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Video Comprehensibility and Attention in Very Young Children

Tiffany A. Pempek and Heather L. Kirkorian
University of Massachusetts at Amherst

John E. Richards
University of South Carolina

Daniel R. Anderson and Anne F. Lund
University of Massachusetts at Amherst

Michael Stevens
University of South Carolina

Earlier research established that preschool children pay less attention to television that is sequentially or linguistically incomprehensible. The authors of this study determined the youngest age for which this effect can be found. One hundred and three 6-, 12-, 18-, and 24-month-olds' looking and heart rate were recorded while they watched *Teletubbies,* a television program designed for very young children. Experimenters manipulated comprehensibility by either randomly ordering shots or reversing dialogue to become backward speech. Infants watched 1 normal segment and 1 distorted version of the same segment. Only 24-month-olds, and to some extent 18-month-olds, distinguished between normal and distorted videos by looking for longer durations toward the normal stimuli. The results suggest that it may not be until the middle of the second year that children demonstrate the earliest beginnings of comprehension of video as it is currently produced.

Keywords: video, television, infant, attention, heart rate

Over the past decade, media specifically produced for infants and toddlers have become widely available. Despite a recommendation by the American Academy of Pediatrics (AAP) that children younger than 2 years have no exposure to electronic screens (American Academy of Pediatrics Committee on Public Education, 1999; 2001), large numbers of infants are exposed to electronic screen media. In a national survey of parents, the Kaiser Family Foundation found that the majority of children younger than 2 years are exposed to screen media in a typical day (Rideout & Hamel, 2006). The failure to follow the AAP guideline may be due to marketing of infant-directed videos and other screen media as being educationally or developmentally beneficial (Garrison & Christakis, 2005).

The AAP guideline was adopted in the face of a near complete lack of experimental research on the impact of videos on infants and toddlers and some correlational evidence suggesting a negative impact of early exposure to screen media. Moreover, very little was known at that time about the ability of very young children to comprehend and learn from video despite educational claims made by producers of infant-directed media products (Garrison & Christakis, 2005). In their review of some early and more recent research, Anderson and Pempek (2005) hypothesized that there may be a "video deficit" (p. 511), whereby infants learn better from real life than from comparable media experiences (e.g., Barr & Hayne, 1999; Schmitt & Anderson, 2002; Troseth & DeLoache, 1998). If this is so, it may be that infants have difficulty comprehending video. Since comprehension of complex stimuli, such as commercial videos for infants, is difficult to test in such young children, we took a different approach in the current study by examining the relation between *comprehensibility* of a video and infants' *attention* to that video. The goal was to determine at what age children become sensitive to the sequential and linguistic comprehensibility of a television program that is specifically produced for very young children. Of particular interest was how much they actually pay attention to television.

Attention to Television

In most studies of children's attention to television, overt looking at the screen is used as the proxy measure of attention (for a

Tiffany A. Pempek, Heather L. Kirkorian, Daniel R. Anderson, and Anne F. Lund, Department of Psychology, University of Massachusetts at Amherst; John E. Richards and Michael Stevens, Department of Psychology, University of South Carolina.

Heather L. Kirkorian is now at the University of Wisconsin at Madison.

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Correspondence concerning this article should be addressed to Tiffany A. Pempek, who is now at the Department of Psychology, Otterbein University, One Otterbein College, Westerville, Ohio 43081. E-mail: tpempek@otterbein.edu

recent review, see Anderson & Kirkorian, 2006). An early study revealed that children's looking at *Sesame Street* increased steadily from 12 to 48 months of age when the children, each accompanied by one parent, watched videos in a laboratory setting with toys available (Anderson & Levin, 1976). At 30 months of age, there was a sharp increase in frequency of looking at the screen in the laboratory that corresponded to parents' reports of sharply increased television viewing at home. Anderson and Lorch (1983) proposed that the increase in viewing around 30 months is due to the development of the cognitive and language skills necessary to begin to understand a program such as *Sesame Street*. A similar study demonstrated that 2-year-olds attended to *Sesame Street* in a laboratory setting for approximately a third of the time the television was on as compared with nearly half of the time for 3.5-year-olds and almost two thirds for 5-year-olds (Anderson, Lorch, Field, & Sanders, 1981).

More recent studies have shown higher levels of attention in infants and toddlers, although the contexts in which looking at the screen was measured were somewhat different than in the earlier studies. Using *Baby Einstein* (i.e., *Baby Mozart*) and *Sesame Street* videos in the homes of 12-, 15-, and 18-month-olds, Barr, Zack, Garcia, and Muentener (2008) found that attention was higher for viewers who had previously seen the video than for those who had not (69.9% for the previous exposure group vs. 59.4% for the nonexposure group). Parenting style also influenced attention, with higher levels of looking by children whose coviewing parents performed more scaffolding-like behaviors during the viewing session (i.e., supportive behaviors aimed at helping the child to reach a goal that is otherwise slightly outside his or her ability; 46.8% for low levels of scaffolding, 68.1% for medium, and 79.2% for high; Barr et al., 2008). These levels of looking are similar to those found by Richards and Cronise (2000) to a *Sesame Street* movie shown to 6- to 24-month-olds in a minimally distracting laboratory context (67%, 77%, 85%, and 87% for 6-, 12-, 18-, and 24-month-olds, respectively).

If infants do, in fact, pay high levels of attention to infant-directed videos (in contrast to relatively low attention paid to programs made for older viewers), is it the case that their attention is being driven by active comprehension processes as hypothesized by Anderson and Lorch (1983)? We examined this question in the present study by comparing infants' attention to normal videos versus distorted ones that reduce comprehensibility without at the same time affecting salient stimulus features of the videos.

Theories of Attention to Television and Development

There are two seemingly contradictory perspectives on children's attention to television. The first is that perceptually salient formal features of television, such as movement, cuts, zooms, pans, and a variety of auditory features, play a primary role in determining how much attention children pay. In its most basic form, this perspective holds that salient formal features repeatedly elicit the orienting reflex, producing more or less sustained attention (Singer, 1980). The second perspective is that attention to television is primarily driven by and in service of comprehension activities. This perspective holds that television viewing is a learned cognitive activity, and, as such, the components of attention to television are deployed in a skilled manner so that the viewer can comprehend the ongoing content (Anderson & Lorch, 1983). A third perspective, however, subsumes both ideas. This perspective posits that children's attention to television is initially and primarily driven by salient formal features, but with maturation and viewing experience, attention comes under active and learned control with perceptual saliency continuing to play a role (Huston & Wright, 1983).

Research with older children has provided support for all three perspectives. Specifically, formal features can elicit orienting reactions, looking is influenced by cognitive processing of content, and there are substantial changes in children's attention to television with development. For a review of findings on these perspectives, see Anderson and Kirkorian (2006). However, very little research of this type has been conducted with children younger than the age of 2.

The theory that there is a developmental shift in attention to television corresponds to Ruff and Rothbart's (1996) more general theory of the early development of attention. Ruff and Rothbart maintained that there are two major systems of attention that arise during the first and second years of life. They proposed that newborns initially attend to high-contrast patterns and contours and have difficulty disengaging attention. However, a slight increase in control is achieved both with the onset of the orienting–investigative system (which arises between 3 and 9 months of age) and with the achievement of reaching and mobility. This system is associated with exploratory behavior as well as with a propensity to orient toward novelty. The second system, which gradually becomes more prominent than the first, is associated with a higher level of control over attention beginning around 18 months of age. Once this system begins to operate, children are better able to shift and inhibit attentional engagement. The onset of this system is thought to result from a qualitative shift caused in part by brain development as well as growth in closely related skills such as planning and language. Considered in light of the three theories of attention to television, Ruff and Rothbart's view of development might help to shed light on potential changes that occur in attention to television during the first few years of life.

Attentional Inertia

Detailed analyses of looking at television reveal a pattern called *attentional inertia* (Anderson, Alwitt, Lorch, & Levin, 1979), which is a central aspect of the comprehensibility theory that posits that television viewing is a learned cognitive activity and that children's attention to television is driven by comprehension processes (Anderson & Lorch, 1983). A number of phenomena are associated with attentional inertia. The longer one maintains a look at the television, the greater one's attentional engagement, as indicated variously by measures of reaction time, distractibility, recognition memory, and comprehension (see Anderson & Kirkorian, 2006). Moreover, physiological measures of engagement (i.e., heart rate) are correlated with look duration (e.g., Richards & Cronise, 2000). Because this increased engagement reduces the effectiveness of external distractors (Anderson, Choi, & Lorch, 1987; Richards & Turner, 2001), it consequently produces a look distribution such that the probability of looking away from the screen diminishes the longer the look is maintained (Anderson et al., 1979). This pattern results in a lognormal distribution of look lengths that has been observed in television viewers ranging in age from 3 months to adult (for a review, see Richards & Anderson, 2004).

Investigators studying attentional inertia have argued that after about 15 s of sustained looking, attentional engagement becomes greatest. For instance, when a look was interrupted in preschool children between the ages of 3 and 5 years, reaction time to orient toward distractor slides was slower during looks longer than 15 s in than during shorter looks (Anderson et al., 1987). In addition, recognition memory for television program content in adults was greater if they had been continuously looking for longer than 15 s when the relevant content occurred (Burns & Anderson, 1993). Likewise, 5-year-olds' reaction time was found to be slower during looks longer than 15 s than during those shorter than 15 s, again indicating greater attentional engagement during long looks (Lorch & Castle, 1997).

Thus, the look length provides a better index of viewers' engagement than does the overall percentage of time that viewers have been looking during a given period. Moreover, a look duration of 15 s appears to be a useful threshold for characterizing attention as engaged.

Overview of Current Study and Hypotheses

This study is based on methodologies and results from two earlier studies. Anderson and colleagues (1981) hypothesized that young children's looking at television is driven by comprehension processes. They argued that if this is so, rendering a television program less comprehensible without changing its formal features (e.g., sound effects, camera changes) should reduce looking by preschool children. They accomplished the comprehensibility reduction in each of three ways: randomly reordering shots in *Sesame Street* segments; editing the dialogue so that each utterance, although occupying the same video frames, ran backwards; and substituting Greek for the normal English dialogue (using the Greek version of *Sesame Street*). They showed distorted and normal versions of the *Sesame Street* segments to 24-, 42-, and 60-month-olds. They found that at each age the children looked less at the distorted than at the normal segments. It is important to note that none of these comprehensibility distortions, sequential or linguistic, affected the formal features contained in the segments; thus, the reduced attention was due to reduced comprehensibility.

This result raises the question as to when in development children begin to become sensitive to the sequential and linguistic comprehensibility of the content of commercial video productions directed at them. A study by Richards and Cronise (2000) cast some light on this issue. They observed infants at 6, 12, 18, and 24 months of age as they watched either a segment from the *Sesame Street* movie *Follow that Bird* or a computer-generated visual stimulus with correlated, randomly selected sounds, interspersed with clips from *Follow that Bird*. It should be noted that there was nothing to comprehend sequentially or linguistically in the latter stimuli. The younger infants, 6- and 12-month-olds, did not discriminate between the two types of video stimuli as assessed either by looking or by heart rate, whereas the 18- and 24-month-olds' looking lengths were longer to the *Sesame Street* movie. For the older infants, heart rate patterns also were consistent with sustained and focused attention.

These results suggest that infants become sensitive to meaningful video content at about 18 months of age, but the results also are open to alternative interpretations insofar as the video stimuli were quite different from each other. For example, the movie used by Richards and Cronise was made for a general audience and was not designed to be optimal for infants. In addition, because the *Sesame Street* movie contained faces and other recognizable objects whereas the computer-generated stimuli did not, it could be that differential attention in 18- and 24-month-olds was driven by object and character recognition rather than any deeper appreciation of the content (e.g., language, story arc). Indeed, prior research has demonstrated that infants as young as 5 months are capable of integrating auditory and visual information from video, at least at a temporally local level. For example, infants prefer to look at (Hollenbeck & Slaby, 1979) and habituate more quickly to (Schiff, Benasich, & Bornstein, 1989) video with coordinated rather than mismatched sounds. Moreover, by 6 months of age, they can recognize video images of their parents and associate them with familiar labels (e.g., *mama* and *papa*; Tincoff & Jusczyk, 1999). However, infants' deeper understanding of content is not addressed in such studies; we do not yet know whether this sensitivity is strictly local and limited to familiar images.

In the current study, we utilized the sequential and linguistic distortion techniques of Anderson et al. (1981) and the methodologies of Richards and Cronise (2000) to examine infant responses to the normal and distorted videos. We assessed 6-, 12-, 18-, and 24-month-old infants' looking and heart rate as they viewed normal and distorted versions of the program *Teletubbies*, which was designed for infants and toddlers. The distortions included reversed speech and random shot sequences. These distortions reduce sequential comprehensibility (random shots) or linguistic comprehensibility (backward English) while the formal production attributes, such as pacing, sound effects, and visual effects, are maintained.

According to the theories of attention to television advanced by Huston and Wright (1983) and of attention development more generally by Ruff and Rothbart (1996), young infants' attention is driven by salient formal features of television that do not vary across comprehensible and incomprehensible stimuli. From these accounts, in the current study, we would expect to find some youngest age at which visual attention is guided by sequential or linguistic comprehensibility. Although Huston and Wright were not specific about when this transition occurs, Ruff and Rothbart suggested that the shift away from a dependence on perceptual salience in favor of goal-driven cognitive control over attention arises during the second year of life. If this improved ability to control attention is combined with improved language comprehension as well as experience with television, older infants should possess the cognitive skills necessary to comprehend a simple television program that has been edited with standard conventions (e.g., cuts connecting different camera angles). Thus, we hypothesized that while 6- and 12-month-olds would show similar levels of visual attention to normal and distorted segments, 18- and 24-month-olds would show greater visual attention to normal than to distorted segments. We further predicted that 24-month-olds would show greater differentiation than 18-month-olds.

We expected an increase in attention by older children to the normal, relative to distorted, segments due to greater attentional engagement (i.e., a qualitative increase in attention as well as a quantitative one). Sustained engagement to comprehensible content should be evidenced by extended looking. Moreover, on the basis of findings by Richards and colleagues (e.g., Richards & Cronise, 2000; Richards & Gibson, 1997), we predicted that analysis of heart rate would reveal a pattern of attentional engagement (i.e., slower heart rate), particularly for longer looks, providing physiological evidence for deeper attentional engagement as looks are sustained. We expected this pattern to be particularly strong for older infants watching the normal video.

Method

Participants

The sample consisted of 103 infants ranging in age from 6 to 24 months of age. Approximately equal numbers of boys and girls were tested in each age group: 6 months (n = 28, 13 girls; M = 0.51 years, SD = 0.014, range 0.49–0.53 years), 12 months (n = 25, 12 girls; M = 1.01 years, SD = 0.013, range 0.98–1.04 years), 18 months (n = 24, 11 girls; M = 1.50 years, SD = 0.022, range 1.47–1.53 years), and 24 months (n = 26, 12 girls; M = 2.00 years, SD = 0.027, range 1.95–2.05 years). A total of 11 infants were dropped from this experiment: four due to equipment problems, five due to experimenter error, one due to parental interference, and one due to the child's being off screen in the videotape of the session.

We solicited the participants from the Columbia, South Carolina, area by contacting parents whose names appeared on commercial mailing lists. Parents who were interested in participating sent back a postcard. Of the 70 parents (68% of sample) who provided information about their child's ethnicity, 77% reported White/Caucasian, 16% reported Black/African American, 3% reported Hispanic/Latino/Latina, and 4% reported mixed ethnicity. Of the 67 parents (65% of sample) who provided information about their own education level, 11% reported obtaining a high school diploma, 28% reported having some college education, 46% reported obtaining a college degree, and 15% reported obtaining a graduate degree.

Stimuli

Stimuli were taken from two episodes of the television series *Teletubbies* (American version). We chose this program because it was one of few television series made specifically for infants and toddlers at the time this project began. Both segments (one from each of two episodes) were 10 min in length. These segments were used in their original form and were also distorted in two ways. Following the method used by Anderson et al. (1981), we created distortions by reversing the speech track or randomly rearranging shots. We created the backwards speech distortion by reversing the original audio track for each utterance so that it occupied the same frames as the nondistorted counterpart. This manipulation maintains many of the voice qualities of the original speech but is incomprehensible. Music and sound effects were not reversed unless they occurred simultaneously with an utterance. We created the random shot distortion by parsing all constituent shots at their pre-existing edit points and rearranging them into a random sequence. No two consecutive shots remained consecutive in the random sequence, thus resulting in a segment in which the sequence of actions was no longer apparently continuous or logical (although the action within each shot was not distorted). The first segment had 101 shots averaging 5.9 s in length; the second segment had 124 averaging 4.8 s. These shot lengths are fairly typical of children's television programs (e.g., Schmitt, Anderson, & Collins, 1999).

Setting and Apparatus

The study took place in a TV viewing room and an adjacent observation room. The viewing room was equipped with a 49-cm (19-in) color television with two speakers, heart rate equipment, and a video camera that recorded the infant's direction of gaze. Other than the television, all equipment was hidden behind a curtain, out of the child's view. The observation room was connected to the viewing room via a one-way mirror. From the observation room, the experimenter was able to control the video and heart rate equipment. The session was videotaped and all tapes were subsequently coded for visual attention to the stimuli. Heart rate was recorded by a computer for later analysis.

Procedure

Each infant participated individually with a parent. Upon arriving at the laboratory, the infant and parent were greeted by the researchers and escorted into the viewing room. After signing the consent form, the parent completed a demographic information questionnaire. Next, the infant sat on the parent's lap at a table that spanned approximately 70 cm (27.56 in.) in front of the television screen. Several age-appropriate toys were placed on the table within the infant's reach. The infant was then presented with 20 min of video from one of two episodes of *Teletubbies*, including one 10-min normal segment and its 10-min distorted counterpart. Distortion type (random shot sequence, backwards speech) was randomly assigned with the constraint that approximately equal numbers of infants received each type. Order of presentation was counterbalanced such that half of the children saw a normal segment first while the other half saw a distorted segment first. While the stimulus was playing, the child was free to play with the toys or watch the television. The parent was instructed not to direct the child's attention to or away from the television screen.

Measures

Looking. We coded visual attention from videotapes of the sessions using the behavioral measure defined by Anderson and Levin (1976) in which a look commences when the eyes are directed toward the television screen and terminates when the eyes are diverted away for any period of time. We recorded videos at a rate of 30 frames per second and coded them using the tape-logging function of the program Adobe Premiere (Adobe Systems, San Jose, CA). Trained research assistants identified the video frames in which each look began and ended. Dependent measures included the percentage of time that the television was on that the child was looking at it (i.e., percent looking) and the average length of looks at the television (i.e., look duration).

Heart rate. The electrocardiographic information was recorded with silver/silver chloride electrodes placed on the infant's chest and was digitized at 1,000 Hz with a microcomputer. A computer algorithm identified the QRS complex in the electrocardiogram (ECG), and interbeat interval (IBI) was defined as the duration between successive R waves in the ECG. We corrected artifacts using the algorithms of Berntson, Quigley, Jang, and Boysen (1990) and Cheung (1981), along with visual inspection of suspect beats. IBI is the inverse of heart rate, such that an increase in IBI corresponds to a decrease in heart rate, indicative of sustained attention. The IBIs were quantified during the entire recording session. However, when analyzing the IBI data, we quantified the data as a change from a 5-s baseline preceding the participant's looking to the period of time when the participant was looking at the television.

Interobserver Reliability

For measures of visual attention coded from videotape, approximately 25% of the infants' sessions (i.e., 25 tapes) were coded by a second research assistant to ensure that data were scored consistently. Intraclass correlations between the primary and secondary coders for visual attention measures (look duration, frequency of looking, percent of time looking) ranged from .87 to .99.

Results

Preliminary analyses indicated that results were generalizable across both episodes of *Teletubbies* and that there were relatively low levels of attention during Trial 2 regardless of comprehensibility or distortion type. In particular, there was a 20% decrease in percent attention from Trial 1 to Trial 2 for all ages. Children looked at the television less than half the time it was on in Trial 2. Therefore, the analyses presented here are between-subjects analyses based on Trial 1, and data were collapsed across the two episodes. See the Discussion for a potential explanation for decreased attention in Trial 2.

Behavioral Measures of Attention

Behavioral measures of attention included the percent of the video for which infants looked at the screen and the mean duration of individual looks at the screen. See Table 1 for descriptive statistics. Analyses were 2 (comprehensibility: normal, distorted) × 2 (distortion type: backwards speech, random shot sequence) × 2 (gender: boy, girl) × 4 (age: 6, 12, 18, 24 months) univariate analyses of variance (ANOVA). Comprehensibility reflects whether a normal or distorted video was seen in Trial 1, whereas distortion type reflects overall group assignment. For infants who viewed a distorted video in Trial 1, distortion type reflects which of the two distorted videos was viewed in Trial 1. For infants who viewed a normal video in Trial 1, distortion type reflects group assignment rather than video viewed in Trial 1. Thus, the distorted video for this condition was presented in Trial 2, for which data are not presented here. This design allows for a normal video comparison group for each of the two distortion types. A comprehensibility effect that varies as a function of distortion type would be reflected in a comprehensibility by distortion type interaction.

Percent looking. There was a main effect of age, $F(3, 71) = 5.53$, $p = .002$, Cohen's $f = .36$, such that the percent of time children looked at the screen generally increased with age. Bonferroni post hoc comparisons revealed that 12-month-olds looked significantly less than did both 18- and 24-month-olds. Although trending in this direction, the percent of looking by the 6-month-olds did not differ significantly from that of the other age groups. There were no main effects or interactions with respect to gender, comprehensibility, or distortion type.

Average look duration. Significant main effects were found for age and comprehensibility, $F(3, 71) = 5.36$, $p = .002$, Cohen's $f = .36$, and $F(1, 71) = 11.52$, $p = .001$, Cohen's $f = .32$, respectively. This was qualified by an Age × Comprehensibility interaction, $F(3, 71) = 4.06$, $p = .010$, Cohen's $f = .30$. Post hoc t tests with which we analyzed each age group individually indicated significant effects of comprehensibility for 18- and 24-month-olds, $t(22) = 2.18$, $p = .040$, Cohen's $d = .93$, and $t(24) = 2.64$, $p = .014$, Cohen's $d = 1.04$, respectively. In both cases, average look lengths were greater to the normal segment than to the distorted segment. See Figure 1 for average look durations for normal and distorted stimuli as a function of age. As was found for percent looking, the pattern of means was nearly the same for backward speech and random shot sequences.

Frequency Distributions

Type of distribution. The distribution of look lengths was positively skewed. Thus, there were many short looks at the screen and relatively few long looks. To test whether the lognormal distribution best described the pattern seen here (as was found in earlier studies), we compared several theoretical distributions to the observed frequency distributions to determine which was the best fit. The Statistical Analysis System (SAS) Proc Capability was used to estimate the parameters of theoretical probability distributions and the discrepancy (chi square) between the fitted

Table 1
Descriptive Statistics for Percent of Looking and Look Duration (in Seconds) by Age and Comprehensibility

	6 months		12 months		18 months		24 months	
Variable	Normal ($n = 13$)	Distorted ($n = 15$)	Normal ($n = 12$)	Distorted ($n = 13$)	Normal ($n = 13$)	Distorted ($n = 11$)	Normal ($n = 13$)	Distorted ($n = 13$)
Percentage	58.18	56.37	47.59	49.66	63.68	64.56	79.34	63.94
Duration	9.20	8.90	8.19	7.98	14.62	8.44	23.12	9.52
SE	1.39	1.27	2.74	1.22	2.49	0.88	4.92	1.51
Median	7.88	7.44	4.23	8.89	14.13	8.22	18.12	8.95
Skewness	1.76	0.43	1.92	−0.05	0.52	0.57	1.91	0.90
Kurtosis	3.62	−0.83	2.32	−0.21	−0.37	−0.42	4.61	0.01

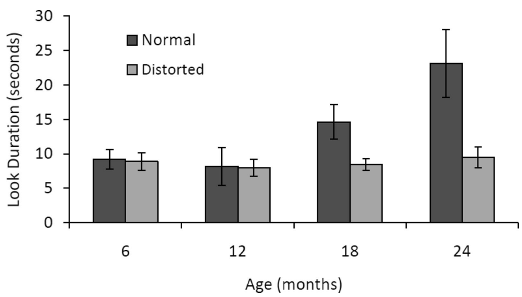

Figure 1. Means and standard errors for look durations for normal and distorted stimuli by age.

theoretical distribution and the empirical histogram. Of five theoretical distributions that were fit to the data (lognormal, Weibull, gamma, exponential, and normal distributions), the lognormal distribution was the best fitting for 87.75% of individuals' look-length distributions.

Lognormal distribution parameters. According to the theory of attentional inertia (Richards & Anderson, 2004), when differences are found, they should be found primarily in the tail of the distribution (i.e., the portion of the curve with fewer but longer looks). To test for distribution differences in the current study, we analyzed two parameters of the lognormal distribution (scale and shape). Similar measures have been calculated in previous research when distributions of the dependent measure were known to be lognormally distributed. See Richards and Anderson (2004) for a detailed description of the measures used here, a summary of research in which similar analyses were used, and a discussion of the relation between the lognormal distribution and sustained attentional engagement. In brief, scale refers to the range of the probability distribution, where a larger scale parameter indicates more spread in the data. Greater attentional engagement resulting from extended looks in particular should be reflected in larger scale values. Shape refers to the contour of the distribution and is analogous to skew. Overall positive skew in the distributions of look lengths should be reflected in larger shape values. These two parameters of the lognormal distribution were calculated separately for each child. With this approach, researchers can account for the fact that the data were not normally distributed without having to perform a transformation that may mask the results. Analyses were 2 (comprehensibility) × 2 (distortion type) × 2 (gender) × 4 (age) univariate ANOVAs.

The ANOVA for shape revealed no significant main effects or interactions with respect to age, gender, comprehensibility, or distortion type. For scale, there was a main effect of age, $F(3, 71) = 3.23$, $p = .027$, Cohen's $f = .24$. This was qualified by a significant Comprehensibility × Age interaction, $F(3, 71) = 3.06$, $p = .034$, Cohen's $f = .24$. Post hoc t tests conducted on each age individually revealed a significant effect only for 24-month-olds, $t(24) = 3.06$, $p = .005$, Cohen's $d = 1.20$. Here, the scale value was larger for the normal segment ($M = 8.64$, $SE = 0.20$), indicating a greater spread in the distribution (i.e., relatively more long looks) than for the distorted segments ($M = 7.93$, $SE = 0.11$). This interaction is shown in Figure 2, which plots frequency distributions by comprehensibility and age. As seen in this figure, the 24-month-olds exhibited fewer short looks (<15 s) to the normal segment than to the distorted segment. These short looks were replaced by a few very long looks at the positive tail of the distribution, thus increasing the scale. There was no effect of distortion type.

Physiological Measures of Attention

Average IBI change. With attentional engagement, heart rate decreases. IBI is the inverse of heart rate (i.e., the period between heart beats) and is thus expected to increase with attentional engagement. The analysis used to assess IBI was a 2 (comprehensibility) × 2 (distortion type) × 2 (gender) × 4 (age) between-subjects ANOVA. There was a significant effect of age, $F(3, 69) = 3.00$, $p = .036$, Cohen's $f = .24$. Bonferroni post hoc analyses revealed that there was a general increase in IBI change with age, although only 6- and 24-month-olds differed significantly from one another. There were no main effects or interactions with respect to gender, comprehensibility, or distortion type. This finding indicates that heart rate varied more over the course of a given look for older children than for younger children; that is, although heart rate typically decreases with time since the onset of a look, on average this change was greater for older children in the present study.

Average IBI change by look length. Because attentional engagement is known to increase as a function of look length and because long looks are indicative of sustained attention, IBI change was compared for looks longer than and shorter than 15 s in duration. The mixed-design analysis was a 2 (comprehensibility) × 2 (distortion type) × 2 (gender × 4 (age) × 2 (look length: <15 s, > 15 s) ANOVA with look length as a repeated measure. There was a significant main effect of look length, $F(1, 54) = 59.74$, $p < .001$, Cohen's $f = .76$, such that greater IBI change was found for long looks ($M = 27.15$, $SE = 2.54$) than for short looks ($M = 12.46$, $SE = 1.77$). Thus, attentional engagement was greater during longer looks. See Figure 3 for average IBI change over time (from look onset) for long looks (>15 s) as a function of age for normal and distorted stimuli. There were no other main effects or interactions.

Discussion

The main purpose of this study was to determine the approximate age at which very young children differentially attend to normal infant-directed video as compared with the same video but with reduced comprehensibility. Increased attention to normal video, manifested as longer look lengths, appeared between 18 and 24 months. Younger infants (6 and 12 months) appeared to be insensitive to sequential and linguistic comprehensibility. This finding suggests that sequential and linguistic comprehension of commercially produced video with conventional edits (e.g., cuts between shots) may not begin until the middle of the second year.

Regarding linguistic comprehension, the finding that the youngest infants were not sensitive to language distortions in the present study is surprising since research has indicated that children begin to understand words and simple sentences even before they can produce language. For instance, by 6 months of age, infants are able to recognize their own name (Hirsh-Pasek & Golinkoff, 1996) and have learned enough about the properties of their native language to allow them to distinguish words in their native lan-

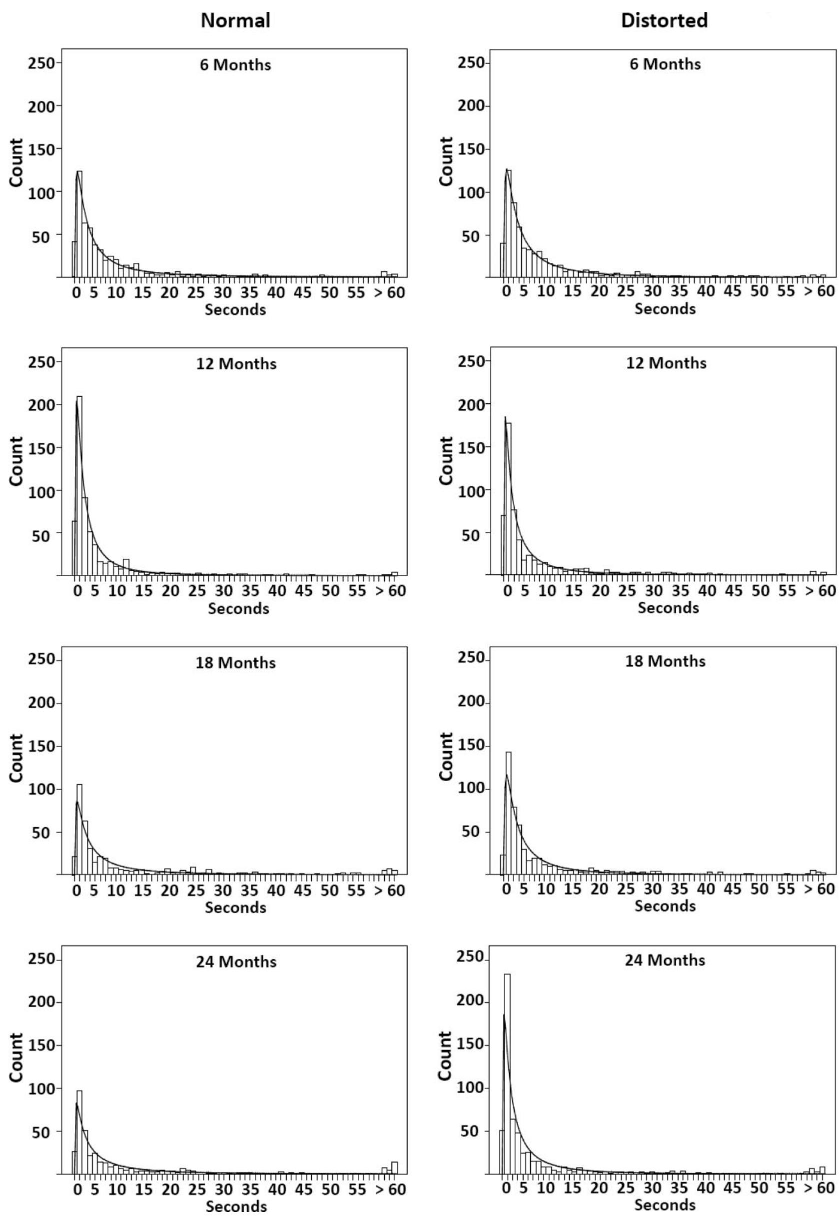

Figure 2. Frequency distribution by age of looks at normal (left column) and distorted (right column) stimuli. The *x* axis represents look duration in seconds; the *y* axis represents the frequency (i.e., number) of looks at each length. The solid line is the best-fitting lognormal distribution.

guage from words in another language (Jusczyk, 1997). Between 9 and 24 months, infants become less dependent on prosodic information for language comprehension and begin to rely more heavily on semantics (Hirsh-Pasek & Golinkoff, 1996). Around 9 months, they begin to respond appropriately to words and short phrases (Oviatt, 1980), and by 11 months, they can comprehend more than 50 words (Fenson et al., 1994). Between 15 and 24 months, infants show rapid increase in both speed and precision of language processing for familiar words (Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998). By the end of the second year, infants understand grammar for simple sentences (Bloom, 1998). Why, then, would infants not be sensitive to backward speech in a television program before about 18 months of age? We suggest that the processing demands of a program such as *Teletubbies,* in which most of the speech comes in the form of voiceover narration, may be too difficult for younger infants. In a typical sequence, for example, a character in the show finds a large ball and kicks it. Across a sequence of shots that follows the ball's flight, the ball eventually bounces to another character who also kicks it, and so the action continues. All of this is described in simple sentences by the disembodied narrative voiceover. It may simply be that the younger infants treat the voiceover as being irrelevant to the ongoing action or that despite the use of simple syntax and vocabulary, the 6- and 12-month-old infants do not comprehend

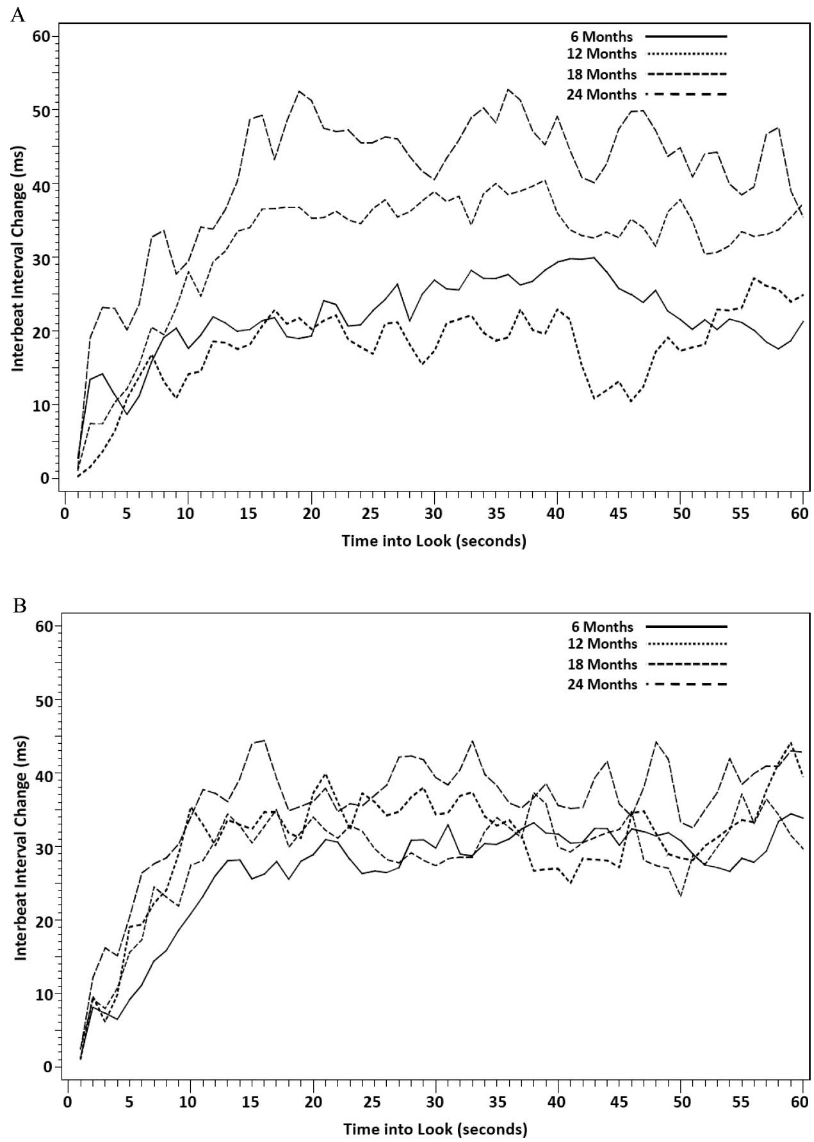

Figure 3. Average interbeat interval change over time since the start of the look by age for long looks (>15 s) at normal (Panel A) and distorted (Panel B) stimuli.

the narration. However, experimental research has demonstrated that older children (24 months) can learn from video voiceovers (Barr & Wyss, 2008). That finding is consistent with the present observation that 24-month-olds clearly attend during exposure to normal English for longer periods than they do during exposure to backward English.

Regarding sequencing, the ability to understand temporal relations develops gradually (Piaget, 1954, 1969). By 10–11 months, infants become sensitive to the sequential structure of repeated action sequences presented on video (Baldwin, Baird, Saylor, & Clark, 2001) and can recognize intentionality of behaviors on video (e.g., Phillips & Wellman, 2005). There has been little prior research on whether children younger than 2 years can comprehend edited video, but they apparently are able to comprehend and imitate simple action sequences under some circumstances (e.g., Barr & Hayne, 1999). Edited video may present particular challenges insofar as children must maintain some kind of memory of the prior shot in order to interpret its relation to a succeeding shot. For example, an establishment shot of the outside a building (such as the Teletubbies' burrow home) with a character jumping into a hole in the top may be followed by a cut to an interior shot showing the character sliding down a ramp into the kitchen. To comprehend such a two-shot sequence, the viewer must imagine the spatial relations conveyed by the two shots (above vs. below as well as outside vs. inside) and conceive of the character's action as continuous across the shots. This may well be beyond the capabilities of an infant younger than 18 months. In a functional MRI (fMRI) study with adults, 17 distinct areas of cerebral cortex were uniquely activated in order to process comprehensible (normal) shot sequences from Hollywood movies, relative to random shot sequences (Anderson, Fite, Petrovich, & Hirsch, 2006). Because many of these cortical areas are slow to mature, it may be that processing edited video is simply beyond the capacity of infants younger than 18 months (cf. Anderson, 2007).

However, these findings are limited to look length, not overall amount of time looking at normal versus distorted videos, as was found for 24-month-old and older children watching *Sesame Street* (Anderson et al., 1981). Comprehensibility, therefore, influenced *sustained* looking in 18- and 24-month-olds in this study, not total amount of looking. This may in part be due to differences in the viewing context between these two studies. In the original study by Anderson and colleagues (1981), children watched in a room resembling a typical family room and were free to move about. In the current study, however, infants sat on parents' laps at a table in front of the television, which may have increased their attention to near maximal levels. Thus, the present findings demonstrate that comprehensible content causes sustained looking in older children, whereas less comprehensible content with the same formal features produces more numerous but shorter looks.

As has been found in previous studies (see Richards & Anderson, 2004), a lognormal distribution best fit the look duration data in the current study. The scale parameter of the lognormal distribution indicated relatively more long looks for 24-month-olds watching the normal video than for those watching the distorted video, whereas the shape parameter was unaffected. Thus, the relatively long looks by older children watching comprehensible video extended the range of values but did not affect the overall shape of look length distributions, supporting the hypothesis that comprehensibility produces sustained attention. These findings closely match those reported by Richards and Cronise (2000) in comparing a *Sesame Street* movie with random computer-generated forms and sounds and suggests that long, sustained looks most reflect comprehension of video in children this age.

With respect to heart rate, change in average IBI compared with baseline increased with age, especially as looks were sustained. Because IBI is the inverse of heart rate, this increase corresponds to a decrease in heart rate, consistent with a deeper level of attentional engagement (see Richards & Casey, 1992). When average IBI change was considered for looks shorter than 15 s and those longer than 15 s, there was greater change with longer looks regardless of age or comprehensibility of the video. This finding is consistent with the phenomenon of attentional inertia in television viewing (Richards & Anderson, 2004). Insofar as attentional inertia serves to maintain attention the longer it has already been sustained, it may be an important bootstrap mechanism for the development of comprehension of television. If an infant is able to follow and comprehend the actions within a single shot, for example, attentional inertia may serve to sustain cognitive processing into subsequent shots, allowing the infant to engage in comparison processes across shots. In this manner, the infant may begin to detect the continuities of actions across shots and so begin to comprehend video montage (Anderson & Lorch, 1983).

The fact that a comprehensibility effect for 18- and 24-month-olds was found only for Trial 1 requires explanation. By the design of the study, if children received random shots or backward speech on Trial 1, they received normal stimuli on Trial 2. Regardless of type of video, look lengths during Trial 2 were short and similar to those for the distorted stimuli on Trial 1. This result is consistent with the hypothesis that when children encounter material that is incomprehensible to them, they continue to monitor the video and audio with brief looks for indicators of comprehensible content (Huston & Wright, 1983; Lorch, Anderson, & Levin, 1979). If superficial features (e.g., characters, settings) have not changed, attention will continue to be reduced; if these features change, attention may be recovered. Essentially, we suspect that once the 18- and 24-month-old children experienced *Teletubbies* as incomprehensible, their sustained attention was lost to that program at least for the duration of the viewing session. We hypothesize that if a different infant-directed video had been presented in Trial 2, older infants' looking at the normal video would have recovered and been greater than for distorted video. An alternative explanation is that fatigue resulted in low attention in Trial 2 across conditions. In the context of this study, it is impossible to determine what is driving this effect.

The results of this study are consistent with Ruff and Rothbart's (1996) position that two distinct attention systems develop during the first years of life. Arguably, the first system, orienting–investigation, may have driven attention to the television for the youngest infants in the current study, producing relatively brief look lengths and few long episodes of attention elicited by salient auditory and visual features such as sound effects and cuts. However, in the second year of life, which Ruff and Rothbart hypothesized as the point at which a second, more top-down system gradually develops, the current study revealed that children distinguished normal content from comprehensibility distortions. These older children also engaged in relatively more long looks along with sustained heart rate decelerations during these looks. Nevertheless, if these older infants encountered linguistic or sequential distortions as they watched, they returned to the more primitive orienting form of attention to television, not returning to the more advanced form of attention even if they subsequently encountered normal video after 10 min. This interpretation is also consistent with Huston and Wright's (1983) hypothesis that the nature of young children's attention to video changes with age and experience, shifting from stimulus-driven attention to top-down processes, and supports Anderson and Lorch's (1983) perspective that television viewing is a learned cognitive activity.

The present findings have implications for the current debate about the value and impact of video produced for infants and toddlers. If children under the age of 18–24 months cannot distinguish between normal and incomprehensible video, it could be argued that television may be an inappropriate teaching tool for such young infants, at least when programs incorporate language or convey a sequence of events through a series of related shots. In this case, infant-directed products claiming to be educational may be at best harmless and at worst play a role in cognitive deficits later in life, as has been suggested by some correlational studies (e.g., Christakis, Zimmerman, DiGuiseppe, & McCarty, 2004; Landhuis, Poulton, Welch, & Hancox, 2007; Zimmerman & Christakis, 2005; Zimmerman, Christakis, & Meltzoff, 2007).

On the other hand, infants may simply need to be considered differently when it comes to media production. For instance, little is known about the structure of commercially available videos for infants and toddlers. Thus, producers and educational consultants may need to discard classic notions of how to create an educational program for very young children in light of more developmentally appropriate concepts. Findings of recent studies suggest that infants may be able to utilize video information in specific circumstances. For instance, when the number of video repetitions was doubled, infants in the second year of life who were shown a brief imitation task on video performed equally as well as those who saw the demonstration by a person who was present with them (Barr, Muentener, Garcia, Fujimoto, & Chávez, 2007). In addition, Troseth and colleagues have found that the video deficit was eliminated when children were given experience with live video footage of themselves and their family members (Troseth, 2003) as well as when children experienced a closed-circuit interaction with an experimenter who provided contingent social feedback (Troseth, Saylor, & Archer, 2006). Although these studies provide some indication that under some circumstances infants can learn from video, there is not yet a single study that shows that infants have learned anything of developmental value from commercially produced infant videos typical of those used in homes. The present research is strongly suggestive that it is not until the latter part of the second year of life that infants actually begin to comprehend standard, edited, narrated video.

A limitation of this study is that *Teletubbies,* while a popular and prominent program, is not necessarily representative of all video produced for infants. It has some character dialogue and a substantial amount of narrative voiceover. It also tells simple stories that have sequentially connected actions conveyed through video editing. Many infant-directed videos, on the other hand, consist of nothing more than disconnected series of shots against a musical sound track. (Most of the videos in the *Baby Einstein* series are of this type.) Insofar as there is little to comprehend in these videos, other than to recognize the objects and events contained within individual shots, the manipulations used in this experiment would not render this latter type of videos less comprehensible, even from an adult point of view. Thus, the present study is somewhat limited by its focus on programs that contain a sequential structure and meaningful language.

We sought to examine infants' attentional engagement independent of effects of parental mediation insofar as parents were asked not to direct their children's attention to or away from the television. However, 68% of parents of young children report being in the room and watching with their children all or most of the time (Rideout & Hamel, 2006), making the presence of a parent an important factor to consider in future research. Parental scaffolding behaviors have been found to increase visual attention to infant-directed content (e.g., Barr et al., 2008), but, as of yet, there is no research indicating whether such conditions might also help to improve comprehension.

Many infants and toddlers watch television (Rideout & Hamel, 2006), most of which has been marketed as "educational" (Garrison & Christakis, 2005). Since video watching by infants is a relatively recent phenomenon (Anderson & Pempek, 2005), it is important to realize that little is known about how much infants actually comprehend of the videos they watch, much less learn from them. This study indicates that sensitivity to the sequential and linguistic aspects of a popular television series directed toward infants does not appear until the latter part of the second year of life. Before that age, it remains to be determined what, if anything, infants comprehend in commercial infant-directed videos. If there is, in fact, little comprehension, then the time spent watching television may well be time better spent engaged in other activities such as toy play.

References

American Academy of Pediatrics Committee on Public Education. (1999). Media education. *Pediatrics, 104,* 341–342.

American Academy of Pediatrics Committee on Public Education. (2001). Children, adolescents, and television. *Pediatrics, 107,* 423–426.

Anderson, D. R. (2007). A neuroscience of children and media? *Journal of Children and Media, 1,* 77–85.

Anderson, D. R., Alwitt, L. F., Lorch, E. P., & Levin, S. R. (1979). Watching children watch television. In G. A. Hale & M. Lewis (Eds.), *Attention and cognitive development* (pp. 331–361). New York, NY: Plenum Press.

Anderson, D. R., Choi, H. P., & Lorch, E. P. (1987). Attentional inertia reduces distractibility during young children's TV viewing. *Child Development, 58,* 798–806.

Anderson, D. R., Fite, K. V., Petrovich, N., & Hirsch, J. (2006). Cortical activation while watching video montage: An fMRI study. *Media Psychology, 8,* 7–24.

Anderson, D. R., & Kirkorian, H. L. (2006). Attention and television. In J. Bryant & P. Vorderer (Eds.), *The psychology of entertainment* (pp. 35–54). Mahwah, NJ: Erlbaum.

Anderson, D. R., & Levin, S. (1976). Young children's attention to Sesame Street. *Child Development, 47,* 806–811.

Anderson, D. R., & Lorch, E. P. (1983). Looking at television: Action or reaction? In J. Bryant & D. R. Anderson (Eds.), *Children's understanding of television: Research on attention and comprehension* (pp. 1–34). New York, NY: Academic Press.

Anderson, D. R., Lorch, E. P., Field, D. E., & Sanders, J. (1981). The effect of television program comprehensibility on preschool children's visual attention to television. *Child Development, 52,* 151–157.

Anderson, D. R., & Pempek, T. A. (2005). Television and very young children. *American Behavioral Scientist, 48,* 505–522.

Baldwin, D. A., Baird, J. A., Saylor, M. M., & Clark, M. A. (2001). Infants parse dynamic action. *Child Development, 72,* 708–717.

Barr, R., & Hayne, H. (1999). Developmental changes in imitation from television during infancy. *Child Development, 70,* 1067–1081.

Barr, R., Muentener, P., Garcia, A., Fujimoto, M., & Chávez, V. (2007). The effect of repetition on imitation from television during infancy. *Developmental Psychobiology, 49,* 196–207.

Barr, R., & Wyss, N. (2008). Reenactment of televised content by 2-year-olds: Toddlers use language learned from television to solve a difficult imitation problem. *Infant Behavior and Development, 31,* 696–703.

Barr, R., Zack, E., Garcia, A., & Muentener, P. (2008). Infants' attention and responsiveness to television increases with prior exposure and parent interaction. *Infancy, 13,* 30–56.

Berntson, G. G., Quigley, K. S., Jang, J. F., & Boysen, S. T. (1990). An approach to artifact identification: Application to heart period data. *Psychophysiology, 27,* 586–598.

Bloom, L. (1998). Language acquisition in its developmental context. In W. Damon, D. Kuhn, & R. S. Siegler (Eds.), *Handbook of child psychology, 2,* 309–370.

Burns, J. J., & Anderson, D. R. (1993). Attentional inertia and recognition memory in adult television viewing. *Communication Research, 20,* 777–799.

Cheung, M. N. (1981). Detection and recovery from errors in cardiac inter-beat intervals. *Psychophysiology, 18,* 341–346.

Christakis, D. A., Zimmerman, F. J., DiGuiseppe, D. L., & McCarty, C. A. (2004). Early television exposure and subsequent attentional problems in children. *Pediatrics, 113,* 708–713.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs for the Society for Research in Child Development, 59*(5, Serial No. 242).

Fernald, A., Pinto, J. P., Swingley, D., Weinberg, A., & McRoberts, G. W.

(1998). Rapid gains in speed of verbal processing by infants in the 2nd year. *Psychological Science, 9,* 228–231.

Garrison, M. M., & Christakis, D. A. (2005). *A teacher in the living room? Educational media for babies, toddlers and preschoolers.* Menlo Park, CA: Kaiser Family Foundation.

Hirsh-Pasek, K., & Golinkoff, R. M. (1996). *The Origins of grammar: Evidence from early language comprehension.* Cambridge, MA: MIT Press.

Hollenbeck, A., & Slaby, R. (1979). Infant visual responses to television. *Child Development, 50,* 41–45.

Huston, A. C., & Wright, J. C. (1983). Children's processing of television: The informative functions of formal features. In J. Bryant & D. R. Anderson (Eds.), *Children's understanding of television: Research on comprehension and attention* (pp. 35–68). New York, NY: Academic Press.

Jusczyk, P. W. (1997). *The discovery of spoken language.* Cambridge, MA: MIT Press.

Landhuis, C. E., Poulton, R., Welch, D., & Hancox, R. J. (2007). Does childhood television viewing lead to attention problems in adolescence? Results from a prospective longitudinal study. *Pediatrics, 120,* 532–537.

Lorch, E. P., Anderson, D. R., & Levin, S. R. (1979). The relationship of visual attention to children's comprehension of television. *Child Development, 50,* 722–727.

Lorch, E. P., & Castle, V. J. (1997). Preschool children's attention to television: Visual attention and probe response times. *Journal of Experimental Child Psychology, 66,* 111–127.

Oviatt, S. L. (1980). The emerging ability to comprehend language: An experimental approach. *Child Development, 51,* 97–106.

Phillips, A. T., & Wellman, H. M. (2005). Infants' understanding of object-directed action. *Cognition, 98,* 137–155.

Piaget, J. (1954). *The construction of reality in the child.* New York, NY: Basic Books.

Piaget, J. (1969). *The child's conception of time.* New York, NY: Ballantine Books.

Richards, J. E., & Anderson, D. R. (2004). Attentional inertia in children's extended looking at television. In R. V. Kail (Ed.), *Advances in child development and behavior* (Vol. 32, pp. 163–212). Amsterdam, the Netherlands: Academic Press.

Richards, J. E., & Casey, B. J. (1992). Development of sustained visual attention in the human infant. In B. A. Campbell, H. Hayne, & R. Richardson (Eds.), *Attention and information processing in infants and adults* (pp. 30–60). Hillsdale, NJ: Erlbaum.

Richards, J. E., & Cronise, K. (2000). Extended visual fixation in the early preschool years: Look duration, heart rate changes, and attentional inertia. *Child Development, 71,* 602–620.

Richards, J. E., & Gibson, T. L. (1997). Extended visual fixation in young infants: Look distributions, heart rate changes, and attention. *Child Development, 68,* 1041–1056.

Richards, J. E., & Turner, E. D. (2001). Extended visual fixation and distractibility in children from six to twenty-four months of age. *Child Development, 72,* 963–972.

Rideout, V. J., & Hamel, E. (2006). *The media family: Electronic media in the lives of infants, toddlers, preschoolers and their parents.* Menlo Park, CA: Kaiser Family Foundation.

Ruff, H. A., & Rothbart, M. K. (1996). *Attention in early development: Themes and variations.* New York, NY: Oxford University Press.

Schiff, W., Benasich, A. A., & Bornstein, M. H. (1989). Infant sensitivity to audiovisually coherent events. *Psychological Research, 51,* 102–106.

Schmitt, K. L., & Anderson, D. R. (2002). Television and reality: Toddlers' use of visual information from video to guide behavior. *Media Psychology, 4,* 51–76.

Schmitt, K. L., Anderson, D. R., & Collins, P. A. (1999). Form and content: Looking at visual features of television. *Developmental Psychology, 35,* 1156–1167.

Singer, J. L. (1980). The power and limitations of television: A cognitive–affective analysis. In P. H. Tannenbaum & R. Abeles (Eds.), *The entertainment functions of television* (pp. 31–65). Hillsdale, NJ: Erlbaum.

Tincoff, R., & Jusczyk, P. W. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science, 10,* 172–175.

Troseth, G. L. (2003). TV guide: Two-year-old children learn to use video as a source of information. *Developmental Psychology, 39,* 140–150.

Troseth, G. L., & DeLoache, J. S. (1998). The medium can obscure the message: Young children's understanding of video. *Child Development, 69,* 950–965.

Troseth, G. L., Saylor, M. M., & Archer, A. H. (2006). Young children's use of video as a source of socially relevant information. *Child Development, 77,* 789–799.

Zimmerman, F. J., & Christakis, D. A. (2005). Children's television viewing and cognitive outcomes: A longitudinal analysis of national data. *Archives of Pediatrics and Adolescent Medicine, 159,* 619–625.

Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007). Associations between media viewing and language development in children under 2 years. *Journal of Pediatrics, 151,* 364–368.

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