A LONGITUDINAL STUDY OF THE IMPACT OF BACKGROUND TELEVISION ON 6- AND 12-MONTH-OLD INFANTS' ATTENTION DURING PLAY

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ABSTRACT

A LONGITUDINAL STUDY OF THE IMPACT OF BACKGROUND TELEVISION ON 6- AND 12-MONTH-OLD INFANTS' ATTENTION DURING PLAY

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A longitudinal design was used to determine the effect of background television on infants' attention during play with toys. Infants at both 6 and 12 months of age were examined as they engaged in 20 minutes of free play with multiple toys. During either the first half or second half of the experimental session, one of thirty 10-minute television program clips was presented on a television in the corner of the room. The television programs were selected to represent a range of programs that are not produced for an infant audience and that typically air during the day. The programs were grouped into three broad categories: children's educational programming, children's action programming, and soap operas. Infants' behavior and heart-rate were recorded to determine attention to background television and the influence of television on the quantity and quality of attention to toys during play. The results point to a decrease in overall looking at the toys and mean look length to toys in the presence of background television, regardless of program category and age. However, this held for only those infants who had an opportunity to play with the toys prior to the television presentation.

The presence of background television had a detrimental impact on the mean length of focused attention episodes during play with toys for all infants, regardless of order of television presentation. The results suggest that perhaps the greatest harm posed by background television lies in its potential to impact look length to toys. With the preponderance of background television exposure in the typical home, this may have important implications for the cognitive development of infants.

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Chapter 1

Introduction

Television is a ubiquitous part of a child's environment, with 99% of Canadian homes having at least one television set and 27% of homes having three or more television sets (Statistics Canada, 2006). In addition, about 30% of preschoolers have a television in their bedrooms (Kotler, Wright, & Huston, 2001). Children are exposed to two forms of television: foreground and background. Foreground television has been defined as programming to which children attend in a sustained manner, presumably because it is at least partially comprehensible to them (Anderson & Pempek, 2005). The increase in programming designed specifically for infants, such as the popular *Baby Einstein* video and the recent *Sesame Beginnings* video series, has resulted in increased exposure to foreground television. In a recent US survey of 1008 parents of children ages 2 to 24 months, it was found that by 3 months of age, 40% of infants were watching TV or DVDs/videos and by 2 years about 90% of children were regularly viewing TV or DVD/videos. The average amount of viewing time for the entire sample was 40.2 minutes a day (Zimmerman, Christakis, & Meltzoff, 2007). In a sample of US children ages 0 to 6 years, it was found that, on a typical day, 75% of children watched TV and 32% watched DVDs/videos for an average of 1 hour and 20 minutes. Eighteen percent of 0- to 2-year-olds, 43% of 3- to 4-year-olds, and 37% of 5- to 6-year-olds had a television in their bedroom (Vandewater et al., 2007).

In one of the few studies specifically examining infants' television viewing experiences, Pierroutsakos, Hanna, Self, Lewis, and Brewer (2004) found that 2.5- to 24-month-olds are exposed to approximately 2 hours of television per day, 50% of which is programming designed for infants and toddlers, 40% is adult programming, and 9% is preteen programming. Therefore, half of the programming to which infants are exposed is not designed for them. There are no Canadian data on exposure to screen media in children under 2 years of age. However, the average Canadian child between 2 and 11 years of age watches 14 hours of television per week, with the figure rising to 19 hours for children in Newfoundland and Labrador (Statistics Canada, 2004). By the time North American children are 18 years old, they have spent more time watching television than any other activity except sleep (Kotler et al., 2001).

Although most of these studies examined children's exposure to foreground television, background television may exert a powerful influence on young children's development. Background TV is programming that may unintentionally capture the attention of members of an audience for whom it was not intended. Exposure to background television, also referred to as ambient television, occurs incidentally, as when a child is present in the room where a family member is watching a television program. Research on the media environment of American households points to extensive exposure to background television. Sixty-six percent of children in the USA live in a home where the television is on at least half of the time or more, even if no one is watching it, and 37% live in households where the television is left on "always" or "most of the time" (Rideout, Vandewater, & Wartella, 2003). In 2007-2008, American households had the television on an average of 8 hours 18 minutes a day (The Nielsen Company, 2008). Recently, a survey of mothers of infants aged 11 to 18 months found that the majority of mothers (56%) reported that the TV was turned on in the home half or more than half of the time during the day (Masur & Flynn, 2008).

Given the omnipresence of television in the lives of young children and the recommendation by the American Academy of Pediatrics (AAP; 1999) that children under the age of 2 years not be exposed to television, it is surprising how little research has been conducted on the impact of television on infants and toddlers. Indeed, Vandewater et al. (2007) recently commented on "the striking dearth of empirically based knowledge [which] stands in stark contrast to popular, policy, parental, and academic interest in the impact of media on young children" (p. 1007). This paucity of research is most striking in the area of background television.

Naturalistic observations of young children while in the presence of television have found that they continue to engage in cognitive and social activities necessary for healthy development. For example, Schmitt, Woolf, and Anderson (2003) found that 2-year-olds spent 41% of their time with the TV looking at the screen, 39% socializing, 34% being physically active, and 32% playing. The largest portion of playtime was spent playing with toys (57%). In a recent naturalistic study, Barr, Zack, Garcia, and Muentener (2008) found that 75% of 12- to 18-month-old infants engaged in toy play in conjunction with the presentation of an infant video. In a recent survey, 44% of mothers reported that the TV was on in the room at least half of the time during children's solitary play with toys, and 53% reported that the TV was on at least half the time during mother-infant play with toys (Masur & Flynn, 2008). This includes 11% of mothers who reported that the TV was *always* on in the room during mother-infant play with toys.

These findings run contrary to the AAP's (1999) statement that television and other media "displaces involvement in creative, active, or social pursuits" (p. 341). However, despite the finding that children may continue to engage in concurrent activities, the presence of television may sufficiently distract a child from these activities thereby affecting the quality, if not the quantity, of play and social interactions. In fact, several researchers have suggested that background television may interfere with cognitive processing (e.g., Anderson & Evans, 2001). Evidence, albeit indirect, lends some support to this possibility. Modest levels of noise exposure have been found to have detrimental effects on cognitive development in children. For example, Lercher, Evans, and Meis (2003) found that memory encoding was adversely affected by noise in school-age children. Attention, measured by visual search tasks, also appears to be impacted by chronic noise exposure (Lercher et al., 2003). Interestingly, Evans, Lercher, Meis, Ising, and Kofler (2001) found elevations of psychophysiological, behavioral, and self-reported indices of stress in children exposed to ambient noise. This increased stress could potentially interfere with children's social and cognitive activities.

The limited data on background television are consistent with the possibility that television impacts children's cognitive and social activities. In a cross-sectional study, Schmidt, Pempek, Kirkorian, Lund, and Anderson (2008) examined 12-, 24-, and 36-month-olds as they played with toys. For half of the 1-hour session a television program (*Jeopardy!*) was playing in the room. Schmidt et al. found that, when the television was on, the length of play episodes decreased, as did the degree to which attention was focused on play. Background television has also been found to decrease the quantity and quality of parent-child interactions (Kirkorian, Pempek, Murphy, Schmidt, Anderson, 2009). In addition, a negative correlation has been found between exposure to background television and time spent reading or being read to in children 3 to 6 years of age (Vandewater et al., 2005). This represents the entirety of research on background television and very young children; the vast majority of research on these relations has been conducted with school-age children and young adults (e.g., Armstrong & Chung, 2000; Armstrong & Greenberg, 1990; Pool, Van der Voort, Beentjes, & Koolstra, 2000). Because of this dearth of research and the omnipresence of television in the lives of very young children, the present study was designed to examine the impact of background television on infants' attention during toy play at 6- and 12-months of age.

Chapter 2

Review of the Literature

In the following literature review, components of attention, the development of attention systems and looking in infancy, phases of attention, and the measurement of attentional engagement using behavioral and physiological means are examined. The literature on distractibility in infants' and young children is also reviewed. Finally, several theories of infants' and young children's attention to television are described.

Attentional Processes

Attention is an elusive construct. Indeed, Hood, Atkinson, and Braddick (1998) commented that "attention is a term that is widely used in cognitive science but very rarely defined adequately" (p. 219). The difficulty in defining attention likely stems from evidence that attention comprises multiple psychological and neurological processes (Posner & Peterson, 1990). Despite this, several major components have been identified as central to the construct of attention. Parasuraman (1998), for example, describes three fundamentally important processes: selection, vigilance or sustained attention, and control. These attentional components allow individuals to focus on particular aspects of the environment by mobilizing the effort and resources necessary to resist distracting stimuli and engage in sustained information processing (Parasuraman, 1998; Ruff, Lawson, Parrinello & Weissberg, 1990). Although many researchers highlight the relative independence of these components, the successful execution of attention requires a flexible exchange among them (Parasuraman, 1998).

Selectivity is an ongoing, dynamic process that allows an infant to restrict attention to a particular stimulus or event (Ruff, 1998). For visual attention, selectivity often refers to the direction of visual gaze or the control of eye movements during attentive tasks (Richards & Hunter, 1997). Sustained attention refers to the ability to maintain attentional focus on a stimulus even in the presence of potentially distracting stimuli (Johnson, 1998). This maintenance of attention, however, may need to be disengaged to allow an infant to respond to some other potentially important information in the environment. Attentional control involves the shifting of attention from one target to another when appropriate (Parasuraman, 1998). What is appropriate at any given moment depends on an interaction between the individual (e.g., needs, goals, motivation) and the characteristics of the environment (Ruff & Rothbart, 1996).

There has been a great deal of research on selectivity and sustained attention during infancy. Several researchers have highlighted the importance of making a distinction between the two processes (e.g., Luck & Vecera, 2002; Cohen, 1972, 1973; Posner & Petersen, 1990). For example, Porges and Smith (1981) proposed a two-component model of attention that includes both reactive and sustained aspects of responsiveness to events. Similarly, Cohen (1972) proposed that infant attention involves two, independent processes: attention-getting and attention-holding. The attention-getting process determines whether or not (and how quickly) an infant will turn toward a stimulus, while the attention-holding process determines how long an infant will visually fixate on that stimulus. Support for this two-component model of infants' visual attention comes from evidence that stimulus characteristics have a differential impact on the two attentional processes. For example, Cohen (1972, 1973) found that infants' attention-getting is affected by the size and movement of a stimulus, whereas attention-holding is influenced by the complexity and familiarity of a stimulus.

Development of Attention during Infancy

An infant in a typical environment is confronted with a multitude of internal and external sensory inputs. The infant's ability to allocate, maintain, and control attention is fundamental to his or her behaving coherently and learning about the world (Kannass, Oakes, & Shaddy, 2006). Although infants' allocation of attention is not fully understood, it likely involves an interaction between exogenous and endogenous features, which changes with age. Several researchers describe a qualitative shift in attention being captured largely by exogenous factors to attention being driven by endogenous factors around the end of the first year of life (e.g., Colombo, 2001; Ruff and Rothbart, 1996; Wright and Vlietstra, 1975).

Ruff and Rothbart (1996) have provided the most comprehensive analysis of the development of attention in infants and young children. They describe a period from approximately 3 to 9 months of age during which the orienting/investigative (O/I) system predominates. The O/I system enables the infant to orient toward potentially important stimuli. The O/I system is largely driven by the orienting response (OR), a relatively automatic or involuntary response to low or moderately intense changes in the environment, which develops in the first 2 to 3 months of life (Sokolov, 1963).[1] The OR can be elicited by both the onset and offset of a stimulus as both represent a change in the environment. Orienting has been described as the "gateway to attention" and is the first step in stimulus information processing (Lang, Simons, & Balaban, 1997). Based on information gathered from this initial response, an infant may disengage his/her attention or engage in further processing of the stimulus (Berg & Richards, 1997).

The O/I system is particularly responsive to novelty. Indeed, research has consistently found that infants' looking times decrease as stimuli become familiar and increase with the presentation of novel stimuli (e.g., Cohen, Gelber, & Lazar, 1975). In addition, when a novel and familiar stimulus are presented simultaneously, infants look longer at the novel stimulus (Fagan, 1974, 1977). Because the OR responds to exogenous features of the environment, episodes of attention are often interrupted by other more salient stimuli, especially when the original stimulus has lost some of its perceptual interest over time. Thus, the O/I system is characterized by rapid habituation, relatively short periods of sustained attention, and numerous shifts in visual fixation (Ruff & Rothbart, 1996).

Ruff and Rothbart (1996) describe a second, higher level system of attention that begins to emerge around 9 to 12 months of age and continues to develop throughout the preschool years. In contrast to the O/I system, this higher-order system is driven by factors that are endogenous to the individual, such as planning, goal setting, and motivation. This increase in the influence of endogenous factors corresponds to

1The defense response is elicited by stimuli of high intensity and, unlike the orienting response, interferes with attention (Sokolov & Cacioppo, 1997).

developments in cortical areas, such as frontal eye fields, parietal cortex, and prefrontal cortex (Johnson, 2005). Thus, as infants develop the second system of attention, cognitive factors begin to override lower-level processes. For example, there is a decrease in the automaticity and magnitude of the orienting response around 9 months of age. As a result, infants become better able to maintain attentional focus and resist distraction. In addition, selectivity, driven largely by physical salience under the O/I system, becomes more deliberate (Ruff, 1998). Ruff and Rothbart describe these developments as part of the larger construct of self-regulation defined as "the ability to modulate behavior according to the cognitive, emotional, and social demands of specific situations" (p. 7).

Development of Look Duration

The most common dependent measure of attention during infancy is visual fixation or looking. Look duration changes significantly across the first year of life (Colombo, Shaddy, Richman, Maikranz, & Blaga, 2004). A meta-analysis by Colombo, Harlan, and Mitchell (1999; cited in Colombo, 2002) revealed a triphasic pattern in the developmental course of look duration across infancy and early childhood. Colombo (2002) describes an increase in infants' look durations from the newborn period to approximately 8 to 10 weeks of age. This is followed by a decline in look duration from 3 to 5/6 months of age, and then a leveling off or gradual increase from 6 to 7 months onward.

Much of the research on infants' looking has used static, two-dimensional pictures of patterns. As such, Courage, Reynolds, and Richards (2006) examined whether the triphasic pattern of look duration with development was dependent on the type of stimuli used. They examined looking in 3- to 12-month-old infants who were presented with static and dynamic pictures of faces, achromatic patterns, and *Sesame Street*. They found that for all stimulus types and at all ages, the dynamic versions of stimuli elicited more looking than did the static versions of the same stimuli. This is consistent with research showing that movement or the sudden appearance of an object are salient attention-getting stimuli (Nagata & Dannemiller, 1996).

Further, Courage et al. (2006) found the expected decrease in look duration from 14 to 26 weeks of age for all stimulus types, except static angles. Shaddy and Colombo (2004) similarly found that the decline in look duration in the middle of the first year traditionally found with static stimuli generalized to dynamic stimuli. However, Courage et al. found that from 26 to 52 weeks of age (the oldest age they tested), look durations increased significantly for some stimuli (dynamic and static *Sesame Street*) but leveled off (static faces, dynamic faces, dynamic angles) or continued to decrease (static dots, dynamic dots) for others. Thus, they found that the developmental course of infants' look durations across the first year was dependent on the type of stimuli used.

The developmental pattern of changes in look duration likely reflects changes in a number of attentional and cognitive processes over the first year of life. The early decline in look duration has been attributed to improvements in processing efficiency (Colombo, Mitchell, Coldren, & Freesman, 1991) and/or the ability to disengage attention (Frick, Colombo, & Saxon, 1999). However, this does not explain the leveling off or increase in look duration toward the latter half of the first year. Consistent with Ruff and Rothbart's (1996) account of the development of attention, Colombo (2002) points to the increasing role of endogenous attention in infants' looking behavior, such that older infants are increasingly able to voluntarily sustain attention on a stimulus. Thus, if a stimulus is sufficiently complex (e.g., *Sesame Street* stimulus), older infants may be motivated to maintain attentional focus in an effort to learn more about the stimulus. In addition, when an infant develops the ability to manipulate an object, the information it affords becomes more complex, and visual attention may increase (Ruff & Saltarelli, 1993). Thus, older infants may learn faster, but they also explore more facets of a stimulus, resulting in a similar level of looking across age.

Phases of Attention

Although duration of looking has been used as a measure of information processing, looking does not necessarily comprise a single attentional process. Indeed, in an effort to examine the processes that underlying looking, researchers have found that a single look is comprised of several phases that vary in attentional engagement (e.g., Richards, 1988). As such, Aslin (2007) cautions interpretation of visual fixation and stresses the importance of partitioning looking time into its components. Investigators have measured attentional engagement in several ways. Both behavioral and heart-rate measures have been helpful in determining what state an infant is in during an activity or task.

Behavioral measures of attentional engagement. Ruff (1984, 1986) examined infants' exploration of objects to better understand processes of attention and how they develop. In an examination of 7- and 12-month-old infants' attention during toy play, Ruff (1986) identified several behaviors and facial expressions that, together, reflect an infants' state of attention. For example, behaviors such as fingering or slow, presumably deliberate object manipulation such as turning an object around and passing it from hand to hand, and an intent facial expression (furrowed brow and/or pursed lips) were identified as reflecting a state of focused attention.[2] Ruff proposed that focused attention could occur in the absence of manipulatory behaviors; however, in general, periods of focused attention involve some haptic manipulation. Alternatively, object-directed activity, such as certain types of mouthing and repetitive banging, together with uninterested facial expressions was labeled casual attention.

Research supports the contention that focused attention is a period of time during which an infant actively processes information, while casual attention reflects inattentive engagement. For example, Ruff (1986; Doolittle & Ruff, 1998) presented infants with toys, one at a time, and observed their behavior while they played with them. It was found that infants' duration of focused attention decreased over time as object familiarity increased, whereas behaviors associated with casual attention (e.g., banging) did not. Similarly, Oakes and Tellinghuisen (1994) adapted Ruff's procedure and found that 7- and 10-month-old infants spent more time in focused attention to novel objects than

[2] Children are more likely to furrow their brows when they are looking downward while attending to something, as when they are playing with toys (Michel, Camras & Sullivan, 1992). As such, it is unclear what facial expression may characterize focused attention when a child is looking up to attend to something, such as a television program (Ruff & Rothbart, 1996).

familiar objects. Oakes, Madole, and Cohen (1991) examined 6- and 10-month-old infants' object discrimination and categorization and found that infants' examining of toys was a better measure of their encoding of information than their nonexamining behavior. In addition, like Ruff, they found that the infants' focused, but not casual attention, decreased with the familiarity of an object. The results of these studies suggest that focused attention is a more accurate indication of information processing than overall look duration.

Development of focused attention. Unlike look duration, focused attention is often measured in the context of toy play as it allows an infant to engage in a greater variety of behaviors. Ruff (1986) examined developmental differences in the latency to engage in focused attention and duration of focused attention in a series of experiments with infants from 6- to 12-months of age. Ruff found that latency to engage in focused attention following the initial presentation of an object consistently decreased with age. She attributed this finding to younger infants' relative difficulty in organizing an exploratory response to objects. There was no reliable association, however, between age and mean duration of focused attention. In one experiment, it was found that 12-month-olds exhibited longer mean durations of focused attention episodes than 7-month-olds. However, in a second experiment, no effects of age on duration of examining were found. Ruff attributed these inconsistencies to differences in the particular toys used.

Further research has revealed increases in focused attention with age. For example, Oakes et al. (1991) found longer overall examining times for 10-month-old infants than 6-month-old infants. In a study of 10-, 26-, and 42-month-olds, Ruff and

Capozzoli (2003) found an increase in focused attention and a decrease in casual attention to toys with age. In addition, Ruff and Lawson (1990) found that duration of focused attention increased with age in 1-, 2-, and 3.5-year-olds. However, the overall amount of focused attention varied with type of stimuli. Total duration and mean duration of focused attention was longer in a single toy condition than a multiple toy condition, regardless of age. In contrast, the number of focused attention episodes did not vary with condition. However, the infants showed less of a decrement in focused attention in the multiple object condition and the episodes of focused attention were spread out over a longer period compared with the single object condition. Therefore, Ruff and Lawson proposed that, while multiple objects may have acted as distractors, they also may have provided relatively novel stimuli to attend to when attention to one object was terminated.

Although these results suggest that focused attention increases with age, the relation between age and duration of focused attention remains unclear. Ruff (1986) suggests that age differences in the duration of focused attention vary with the features of the particular objects, the conditions under which they are presented, and the infant's cognitive and physical abilities at any particular age. For example, the finer manipulation skills of older infants enable them to explore finer details of a complex object. At around 5 months, infants begin to reach, grasp, and manipulate objects that engage their visual attention, and by 9 months, infants are relatively skilled at manipulative, as well as visual, exploration of objects (Ruff & Rothbart, 1996). Thus, although younger infants examine simpler objects more than older infants, when objects are more complex, older infants examine for longer durations (Oakes & Tellinghuisen, 1994). Thus, the level of complexity that infants prefer changes with age.

Heart-rate measures of attentional engagement. Heart-rate is the most common measure used by psychophysiologists who study infant attention. Early research on heart-rate identified the possibility that changes in heart-rate were indicative of an organism's changing responsiveness or sensitivity to stimulation. For example, in a review of the literature, Graham and Clifton (1966) concluded that heart-rate deceleration typically observed during the initial presentation of a stimulus is a component of the orienting response, whereas heart-rate acceleration is a component of the defense reflex. Lewis, Kagan, Campbell and Kalafat (1966) first noted that heart-rate was lower during longer episodes of looking than during shorter episodes and suggested that the examination of looking and heart-rate might make it possible to add "an 'intensity' dimension [to] the construct of attention" (p. 70).

Richards and colleagues (Casey & Richards, 1992; Richards, 1988) further partitioned infants' looking by using changes in heart-rate to differentiate four phases of attention which occur sequentially: the automatic interrupt, the orienting response, sustained attention, and attention termination. Richards proposed that an episode of attention begins with the automatic interrupt phase, an obligatory response to transient changes in the environment. The automatic interrupt phase is marked by a brief biphasic heart-rate response (deceleration-acceleration) which may or may not be followed by further processing stimulus processing. Stimulus orienting is the second phase of attention and is identical to Sokolov's (1963) orienting response. A large deceleration in heart-rate lasting about 5 seconds is indicative of an orienting response. Stimulus orienting is hypothesized to be an early phase of information processing in which the infant processes preliminary stimulus information (Ruff & Rothbart, 1996). An infant then engages in sustained attention if attention is maintained following the orienting response. This is marked by a further deceleration in heart-rate. In contrast to the automatic interrupt and orienting response, Richards (2001) describes sustained attention as a voluntary phase. The duration of this phase may last from 2-3 seconds to 20 seconds or longer. Sustained attention then begins to terminate as the heart-rate accelerates back to baseline (Reynolds & Richards, 2008). The infant will continue to fixate on the stimulus during this attention termination phase, which can last for approximately 6 seconds.

Heart-rate defined sustained attention, like focused attention, is thought to support information processing. Richards (1997a) used a paired-comparison procedure to examine 3- to 6-month old infants' recognition memory for visual stimuli presented for different lengths of time. Infants showed a familiarity preference for briefly presented stimuli (2.5 or 5.0 s), suggesting incomplete processing of the stimulus, but a novelty preference for stimuli presented for longer periods of time (10 or 20 s). In a second experiment, Richards presented infants with a Sesame Street movie until they showed heart-rate patterns consistent with either sustained attention or attention termination. During these attentional phases, the Sesame Street stimulus was turned off and the target stimulus was presented. Richards found that, when the target stimulus was presented during sustained attention, but not attention termination, infants demonstrated a novelty preference following only a 5 second exposure. Thus, the infants processed sufficient information from the stimulus during that 5 second exposure provided they were in the sustained attention phase. In fact, a positive correlation was found between the duration of infants' sustained attention during the familiarization phase and a subsequent preference for a novel stimulus. Similarly, Frick and Richards (2001) found greater evidence of recognition memory when stimuli were presented during periods of sustained attention in a longitudinal study of 14-, 20-, and 26-week-old infants.

The developmental course of sustained attention has not been fully established. However, Richards (2004) compiled data from a number of studies from his lab and found an increase in heart-rate deceleration to stimuli from 8 weeks to 26 weeks of age. There is also some evidence that the magnitude of heart-rate decelerations increases with age from birth to 10 months (Berg, 1975; cited in Reynolds & Richards, 2008). In a longitudinal study of infants from 3 to 9 months of age, Colombo et al. (2004) found a nonlinear course of development in sustained attention. They measured the percentage of time spent in sustained attention, as opposed to depth of heart-rate deceleration (cf., Richards, 2004), and found an increase in sustained attention from 3 to 6 months of age followed by a decrease to 9 months of age.

Distractibility in Infants and Young Children

Given the sheer number of external and internal events to which infants are exposed, the ability to selectively direct attention to some stimuli while shutting out others is critical for early learning. To better understand how infants allocate and maintain their attention, researchers have observed infants in competitive contexts in which more than one stimulus is available. Infants' ability to sustain attention to an object or task in the midst of competition for attentional focus is measured in terms of distractibility (Colombo, 2001). In the traditional distractibility paradigm, the infant is presented with a central stimulus, and while he/she visually attends to that stimulus, a distractor stimulus is presented in the periphery. The distractor is usually a discrete stimulus which remains on for a few seconds or until the infant visually fixates on it. Measures of distractibility in this context include the proportion of distractor trials to which the infant shifts his/her gaze to the distractor and distraction latency, measured as the amount of time between the onset of the distractor and the point at which the infant turns from the central target to the distractor (Tellinghuisen, Oakes, & Tjebkes, 1999).

Distractibility has also been measured in the context of multiple object free play tasks, in which the infant is presented with several toys simultaneously. As an infant explores a particular toy, the surrounding toys act as distractors. Measures of attention in this context include the number of shifts in attention and the duration of looking. These competitive tasks can be thought of as representing the infant's natural environment in which a number of stimuli are available, only some of which are relevant to the infant's current behavior.

Research on distractibility has revealed that infants' attention allocation is influenced by exogenous factors such as the characteristics of the target and distractor stimuli and endogenous factors such as the infants' attentional state. Further, the interactive influence of endogenous and exogenous factors on attention changes with age.

Effect of attentional state on distractibility. Researchers have consistently found that infants' peripheral stimulus localization and distraction latencies vary as a function of their level of cognitive engagement or attentional state. For example, Ruff and colleagues (Doolittle & Ruff, 1998; Ruff, 1986; Ruff, Capozzoli & Saltarelli, 1996; Ruff, Saltarelli, Capozzoli, & Dubiner, 1992; Ruff & Saltarelli, 1993) and Oakes and colleagues (Oakes, Kannass, & Shaddy, 2002; Oakes & Tellinghuisen, 1994; Oakes, Tellinghuisen, & Tjebkes, 2000; Tellinghuisen & Oakes, 1997; Tellinghuisen et al., 1999) have found decreased distractibility during behaviorally defined periods of focused attention compared with periods of casual attention. Ruff et al. (1996) examined distractibility in 10-month-old infants as they played with four novel toys, presented one at a time. Infants in the distractor condition were presented with discrete audio-visual stimuli (slides of pictures from children's books accompanied by a sound) presented on an unpredictable schedule in the infants' periphery. They found that the infants were less likely to respond to the distractors when they were engaged in focused attention to a toy. In addition, when the infants' focused attention as opposed to casual attention was interrupted, they were slower to turn toward the distractor, they looked for shorter times at the distractor, and they were more likely to return to focused attention immediately following the look away.

Studies using heart-rate defined attentional phases (sustained attention, attention termination) have also consistently found a link between attentional state and distractibility in infants (e.g., Lansink, Mintz & Richards, 2000; Lansink & Richards, 1997; Richards, 1989; Richards & Hunter, 1997). For example, Richards (1997b) examined the influence of attentional engagement on 3-, 4.5-, and 6-month-old infants' peripheral stimulus localization. The infants were presented with a central stimulus consisting of a *Sesame Street* TV program or computer-generated patterns. The distractor stimulus, consisting of a white square moving vertically on a TV screen for a period of 2.5 seconds, was presented during periods of heart-rate deceleration (sustained attention) or acceleration (attention termination). Richards found that the probability of peripheral localization was significantly lower during periods of sustained attention than during periods of attention termination.

Lansink and Richards (1997) extended these findings by examining the relation between heart-rate and behavioral measures of attention on distractibility. While 6-, 9-, and 12-month-old infants were playing with a toy, a distractor stimulus was presented for a period of up to 30 seconds or until the infant fixated on it. The distractors were presented during sustained attention, attention termination, focused attention, and/or casual attention. Richards found some correspondence between heart-rate changes and behavioral indicators of attentional engagement. Concordance between focused and sustained attention was found on 61% of the trials. In addition, there was a larger heart-rate deceleration during those periods when the infant was engaged in focused attention. The infants also took longer to look at a distractor during attentive than inattentive trials when heart-rate measures were in concordance with behavioral measures, and distraction latencies were shortest when the measures were concordant for inattentive activity.

This pattern of results indicates that infants' distractibility varies as a function of the type of attention in which they are engaged. Ruff and Rothbart (1996) suggest that this occurs because, during a period of focused attention, fewer stimuli are selected for processing due to the increased amount of information processing directed to the focal target. Interestingly, when Ruff et al. (1996) compared infants' attention with and without the presence of distractors, they found that infants exposed to both toys and distractors spent less time casually attending to the toys and more time focused on the toys. They point to the potential role of peripheral narrowing, or an increased effort to maintain attentional focus in the face of competing stimuli. Peripheral narrowing during focused attention may be an adaptive mechanism that enables an infant to maintain organized behavior under noisy and stimulating conditions.

It is unclear if the infants fail to detect the peripheral stimuli or if they detect the stimulus but ignore it. Richards (1997a) argued that a failure to orient to a peripheral stimulus is due, not to the failure to detect and discriminate the peripheral stimuli, but rather, to "inhibition by the neural systems governing foveal stimulus processing" (p. 27). Data from Finlay and Ivinskis (1984) support this contention. They found in a sample of 4-month-old infants that heart-rate change varied as a function of the interaction between the central and peripheral stimuli, even in the absence of overt orienting to the peripheral stimulus. Thus, Finlay and Ivinskis concluded that the peripheral stimulus was still being detected.

Effects of distractor and target characteristics on distractibility. In support of the supposition that infants detect peripheral stimuli even if they fail to turn toward them are data from several studies showing an interactive effect of central and distractor characteristics on distractibility. The likelihood of a peripheral turn has been shown to be determined by the characteristics of the central target and distractors. Specifically, Finlay and Ivinskis (1984) found that infants presented simultaneously with a central stimulus that rotated at a slower speed than the peripheral stimulus oriented more readily to the peripheral stimulus than infants presented with central and peripheral stimuli that were rotating at the same speed. Tellinghuisen et al. (1999) presented 7-month-olds with two different types of distractor stimuli (single tone vs. alternating tone). While in a casual state of attention, infants exhibited equally short distraction latencies to both single and alternating tones. However, only the alternating tone yielded rapid orienting to the distractor during focused attention. Oakes, Tellinghuisen, and Tjebkes (2000) extended these findings and found a three-way interaction between attentional state, distractor characteristics, and central target characteristics on distractibility. The 7-month-old infants oriented to a high proportion of checkerboard distractors, regardless of central target characteristics and attentional state. Thus, the checkerboard distractor was sufficiently salient to elicit attention. In contrast, the proportion of solid rectangle distractors to which they turned varied as a function of attentional state and central target characteristics. Specifically, the infants were least likely to orient toward the solid rectangle distractor when engaged in focused attention to a multi-component versus a single component central target. Thus, presuming that the infants' depth of engagement was greater with the multi-component versus the single component toy, the intensity of focused attention impacted the probability that the distractor stimulus would interrupt the infants' ongoing activity.

These results are consistent with a biased competition model of visual attention (Desimone & Duncan, 1995; Duncan, 1996) in which stimuli compete for attention in a manner that is biased by endogenous factors such as goals and states. When an infant is engaged in focused attention toward an object, the evidence points to the possibility that they are actively learning about it (e.g., Oakes & Tellinghuisen, 1994; Ruff, 1986; Ruff et al., 1992). Thus, maintaining attention toward that object becomes important for the infant's ongoing behavior. During this state, a distractor would need to be more salient to win the competition for infants' attention. In contrast, when the infant is in a state of casual attention, the competition may be biased toward any novel event that occurs in the environment. Thus, any reasonably salient distractor should "win" the competition for attention (Tellinghuisen et al., 1999).

Age differences in distractibility. There is limited research on developmental changes in infants' and toddlers' distractibility. Richards (1987) found that distraction latencies got shorter from 2 to 6 months of age, whereas Oakes and Tellinghuisen (1994) found that distraction latencies got longer from 7 to 10 months. These data suggest a U-shaped developmental curve in the first year of life. However, in the Richards study, the stimuli used across ages remained constant. Thus, as the infants became more adept at processing information from the central stimulus with age, they may have begun to turn more quickly to the distractor. Ruff and Capozzoli (2003) examined the development of attention and distractibility in 10-, 26-, and 42-month-olds and found that the 10-month-olds were more distractible than the other children, even during focused attention. Thus, much of the data points to a decrease in distractibility with age. Ruff and Capozzoli also found an interaction between age and distractor characteristics, such that the infants were more distracted by auditory-visual distractors, whereas the oldest children were most distracted by visual distractors.

Oakes, Kannass, and Shaddy (2002) examined the impact of age on the interaction among endogenous and exogenous factors on distractibility. They examined distraction latencies in 6.5- and 9-month-old infants as they explored familiar toys and novel toys, while a distractor stimulus (blinking rectangles accompanied by beeping) was presented in the periphery. They found that the 6.5-month-olds' distraction latencies did not vary as a function of target familiarity, but the 9-month-olds' latencies were longer when exploring novel versus familiar toys. Although Oakes et al. did not explicitly measure attentional engagement, they proposed that the older infants inhibited responding to the distractor in an attempt to explore and process information about the novel objects. In contrast, the younger infants' attention allocation seemed to be driven by the physical characteristics of the environment.

Infants' Attention to Television

There is little direct research on infants' attention to television; the majority of the extant research has been conducted on older children in an attempt to determine the influence of televised content (e.g., impact of violent television on children's behavior), rather than the medium per se. In most research, children's attention to television has been inferred from overt looking at the screen and tends to show a linear increase in attention to television with age (Anderson & Pempek, 2005). For example, Schmitt

(2001) found a linear increase in attention with 6-month-old infants looking at the TV 11% of the time and 3-year-olds looking at the TV 39% of the time. When Anderson and Levin (1976) examined young children's attention to *Sesame Street,* they also found a linear increase in looking at the TV from 12 to 48 months of age. Anderson and colleagues (e.g., Anderson & Lorch, 1983) argued that the increase in looking at the television from infancy through the preschool years was due to increased cognitive and language abilities, such that preschool programs became sufficiently understandable to allow children to attend to them in a sustained manner.

Research examining the pattern with which infants, children, and adults view television has revealed remarkable consistency. In a review of the literature, Richards and Anderson (2004) found that for all ages from 3 months to adulthood, the distribution of look lengths to television is lognormal; the distribution is skewed so that there are many short looks interspersed with progressively longer looks. This pattern is consistent with a phenomenon called attentional inertia, which is a progressive increase in attentional engagement as a look is sustained (Richards & Anderson). Thus, with longer looks, the viewer becomes less distractible and slower to react to secondary tasks, has a pattern of heart-rate that indicates sustained attention, and has greater memory for the target of the look.

It remains unclear what underlies infants' and young children's attention to television. Theories tend to distinguish between two major alternatives. One possibility is that their attention is driven by formal features (Huston & Wright, 1983). Formal features are attributes of programs that result from visual and auditory production techniques. Visual techniques include cuts, dissolves, fades, pans, zooms, wipes, and visual special effects. Auditory characteristics include adult and child speech, peculiar speech (e.g., Teletubbies' vocalizations), sound effects, music and singing. Formal features that are defined as perceptually salient are relatively high on the dimensions of intensity, movement, contrast, change, novelty, and incongruity (Berlyne, 1960; cited in Calvert, Huston, Watkins, & Wright, 1982). For example, salient formal features include rapid action, visual special effects, loud music, and sound effects (Calvert et al., 1982). These formal features contribute to a program's pace. A second possibility is that children's attention to television is driven by higher cognitive factors, such as their ability to comprehend what they are viewing (Anderson & Lorch, 1983). Several theories have been proposed to address the role of formal features and comprehensibility in determining attention to television in children: 1) the passive model; 2) the active model; 3) the feature-sampling model; 4) the exploration-search model; and 5) the moderate-discrepancy hypothesis.

Passive model. When interest in the cognitive effects of television on children began in earnest in the 1970s, researchers initially embraced the passive (or reactive) model of attention (Singer, 1980). This model holds that children's attention to television is passively directed by salient formal features regardless of content and is consistent with the notion that children are transfixed by television images and, as such, lose the ability to think critically about what they are watching. In fact, the salient features that are most likely to elicit and hold children's attention to television are thought to interfere with their ability to learn.

Active model. In the early 1980s, the passive model began to fall into disfavour as several studies found that salient formal features did not exclusively drive children's attention (e.g., Anderson, Lorch, Field, & Sanders, 1981; Lorch, Anderson, & Levin, 1979). Based on these studies, Anderson and colleagues concluded that there was no evidence that the television medium had any control over a young child's attention separate from its content. In their active model of television viewing the role of formal features is to alert the viewer to content that is interesting and comprehensible. For example, if a feature predicts age-appropriate content, it will elicit or sustain attention. Therefore, in contrast to the passive model, the active model posits that there is a causal relationship between comprehension and attention (Anderson & Lorch, 1983). Evidence for this relationship comes from Lorch et al. (1979) who analysed the relationship between children's visual attention and their performance on a test of comprehension. In their study, 5-year-old children watched *Sesame Street* in a room with or without toys. Although the groups yielded differences in visual attention, such that the children in the no-toy condition spent twice as much time looking at the television screen, there was no difference between the groups in comprehension of the program's content. Lorch et al. concluded that cues from the auditory track informed the children of the presence of comprehensible material, which in turn captured their visual attention.

Anderson et al. (1981) further tested the relationship between comprehension and attention by varying the comprehensibility of a television program while holding the formal features constant. They found that segments of *Sesame Street* made relatively incomprehensible by the addition of foreign or backward dialogue produced lower visual attention in 2-, 3.5-, and 5-year-old children. However, scrambling scenes within a segment produced little or no reduction in attention particularly for the older children. In keeping with the active model's prediction, Anderson et al. concluded that the scrambled scenes remained relatively comprehensible. However, Pingree (1986) found that children attended equally to random and normal program segments, despite reporting more difficulty in comprehending the random segments. This suggests that, in addition to comprehensibility, other aspects of viewing may be important predictors of attention (e.g., novelty).

Feature-sampling hypothesis. The active model contends that formal features serve a marker function by signaling to children that relevant, interesting material is being presented. Huston and Wright (1983) proposed the feature-sampling hypothesis to account for how formal features influence children's television viewing when the children are not attending to the screen. They suggested that children take periodic samples of the formal features and content of television, and in so doing, can direct their attention elsewhere when the television's programming is of little perceptual or cognitive interest. This attentional sampling is not continuous, but occurs at identifiable points in the program. For example, auditory information allows the child who is not looking at the screen to attend during the first few seconds of a segment and to make a decision about whether to continue looking. Consistent with this hypothesis, Lorch et al. (1979) found that 5-year-olds' visual attention to television decreased while in the presence of toys compared to children in the no-toys condition, but there was no difference between the groups in comprehension. This suggests that children who are engaged in play activity monitor the sound track of the television program. Anderson and Lorch (1983) also concluded that children who play in front of the television monitor the sounds of the program and look up when the sound track signals something interesting. Thus, older children who understand more, look up more often, and their total looking time at the television increases.

Although the feature-sampling hypothesis does not specify the age at which children begin to use a sampling strategy, Valkenburg and Vroone (2004) offer some evidence that infants as young as 6 months of age use program features to allocate their attention to television. In their study, the presentation of opening scenes signaling adult-oriented content (e.g., news programs, adult commercials) led to decreases in visual attention, while opening scenes signaling child-oriented content (e.g., *Teletubbies*, children's commercials) resulted in increased attention. Similarly, Barr et al. (2008) found that 12- to 18-month-old infants' attention allocation was associated with the occurrence of formal features. For example, sound effects were able to generate an orienting response from all infants who viewed an infant-directed video (*Baby Einstein*).

Exploration-search model. In the exploration-search model, Huston and Wright (1983) propose that children move from an exploration mode early in development to a search mode as they gain cognitive maturity and experience with television. As such, although perceptually salient formal features initially drive young children's attention, with age and experience, they learn that these formal features may signal relevant content. Huston and Wright predicted that with repeated exposure, looking time to television programming would be maintained or possibly increase. Thus, rather than habituate to repeated presentation of formal features, children might use their knowledge that formal features signal specific content as a means to reorient and maintain attention (Richards & Anderson, 2004). Consistent with this contention, Barr et al. (2008) found that infants' with prior exposure to the video content showed an increase in overall looking time, attending during segments that did not include perceptually salient sound features.

The exploration-search model does not stipulate when this shift occurs. However, the theory predicts that, because infants know little about the connection between features and content, they will attend automatically whenever perceptually salient features occur. This responsiveness to perceptual salience is predicted to decline with age (Huston & Wright, 1983). However, evidence for a developmental change is weak. For example, contrary to the developmental predictions of the exploration-search model, Anderson and Levin (1976) found that, from 1 to 4 years of age, children become increasingly responsive to salient features when viewing *Sesame Street*. In addition, from 4 to 10 years of age, several studies have found relatively small age differences in patterns of attention, as both older and younger children attend to salient features (e.g., Calvert et al., 1982).

Although children may not show a decrease in responsiveness to salience, there is some evidence to suggest that they do show an increase in attention to content features. For example, Valkenburg and Vroone (2004) found that the scenes that attracted the attention of 6- to 18-month-olds used salient formal features, such as applause, laughter, rapid character action, and visual surprise. Although the scenes that attracted the attention of 1.5- to 3-year-olds still contained salient formal features, they were also characterized by content features. Based on these findings, Valkenburg and Vroone suggested that the developmental shift in attention to content features begins between 1.5 and 2.5 years of age.

Moderate-discrepancy hypothesis. The moderate-discrepancy hypothesis (McCall, Kennedy, & Applebaum, 1977) posits that children prefer to look at stimuli that they can partially incorporate into their existing schemata and show less interest in extremely simple or extremely complex stimuli. As such, this model predicts that at any given age, a moderate level of stimulus complexity will maintain attention. The relationship between comprehensibility and attention is characterized by an inverted U shaped curve (Rice, Huston, & Wright, 1982). As a result of both cognitive development and experience with television, a child's attention shifts toward increasingly complex material.

Although very few studies have explicitly tested the developmental predictions of the moderate-discrepancy hypothesis, Anderson and colleagues offer results that are consistent with this model (Anderson et al., 1981; Lorch et al., 1979). In addition, Valkenburg and Vroone (2004) found an interaction between age and stimulus complexity in determining visual attention. When they presented children with scenes of varying complexity, they found that the easiest segment (*Teletubbies*) attracted relatively high attention among the 6- to 18-month-olds. The most difficult child-oriented segments (*Lion King* and children's commercials) drew relatively high attention among 36- to 58-month-olds. However, Valkenburg and Vroone claim that the *Lion King* and

Teletubbies segments did not differ in their use of formal features known to attract children's attention. Therefore, they concluded that the stimulus complexity was responsible for the differential attentional responses. Further evidence comes from developmental changes in children's television programming preferences. Acuff (1997) found that young children prefer slow-paced programs with repetition and familiar content and suggested that young children need more time to make sense of television images. Similarly, Barr et al. (2008) found that infants' attention to infant-directed videos increased with repeated exposure. However, by the time they are 5 or 6 years of age, children begin to show a preference for content that is more difficult to understand. They prefer more fast-paced programs with less redundancy and more complicated characters (Huston, Wright, Rice, Kerkman, & St. Peters, 1990).

Children's attention to and comprehension of television is more complex than originally outlined by the passive and active models. The evidence, albeit limited, suggests that attention to television is a result of a confluence of factors, including program comprehensibility, the cognitive developmental level of the child, and their experience with the medium and program features. However, little is known about the relative contribution of each these factors and how it changes with age.

Chapter 3

Goals and Hypotheses

Infants' and young children's exposure to television in their homes is extensive. Preliminary evidence is suggestive of a potentially negative impact of background television on young children as they engage in cognitive and social activities (e.g., Schmidt et al., 2008). As such, the current study was designed to examine the impact of background television on infants' attention to toys during play. The infants in the current study were free to engage in play with toys or to watch television with few restrictions on their behavior. This provided an opportunity to observe infants' spontaneous ability to focus attention and resist distraction and was intended to mimic an infant's play environment at home. The study employed a longitudinal design so that infants were tested at both 6 and 12 months of age. These ages were chosen because processes governing attentional engagement are thought to undergo significant development during this time (Ruff & Rothbart, 1996).

Three categories of television programming (children's educational, children's action, and soap operas) that differ in their density of formal features were examined to determine the influence of programming features on infants' attention. Several theories posit that infants and toddlers attend automatically to perceptually salient formal features (e.g., feature-sampling model; exploration-search model, Huston & Wright, 1983). Indeed, Valkenburg and Vroone (2004) found that infants as young as 6 months of age use program features such as laughter to allocate their attention to television.

The infants' attentional engagement with the toys was examined by using behavioral measures of overt looking and focused attention. Attention to the television was examined using behavioral measures of looking and heart-rate indices of sustained attention.

Goal 1: To examine the impact of background television on infants' allocation of attention during toy play.

Consistent with the extant research, it was predicted that the presence of background television would increase infants' looking at the television screen and disrupt the infants' looking at the toys. However, the extent of the disruption was expected to differ by program type. If attention is driven by the perceptual salience of formal features, attention to the television may be highest to the children's action programming. However, if comprehensibility is a factor in infants' attention to background television, the children's educational programming may create the greatest distraction. Due to their relatively slow pace and incomprehensible content, soap operas were expected to cause the least disruption to infants' visual attention to toys.

Age related changes in infants' attention to background television were examined by testing the same group of infants at 6 and 12 months of age. There were several possible developmental outcomes: 1) because infants' distractibility decreases with age, attention to background television may decrease with age; 2) because infants' experience with and understanding of television programming may increase with age, attention to background television may increase with age. This may be most evident in those infants exposed to the children's educational programming; 3) if the orienting response to the salient formal features in television is invariant across the first year of life there may be no effect of age on attention to television (cf., Calvert et al., 1982).

Goal 2: To examine the impact of background television on infants' quality of attention to toys

In addition to its potential impact on the quantity of infants' looking, background television was anticipated to affect the quality of attention to toys. Thus, behavioral indices were used to identify periods of focused attention to the toys (cf., Ruff, 1986). Overall, rates of focused attention were predicted to increase with age, consistent with increases in the development of endogenous attention. It was also predicted that the presence of background television would lead to lower rates of focused attention to toys. However, paralleling the predictions for infants' looking behavior, it was expected that the impact of background television on focused attention would depend on program category. The greatest disruption to focused attention may occur for those infants presented with the children's action programming, while the least disruption may occur for those infants presented with the soap operas. In addition, consistent with Oakes et al. (2002), the impact of program category on focused attention may differ with age; the infants at 6 months of age may experience a disruption in focused attention in the presence of background television regardless of program category, while the infants at 12 months of age may experience a disruption when presented with the children's action programming only.

Chapter 4

Method

Design

A 3 (program category: child-action, child-educational, adult) X 2 (gender) X 2 (order: TV presented in the 1st 10 mins vs. TV presented in the 2nd 10 mins) X 2 (treatment: no TV vs. TV) X 2 (age: 6 mo vs. 12 mo) mixed design was employed with program category, gender, and order as between-subject variables and treatment and age as within-subjects variables. The infants were tested at 6 months and again at 12 months of age. At 6 months of age, the infants were randomly assigned to 1 of the 30 television program clips with the restriction that only one boy and one girl watch each clip. The order of television presentation (TV first vs. TV second) was counterbalanced within gender and program category. The infants at 12 months of age were presented with a different program from the same category, but in the same order as their 6-month session.

Ethics Approval

Ethics approval was obtained for this study from the Memorial University Interdisciplinary Committee on Ethics in Human Research (ICEHR No. 2004/05–118-SC).

Participants

Of the 88 infants tested at 6 months of age, data on 28 infants were eliminated due to crying/fussiness (22), mother interference (3), sleepiness (1), and equipment failure (4). The final 6-month-old sample comprised 60 infants (30 boys; 30 girls). The mean age at time of testing was 26.3 weeks (*SD* = 1.08, range = 22.9-29.6). Fifty-two of the

60 infants returned at 12 months of age. Five infants were eliminated due to crying/fussiness (3), sleepiness (1), and experimenter error (1). The final sample consisted of 47 infants (25 boys; 22 girls). The mean age at testing was 51.5 weeks (*SD* = 1.21, range = 49.3-53.4). Preliminary analyses revealed no differences in measures of temperament and attention to the toys and television at 6 months of age between those 13 infants who participated only at the 6-month session and those who participated in both 6- and 12-month sessions (all *ps* > .05).

The infants were full term and healthy at birth (38-42 weeks gestation and at least 2500 grams), and were without any known developmental, visual or auditory anomalies. The participants were recruited from an existing database of mothers' names and phone numbers that were provided by the parents following a contact at the time of their child's birth. Prior to the present research, parents were contacted with a letter describing the purpose and procedures of the study. Approximately one week later the parents were contacted by phone, a brief description of the study was provided, and an appointment was made for those parents who were interested in participating with their infants. The parents were not compensated, but the infants were provided with a certificate of participation at 6 months and a t-shirt at 12 months of age. Those parents who incurred the cost of taking a taxi or bus to the lab were reimbursed.

Materials and Apparatus

The testing and control rooms are depicted in Figure 1.

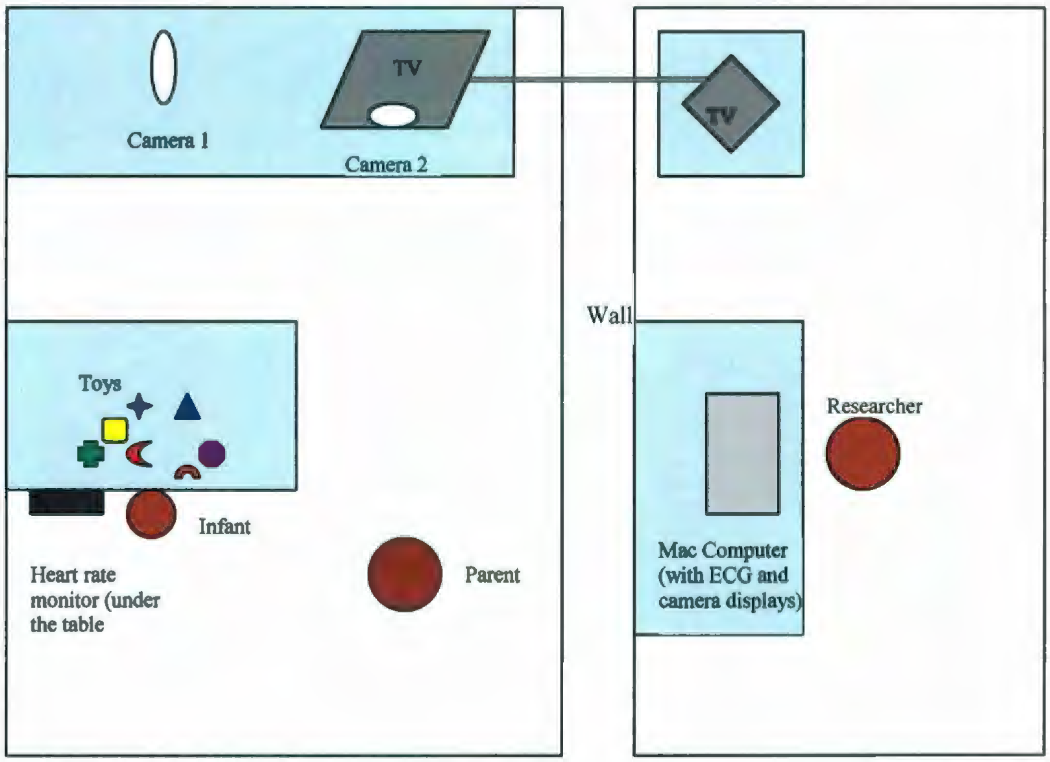

Figure 1: A schematic depiction of the testing and control rooms

Cameras and computer. Two analog cameras were connected to a Power Macintosh G5 computer in the control room. One camera (Camera 1) was mounted in front of and on the same level as the infant's face and torso so that behavioral indices of attention could be measured. A second camera (Camera 2) was mounted on top of the television and recorded the entire room so that the infants' direction of gaze could be determined. The input from the two cameras was converted to digital files using the

Canopus Advanced Digital Video Converter (ADVC110) and saved as one file using Security Spyware software, which enabled temporally synchronized playback of the two digital videos.

Heart-rate monitor. Infants' heart-rate was measured with two shielded pinch leads. The leads were placed on either side of the chest and grounded with an unshielded lead placed just above the navel. The electrodes were latex free, had disposable adhesive collars, and were designed for infants. The electrocardiogram was digitized through the use of a data acquisition interface and a Power Macintosh G5 computer running software from a commercial data acquisition package (BIOPAC Systems, Inc., Santa Barbara, CA) configured for psychophysiological recording. The ECG sampling rate was 250 Hz.

Televisions. A 20" RCA flat screen color television was used to present the television program clips. The television was positioned 6.5' away and at a 33-degree angle to the infant's right side. A second television was located in the control room enabling the researcher to view the same program as the infant to ensure that it ran in its entirety and was free from glitches.

Television programs. The television clips were selected from three classes of programs that were intended to reflect what might be commonly viewed by older siblings and caretakers during a weekday morning or afternoon. The broad program categories are children's educational programming, children's non-educational/action programming, and soap operas. Ten programs per category were selected so that the results could be generalized across programs within each category and not be restricted to specific properties of a particular program. A 10-minute segment from each program was randomly selected with the restriction that the opening theme song and closing credits would not be included. The children's educational programs included one clip each from *Barney, Sesame Street, Blue's Clues, Big Comfy Couch, Dora the Explorer, Arthur, Clifford's Puppy Days, Dragon Tales, Bob the Builder,* and *Reading Rainbow*. The children's non-educational/action programs included one clip each from *Pokemon, Yu-Gi-Oh!, Mew Mew Power, Rocket Power, Krypto the Super Dog, Justice League, Sponge Bob Squarepants, Fairly Odd Parents, Transformers,* and *Jacob Two Two.* The soap opera programs included one clip each from *Days of our Lives, All My Children, Young and the Restless, Passions, Guiding Light, General Hospital, As the World Turns, One Life to Live,* and two clips from *Bold and the Beautiful.*

The soap operas and children's non-educational cartoons aired on a local television channel (NTV), a Canadian cable channel (YTV) and American cable channels (CBS, ABC). As such, some of the clips from these programs contained commercials, weather and news updates, and/or network promotions. These programming interruptions were not removed from the clips in an attempt to increase the ecological validity of the experiment. However, if the 10-minute program clip contained over 50% non-program content, a new clip was randomly selected until it contained less than 50% non-program content. This occurred for two soap operas. Minor editing was also required to eliminate a brief erotic scene and a violent scene from two of the soap opera segments. The children's educational programs aired on PBS and Treehouse and, as such, did not contain any commercial interruptions.

A random sample of five program clips from each category was viewed to determine the occurrence of formal features. These formal features were used to calculate a pacing index developed by McCollum and Bryant (2003). The formal features included a) frequency of camera cuts within a scene, b) frequency of related scene changes, c) frequency of unrelated scene changes, d) frequency of auditory changes, e) percentage of active motion (faster than walking), f) percentage of active talking, and g) percentage of active music. McCollum and Bryant assigned different weights to each of these features. Many of the criticisms aimed at children's television programming involve switching from one camera to another. In fact, pace has traditionally been measured as the frequency of scene and character changes (e.g., Wright et al., 1984). As such, the greatest weight, 50%, was assigned to cuts and scene changes. Movement on the screen was assigned 20%, and talking, music, and auditory changes were assigned 10% each. To normalize the data, the frequencies were transformed into percentages. The following formula was used to yield each program's pacing index: [(normalized percentage of camera cuts) X .15] + [(normalized percentage of unrelated scene changes) X .20] + [(percentage of active motion X .20] + [(percentage of active talking) X .10] + [(percentage of active music) X .10]. The result was an average pacing index of 53.13 for the children's action programs, 45.13 for the children's educational programs, and 34.23 for the soap operas.

Toys. The 6-month-olds were presented with seven commercially available, age-appropriate toys which included the following: a Fisher-Price® 'Brilliant Basics' activity magnet and activity block, Mega-Bloks® 'Block Buddies' fire truck with driver, Bruin®

'Twist 'n Learn' and 'Push 'n' Go Crab' and a rattle shaped like a girl, and a toy car (see Figure 2). The 12-month-olds were presented with seven age-appropriate toys including two toys (Crab and Fire Truck) used for the 6-month testing that were deemed to have sufficient complexity (e.g., multiple colors and moving parts) for a 12-month-old infant. The five new toys were: Baby Einstein® 'Splash & Stack" color cups and 'Traveling Discovery Cards', Bruin® 'Activity Bug' (with the sound turned off), Playskool® 'Rumblin' Roller' truck, and Fisher-Price® 'Amazing Animals' panda (see Figure 3). All toys were easily graspable and intended to support age-appropriate activity.

Figure 2: Toys used with infants at 6 months of age

Figure 3: Toys used with infants at 12 months of age

Parent questionnaires. The parents were asked to complete two questionnaires during the experimental session, a television-viewing questionnaire and a temperament questionnaire. These questionnaires provided additional data, but they also served to keep the parents occupied in an attempt to minimize interference. A brief television questionnaire was devised specifically for this study to determine the infants' experiences with television in their home, including their previous exposure to the television and toy stimuli used in the experiment (see Appendix A). Infant temperament was measured at both 6 and 12 months of age using the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003). The IBQ-R is a rationally derived parent-report assessment tool designed for use with infants from 3 to 12 months of age. The IBQ-R consists of 14 scales and a total of 191 items.

Because the IBQ-R takes approximately 30 minutes to fill out, those parents who did not complete the questionnaire during the session were asked to complete it at home. A self-addressed stamped envelope was provided to those parents who completed the IBQ at home. Forty-three IBQ-R questionnaires were completed and returned at 6 months of age and 40 were returned at 12 months of age. Analysis of the temperament data to determine the potential relationship between temperament and attention to background television are beyond the scope of the current study and will be reported in a subsequent paper.

Procedure

A list of television clips with a corresponding order (TV first; TV second) was randomly generated with the restriction that only one boy and one girl see each program clip and that each program clip be presented in a TV-first and TV-second condition. The 6-month-old infants were assigned to a condition based on the order in which they arrived at the laboratory. Upon their arrival, an experimenter provided the parent with an information letter and consent form, verbally reviewed the procedure with the parent and answered any questions. After obtaining informed consent, the infant was secured by a lap belt in a hook-on chair attached to a table. The parent remained in the testing room for the entire session and was seated slightly behind and to the right of the infant. Therefore, the infant could see his/her parent with a right turn of the head. While one experimenter placed three heart-rate leads on the infant's torso, under his/her shirt, a second experimenter verbally instructed the parent to pick up any toy that the infant dropped or pushed out of reach during the experiment. Otherwise, he/she was instructed to keep interactions with the child to a minimum. These instructions were also provided in writing to the parent (see Appendix B). The parent was also instructed to fill out the television viewing questionnaire and IBQ during the experimental session and was provided with a pen and a clipboard to do so. At this point, both experimenters left the room.

The infant sat at the table for a period of approximately 1 minute before the stimuli were presented to determine if the heart-rate was recording correctly. The experimenter then re-entered the room, placed the toys on the table in front of the infant, and left the room. For infants assigned to the TV-first condition, the television program began playing as soon as the experimenter left the room. For infants assigned to the TV-second condition, the TV program began 10 minutes after the experimenter left the room. The infants were visually recorded for the entire experimental session. These digital files were time-coded so that they could be synchronized with the heart-rate files for the purposes of coding. When the session was over, the experimenter reentered the room, removed the electrodes from the infant's turso and returned him/her to the parent.

At 12 months of age, the infants were randomly assigned to a different program clip within the same program category (children's educational, children's action, soap opera) and in the same order (TV first or TV second) as that viewed at 6 months of age. The same procedure was used for the infants at 12 months of age.

Dependent Measures

Direction of gaze. The digital files of each infant's session were coded based on the direction of the infant's looks. Two independent observers were trained to determine if the infants were visually fixating on the toys, the parent, the television, or other (any other point in the room). Infants were coded as crying if their crying resulted in an unfixed gaze (i.e., had their eyes shut or seemed unfocused). When the television was on it caused a flickering of light in the room, so that, although the observers could not see the television screen, they were aware of when it was on and off. However, they did not know which of the 30 television programs was playing or the hypotheses of the study. A look to the toys was coded every time the infants visually attended to one or more toys regardless of the length of the look or the co-occurrence of other behaviors. When the infants shifted their gaze among the toys, this was counted as one look. Although many studies of multiple-object free play tasks use measures of attention which include the number of shifts of attention from one toy to another, the distribution of attention among the toys was not of particular interest in the current study. The primary question of interest was in the potential of television to distract from the toys, rather than the potential of the multiple toys to distract from each other. A look to the television was coded every time the infants shifted their visual gaze to the TV screen, regardless of the length of look or the co-occurrence of other behavior. The observers viewed the infants' digital files at real-time speed (the coding program did not allow for pausing or playback), while pressing buttons on a keyboard. Each press of a button recorded the corresponding time with an accuracy of $1/10^{th}$ of a second. Thus, the temporal onsets and offsets of a look were recorded, allowing for the calculation of both frequency and duration.

Inter-rater reliability was assessed by having a second rater code 12 each of the 6- and 12-month-old participants' files. An inter-rater reliability analysis using the Kappa statistic was performed to determine consistency among raters. Cohen's Kappa is considered a stringent measure of agreement. Altman (1991) suggests that Kappa from .60 to .80 is considered good agreement. At 6-months, Cohen's Kappa was 0.73 and the percent agreement was 88.7. At 12-months, Cohen's Kappa was 0.69 and the percent agreement was 86.5. Determination of the direction of looking is relatively unambiguous, but because playback for the purpose of coding the digital files occurred at real-time speed without the ability to pause or slow-down, discrepancies between the two raters existed due to slight differences in the timing of a look's onset and offset.

Focused attention. The videotapes were reviewed by two observers who were trained in the coding of behavioral aspects of attention using Ruff's (1986) classification scheme. All looks to a toy(s) greater than or equal to 2 seconds were examined for the following behavioral indices of a focused state of attention: a) gaze is directed to a toy, b) facial expression is serious – brows may be knit and mouth may be pursed or slightly open, c) posturally, head and shoulders are oriented forward, and often down, toward the toy, d) general body motion is stilled, e) minimal or no vocalization, and f) fingering or manipulation of the toy (Ruff et al., 1992; Ruff et al., 1996). Each infant presented somewhat differently. Thus, coding of focused attention was individualized for each infant after sufficient viewing occurred. The two observers coded all of the infants at 6 and 12 months of age. Like Ruff and colleagues (Ruff & Capozzoli, 2003; Ruff, Capozzoli, & Saltarelli, 1996), the two observers then reviewed the coding for focused attention and all areas of disagreement were resolved. The frequency and duration of each focused attention episode were used to calculate the total duration of focused attention, the percentage of toy play spent in focused attention, and the mean duration of focused episodes (total duration/frequency).

Heart-rate. The BioPac system has the capacity to record several channels of information concurrently. For the current study, it was programmed to record the infant's electrocardiogram (ECG), heart-rate, and the sound waves associated with the television program's audio stream. The point in the ECG stream at which the television program was presented to the infant was identified by the onset of the sound waves associated with the television program. Artifact correction was performed manually by visually inspecting the BioPac files and replacing a suspect beat (e.g., a skipped beat) with the average rate of the beat immediately before and after the suspect beat (Richards, personal communication, 2006). Looks greater than 2 seconds to the television were then identified and the corresponding period of heart-rate was examined. Due to the continuous availability of stimuli throughout the experiment, the more traditional baseline measure of heart-rate prior to the presentation of a stimulus could not be obtained. Instead, baseline heart-rate was obtained by calculating the mean beats per minute (bpm) during the 2.5-second period immediately preceding the onset of each look to the television (cf., Richards & Gibson, 1997; Richards & Turner, 2001). The mean bpm for a look was then subtracted from the mean baseline bpm to determine the change in heart-rate. Negative change scores represented an increase in heart-rate from baseline to the look, whereas positive change scores indicated a decrease in heart-rate from baseline to the look.

Chapter 5

Results

The results are organized into five sections. First, loss of participants from 6 to 12 months of age is outlined. In the second section, the data from the parent self-report television questionnaire are described. Third, the influence of previous exposure to the experimental stimuli is examined. Fourth, the measures of visual attention to the television and heart-rate changes during looks to the television are examined. Finally, measures of visual attention to the toys and focused attention during play with toys are discussed. These latter two sections address the broad goals of the experiment.

Participant Attrition

Of the 60 infants who completed the study at 6 months of age, 13 failed to return or provide complete data at 12 months of age. Preliminary analyses revealed no differences in measures of temperament and attention to the toys and television at 6 months of age between those 13 infants who participated only at the 6-month session and those who participated and provided complete data in both the 6- and 12-month sessions (all $ps > .05$).

Questionnaire Data: Exposure to Television at Home

The parents' responses on the television questionnaire are provided below. Missing data points were not adjusted. Instead, results reported as percentages are based on the numbers of mothers/fathers responding to each question. Although the television questionnaires were completed for all 60 of the infants who successfully completed the experiment at 6 months of age, the questionnaire data from the 6-month testing are reported for only those 47 infants who returned at 12 months of age.

The parents reported that, at 6 months of age, their infants watched an average of 40.8 minutes (SD = 40.7) of television a day, and at 12 months of age, they watched an average of 62.7 minutes (SD = 49.6) of television a day. This represents a significant increase in television viewing with age, t (41) = -2.59, $p < .05$. There was a wide range in the amount of television exposure in the home. At 6 months of age, television viewing ranged from no television exposure to 3.5 hours a day, and at 12 months of age, television viewing ranged from no television exposure to 4 hours a day. The modal duration of television viewing by the infants at both 6 and 12 months of age was 30 minutes a day (19% and 27%, respectively). When asked to describe their infants' reaction to television at 6 and 12 months of age, the majority of parents indicated that they became "focused on the television" (64% and 54%, respectively). The remaining infants were reported to show "no reaction" (7%, 19%), become "somewhat distracted as if bored by the TV" (22%, 26%), or become "very focused on the TV" (7%, 2%).

When asked about the extent of the infants' exposure to background television, the most common response, at both 6 and 12 months of age, was that the television was "often" on even when no one was watching it (47%, 46%, respectively). The remaining parents indicated that the television was never (2%, 0%), rarely (9%, 11%), sometimes (19%, 30%), or always (23%, 13%) on. Thus, when their infants were both 6 and 12 months of age, the majority of parents kept the television on "often" or "always" (70% and 59%, respectively). The parents were asked to describe the degree to which their infants were distracted by the presence of background television in the home. At 6 and 12 months of age, most parents indicated that their infants were "sometimes distracted" (68% and 70%, respectively). The remaining infants were described as being "rarely distracted" (15%, 19%, respectively) or "often distracted" (11%, 11%, respectively) by the presence of background television.

The number of television sets in the home was not significantly different at 6 and 12 months of age and, therefore, the data were combined. Most of the parents (42%) reported having two working television sets in their home while 19% had one television set, 23% had three, and 17% had four or more. The number of infants who had a television in their bedrooms ($M = 2.0$, $SD = 0.18$) was low and did not differ significantly by age.

A series of Pearson correlations using 2-tailed tests of significance were conducted separately for the infants at 6 and 12 months of age. They revealed no significant relationship between amount of active television viewing and exposure to background television at home and attention to television (duration of looking at the television and number of looks at the television) during the experiment (all $ps > .05$).

Previous Exposure to the Experimental Stimuli

At the 6-month testing, the parents reported that 10 of the 47 infants had some previous exposure to the television program used in the experiment (although not necessarily the particular episode used in the experiment). At 12 months of age, the parents indicated that 11 of the 47 infants had previous exposure to the television show used in the experiment. To determine if this previous exposure impacted measures of attention to television, one-way ANOVAs were conducted separately for the infants at 6 and 12 months of age. At both 6 and 12 months of ages, there was no significant difference between those infants who had previous exposure and those who did not on total duration of looking at the TV, $F(1, 42) = .16, p > .05$; $F(1, 42) = .23, p > .05$, and number of looks at the TV, $F(1, 42) = .1.71, p > .05$; $F(1, 42) = 0.6, p > .05$. None of the infants had previous experience with the toys used in the experiment.

Data Analyses

Unless otherwise specified, in the following analyses, each dependent variable was entered into 2 (age: 6 and 12 months) X 2 treatment (TV on and off) X 2 gender (boys and girls) X 2 (order: TV first and TV second) X 3 (program category: children's educational, children's action and soap operas) mixed analysis of variance (ANOVA) with age and treatment as within-subject variables and gender, order, and program category as between-subjects variables. Due to the large number of analyses, the alpha level was set at $p < .01$ to better control the experimentwise error rate. Unless otherwise indicated, no meaningful main effects or interactions involving age, gender, or program category were found.

Visual Attention

Several measures of visual attention were calculated separately for toys and television: 1) total number of looks to the television or toys, 2) the percent of the session spent looking at the toys or television [(total duration of looking in seconds/600) * 100], and 3) mean length of looks to the toys or television (total duration of looking in seconds/total number of looks). These measures tap into the attention-getting (number of looks) and attention-holding (percent of session and mean look length) components of visual attention (cf., Cohen, 1972). The number of looks to the television (≥ 2 seconds in duration) that were immediately preceded by a look at the toys (≥ 2 seconds in duration) was obtained as an additional measure of distractibility from toy play. Although the infants' actions with the toys immediately before and after the look to the television were not examined, it was presumed that the longer looks to the television would interrupt toy play more than the shorter looks to the television (less than 2 seconds). The measures of attention to the television while it was on are provided in Table 1 by age and order. The measures of attention to the toys are provided in Table 2 by age, order, and treatment.

A visual examination of the means reveals that the toys, regardless of the presence of television, occupied the majority of the infants' visual attention. However, the infants looked at the television often; in the 10-minute session, the average number of looks to the television ranged from 22.5 to 28.5. It is interesting to note that the range of total television viewing at both ages was large, from as little as 4 seconds to as much as 552 seconds out of a possible 600 seconds. Similarly, the range in number of looks to the television screen ranged was large, from as few as 2 looks to as many as 61 in the 10-minute TV-on session.

Table 1

Means and standard deviations for the measures of attention to television when it was on by age and order of presentation

Measures of attention	6 months M	(SD)	12 months M	(SD)
TV-first group (N = 20)				
Number of looks	22.5	(10.5)	25.8	(14.1)
Percent of session looking at TV	15.7	(14.2)	14.6	(13.8)
Mean look length	3.7	(1.98)	3.1	(1.5)
Number of looks from toys to TV	10.6	(7.5)	8.5	(7.1)
TV-second group (N = 27)				
Number of looks	28.5	(11.5)	28.1	(10.3)
Percent of session looking at TV	36.1	(24.4)	30.4	(21.0)
Mean look length	7.8	(6.07)	7.5	(6.63)
Number of looks from toys to TV	10.4	(5.5)	7.7	(5.1)

Table 2

Means and standard deviations for the measures of attention to toys by age, order of TV presentation, and treatment (TV on and off)

Measures of attention	6 months TV on M (SD)	6 months TV off M (SD)	12 months TV on M (SD)	12 months TV off M (SD)
TV-first group				
Number of looks	31.7 (9.7)	26.7 (9.6)	35.4 (12.6)	26.4 (11.4)
Percent of session looking at toys	75.8 (15.4)	78.2 (12.4)	77.8 (12.5)	78.5 (15.1)
Mean look length (in secs)	16.6 (8.5)	20.8 (11.4)	15.6 (8.6)	27.7 (31.1)
TV-second group				
Number of looks	32.8 (12.4)	21.6 (10.9)	33.0 (9.8)	24.9 (8.2)
Percent of session looking at toys	50.1 (23.9)	86.8 (8.9)	55.1 (18.7)	84.2 (11.5)
Mean look length (in secs)	11.69 (12.5)	30.1 (15.8)	10.0 (3.2)	24.3 (13.9)

Visual Attention to Television

Frequency of looks to the television. The number of times an infant looks toward the television screen has perhaps the greatest potential to interrupt their concurrent activities, such as toy play. The mixed ANOVA revealed a main effect of treatment, $F(1, 35) = 311.66, p < .001$. Additionally, there was a significant interaction between treatment and order, $F(1, 35) = 7.93, p < .01$, such that those infants who saw the TV second exhibited a greater number of looks to the TV while it was on than those infants who saw the TV first (*Ms* = 28.46 looks vs. 24.50 looks, respectively). The number of looks to the TV while it was off did not differ between groups (see Figure 4).

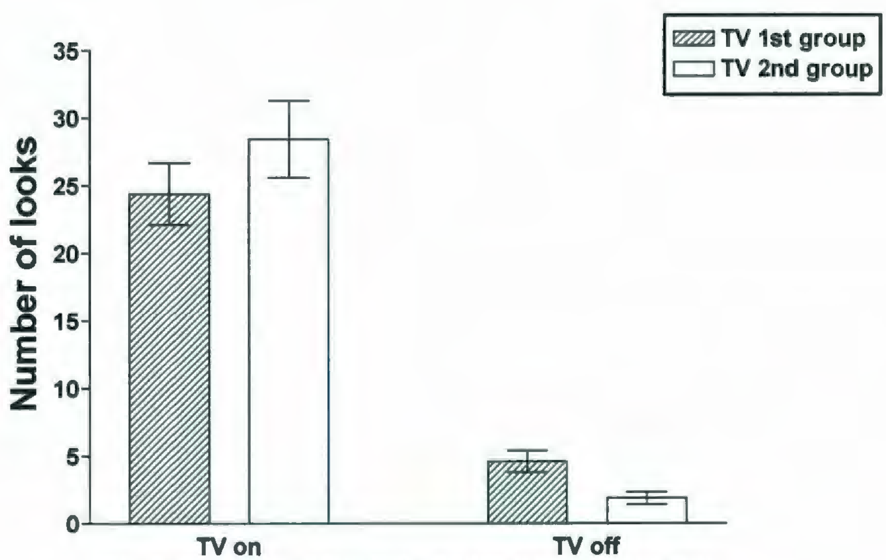

Figure 4. Number of looks to the TV by order (TV first; TV second) and treatment (TV on; TV off)

There was also a significant 3-way interaction among gender, program category, and treatment, $F\,(2, 35) = 5.78, p < .01$ (see Figure 5). Although the 3-way interaction was significant, a series of one-way ANOVAs revealed no significant differences among the three program categories in number of looks to the TV for boys or for girls. In addition, independent sample t-tests revealed no significant differences between the boys and girls for each of the program categories. Some of these differences might have been significant if the sample size was larger.

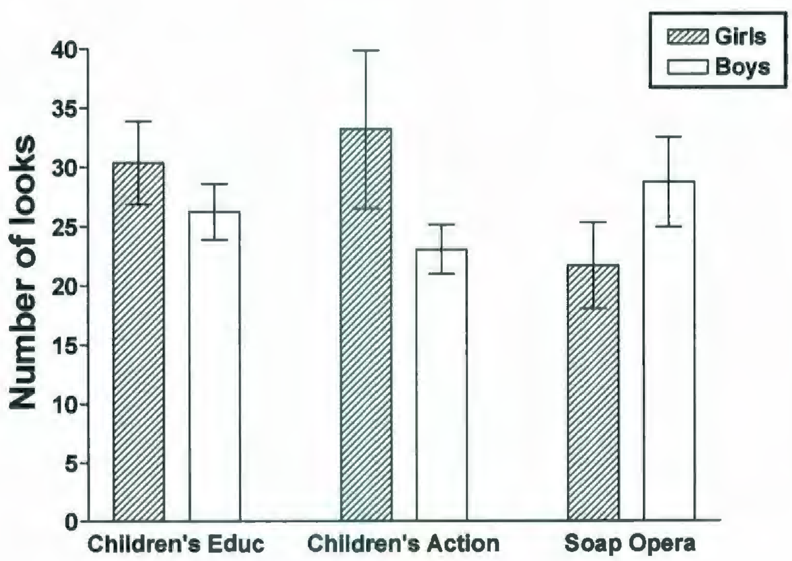

Figure 5. Number of looks to the TV by program category and gender

Percent of session spent looking at the television. A mixed ANOVA revealed a main effect of treatment on percent of the session spent looking at the TV, $F\,(1, 35) = 95.29, p < .001$. However, treatment interacted with order, $F\,(1, 35) = 15.59, p < .001$, such that the infants in the TV first group spent less time looking at the television when it was on than the infants in the TV second group (*Ms* = 15% vs. 33%) (see Figure 6).

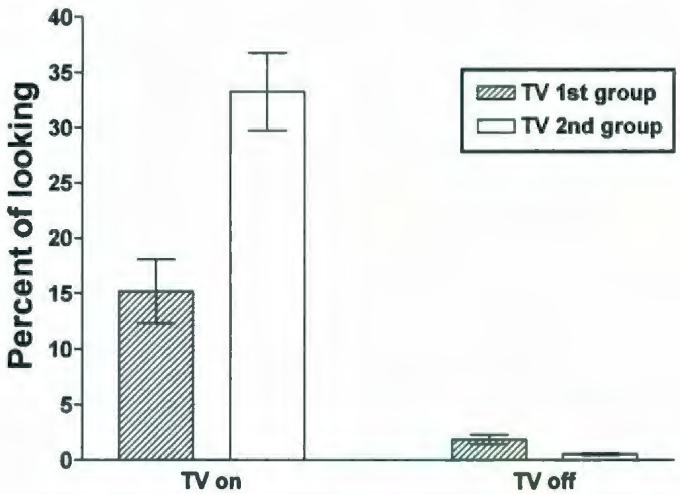

Figure 6. Percent of the session looking at the TV by order (TV first; TV second) and treatment (TV on; TV off)

Mean look length to the television. The mean look length to the TV was calculated for each participant by dividing his or her total look duration by his or her number of looks. A significant main effect of treatment, $F(1, 35) = 40.62, p < .001$, and an interaction between treatment and order were found, $F(1, 35) = 13.90, p < .01$, When the TV was on, the infants in the TV second group engaged in longer mean looks to the TV than infants in the TV first group (*Ms* = 7.62 s vs. 3.38 s, respectively). The mean look length to the TV while it was off was equivalent for the TV first and TV second groups (*Ms* = 2.38 s vs. 1.28 s, respectively) (see Figure 7).

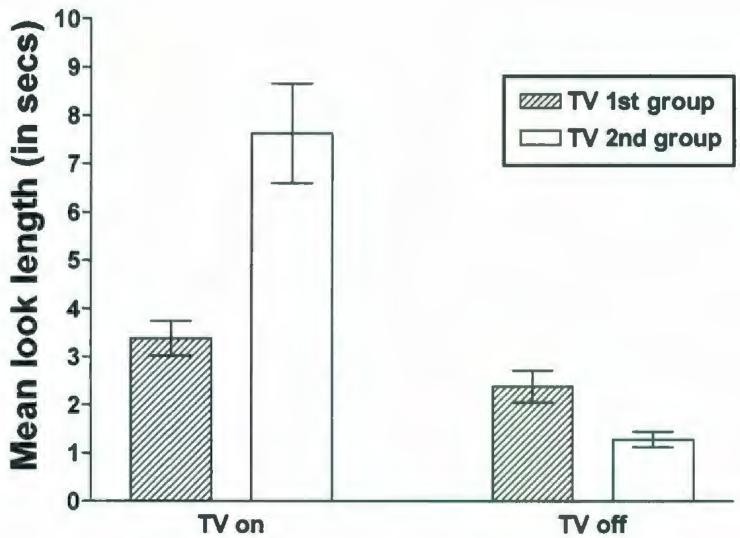

Figure 7. Mean look length to TV by order (TV first; TV second) and treatment (TV on; TVoff)

Habituation to Background Television

The infants' attention allocation was examined over time to determine patterns of habituation to the television in a competitive context. The infants' looking over time was examined for both total duration of looking at the TV, a measure of attention-holding, and number of looks to the television, a measure of attention-getting (cf., Cohen, 1972). The 10-minute TV on session was divided into four 2.5-minute time periods. Total duration of looking at the television and total number of looks at the television were calculated for each of the four time periods.

Attention-holding: Duration of looking at the TV. The total duration of looking at the television while it was on was entered into a 2 (order) X 3 (program category) X 2 (gender) X 2 (age) X 4 (time periods) mixed ANOVA with age and time periods as within subject variables. Mauchley's test for the time periods variable was significant, $F(5) = .61, p < .01$, indicating a violation of the sphericity assumption. Therefore, the Greenhouse-Geisser statistic was used to determine significance. There was a significant main effect of time period, $F(2.23, 105) = 13.65, p < .001$. For infants in both groups (TV first; TV second), the initial presentation of the television elicited relatively high rates of viewing, which subsequently dropped off with time (see Figure 8). Although there was a significant difference between the first ($M = 51.3$ s) and second ($M = 36.4$ s) quarter of the session in duration of looking at the TV, $t(46) = 5.41, p < .001$, there was no significant change in look duration to the television after the first 2.5 minutes (all *ps.* > .05). The analysis with order, gender, program category, and age revealed no main effects and no interactions with time period.

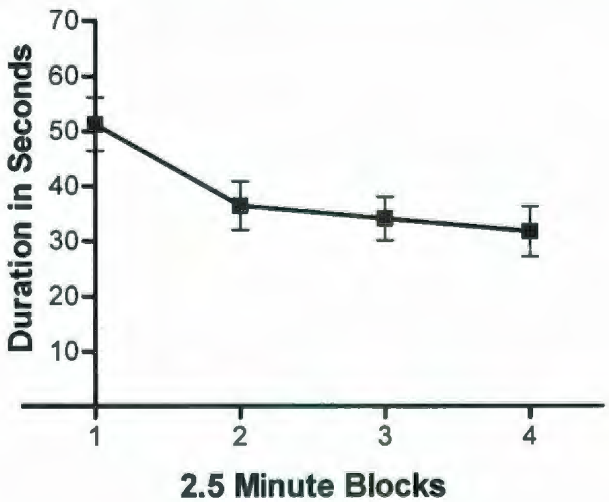

Figure 8. Total duration of looking to television when it was on over four 2.5 minute time periods

Attention-getting: Frequency of looks to the TV. To determine if the television maintained its ability to elicit looks in the infants over time, the number of looks to the television was entered into a 2 (order) X 3 (program category) X 2 (gender) X 2 (age) X 4 (time periods) mixed ANOVA with age and time periods as within subject variables. There was a significant main effect of time period, $F(3, 105) = 19.57, p < .001$ (see Figure 9). Mirroring the results for duration of looking to the television, the number of individual looks to the television decreased from time period 1 to time period 2, $t(46) = 5.44, p < .001$, ($Ms = 8.9$ looks vs. 6.2 looks, respectively) but then leveled off for the remainder of the 10 minute session (all $ps > .05$). The analysis with order, gender, program category and age revealed no main effects and no interactions with time period. An absence of an interaction with order suggests that infants in the TV first and TV second groups demonstrated a similar pattern of looking over time.

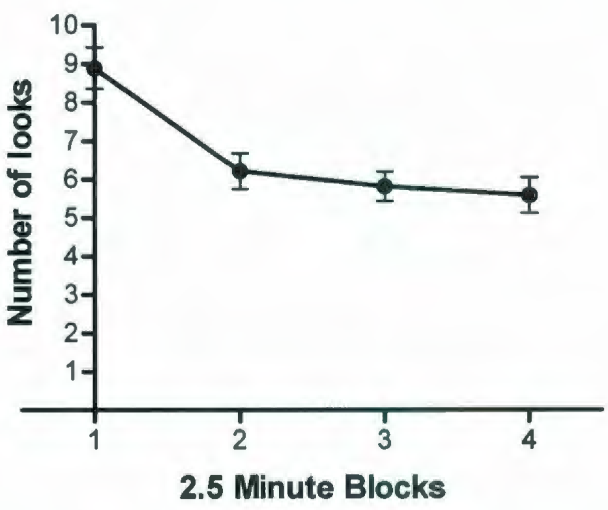

Figure 9. Number of looks to the television when it was on over four 2.5 minute time periods

Stability of Individual Differences in Looking to the Television across Age

To determine if the infants engaged in a similar pattern of looking to television with age, a series of Pearson correlations using 2-tailed tests of significance were conducted. There were significant positive correlations between 6 and 12 months of age on the percent of TV viewing, r (N=47) = .49, $p < .001$, the frequency of looks to the TV screen, r (N=47) = .45, $p < .01$, and the mean look length to the TV, r (N=47) = .54, $p < .001$. These results provide evidence for the stability of attention-getting and attention-holding by television across age, so that, for example, infants who engaged in long looks to the TV at 6 months also exhibited long looks to the TV at 12 months of age.

Summary of Visual Attention to Television Results

The order in which the television program was presented impacted infants' attention to the TV. The infants who saw the TV in the second half of the experimental session engaged in consistently more television viewing than infants who saw the TV in the first half of the session. This was found in every measure of attention to television (number of looks to the TV, percent of the session looking at the TV, and mean look length). There were no effects of age on attention to television; infants at both 6 and 12 months of age engaged in similar patterns of television viewing. In addition, there were no significant effects of program category. The results provide evidence of stability of individual differences in attention to background television from 6 to 12 months of age.

Heart-rate During Looks to the Television

Little is known about the quality of infants' attention to television. The behavioral indices of focused attention to toys do not extend to looks at a television screen (cf., Ruff & Rothbart, 1996). Thus, the infants' heart-rate during looks to television was examined to determine the infants' attentional engagement with background television. Looks to the television that were 2 seconds or more were identified and changes in heart-rate were calculated by subtracting the mean beats per minute (bpm) during a look to the television from the mean bpm during the baseline period, which occurred in the 2.5 seconds immediately prior to the onset of the look (cf., Richards & Gibson, 1997). Thus, larger values of heart-rate change represent greater decelerations in heart-rate during looks to the television.

Looks to the television were divided into several look length categories similar to those used by Richards and colleagues (Richards & Cronise, 2000; Richards & Gibson, 1997): less than 2 s, 2-5 s, 5-10 s, 10-20 s, 20-40 s, and greater than 40 s. The mean heart-rate change for each look length category was calculated for each participant. The number of infants' looks to the television by look length category, age, and order (TV first group; TV second group) is presented in Table 3. At 6 and 12 months of age, many of the infants' looks to the TV were less than 2 seconds in length. However, these looks were not included in subsequent analyses as they were too short to reflect meaningful changes in heart-rate.

Table 3

Total number of looks to the TV by duration of look, order, and age

Category	Duration (in seconds)	6 months		12 months	
		TV-first	TV-second	TV-first	TV-second
	< 2	187	359	270	336
1	2-5	153	171	154	205
2	5-10	74	109	61	99
3	10-20	24	66	24	62
4	20-40	8	37	5	45
5	>40	4	28	1	11
Total		450	770	515	758

Means for each look length category (> 2 seconds) are captured in Figure 10 for infants at 6 months of age and Figure 11 for infants at 12 months of age. To determine if the infants' heart-rate decreased significantly during looks to the TV, one sample t-tests were conducted with mean HR change scores at each look length category for infants at both 6 and 12 months of age. For the infants at 6 months of age, heart-rate decreased significantly for all look length categories [2-5 seconds, $t\ (44) = 2.2, p < .05$, 5-10 seconds; $t\ (42) = 3.47, p < .01$, 20-40 seconds; $t\ (19) = 3.90, p < .01$; and 40 seconds or more; $t\ (17) = 2.35, p < .05$], with the exception of looks 10-20 seconds in length, $t\ (30) =$

2.0, $p > .05$. At 12 months of age, heart-rate decreased significantly during looks from 5-10 seconds, t (38) = 2.17, $p < .05$, 10-20 seconds; t (27) = 4.02, $p < .001$; and 20-40 seconds; t (20) = 3.06, $p < .01$. Heart-rate did not, however, decelerate significantly during looks from 2-5 seconds in length, t (46) = 1.87, $p > .05$, or 40 seconds or more, t (6) = 1.34, $p > .05$.

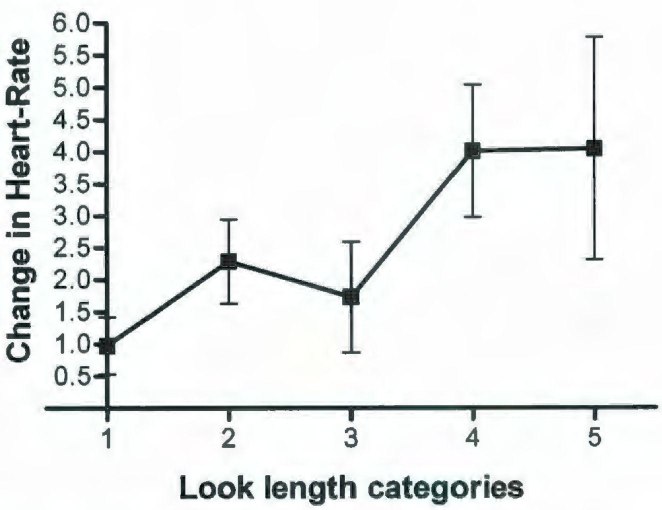

Figure 10. Change in heart-rate during 6-month-olds' looks to TV by look length category

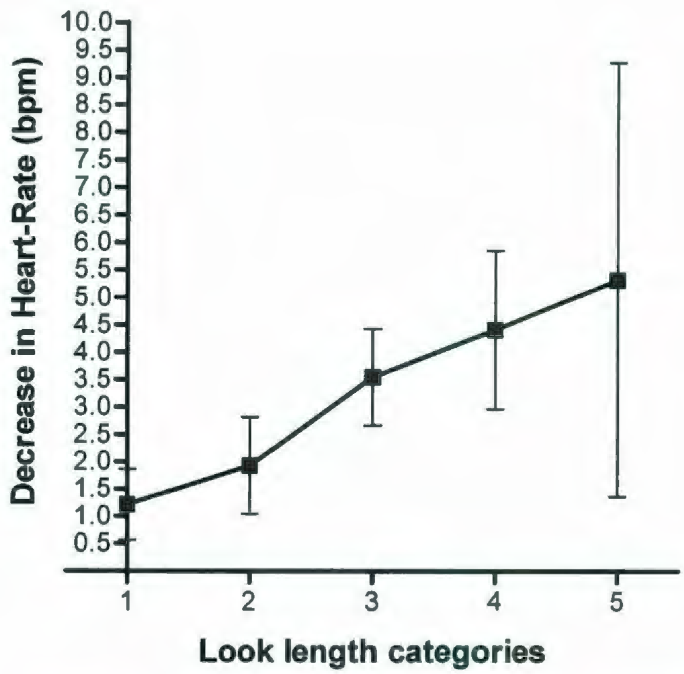

Figure 11. Change in heart-rate during 12-month-olds' looks to TV by look length category

To determine if changes in heart-rate interact with gender, program category or order the mean change in heart-rate during looks to the TV for each participant was entered into a 3 (look length categories: 2-5 s, 5-10 s, 10-20 s) X 2 (order) X 2 (gender) X 3 (program category) mixed ANOVA with look length category as a within-subject variable. This was done separately for infants at 6 and 12 months of age. Although the majority of infants engaged in looks to the television belonging to the first three look length categories (2-5 s, 5-10 s, 10-20 s), few engaged in looks across all five categories. Thus, to preserve a sufficient sample size, only the first three look length categories were examined in a mixed ANOVA. No significant main effects or interactions were found for the infants at 6 months and 12 months of age.

Visual Attention to Toys

Frequency of looks to toys. The frequency of looks to the toys does not represent the infants' attention to a single toy, but rather, the maintenance of visual attention to the toys as a group. A low number of looks to the toys represents greater maintenance of visual attention to the toys, whereas a high number of looks to the toys represents higher rates of the infants' shifting their gaze away from and back to the toys. A mixed ANOVA revealed a main effect of treatment, $F\ (1, 35) = 36.17, p < .001$, such that infants looked at the toys more often (i.e., shifted their gaze to and from the toys more often) when the TV was on ($M = 33.18$ looks) than when the TV was off ($M =$ 24.64 looks).

Percent of session spent looking at toys. A mixed ANOVA revealed a main effect of treatment, $F\ (1, 35) = 45.66, p < .001$, such that infants spent significantly less time looking at the toys when the TV was on than when it was off. However, this was qualified by a significant interaction between treatment and order, $F\ (1, 35) = 36.68, p <$ .001 (see Figure 12). For those infants in the TV-first group, the presence of background television did not impact the amount of time spent looking at toys (77% vs. 78%). However, infants in the TV-second group spent less time looking at the toys when the TV was on (52%) than when it was off (86%), $t\ (26) = -10.73, p < .001$. In addition, when the TV was on, infants in the TV first group spent more time looking at the toys than infants in the TV second group, $t\ (45) = 5.45, p < .001$, (*Ms* = 77% vs. 52%).

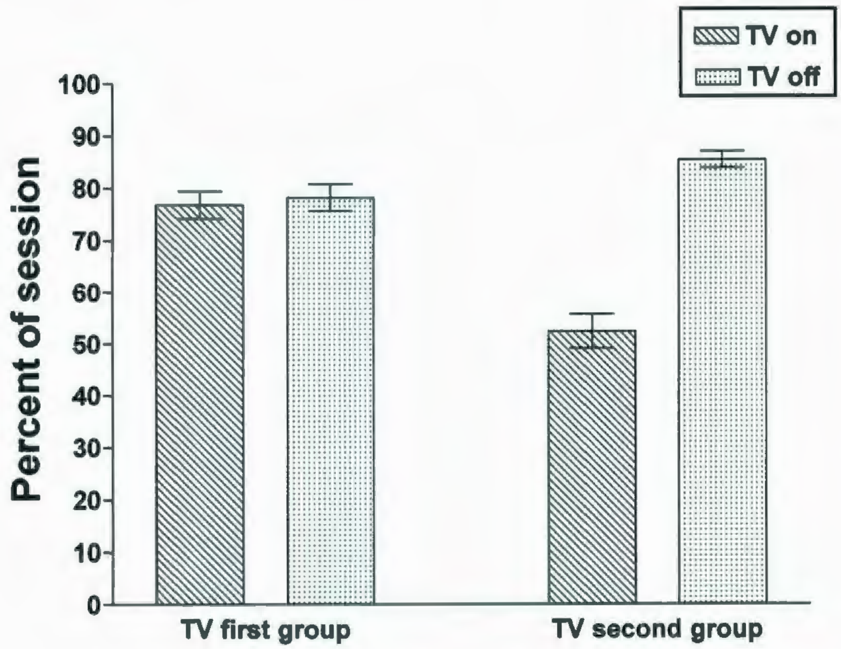

Figure 12. Percent of the session spent looking at toys by order of TV presentation (TV first; TV second) and treatment (TV on; TV off)

Mean look duration to toys. A mixed ANOVA revealed a significant main effect of treatment, $F(1, 35) = 33.10, p < .001$, and a significant interaction between treatment and order, $F(1, 35) = 4.93, p < .01$ (see Figure 13). Post hoc analyses indicated that the presence of background television decreased mean look length to toys for those infants in the TV second group only, $t(26) = -8.94, p < .001$ (*Ms* = 10.29 s vs. 25.05 s). In addition, when the TV was on, there was a significant difference between mean look length to the toys for the TV first and TV second groups, $t(45) = 2.90, p <. 01$, (*Ms* = 15.30 vs. 10.29, respectively). However, when the television was off, the TV first and TV second groups did not differ in their mean length of looks to the toys, $t(45) = -1.57, p > .05$ (*Ms* = 20.35 vs. 25.05, respectively).

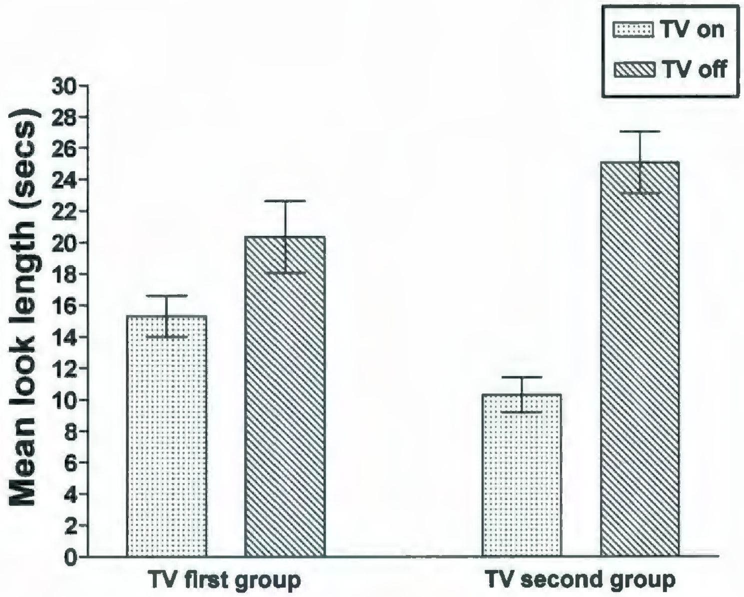

Figure 13. Mean look length to toys by order (TV first; TV second) and treatment (TV on; TV off)

Frequency of looks from toys to TV. Of particular interest to the issue of the potential of the television to distract infants from toy play is the number of times the infants shift visual attention from the toys to the TV. As such, looks to the TV that were maintained for 2 seconds or more and which were immediately preceded by a look to the toys that was maintained for 2 seconds or more were summed for each participant. There was a single significant main effect of treatment, $F(1, 35) = 141.35, p < .001$, with infants looking from toys to TV more often when TV was on vs. off (*Ms* = 9.4 looks vs. 1.1 looks).

Summary of Visual Attention to Toys Results

Like measures of attention to television, the order of the television presentation impacted the infants' visual attention to the toys. The presence of background television had a greater impact on toy play for those infants in the TV-second group than those infants in the TV-first group. The television decreased toy play (lower percent of the session engaged in toy play and lower mean look length to toys) for those infants who were presented with the television program in the second half of the session. However, the television increased the number of looks to the toys for all infants, regardless of order. This suggests that infants' attention to toys was interrupted as they shifted their gaze more often when the television was on. Infants at 6 and 12 months of age did not differ in their visual attention to the toys. In addition, the background television did not differentially impact the infants' toy play based on program category.

Focused Attention to Toys

Of particular interest in the current study is the impact of television on the infants' quality of attention during play. The quality of attention was measured using behavioral indices of focused attention toward toys (Ruff, 1986), as focused attention involves the active processing of information from the stimulus. It was hypothesized that the presence of background television would reduce infants' focused attention to toys, but that the impact may be more pronounced for those infants exposed to children's action programs.

Several measures of focused attention were calculated: 1) the percent of play spent in focused attention [(total duration of play with toys/focused attention to toys) *

100], 2) total number of focused attention episodes, 3) average length of focused attention episodes (total duration of focused attention/total number of focused attention episodes), and 4) peak focused attention episode (longest focused attention episode for each infant). Because the presence of television reduced overall play with toys for the TV-second group, the percent of focused attention measure examined focused attention independent of the length of play. Preliminary analyses showed that there were no main effects or interactions that involved gender or program category. The means and standard deviations for focused attention measures are presented in Table 4.

Similar to the measures of looking, there were substantial individual differences in infants' focused attention. At 6 months of age, some infants in the TV-first condition engaged in no focused attention while others spent over half of their play in focused attention. For the 6-month-olds in the TV-second condition, focused attention ranged from 0 to 21% of play. Similarly, at 12 months of age, the infants in the TV-first group engaged in as little as no focused attention to spending 48% of their play in focused attention, while the infants in the TV-second condition ranged from 0 to 27% of play spent in focused attention.

Table 4

Means and standard deviations for focused attention measures by order of television presentation, age, and treatment (TV on, TV off)

	TV-first group			
	6 months		12 months	
	TV on	TV off	TV on	TV off
Measure	M (SD)	M (SD)	M (SD)	M (SD)
Percent of play in FA	9.7 (12.6)	9.1 (12.8)	13.1 (10.5)	17.1 (12.6)
Frequency of FA episodes	5.8 (5.4)	3.7 (2.89)	4.9 (3.2)	4.9 (3.1)
Mean duration of FA episodes (in secs)	5.3 (3.8)	9.2 (11.1)	12.7 (6.7)	17.0 (10.7)
Duration of longest FA episode (in secs)	12.2 (14.2)	17.3 (23.2)	24.9 (15.4)	35.4 (22.5)

	TV-second group			
	6 months		12 months	
	TV on	TV off	TV on	TV off
Measure	M (SD)	M (SD)	M (SD)	M (SD)
Percent of play in FA	4.1 (4.8)	6.9 (6.0)	9.5 (7.9)	9.1 (7.2)
Frequency of FA episodes	2.4 (2.8)	5.0 (3.5)	3.4 (3.2)	4.1 (2.6)
Mean duration of FA episodes (in secs)	4.4 (4.5)	6.5 (3.2)	8.7 (8.1)	11.4 (11.8)
Duration of longest FA episode (in secs)	6.6 (8.2)	12.0 (9.2)	14.3 (11.8)	21.5 (15.7)

Percent of toy play spent in focused attention. The percent of play spent in focused attention to the toys was entered into a mixed ANOVA. A significant main effect of age, $F(1, 35) = 8.17, p < .01$ was found, such that infants at 12 months of age spent significantly more of their play in focused attention (11.7%) than at 6 months of age (7.2%). Treatment (TV on and off), however, did not have a significant effect on percent of play spent in focused attention, $F(1, 35) = 1.45, p > .05$.

Frequency of focused attention episodes. Although there was no main effect of treatment on the number of FA episodes, a mixed ANOVA revealed a significant interaction between treatment and order, $F(1, 35) = 10.60, p < .01$ (see Figure 14). Subsequent analyzes revealed that infants in the TV second group engaged in significantly more FA episodes when the TV was off ($M = 4.52$) than when it was on ($M = 2.93$), $t(26) = -3.95, p < .01$. In addition, when the TV was on, infants in the TV first group engaged in more episodes of FA ($M = 5.33$) than infants in the TV second group ($M = 2.93$), $t(45) = 3.13, p < .01$.

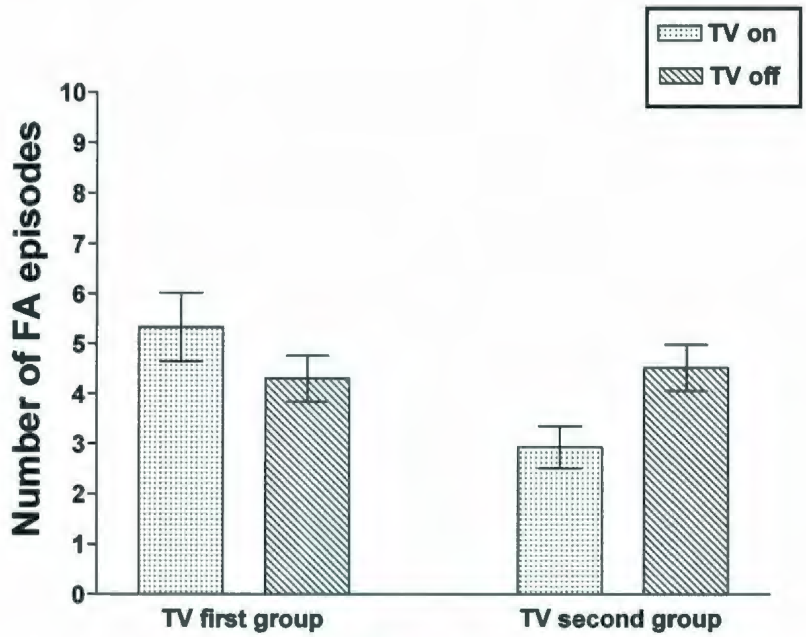

Figure 14. Number of FA episodes by treatment (TV on; TVoff) and order (TV first; TV second)

Mean length of focused attention episodes. A mixed ANOVA revealed a main effect of age, $F(1, 35) = 16.05, p < .001$, such that infants at 12 months of age engaged in longer episodes of FA than at 6 months of age, (*Ms* = 12.18 s vs. 7.30 s, respectively). In addition, treatment significantly impacted mean length of FA episodes, $F(1, 35) = 11.29$, $p < .01$, so that the infants engaged in longer mean FA episodes when the TV was off (M = 12.93 s) than when it was on (M = 8.89 s).

Peak focused attention episode. Each infant's longest FA episode was identified and examined in a mixed ANOVA. The results paralleled those of mean duration of FA episodes. A main effect of age, $F(1, 35) = 18.87, p < .001$, indicated that, at 12 months of age, the infants' peak FA episode was twice as long as their peak FA episode at 6 months of age (*Ms* = 23.14 s vs. 11.62 s, respectively). A main effect of treatment, $F(1, 35) = 20.20$, $p < .001$, indicated that the peak FA episodes were significantly longer when the TV was off ($M = 20.85$ s) than when it was on ($M = 13.91$ s).

Summary of Focused Attention Results

Although the presence of background television did not influence the percent of play spent engaged in focused attention, it did reduce the mean length and peak length of focused attention episodes. In addition, the infants in the TV-second group engaged in more FA episodes when the TV was off than when it was on. The infants engaged in more focused attention and in longer periods of focused attention at 12 months of age than at 6 months of age. However, the presence of background television did not influence the infants' focused attention differentially by age or program category.

Chapter 6

Discussion

Despite the critical importance of play for infants' healthy development, little is known about the influence of background television on infants' play with toys. Thus, the overarching goal of the current study was to investigate the impact of background television on infants' allocation of attention during play with toys. The parents in the study reported that 70% of the infants at 6 months and 59% of the infants at 12 months of age lived in homes where the television was "often" or "always" on, despite the fact that 79% of the parents indicated that their infants were "sometimes" or "often" distracted by the presence of background television at home. Similarly, Masur and Flynn (2008) found that 56% of infants aged 11- to 18-months live in a home where the TV is on at least half of the time. Rideout et al. (2003) in a nationally representative survey of more than 1000 parents in the USA found that 66% of children ages 6 months to 6 years live in a home where the TV is on at least half of the time. These data, from a variety of samples, are consistent in pointing toward the predominance of television in young children's home environment.

The Impact of Background Television on Infants' Attention to Toys

Infants' allocation of looking. In the current study, the infants at both 6 and 12 months of age demonstrated a visual preference for the toys over the television; the majority of the infants' time was spent looking at the toys. However, the infants' allocation of visual attention was impacted by the order in which the television program was presented. Those infants who were shown the television program in the second half of the experiment engaged in considerably more overall looking at the television (33%) and a greater number of looks to the television (28.5 looks) than those infants who were presented with the television in the first half of the experiment (15% and 24.5 looks, respectively). In addition, the average length of a look to the television in the TV-second group was more than twice that of the TV-first group (7.6 s vs. 3.4 s). Thus, the television was more likely to get and to hold the infants' visual attention when it was presented in the second half of the experimental session.

It was hypothesized that the presence of background television would disrupt infants' looking at the toys. This hypothesis was supported for those infants in the TV-second group only. Infants in the TV-second group demonstrated a lower duration of looking at the toys when the television was on (52%) than when it was off (86%). In addition, the average look to the toys decreased considerably when the television was on, from 25 seconds to 10 seconds. In contrast, for those infants in the TV-first group, both the duration of looking at the toys and mean look length to the toys were equivalent when the television was on and off. Both the infants' orienting to the television screen (number of looks to the television) and total duration of looking at the television were negatively correlated with mean look length to the toys, r (N = 47) = -.74, $p < .001$, r (N = 47) = -.59, $p < .001$, respectively. Thus, the infants' *visual* attention to the television can be implicated as a factor in determining the length of infants' looks to the toys.

The effects of order of television presentation on infants' looking behavior likely reflect a change in the relative familiarity of toys and television with exposure over time.

Infants in the TV-second group had an opportunity to interact with the toys for 10 minutes prior to the presentation of the television program. In contrast, infants in the TV-first group were presented with the toys and television program concurrently. Although fatigue could account for the TV-second group's decrease in interacting with the toys and the increase in looking at television in the second half of the session, infants in the TV-first group evidenced no decrease in looking at the toys from the first to the second half of the session. Thus, presumably, the infants' increased familiarity with the toys led to increased looking at the television. The importance of target familiarity on infants' distractibility has been found in several studies (e.g., Oakes et al., 2000, 2002; Tellinghuisen et al., 1999). For example, Oakes et al. (2002) found that distraction latencies decreased as target familiarity increased for infants at 9 months of age. They suggested that the infants were motivated to process information about novel objects as compared to familiar objects, and thus inhibited looks to a distractor in the novel object condition.

Although the infants' familiarity with the toys was not formally assessed, it is unlikely that the infants became fully familiarized with all of the objects during the 10-minute session. Indeed, the availability of multiple toys would have provided the infants with additional objects to attend to when attention to one toy was terminated. Ruff and Lawson (1990) found that infants showed little decrement in focused attention to toys in a multiple-object condition compared to a single-object condition. Thus, it is interesting to note that, after only 10 minutes of exposure to the toys, the infants in the current study demonstrated a significant increase in interest to television and decrease in interest to toys, suggesting that with only a slight decrease in the toys' novelty, the television became the more salient stimulus. The importance of the relative salience of distractors and central targets has been well documented. For example, Tellinghuisen and Oakes (1997) found that distractor stimuli that combine auditory and visual components are more likely to capture attention away from a central target than visual or auditory events alone. In addition, several researchers have found an interactive influence of distractor and target stimuli characteristics on infants' distractibility (e.g., Finlay & Ivinskis, 1984; Oakes et al., 2000). For example, Finlay and Ivinskis (1984) found that infants presented with a peripheral stimulus that rotated at a faster speed than a central stimulus oriented more readily to the peripheral stimulus than infants presented with central and peripheral stimuli that were rotating at the same speed.

Infants' focused attention to toys. In addition to the quantity of looking, the infants' focused attention to toys was examined to determine the effect of background television on the quality of attention. As predicted, the infants at 12 months of age engaged in more focused attention than they did at 6 months of age. Because the number of focused attention episodes did not differ by age, the infants at 12 months had longer mean episodes and longer peak episodes of focused attention than at 6 months of age. It was also hypothesized that the presence of background television would disrupt the infants' focused attention to the toys. This hypothesis was supported, and, unlike the looking data, held for all infants regardless of order of television presentation. Although the percentage of play spent in focused attention was not impacted by the television, the mean length of the focused attention episodes decreased by 4 seconds on average, from

12.9 to 8.9 seconds, while the television was on. The infants' peak looks in focused attention were also significantly impacted by the presence of the television, decreasing from an average of 20.9 seconds while the TV was off to 13.9 seconds while the TV was on. Similarly, Schmidt et al. (2008) found a reduction in mean length of focused episodes in young children exposed to background television. A significant negative association between both duration of looking at the television and number of looks to the television on mean length of focused attention episodes [r (N = 47) = -.30, $p < .05$; r (N = 47) = -.33, $p < .05$, respectively] lends support to the conclusion that the infants' visual attention to the television and frequent orienting to the television, while not impacting the overall amount of focused attention, interrupted the focused episodes, in effect, cutting them short.

The absence of an order by treatment interaction suggests that the presence of television impacted the infants' ability to maintain focused attention regardless of their prior exposure to the toys. This is consistent with Oakes et al. (2000) who found that infants' distractibility during focused attention was dependent upon an interaction between target and distractor characteristics. For example, infants were less likely to turn toward a solid rectangle distractor when engaged in focused attention to a multi-component toy versus a single component toy. In contrast, infants responded to a checkerboard distractor at a uniformly high rate regardless of the toys' characteristics. Thus, the background television programs used in the present study may have been sufficiently salient to disrupt infants' focused attention regardless of their familiarity with the toys. Contrary to the study's predictions, the background television did not have a differential impact on focused attention based on program category or age of the infants.

In contrast to the present results, Ruff and colleagues (Ruff et al., 1996; Ruff & Capozzoli, 2003) found a preservation of focused attention in a distractor condition and suggested that young infants may rely on lower level processes, such as peripheral narrowing, to resist distraction and maintain focused attention on a central target or activity. Other studies have found a facilitation effect on certain tasks performed by older but not younger children who are presented with auditory distractors (children's songs and stories) in an experimental setting (e.g., Turnure, 1970; Higgins & Turnure, 1984). Infants in the current study may have failed to demonstrate a preservation of focused attention due to the nature of the distractor used. Unlike Ruff and colleagues, who presented infants with intermittent distractors, background television is a continuous audiovisual stimulus that presents images and sounds that are constantly changing. The level of interference from the continuous presence of background television may have been too great for the infants to tune out. Indeed, Kannass and Colombo (2008) found that children showed greater levels of distractibility when presented with a continuous distractor compared with an intermittent distractor. Future research is needed to examine the precise conditions under which peripheral narrowing or attention mobilization may be found. Indeed, the possibility remains that background television, under some conditions, may enhance children's focused attention.

Limited attentional capacity theories are most often cited to account for the negative impact of background television on the performance of older children and adults as they engage in concurrent cognitive tasks (e.g., Armstrong & Chung, 2000; Armstrong & Greenberg, 1990; Lang, 1995). Kahneman (1973), in his model of attention, suggested that individuals have a limited amount of general attentional capacity that can be allocated to different cognitive tasks at any one time. When the total information-processing demands of the cognitive tasks exceeds an individual's available attentional capacity, performance on one or more of the cognitive tasks declines. The finding that children's and adults' performance declines on difficult tasks compared with easier tasks when combined with watching television is consistent with a limited capacity interpretation (Pool et al., 2000). The constant competition for attention posed by background television may exceed the attentional capacity of infants in particular, who must relay on lower level processes to resist distraction and in whom endogenous attention is not yet fully developed. Indeed, Schmidt et al. (2008) found increased looking to background television in a group of 1-year-old infants compared to 2- and 3-year-olds while they played with toys.

Effects of Age on Infants' Looking at Toys and Television

No significant differences were found between the infants at 6 months and 12 months of age in the frequency or duration of looking at the television or toys. This absence of age effects was somewhat surprising. The majority of research involving television viewing in young children has found increased rates of attention to television with age (e.g., Schmitt et al., 2001). For example, Anderson and Levin (1976) found a linear increase in looking at television in children from 12 months to 3 years of age.

Similarly, Valkenburg and Vroone (2004) found increases in attention to television in several age groups from 6 to 48 months of age. The distinction between foreground and background television may be important in explaining the absence of age differences in behavioral measures of looking at the television. Because infants are more likely to actively attend to foreground television, increases with age in both the ability to sustain attention and the understanding of and familiarity with television features and content may produce greater visual attention to foreground television with age. In contrast, provided that infants and young children are sufficiently interested in toy play, background television may function more like a distractor than a focal activity.

Research on developmental differences in distractibility tends to show a decline in children's susceptibility to distraction with age (Colombo, 2001; Ruff & Lawson, 1990; Ruff & Rothbart, 1996). For example, Ruff and Capozzoli (2003) examined the effect of distractors on toy play in 10-, 26-, and 42-month-olds. They found that the 10-month-olds were twice as distractible as the older children (who did not differ from each other), particularly when presented with intermittent audio-visual distractors. The decrease in distractibility has been attributed to developmental changes in attention, specifically, a decrease in infants' responsiveness to exogenous features of the environment and an increase in endogenously controlled attention and sustained attention (Ruff & Rothbart, 1996). Ruff and Rothbart (1996) posit that this shift in attention occurs around 9 months of age. Thus, the examination of infants at 6 and 12 months of age in the current study was done in an attempt to span the shift that occurs in the relative influence of exogenous and endogenous factors in attention. However, the age range might have been too narrow to capture these changes. Ruff and Rothbart point to a transition period around 12 months of age as infants begin to habituate more readily to novel objects and events, while their endogenous attention is not yet sufficiently mature to maintain attention. Indeed, although no difference was found in total duration of looking at the television between infants at 6 and 12 months of age, in preliminary analyses, it was found that the same infants at 24 months of age engaged in significantly less looking at the television than at 6 and 12 months of age when provided with the opportunity to play. Similarly, in an examination of background television, Schmidt et al. (2008) found the lowest levels of looking to the television in the oldest age group tested (3-year-olds).

The vast majority of investigators reporting a decrease in distractibility with age have presented the children with intermittent distractors, such as slides (e.g., Oakes et al., 2002; Oakes & Tellinghuisen, 1994). However, while Kannass and Colombo (2007) found a decrease in distractibility with age to an intermittent distractor, when they presented children with a continuous distractor, they failed to find any age differences. They suggested that the demand for attentional focus from the continuous distractor was too great for the children to tune out, regardless of age.

Effects of Program Category on Infants' Looking at Toys and Television

One of the unique features of this study was the presentation of television clips from a number of different programs. This provided an opportunity to vary the relative salience (measured as programming pace) of the television stimuli and allows for greater generalization of the results, as they are not tied to a single program. Contrary to the study's hypotheses, program category had no impact on the infants' attention. Several possibilities could account for the absence of program category effects. The sample size may have been insufficient to reveal statistically significant results based on program category. In addition, although several studies point to the importance of comprehensibility on older children's attention to television (Anderson et al., 1981; Pingree, 1986), what little research there is on younger infants is mixed. For example, Richards and Anderson (2004) found that infants from 3 to 6 months of age had the same average look duration for the incomprehensible and comprehensible stimuli. In contrast, Valkenburg and Vroone (2004) offer some evidence that infants as young as 6 months of age use content features to allocate their attention to television. In their study, the presentation of opening scenes signaling adult-oriented content (e.g., news programs, adult commercials) led to decreases in visual attention, while opening scenes signaling child-oriented content (e.g., *Teletubbies*, children's commercials) resulted in increased attention, despite the authors' claim that the occurrence of formal features was similar.

In the present study, the children's programs were classified into educational or action categories based on the educational claims of the program producers. A global measure of programming pace was then calculated for each program category. Although there is empirical support for the effects of particular formal features on increasing attention to television, the effects of pace on children's attention have been mixed (Wright et al., 1984). Thus, differential programming effects on attention may have been revealed had the programs been categorized based on the occurrence of specific features known to capture infants' attention (e.g., laughter, infant-directed speech). In addition, because the television was presented in the infants' periphery and in conjunction with toys, the occurrence of auditory features and movement may have been particularly important in the likelihood that the background program would capture infants' attention. Future research could yield more information on infants' response to background television based on both the content and formal features of the programming.

Implications of Background Television's Impact on Look Length and Focused Attention to Toys

The results suggest that perhaps the greatest impact of background television lies in its potential to decrease infants' look length to toys and their ability to maintain focused episodes during play. This has several potentially important implications for the cognitive development of infants. Focused attention represents a state in which the processing of information is facilitated or enhanced, and it is important for learning and memory (Lawson & Ruff, 2004). Ruff et al. (1996) found that 10-month-olds' focused attention tended to occur during long play episodes whereas casual attention was associated with short play episodes. Similarly, Oakes, Ross-Sheehy and Kannass (2004) found that focused attention was more likely to be observed in the latter portions of long play episodes. In fact, focused attention, when it occurred early in a play episode, did not reduce distractibility as much as it did when it occurred later in a play episode. Thus, the overall amount of time spent on an object or task can influence both the likelihood that focused attention will occur and the depth or quality of focused attention episodes.

Several investigators have found that amount of time spent in focused attention is positively predictive of intellectual outcome (see Ruff & Rothbart, 1996, for a review). For example, Kopp and Vaughn (1982) found that duration of sustained attention during active manipulation of objects at 8 months of age was a positively predictive of developmental outcome at 2 years of age. Similarly, Lawson and Ruff (2004) found focused attention at 7 months of age was predictive of reported problems in hyperactivity/impulsivity and cognitive abilities at 2, 3, and 4/5 years of age. Although infants' temperamental characteristics have been found to influence infants' ability to maintain attention (cf. Ruff, 1990), long-term cognitive outcomes may also be directly impacted by the length of attentive episodes and what is learned during these episodes. Ruff (1990) suggested that "infants who attend to objects and learn about their properties will have a better foundation for developing knowledge of the environment and for cognitive development, in general" (p. 260). For example, infants who play attentively with objects and who are able to maintain play episodes may be more likely to generate activities that will lead to their learning new information about the objects. Indeed, long look duration during toy play has been found to be associated with greater sophistication in play in young children (Tamis-LeMonda & Bornstein, 1993). Thus, the current findings that the presence of background television decreases both look length to the toys and average length of focused episodes has potentially important implications for infants' cognitive development. Further research is required to determine the short- and long-term impact of background television on infants' cognitive development.

Infants' Attention to Television

Infants' looks to the television. Recent research on attention to television in young children has yielded a wide range of viewing rates, likely stemming from contextual and stimulus differences across studies (e.g., Barr et al., 2008; Schmidt et al., 2008). In the present study, overall duration of television viewing ranged from 15% to 36% of the total session. These rates are similar to Anderson and Levin (1976) in a study of 1-, 2-, and 3-year-old children presented with *Sesame Street* in circumstances comparable to the present study. They found television viewing rates of 12%, 22%, and 40%, respectively. In contrast, Schmidt et al., found that 1-, 2-, and 3-year-old children spent only 5% of the session looking at the TV with an average look length of 3 seconds. They presented the children with an adult game show (*Jeopardy!)* for 30 minutes while they were free to explore the lab and play with toys. Barr et al. (2008), in a naturalistic study in the participants' homes, presented 12- to 18-month-old-infants with an infant video (e.g., *Baby Mozart*) for a period of 12 minutes. This resulted in the infants spending 65% of their time looking at the television with an average look length to the television of 19 seconds. Like Schmidt et al., the infants had the opportunity to explore their environment and play with toys. However, no restrictions were placed on the parents' interactions, many of which involved vocalizations related to the television program (e.g., labelling), which increased infants' looking at the television.

The relatively short 10-minute presentation of television in the current study may account for the higher rates of television viewing (15-36%) than those found by Schmidt et al. (2008). In addition, because the infants' mobility was restricted by being secured in an infant chair, they had less opportunity to explore their environment. The infants were also positioned in such a way that the majority of looks to the television consistently required a right head turn of approximately 30 degrees. Anderson and Levin (1976) found that infants and toddlers often positioned themselves with their backs to the television and facing their mothers, a position that would limit the potential for visual distraction. However, unlike Barr et al. (2008), the infants were presented with novel toys and programming produced for older children and adults. In addition, the parents in the present study were instructed to keep interactions with their infant to a minimum. Thus, infants' interest in television is likely determined, in part, by the opportunity for co-viewing and the television program. Compared with infant-directed programs that have been found to elicit high rates of active viewing in infants (cf., Anderson & Pempek, 2005), the stimuli in the present experiment did not encourage active attending, highlighting the difference between foreground and background television.

The infants shifted their gaze to the television once every 21 to 25 seconds on average throughout the 10-minute television clip and their looks were maintained for an average of 3 to 7 seconds. The brevity of looks suggests that, compared to infant-directed programs, the television programs in the current study were relatively unsuccessful in holding the infants' attention. A closer examination of the infants' distribution of looks to the television revealed that many looks were less than 2 seconds in length (46%), with only 13% lasting longer than 10 seconds. This corresponds closely to look distributions found in both children and adults as they watch television (e.g., Anderson & Lorch, 1983; Hawkins, Pingree, Bruce & Tapper, 1997) and is consistent with the model of attentional inertia (Richards & Anderson, 2004).

Although these brief looks (< 2 seconds) are too short to allow for much information processing, they point to the possibility that the infants engaged in an active viewing strategy that involved continued awareness of the television. Hawkins et al. (1997) referred to these short looks as monitoring looks that, rather than being random, reflect purposeful turns toward the television. This viewing strategy is consistent with Huston and Wright's (1983) feature sampling model of attention in which children attend periodically to the television program and make decisions to continue watching or not based on its salient formal features or interesting content. This allows children to direct their attention elsewhere when the program is of little interest while, at the same time, maintain their ability to follow the program. For example, Lorch et al. (1979) found that 5-year-old children monitored the sound track of *Sesame Street* and attended when something potentially comprehensible was on the screen. Thus, although overall visual attention to the television decreased when the children had an opportunity to play with toys compared to a no-toy condition, there was no difference between the groups in their understanding of the television program.

Infants' heart-rate during looks to television. Hawkins et al. (1997) suggest that looks greater than 5 seconds are more likely to reflect substantial attentional engagement because they have passed Huston and Wright's (1983) initial, formal feature based test for continuing attention. Indeed, Richards (2001) suggests that the first 5 seconds of a look reflects an orienting response. In the absence of behavioral indices of focused attention to television, the present study utilized heart-rate data to gauge infants' attentional engagement during looks to the television. An examination of categories of looks based on length revealed that the 6-month-old infants' heart-rate decelerated for all looks, with the exception of looks lasting 10 to 20 seconds in length. For the infants at 12 months of age, heart-rate during looks to the television decreased for all looks with the exception of looks lasting 2 to 5 seconds and greater than 40 seconds. It is unknown why these looks did not show the predicted pattern of heart-rate deceleration. However, the absence of a heart-rate deceleration for the longer looks may be due to the small number of looks greater than 40 seconds (n = 12) and high variability. It is also possible that these prolonged looks involved mere perseveration with little information processing. For example, Richards (2001) describes a phase of attention, attention termination, in which information processing has ceased while visual fixation continues. This latter explanation is consistent with the passive model of attention to television (Hawkins et al., 1997; Singer, 1980), and points to the importance of physiological data to elucidate the cognitive activity that occurs during looks to television (cf., Aslin, 2007). The measurement of heart-rate during looks in the current study was somewhat imprecise, due in part, to the low sampling rate. A reexamination of the heart-rate data in an attempt to identify heart-rate defined attentional phases (cf., Richards & Casey, 1992) would be useful to determine if infants engaged in one or more phases of sustained attention during these prolonged looks. This would require the acquisition of additional software and was beyond the scope of this study. Despite these few inconsistencies, an examination of the mean heart rate changes revealed a linear increase in heart-rate deceleration with increases in look length, especially in the infants at 12 months of age. This is consistent with Richards and colleagues (e.g., Richards & Cronise, 2000; Richards & Turner, 2001) and points to a greater depth of sustained attention as looks to the television progressed.

The examination of the heart-rate changes during looks to the television also revealed no effects of program category or age. Because the heart-rate was calculated from look onset, the measurement of heart-rate change included the initial orientation phase. Panneton and Richards (in press) suggest that this orienting phase does not vary much from one kind of event to another. Thus, timing the calculation from heart-rate deceleration onset would remove stimulus orientation time and may allow for ascertaining different degrees of heart-rate change based on program type and age of the infants (Panneton & Richards).

Habituation to television. Ruff et al. (1996) proposed that habituation to distractors plays a large role in young infants' ability to resist distraction and maintain focus. Given the almost continuous presence of television in the lives of many infants, the potential of infants to habituate to television becomes an important one. Unlike static stimuli to which infants have been shown to habituate over time (e.g., Cohen et al., 1975; Fagan, 1974), it is unclear if infants habituate to the continuous and dynamic audio-visual elements of television. Indeed, Richards and Anderson (2004) propose that, because television provides changes in information over time, habituation would account for little of the dynamics of attention to television. An examination of the infants' looking to television over time revealed a decrease in both the duration of looking and the number of looks in the first 2.5 minutes of the television presentation, regardless of order of television presentation, age, or program category. However, there was no further decline in looking after the first several minutes, suggesting that the infants habituated attention to television somewhat but that there was no further habituation.

The possibility that television may be unique in its ability to elicit attention comes from a number of sources. Malcuit, Bastien, and Pomerleau (1996) point to the importance of the functional significance of a stimulus in its ability to continue to capture infants' visual attention over time. They found that 4-month-old infants habituated to a visual stimulus that had only a triggering function (a stimulus of short duration was presented). In contrast, when the presentation of the same brief stimulus was followed by another attractive stimulus (an animated cartoon) that remained on for as long as the infant looked at it, not only did the infants fail to habituate to the brief stimulus, there was an increase in visual orientations over successive presentations. This would suggest that, if an orienting response to a formal feature in a television program is reinforced by the continuing presence of interesting features or content, infants may fail to habituate and television may continue to exert a distracting influence over play.

Indeed, Kannass and Colombo (2007) found that preschool children habituated more readily to an intermittent distractor than to a continuous one. In addition, consistent with the exploration-search model (Huston & Wright, 1983), several researchers have found a familiarity preference in children for televised stimuli, suggesting that attention to television is not driven solely by novelty. For example, Barr et al. (2008) found that infants who had prior exposure to a video exhibited increased looking to that video upon subsequent viewing. Future examination of infants' pattern of looking to background television over a longer period of time would be necessary to determine if they exhibit any further habituation to the television. The ability of formal features to capture attention in infants for whom looking at television had decreased is also worth further examination. The issue is an important one, as habituation may impact the potential of television to distract from concurrent activities, such that, over time, background television may exert less influence over infants' attention during play.

Stability of individual differences in looking to television across age. The range of interest in the background television was large; some infants engaged in as little as a few seconds of looking at the television while others spent almost the entire 10-minute session watching television. In addition, they evidenced a wide range (2 to 61) in number of looks to the television. Positive correlations suggest that these individual differences were maintained from 6 to 12 months of age so that infants who engaged in long looks to the television at 6 months of age continued to do so at 12 months of age. It would seem that some infants, in this experimental context, are "television watchers" while others are not. However, no relation was found between the infants' looking at the television in the experimental context and the amount of television at home, both in their active viewing of television and exposure to background television, as reported on the television viewing questionnaire. Future research could determine the stability in individual differences in television viewing, and the interaction between individual differences and environmental factors. The data obtained from the completed IBQ-R questionnaires will be examined in the future to determine possible temperamental factors associated with infants' interest in television.

Conclusion

Play with toys provides an important means by which infants learn about the world. The examination of objects in particular is a sensorimotor experience that supplies infants with information about the physical world and the objects within it. Indeed, infants' exploratory activity with objects is central to Piaget's (1952) theory of sensori-motor intelligence. Chase (1992) describes exploration and play with objects as being the foundation "for the growth of intellectual skills…that are necessary for all later cognitive development" (p. 11). The importance of play, in conjunction with the high levels of exposure to television in the home, point to the critical importance of determining the influence of background television on infants' play with toys.

In the current study, the infants spent the majority of the session in toy play, despite the presence of background television. Similarly, Diener, Pierroutsakos, Troseth, and Roberts (2008) found that infants looked longer at, reached more to, and showed more interest in real objects compared to the same objects presented on video. However, the allocation of visual attention was impacted by the order in which the television was presented. The background television did not impact time spent looking at toys for those infants who were presented with the television in the first half of the session. In contrast, for those infants in the TV-second group the presence of television led to a decrease in both overall duration of looking at toys and mean look length to toys. The differences between the groups' relative interest in the toys and television likely reflect the influence of familiarity of the toys and the relative salience of the toys and television. It could be argued that the conditions in the TV-second group approximate those of a typical home in which the toys are familiar and the television is on. The presence of the background television also reduced the infants' mean look length and peak look length in focused attention regardless of the order of the television presentation. The impact of background television on infants' attention to toys did not differ based on program category or age. This reduction in total duration of looking at the toys, mean look length, and mean length of focused episodes may have a cumulative impact on infants' development through high levels of exposure to background television at home. For example, research has found that length of play episodes is positively associated with the likelihood that focused attention will occur (Ruff et al., 1996). In addition, long looks have been associated with deeper attentional engagement and greater information processing (Richards & Anderson, 2004).

In all likelihood, background television will continue to be a persistent presence in the homes of many young children. Although the results from the present study point to a potentially deleterious impact of background television on infants' attention to toys, many questions remain unresolved. It is important that future researchers conduct naturalistic observations to determine the impact of background television on infants and young children in their homes. Of particular interest may be the potential of background television to affect the quality or nature of infants' social interactions. For example, joint attention, which involves the infant's ability to coordinate attention between people and objects or activities and which is critical in providing infants with learning opportunities (Tomasello, 1998), may be impacted by both the infant's and caregiver's attention to background television. It is imperative that further research is conducted to determine the short- and long-term effects of background television on infants and young children.

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Appendix A

Parent Questionnaire - Television Viewing at Home

1. How much time does your child spend watching TV (including videos and DVDs) on an average day? ____________

2. How much time does your child spend watching or interacting with a computer screen (e.g., playing or watching computer games, etc.) on an average day? _________

3. When someone is at home in your household, how often is the TV on, even if no one is actually watching it?

Never   Rarely   Sometimes   Often   Always

4. When your child is playing and the TV is on in the background, how frequently does it distract his/her attention from what he/she is doing?

Never   Rarely   Sometimes   Often   Always   TV is never on in the background

5. When watching TV, does your child generally:

Become very distracted as if bored	Become somewhat distracted as if bored	Show no reaction	Become focused on the television	Become very focused on the television

6. How many working TV sets are in your home? ___________

7. Does your child have a TV in their bedroom? YES NO

8. What TV program (if any) is your child's favorite? ______________________

9. What video or DVD (if any) is your child's favorite? _____________________

10. How many brothers/sisters does your child have in the home and what are their ages?

_________ Ages: _____________________________________

11. Has your child ever seen or been exposed to <u>(insert name of TV program here)</u>?

YES   NO   I don't know

12. Does your child have any of the toys used in this experiment at home?

YES NO

Appendix B

Interacting with your baby during the experiment

- Guidelines for Parents -

- Because this is a study on what infants are interested in – what they will pay attention to – it would be best to keep interactions with your baby to a minimum.
- If your baby drops a toy and wants it back, you can pick it up and place it on the table in front of him/her.
- If your baby is reaching for a toy that is out of his/her reach, you may push it forward so that it is within your baby's grasp.
- If your baby becomes fussy or upset, you may do whatever you like to comfort him/her. However, after your baby has been comforted, please try to discontinue your interactions.

We know that it is difficult not to interact and play with your baby, but we would appreciate your efforts to follow these guidelines as best as you can. Your child will be seated in the hook-on chair for only 22-25 minutes in total.

Thank you.