter first, only whole-program seriation entered, and it accounted for only a 6% increment in R^2. Continuity was the only other significant predictor. For animated programs, comprehension (whole-program seriation) was the only significant predictor. The total amount of variance predicted was considerably smaller when attention was

Table 6
Multiple Regression of Attention Duration Scores

	Live programs			Animated programs		
Predictor	Beta	Increment in R^2	F to enter	Beta	Increment in R^2	F to enter
1. Whole-program seriation	.05	.06	4.60*	.42	.18	17.49**
2 Segment seriation	.20	.04	3 47	.06	.01	0.67
3 Age group	.17	.02	1.88	.04	.00	0.14
4. Continuity	.24	.07	6.56*	−.04	.00	0 07
5. Pace	.23	.04	3.60	.07	.01	0.47
Overall F	(5, 74)	4.34**		(5, 74)	3.64**	
Overall multiple R^2	.23			.20		

* $p < .05$. ** $p < .01$.

the dependent variable than when comprehension was the dependent variable.

Discussion

We began with the general notion that attention to, and comprehension of, television programs was a complex resultant of program features such as pace and continuity in interaction with the active processing skills and motivation to employ them brought to the situation by the child. Some features, like pace, create both perceptual salience and processing difficulty. Program formats, like magazine vs. story and animated vs. live production, can demand and support different kinds and depths of processing of content. That anticipated complexity is supported by the results, for few effects took the same form across all types of programs and both ages of viewers.

Regardless of animation, pace, and continuity, older children visually fixated the screen during greater portions of the programs and achieved higher seriation scores than younger children. The differences in comprehension would have been remarkable only if they had failed to occur.

Contrary to assumptions often made by both producers and their critics, high-paced programs did not receive consistently greater attention than low-paced programs. A nearly significant effect in that direction occurred only once: for younger children when they were watching magazine format shows. By contrast, the effects of pace on comprehension were clear: High-paced shows were more difficult to integrate and sequence over time than were low-paced shows.

Pace did significantly affect the patterning of attention for older children, primarily when they viewed high-continuity programs. In that one case, where processing may have been most intensive and integrative, length of looks appeared to depend on length of scenes or bits as indexed (negatively) by pace. This finding also supports the hypothesis that older children are more sensitive to the formal feature cues for transitions in content than are younger children.

Stories received more overall attention than did magazine programs. Both seriation measures of comprehension also favored story programs over magazine shows for both age groups, suggesting that younger as well as older children benefited from the schematic organization of the stories. The view that the stories were processed schematically is further supported by the finding that there were no recency effects for story recall. For magazine shows, there were recency effects on segment seriation. Close attention to stories was more likely to improve serial recall; presumably the schematic organization provided by the story could be used by an attentive child. In magazine shows, attention did not produce large improvements in seriation; instead, the overall number of segments (per unit time) indexed by pace seemed to govern the ease of recall.

These findings suggest that both age groups were able to use schematic processing and to achieve temporal integration of the content of stories. The major difference between age groups was the extent to which "supportive attributes" (i.e. high continuity and low pace) were important. For the older children, either attribute was sufficient to enable them to achieve high levels of recall. For the younger children, the contributions of story format and low pace to comprehension were additive: Either one was better than neither, and together they were even more helpful.

The findings provide some support for the hypothesis that ongoing comprehension of content increases attention (Anderson, Lorch, Field, & Sanders, 1981). Comprehension scores predicted attention. They accounted for the effects of age on attention, and, for animated programs, they accounted for the main effects of continuity. As there were no main effects of pace on attention, there was little variance associated with pace to account for. In live programs, however, the effects of continuity on attention remained after comprehension was removed. Children's attraction to live stories was apparently based on more than the comprehensibility of the content.

Animated programs in America are a different genre than live programs. A much narrower and more stereotyped set of expectations is aroused by knowing that a program is animated than by knowing it is live. The range of pace variation we were able to find in animated programs was smaller, and the overall pace was higher than in live programs. These differences are part of the reality of broadcast

television. Although animation had only one weak effect on attention (boys preferred animated to live programs in overall attention; girls did not) and had no effects on comprehension, it nevertheless seemed to amplify the relationship between attention and comprehension. It is as if animated stories are more predictable and familiar than either animated magazine bits or live programs, especially to the older children, who presumably have more experience with the medium and its conventions. They are thus able to make more nearly dichotomous decisions about the appeal of a program early in the show. If they like the genre, they attend more closely and recall correctly; if not they do neither. Hence, in those cells and for those children, the correlations between attention and comprehension are exceptionally high.

In summary, with increasing age, young television viewers came to attend more consistently and strategically, and they comprehended more effectively what they viewed, at least as measured by recall of temporal sequences. Pace of events in a program, the inverse of average scene or bit length, determined difficulty for comprehension and controlled the tempo of looking by older children for story programs but tended to enhance attention only for younger children—and then only to the less schematically organized magazine programs. Continuity of format played a consistent role in both attention and comprehension. Stories elicited more attention and better comprehension than magazine shows. Finally, animation was a cue to program stereotypy: Attention and comprehension covaried with one another more in animated than in live shows. This effect was especially pronounced when animated stories were viewed by older children, the case where the most stereotyped programming was viewed by the children with the best knowledge of those stereotypes.

The implications of this study for improved programming of television for children are clear. High pace does not often enhance attention and may interfere with comprehension. Content presented in story format is in general more effectively communicated than content presented in a magazine format. Live formats elicit less all-or-none processing than animated formats.

The results contain significant implications for models of basic cognitive development as well. Not only is television viewing a context in which active cognitive processing takes place and can be profitably studied, but it is a context in which children use a variety of subtle cues to determine the level of processing that is necessary and sufficient for comprehension. Neither comprehensibility nor salience alone determine the nature and extent of processing. Rather, it appears that they are determined instead by a combination of schematic knowledge (e.g., animated story scripts) and strategic decision making at key points in response to the level of processing demanded or supported by the program's format and structure. Form and format of a familiar medium play roles in cognitive processing that are in part independent of content. A more precise delineation of what children know who know how to process their favorite medium awaits further investigation.

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