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THE INFLUENCE OF EARLY MEDIA EXPOSURE ON CHILDREN'S DEVELOPMENT AND LEARNING

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THE INFLUENCE OF EARLY MEDIA EXPOSURE ON CHILDREN'S DEVELOPMENT AND LEARNING

A Dissertation Presented

by

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ABSTRACT

THE INFLUENCE OF EARLY MEDIA EXPOSURE ON CHILDREN'S

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A number of studies suggest that the amount of early screen media exposure is related to negative developmental outcomes, namely poorer executive functioning and language skills (Anderson & Pempek, 2005). Television's constant presence in the home could lead to potentially serious consequences for infants and toddlers. However, hypotheses attributing long-term negative outcomes to the direct effects of television on children are limited. There are no definitive mechanisms to explain how these effects are instantiated within children over time. Furthermore, the indirect influences of television on children remain entirely unexplored. Television's impact can have a potentially greater indirect effect on young children by directly influencing parents' behaviors, which in turn, disrupt the quality of their interactions with their children. As a result, the current longitudinal study investigated the impact of infant television exposure on later cognitive and learning outcomes at age 6 to 9 years of age to assess whether parent-child interactions mediate this association. Results indicated that parent engagement and parent language during infancy did not mediate this relationship between early television exposure and children's later cognitive skills. Rather, the amount of coviewing television during infancy directly and negatively predicted later school-age children's working memory skills, academic abilities, and language outcomes. These results seemingly contradict the current recommendation to coview television because of its known educational benefits for preschool-aged children and older; findings, therefore, are discussed in terms of what these data mean for future recommendations and guidelines for children's media use.

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CHAPTER I

INTRODUCTION

In the late 90s, the media industry began to target children as young as 6 months as prime viewers for television programs, such as *Teletubbies*, and video series, such as *Baby Einstein*. Many producers claimed these programs have educational or cognitive benefits for young children despite a lack of research to substantiate these claims (Garrison & Christakis, 2005). With the rise in popularity of infant-directed media among families, the American Academy of Pediatrics (AAP, 1999, 2001) made recommendations against early screen media use for children less than 2 years of age based on the assumption that media use would displace important social interactions necessary for healthy development. The AAP (2016) recently amended their recommendation to no screen media for children aged 18 months and younger. For 18- to 24-month-old children, they recommend using high-quality media with caregiver supervision.

Despite the AAP's recommendations, infants and toddlers spend significant amounts of time with screen media. In a typical day, children under 2 years of age watch about 1 hour of television per day (Common Sense Media, 2013). In comparison, infants and toddlers only spend about 19 minutes with books each day (Common Sense Media, 2013). Moreover, 36% of young children live in households where the television is on most or all of the time (Common Sense Media, 2013).

What are the consequences of television exposure during infancy? Despite the marketing claims of the 'educational' value of infant-directed video programs, there are no documented studies that show any substantial benefits from viewing them (Garrison &

Christakis, 2005). In fact, research to date suggests the contrary. Infants and toddlers have difficulty learning from television (Anderson & Hanson, 2010; Anderson & Pempek, 2005), and only show rudimentary signs of comprehension around 18 to 24 months of age (Pempek, Kirkorian, Richards, Anderson, Lund, & Stevens, 2010). In addition, a number of correlation-based studies suggest that the amount of early media exposure is negatively related to developmental outcomes, namely poorer attention and language skills (see Anderson & Pempek, 2005 for a review). Recent experimental studies corroborate these findings, demonstrating that the presence of television directly reduces the quality of children's play behaviors and attention (Courage, Murphy, Goulding, & Setliff, 2010; Schmidt, Pempek, Kirkorian, Lund, & Anderson, 2008; Setliff & Courage, 2011), and parent language (Lavigne, Hanson, Pempek, Kirkorian, & Anderson, 2015; Pempek, Kirkorian, & Anderson, 2009; Zimmerman et al., 2009).

Over time, television's constant presence in the home could lead to potentially serious developmental issues for infants and toddlers. However, hypotheses attributing long-term negative outcomes to the direct effects of television on children are limited. There are no definitive mechanisms to explain how these effects are instantiated within children over time. Furthermore, what remains entirely unexplored are the indirect influences of television on children. Television's impact can have a potentially greater *indirect* effect on young children by directly influencing parents' behaviors, which in turn, disrupt the quality of their interactions with their children.

During the first few years of a child's life, parents are crucial in supporting the development of key cognitive outcomes, such as attention, executive functioning skills, and language development (Vygotsky, 1978). Parents can offset some of the potential harmful effects of media exposure on their children, but they can only do so if media do not compromise their own behavior. For example, parents have the potential to buffer some of television's disruptive consequences by supporting their children's attentional focus during play. However, the quality and quantity of parents' interactions with their children tend to be reduced by the presence of television (Courage et al., 2010; Kirkorian, Pempek, Murphy, Schmidt, & Anderson, 2009; Pempek, Demers, Hanson, Kirkorian, & Anderson, 2011). That is, when the television is on, parents tend to be less responsive, attentive, and engaged with their children. Thus, as media presence in infants' and toddlers' lives continues to grow, it is ever more important to understand effects on both children *and* parents.

The present dissertation study takes advantage of a unique opportunity to follow a cohort of children and their parents who participated in an earlier study that examined the influence of infant-directed videos on parent-child interactions. The original study took place when the children were 12- to 21-months-olds (Pempek, et al., 2011). These same children returned to participate when they were 6 to 9 years of age, providing an opportunity to assess the relationship between early media exposure during infancy and later cognitive outcomes. Specifically, this dissertation investigates how television has the potential to shape everyday parent-child interactions, and how this effect, in turn, influences young children's cognitive and learning from television outcomes. This study sought to answer key questions about the mechanisms by which television exerts its long-term effects on children. This project is novel as one of the first to study television's effects from infancy to middle childhood assessing actual behaviors of children and parents. Such knowledge can help create recommendations and guidelines for media use that can be broadly applied to a wide range of areas, from public policy to daily parenting practices.

The following literature review discusses theories and research that have helped to inform the design of the study, including 1) children's learning from television, 2) the importance of parent-child interactions on children's attention, executive functioning, and language development, and 3) media effects on children's cognitive outcomes as well as potential mediators of such effects.

Learning from Television among Infants and Toddlers

Many parents bought into the educational claims made by the producers of infant-directed videos, reporting that they considered educational videos important for their children's intellectual development (Garrison & Christakis, 2005). However, of the studies that have directly tested the educational efficacy of commercially produced baby videos, none of them found evidence of substantial learning (Deloache et al., 2010; Kremar, Grela, & Lin, 2007; Robb, Richert, & Wartella, 2009; Vanderwater, Barr, Park, & Lee, 2010). Only one study with 18- to 33-month-old children found evidence for learning a new word from video after a 15-day exposure period (Vanderwater et al., 2010). Although this is a sign of learning, it is not considerable given that children had 15 days to learn a single word. At this age, children can learn a new word during a live presentation after a few brief encounters (Woodward, Markman, & Fitzsimmons, 1994).

This lack of learning from commercial videos could be due to the fact that they are poorly designed. Many baby videos are too fast-paced and complex for infants' and toddlers' limited cognitive abilities, and include edits and transitions that are even difficult for preschoolers to comprehend (Goodrich, Pempek, & Calvert, 2009).

Furthermore, many of the educational claims made by infant-directed videos do not match the actual content in the videos or include the best practices suited to teach young children (Fenstermacher et al., 2010).

Although poor design may hinder some learning from television, infants' and toddlers' difficulty in learning from media is more likely due to their cognitive immaturity and lack of media experience (Anderson & Hanson, 2010). Children under 3 years of age, for example, generally perform worse on tasks that they have learned from video compared to an equivalent live experience (Anderson & Pempek, 2005). This phenomenon, known as the *video deficit*, has been found across different research paradigms from imitation (Barr & Hayne, 1999) and object retrieval (Schmitt & Anderson, 2002; Troseth & Deloache, 1998) to word learning (Krcmar, Grela, & Lin, 2007). More recently, it has been called the *transfer deficit* because the problem is not specific to video but to transferring information from a two-dimensional space to a three-dimensional space (Barr, 2010).

A number of theories have been posited to explain this transfer deficit. Some have attributed the learning difficulty to the perceptual impoverishment of the video image relative to the richness of the equivalent real-life experience; these perceptual differences potentially lead to encoding, retrieval, or transfer difficulties as the information is translated from a two dimensional televised space to a three dimensional real-life representation (Barr, 2010; Schmitt & Anderson, 2002). Others have shown that difficulties in learning from television may be due to the audiovisual complexity of television, which has the potential to overwhelm the attentional system (Kirkorian, Anderson, & Keen, 2012). Young children also may have trouble understanding the symbolic nature of television; they do not yet understand the representational nature of television as it relates to the real world until about 3 years of age (Troseth & Deloache, 1998). There is evidence for all of these theories; none of these theories are mutually exclusive, and all highlight the complexity involved in learning from television.

Thus, from a developmental perspective, television viewing is a complex task that requires sophisticated cognitive abilities that come with maturation and media experience. Television viewing is a cortically active process integrating a number of brain regions in service of narrative comprehension (Anderson, Fite, Petrovich & Hirsch, 2006). Areas related to cued attention, visual face and object recognition, visual working memory, action and intention recognition among other areas are uniquely activated when watching video. Many of these activated areas have a protracted rate of development during early childhood. Accordingly, children build on their maturing cognitive abilities to successfully integrate information about actors, actions, and dialogue across scenes necessary for comprehension. With media experience, children also learn how to decode the formal features of television. These formal features or production techniques, such as edits, pans, zooms, and sound effects, are the underlying grammar of television, imparting continuity across scenes and marking scene and content changes (Huston & Wright, 1983). By age 3, children can comprehend and learn from television (Anderson & Hanson, 2010). However, adult-like narrative comprehension continues to develop well into early adolescence (Collins, 1979).

The Importance of Coviewing

Since young children lack the cognitive skills and experience necessary for learning from media, parents can scaffold children's media experience, helping them to comprehend and learn the lessons at hand. There is ample research demonstrating that coviewing television with an adult can promote the educational value of media for preschool-age children and older (e.g., Reiser, Tessmer, & Phelps, 1984; Salomon, 1977; Watkins, Calvert, Huston-Stein, & Wright, 1980). Adult coviewers, who *actively* mediate children's viewing experience, can enhance the value of media by highlighting important information necessary for comprehension, drawing connections within the narrative, and elaborating on lessons. Parental coviewing has been shown to not only enhance learning, but also children's enjoyment, especially for children from lower SES (socioeconomic status) households (e.g., Salomon, 1977).

Many baby videos encourage parental coviewing in order to facilitate the programs' educational benefits for children (Garrison & Christakis, 2005). Survey data indicate that parents report that they do in fact coview with their infant or toddler (Zimmerman, Christakis, & Meltzoff, 2007). Approximately 88% of parents whose children watch television everyday are in the same room 'most of the time' (Rideout & Hamel, 2006). However, what is unclear from such reports is whether the parent was merely present or actively engaged with the child while viewing.

There are a few studies that suggest that parental coviewing can enhance the viewing experience for children under 3 years by highlighting important aspects of the program content necessary for comprehension, elaborating or clarifying information, and connecting it to their every day life (Lemish & Rice, 1986). Parents who navigate the viewing environment, have children who show increased attention to, engagement with, and learning from television (Barr, Zack, Garcia & Muentener, 2008; Fidler, Zack, & Barr, 2010; Demers, Hanson, Kirkorian, Pempek, & Anderson, 2012). For example, infants and toddlers are more likely to learn from television when parents verbally labeled objects on screen (Barr & Wyss, 2008). Young children also are influenced by parents' attention to the television screen and will follow their parents' looks to and away from television (Demers et al., 2012). When infants do so, they often look longer at the television screen, compared to when they look independently, suggesting that parents' looking signals important or meaningful content to the infants.

Although parents tend to coview with their young children, how they coview differs among parents. Fender, Richert, Robb, and Wartella (2010) found that differences in parental scaffolding, while viewing DVDs intended to teach children new words, influenced children's verbalization of the target words. Children, who had parents that exhibited a high TV teaching focus (e.g., attention focusing behaviors and TV-related talk) while viewing, were more likely to be engaged and say more words than children with parents who had a moderate to low teaching focus. Parental coviewing behaviors (e.g., TV-related talk) have the potential to be internalized and adapted by children when they view independently. That is, active parental coviewers can model the behaviors that elicit cognitive engagement and learning from television, and over time, children can do so when they begin to view alone.

Media's Effects on Children

Given that children under 3 years of age comprehend and learn very little from television on their own, it is not surprising that a majority of research indicates that media exposure during infancy exerts a negative influence on children's development. Though, a few studies have demonstrated no relationship between early exposure and cognitive outcomes (e.g., Schmidt, Rich, Rifas-Shiman, Oken, & Taveras, 2009). However, most correlation-based studies have found a relationship between early television viewing and poorer language outcomes, attention, and executive function skills (for a review, see Anderson & Pempek, 2005). Such studies assume a direct effect of television on children, such that in its presence, children's everyday activities are disrupted, thereby hindering healthy development. Everyday activities, such as playing or interacting with others, provide children with the opportunities to gain knowledge and practice skills that contribute to their development (Bronfenbrenner, 1979; Gibson & Pick, 2000; Piaget, 1936; Vygotsky, 1978).

A number of developmental theories emphasize the importance of these early interactive processes between children and their environment. In terms of brain development, for example, the first few years of life are a time of enormous change and growth. Although genetic factors set development in motion, experience shapes its trajectory (for a review, see Shonkoff & Phillips, 2000). Environmental interactions influence and strengthen neural connections in the brain, which in turn, engender more complex behaviors between infants and their environment (Nelson, 1999). That is, as children engage with their environment, they construct their own intelligence through these direct, hands-on experiences (Piaget, 1936). Given the developmental literature, it is not surprising that many concerns regarding children's media use deal with the amount of time that children spend with television due to its potential to displace important social interactions and experiences (Wartella & Robb, 2008).

Displacement occurs if media replace or disrupt time spent in non-media related activities. Media displacement is often considered a negative event, displacing valuable interactions or opportunities necessary for healthy development. However, for this negative event to occur, it has to be shown that children would actually engage in an activity that is more beneficial than media use alone. In contrast, media use has the potential to displace harmful or less valuable activities given that some forms of media can benefit children. Media displacement can also have a neutral effect, displacing something that is functionally similar (e.g., viewing television displaces time playing video games). Although the issue of displacement is a concern for children of all ages, there are important age-related differences that determine the valence of displacement.

Anderson and Evans (2001) posit that television's effects on children depend upon the degree to which children attend to and can comprehend the media content, and can be broadly divided into two categories—background and foreground television. Background television (BTV) refers to young children's exposure to programs that are designed for older children and adults. Here, television is on in the background because young children do not actively pay attention to it and most likely do not understand the content. Past research indicates that background television can have a disruptive influence on young children's toy play, attention, and social interactions (Courage et al., 2010; Kirkorian et al., 2009; Nathanson & Rasmussen, 2011; Schmidt et al., 2008; Setliff & Courage, 2011). In contrast, foreground television (FTV) refers to children's exposure to programs designed for them, to which they will attend and presumably understand.

Watching educational programs designed to engage children, like *Sesame Street,* can have a beneficial effect for preschool-age children because they can comprehend and learn from such programs (e.g., Anderson, Huston, Schmitt, Linebarger, & Wright, 2001). In this case, media displacement has a positive influence if it displaces something of lesser value. In contrast, infants' and toddlers' attention to television is highly variable and intermittent (Anderson & Levin, 1976; Demers et al., 2012), and they do not show signs of comprehension until about 18 to 24 months (Pempek, et al., 2010). Therefore, television use among very young children most likely has a negative displacement effect. The amount of time spent using media has the potential to influence developmental outcomes if it replaces other important experiences. In the research literature, there have been two areas of concern regarding media-based displacement effects among infants and toddlers: the development of attention-related skills and language skills.

The Influence of Television on Attention and Executive Functioning

During the late 1970s, critics began voicing concerns over children's television consumption, claiming that the fast-paced nature of television's format has the potential to negatively influence the development of children's attention. Specifically, some have argued that television shortens children's attention spans (see Anderson & Collins, 1988 for a review). At that time, there were no experimental studies to support such an association (Anderson, Levin, & Lorch, 1977).

This same concern rose again with the popularity of baby videos in the early 2000s, instigated by a study from Christakis and colleagues (2004). Using a nationally representative longitudinal data set, Christakis et al. (2004) found that the more television children watched at age 1 and 3, the more likely they were to exhibit attention problems at age 7. Although the researchers noted the correlational nature of the study, it was nevertheless conveyed to the public[1] as a causal relationship, reporting that television is a significant risk factor for attention deficit disorder because it over-stimulates and rewires

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[1] As an example, here is a news article based on Christakis et al.'s (2004) study: Associated Press. (2004, April 4). *MSNBC*. Watching TV may hurt toddlers' attention spans Researchers say there is 'no safe level' of viewing. Retrieved October 1, 2010 from http://msnbc.msn.com/id/4664749/

the brain. Some have also speculated that infants are particularly vulnerable to television's effects given the plasticity of early brain development (Courage & Setliff, 2009).

How does television exert such effects? Rothbart and Posner (2015) posit that it may be due to television's effects on infants' developing attention network. They define the attention network as consisting of three components: alerting (highly sensitive to incoming information), orienting (selecting specific information from environmental input), and executive attention (managing, monitoring, and switching attention in service of a goal, i.e., regulating oneself in the face of conflict). At first, the orienting reflex is dominant, but slowly gives way to the executive attention system as it substantially improves from 4 to 8 years of age. The *scan and shift* hypothesis (Jensen et al., 2007 as cited in Nikkelen, Valkenburg, Huisinga, & Bushman, 2014) posits that the frequent cuts and edits in television programs induces an attentional style that actively seek out constant stimulation even when one is away from television. Based on this theory, it can be hypothesized that television exposure is constantly activating the orienting reflex of infants, thereby reinforcing this system and potentially disrupting the development of the executive attention system.

With respect to early development, this conjecture directly applies to Greenough, Black, and Wallace's (1987) theory on how experience shapes brain development. *Experience expectant* development is sensitive to basic sensory system input (e.g., visual, auditory, linguistic) that is expected to occur early in life during a time-sensitive period for optimal development of basic perceptual and cognitive abilities (vision, hearing, language learning). These early experiences shape the development of the brain through synaptic pruning of existing neural connections. Through *experience dependent* processes, idiosyncratic life experiences of an individual affect brain development by stimulating the production of new neural connections. This latter process is not tied to a pre-specified time period but available through out life, and allows one to learn from unique experiences. Theories that posit positive learning effects from television attribute this to experience dependent learning, whereas, theories, such as the scan-and-shift-hypothesis would argue that television hinders typical experience expectant processes (Courage & Setliff, 2009).

To test this latter hypothesis, Christakis, Ramirez, and Ramirez (2012) conducted an experiment with mice to simulate what happens to development when immersed in a typical environment that is auditorily and visually over stimulating (i.e., simulating a heavy TV household). The researchers randomly assigned 10-day-old mice into a control group or a stimulated group that received 6 hours of auditory (i.e., children's TV show playing at 70 db) and visual (i.e., flashing lights) stimulation a day for 42 days. They chose this postnatal period in mice to simulate human infancy. They found that the stimulated group performed worse on measures related to attention and self regulation (e.g., risk taking, hyperactivity, anxiety), suggesting that growing up in this atypical and over stimulating environment leads to atypical development mirroring similar affects hypothesized for heavy television use during infancy.

Hypotheses like these have been controversial given that the direct evidence between television exposure and ADHD is sparse and correlational. For example, other correlational studies have found mixed results, reporting small to no effects, for the association between television viewing and later attention problems (e.g., Johnson, Cohen, Kasen & Brook, 2007; Landhuis, Poulton, Welch, Hancox, 2007; Obel, Henriksen, Dalsgaard, Lineet, Skaja & Thomsen, 2004; Stevens & Mulsow, 2006). Moreover, a re-analysis of the same dataset used by Christakis et al. (2004) found no meaningful relationship between TV viewing and attention problems after including two additional control variables (mother's academic achievement and poverty status) and applying a different analytical method (semi-parametric regression instead of logistic regression) (Foster & Watkins, 2010). The re-analysis revealed that the relationship in Christakis et al.'s study was not linear and was driven by children who watched more than 7 hours of television. In fact, moderate levels of viewing were not associated with any negative consequences.

Recent experimental research suggests that the link between television exposure and attention deficit symptoms may be due to a more global problem with the development of executive functioning skills. Executive function (EF) is a construct describing higher level, inter-related, cognitive processes involved in goal-directed behaviors, such as planning, problem solving, and self regulation (Zelazo & Muller, 2002). Some posit that ADHD is primarily a deficit in executive functioning skills and impairment of the frontal lobe (Pennington & Ozonoff, 1996). Children with ADHD consistently perform worse than controls on executive function tasks related to inhibition, working memory, and planning (Holmes, Gathercole, Place, Alloway, Elliot, & Hilton, 2010; Pennington & Ozonoff, 1996; Willcutt, Doyle, Nigg, Farone, & Pennington, 2005) as well as attention shifting and cognitive flexibility tasks (Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010; Willcutt, Doyle, Nigg, Faroane, & Pennington, 2005).

The Development of Executive Functioning Skills

Miyake and colleagues (2000) initially posited that there are three core executive functioning (EF) skills that are interrelated: Working memory (fluency, speed, and efficiency of manipulating incoming information), inhibition (ability to inhibit prepotent responses for weaker ones), and cognitive flexibility (ability to shift between responses or strategies). Such abilities are not only important for engaging in everyday adaptive behaviors, but also related to success in other areas of life.

Self-regulatory behaviors, such as inhibition, working memory, attentional flexibility, planning, and self-monitoring, are related to success in reading and math achievement (Best, Miller, Naglieri, 2011; Blair & Razza, 2007; Espy, McDiarmid, Cwik, Stalets, Hamby & Senn, 2004). Bull and Scerif (2001), for example, found that 7-year-olds' math abilities are positively related to their inhibitory skills, cognitive flexibility, and working memory. Similarly, among younger children, Clark et al. (2010) found that EF skills related to planning, cognitive flexibility, and working memory predicted math achievement at age 6. Furthermore, McClelland, Connor, Jewkes, et al.'s (2007) study demonstrated that children's self-regulation is related to their vocabulary and pre-literacy skills as well as their math abilities. These EF tasks that tap into children's working memory, inhibitory control, and self-regulation are, in general, positively related to academic skills because these types of behavior regulatory-based skills provide children with the ability to listen, focus, and attend to lessons in school as well as follow directions. In addition, these skills may be particularly important for learning math because children often have to hold and manipulate information in working memory, inhibit different strategies, and switch and evaluate their learning strategies.

Although different executive functioning skills have different rates of development, these skills generally begin to appear at the end of the first year of life, greatly improve from 3 to 8 years of age, and continue to develop well into adolescence (Anderson, 2002; Best, Miller, & Naglieri, 2011; Davidson, Amso, Anderson, & Diamond, 2010; Huisinga, Dolan, & Van der Molen, 2006; Welsch, Pennington, & Grossier, 1991; Zelazo, Carlson, & Kesek, 2008). On a neural level, the prefrontal cortex (PFC) is the main cortical region underlying executive functioning (e.g., Houde, Rossi, Lubin, & Joliot, 2010). The PFC connects different areas of the brain related to emotions, thoughts, and actions (Zelazo & Muller, 2002). The dorsolateral prefrontal cortex is thought to be responsible for "cool", or more abstract executive function abilities, while, the orbitofrontal cortex is posited to underlie the "hot", or emotion-related executive functions (Zelazo & Muller, 2002). Dysfunctions in "cool" abilities, such as inhibition, working memory, self-regulation, are thought to underlie problems with ADHD (Barkley, 1997; DeLuca & Leventer, 2008; Hongwanishkul, Happaney, Lee, & Zelazo, 2005).

Although formed prenatally, the prefrontal cortex has a protracted rate of development due to the continued growth in connectivity among different regions in the brain. The first few years of life are particularly important because the cortical maturation of the PFC is directly related to early life experiences. For example, the formation of new synapses reaches peak production around 15 months (Nelson, Thomas, & DeHaan, 2006), and the persistence or elimination of these synaptic connections are determined by the frequency of activation. Consequently, early interactions with the environment are particularly important in shaping the immature brain (Greenough & Black, 1992).

Television Exposure and Executive Function

Factors that can influence children's early physical and social environments, such as television, have the potential to disrupt healthy brain development. Television exposure has been linked to poorer executive functioning. Barr, Lauricella, Zack, and Calvert (2010) investigated the early influence of foreground and background television at 1 and 4 years of age on cognitive outcomes at age 4. According to parent report, children who were exposed to high levels of background television at 1 year of age were more likely to exhibit poorer global executive functioning skills, inhibitory self-control, and emergent metacognition at age 4. There was no association found for foreground television. The researchers posit that early exposure to adult television programming has the potential to interfere with developmental processes related to the development of executive functions, such as attention regulation, by acting as a source of constant distraction for children.

Other correlational studies have also examined this relationship between EF skills and TV viewing and have found differences due to program content. Nathanson, Sharp, Alade et al.'s (2014) study revealed a negative relationship between children's performance on an EF composite measure and the total number of hours watching TV, but found a positive relationship when they looked at PBS viewing alone. Linebarger, Barr, Lapierre, and Piotrowski (2014) using a nationally representative sample found that the amount of educational children-friendly programming, reading, and background music was related to better EF skills, whereas the amount of background television exposure was related to poorer EF skills. Taken together, it appears that educational, child-friendly programs are related to no or positive effects, whereas, background television is related to poorer EF outcomes.

Corroborating Barr and colleagues' hypothesis as well as the other correlational studies, a few experimental studies have demonstrated that children are distracted when the television is on, and television can thereby have a direct effect on children's developing attentional skills. Schmidt and colleagues (2008) compared 12-, 24-, and 36-month-old children's attention and play behaviors in the presence and absence of an adult-directed television program. Although the children paid little attention to the television program, their overall play was still disrupted. Specifically, the proportion of time spent in play, average play length, and focused attention during play were reduced when the television was on. Such outcomes have been shown to be measures of attention indicative of later attentional problems (Alessandri, 1992; Handen, McAuliff, Janosky, Feldman & Breau, 1998; Roberts, 1986). A study by Setliff and Courage (2011) found similar results with children who were observed at 6, 12, and 24 months of age. These young infants were more distracted from their play while the television was on, and were more distracted, the longer that it was on. This latter finding is particularly important given that about one third of infants and toddlers live in homes when the television is on most of the time, regardless of whether or not someone is watching (Common Sense Media, 2013).

Television has the potential to not only act as a source of distraction within children's home environment, but also watching the programs itself has the potential to influence children's cognitive abilities as suggested by earlier critics of television as alluded to previously. Lillard and Peterson (2011) examined whether the pacing of certain programs induces deficits in executive functioning skills. For this study, 4-year-olds viewed either a 9-min fast-paced, popular entertainment program (i.e., *Spongebob*) or a slow-paced PBS educational program, or were assigned to a drawing condition. Afterwards, the children were tested on a variety of executive function tasks (e.g., Tower of Hanoi, Delay of Gratification). Results showed that children in the drawing group outperformed children in the fast-paced TV condition on executive function tasks, but did not differ from children in the slow-paced TV condition. The difference between the TV conditions was marginal ($p = .05$).

Complementing the *scan and shift hypothesis*, Lillard and colleagues (2011; 2015) posit that the combination of the fast-paced and fantastical nature of children's television programs tax children's cognitive resources while viewing, resulting in a cognitive depletion for children to self-regulate on later tasks. That is, while watching television, there are competing factors that vie for children's attention and other cognitive resources—the media message as well as the resources to process it. When a program is fast-paced (i.e., more cuts, edits, scene changes, etc.), it consumes more cognitive resources because children need to not only process the narrative, but also the formal features of the program to convey the message (Lillard, Li, & Boguszewski, 2015). Over time, this constant processing depletes children's attention-based skills, leading to poorer performance on EF tasks later on. It should be noted that a study by Anderson et al. (1977) looked at this issue of pacing by editing the same episode of Sesame Street into a fast-paced or slow version, and they did not find any differences among 4 year olds on measures of impulsivity or task persistence.

In summary, research indicates that there are two ways that television could negatively influence the development of children's attention and executive functioning skills. It has been hypothesized that television affects children's attention even when they are not actively watching by distracting them while they are engaged in other important developmentally enhancing activities. Another theory posits that television exposure directly influences children's developing attention and executive functioning skills through viewing due to the fast paced nature of television, which not only taxes and depletes children's cognitive resources, but it also engenders an expectation or attentional style that seeks constant stimulation. Infants are particularly vulnerable to television's effects because they have very limited cognitive resources to comprehend television and to navigate the distraction of television in their homes.

The Influence of Television on Young Children's Language Development

Television lacks the affordances inherent in real life interactions, such as interactivity and temporal contiguity, that are necessary for infants and toddlers to learn language (Krcmar, Grela, & Lin, 2007; Kuhl, Tsao, & Liu, 2003; Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). Not surprisingly, research on word learning from infant-directed videos has found little evidence for it (Deloache et al., 2010; Robb, Richert, & Wartella, 2009; Vandewater et al., 2010). Instead, there is a growing body of correlational research suggesting that screen media has a negative influence on infants' language development. A few studies conducted in the 1970's and 1980's implicated early television exposure with poorer language later on (e.g., Carew, 1980; Nelson, 1973). More recent correlation-based studies have supported these early negative findings regarding television and language development (Mendelsohn, Brockmeyer, Dreyer, Fierman, Berkule-Silberman, & Tomopoulos, 2010; Linebarger & Walker, 2005; Zimmerman & Christakis, 2005; Zimmerman, Christakis, & Metlzoff, 2007).

Research shows that it may not be just the amount of television that influences language development, but effects may be moderated by differences in age and content. Zimmerman, Christakis, and Meltzoff (2007), for example, found a significant negative association between watching baby videos at 8 to 16 months and language abilities, such that for each hour of viewing baby videos, there was a 16.99 point decrement (i.e. 6-8 words) on the MacArthur-Bates Communicative Development Inventory (CDI), a standardized language assessment measure. Interestingly, this association was not found for infants 17 to 24 months.

Other studies have found that television can have differential effects based on program content differences. Linebarger and Walker (2005) assessed the effects of television exposure starting at 6 months on language outcomes at 30 months. Findings indicated that outcomes were program specific. Programs that had a strong narrative, such as *Dora the Explorer* and *Dragon Tales*, were positively associated with greater vocabulary and expressive language, whereas, programs that had little narrative structure and spoken language, such as *Teletubbies*, were negatively associated with vocabulary and expressive language. Together, the studies suggest that not only does the amount of television exposure influence language development, but also there are other important factors to consider such as age and content differences.

The Development of Language

To understand the ways in which television has the potential to exert its effects on language development, it is useful to understand how language typically develops.

Children's language skills rapidly unfold over the first three years of life (Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994). At 10 months, children produce about 0 to 10 words on average. At 18 months, children can say about 75 words, and at 30 months, they can say about 555 words. During this time, language acquisition is determined by the total number of words heard in children's everyday environments and by the syntactic richness and complexity of language expressed in the home environment (Hart & Risley, 1995; Hoff & Naigles, 2002). As language skills develop over the first two years, language processing becomes more efficient and specialized in the brain. Among 20-month-old infants, for example, familiar words are processed in the left hemisphere in the parietal and temporal regions, whereas younger infants exhibited broader dispersement of activity over both hemispheres (Mills, Coffey-Corina, & Neville, 1997).

To acquire language, there are a variety of cues, such as perceptual and social cues, available to children to facilitate word learning. Children's use of specific types of cues depends on their developmental level (Hollich, Hirsh-Pasek, & Golinkoff, 2000). At 10 months, infants are particularly sensitive to attention-based cues, such as perceptual salience and temporal contiguity of word-object pairings (Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006). At 12 months, when infants begin to recognize others as intentional beings (Gergely & Csibra, 2003), infants start to show a sensitivity to social cues, such as eye gaze and pointing, to learn new words, but this does not become fully evident until about 18 to 24 months. Given these differences in word learning, television exposure could have differential effects based on children's developmental level.

Television Exposure and Language Development

Television's presence in the home is likely to affect many cognitive and social processes related to language processing and, in turn, language development over time. Children under 18 months may be particularly sensitive to television's effects on word learning because their attention system is driven by an orienting reflex that responds to novel and salient objects and events in their environment (Colombo, 2001; Ruff & Rothbart, 1996). Given this reflexive system, infants are susceptible to complex audio-visual distracters such as television (Oakes & Tellinghuisen, 1997; Tellinghuisen, Oakes and Tjebkes, 1999). Ironically, these negative effects may be exacerbated by exposure to program content specifically designed for young children. Baby programs are particularly good at eliciting young children's attention, but are poor in actually teaching language skills (e.g., Robb, Richert, Wartella, 2009). As a result, television may be a source of constant distraction for infants from attending to and learning speech in their natural environment.

Background noise, like television, has been shown to tax very young children's attentional abilities (Dixon, Salley & Clements, 2006; Schmidt et al., 2008). Consequently, if children's attention is distracted or dispersed, they may not be able to allocate attention to the relevant linguistic stimuli in their environment. Furthermore, young infants have difficulty hearing words against competing speech streams (Newman, 2005). At 12 months, infants can selectively attend to their own name, but only when it is spoken 5 decibels higher than the distracter speech stream. Taken together, television can have a direct influence on children's language development because young children are particularly susceptible to the direct distracting effects of television due to their immature attentional system.

Indirect Effects of Television on Parent-Child Interactions

Although there is evidence to suggest that television can have direct effects on children, television can also exert indirect effects on children through the parent. One correlational study, for example, indicated that there is a negative relationship between children's total hours of TV viewed per week and an EF composite measure based on a number recall task and stroop task. However, when the researchers took into account other covariates, such as parent scaffolding abilities during a puzzle task, the relationship was no longer significant (Blankson, O'Brien, Leerkes, et al., 2015). Although not tested, it could be that parents somehow mediated the effect between TV exposure and developmental outcomes.

Lev Vygotsky (1978) noted the importance of social supports in facilitating children's learning and development. According to Vygotsky, children first learn information and gain new cognitive skills with help from other people. Over time, children internalize these lessons and can independently perform them without assistance.

Vygotsky elaborated on this developmental process through his theory of the Zone of Proximal Development (ZPD). The first level in the ZPD is related to what children can do by themselves, and the second level of the ZPD is related to what children can accomplish with the support of a more advanced social partner. Through a process called scaffolding, in which children collaborate with an adult or competent peer, children can solve tasks or problems that are beyond their current abilities. This scaffolding, or collaboration, enables children to learn with assistance, and over time, allows them to move through the ZPD to where they can perform the problem or task independently. Consequently, an important determinant of children's developmental outcomes is the quality of parent-child interactions (Akhtar, Dunham, & Dunham, 1991; Landry, Smith, Swank, 2006).

Executive Functioning Skills and Parent-Child Interactions

Parents play a crucial role in the development of executive functioning skills. Scaffolding difficult situations and responding sensitively to infants' signals are two particularly important parental behaviors that promote EF development (Carlson, 2003). These maternal behaviors are posited to provide children with the necessary support to solve problems and gain a sense of mastery of their environment. Bernier, Carlson, and Whipple (2010) tested whether such early caregiving behaviors (maternal sensitivity, mind-mindedness talk, and scaffolding) were related to better executive functioning skills (working memory, inhibition, and set shifting) later on. Infants were assessed at 12, 15, 18, and 26 months of age. Although there was a positive relationship among maternal sensitivity and mind-mindedness with executive function outcomes, the relationship did not hold when the control variables (IQ, maternal education) were included. Early scaffolding behaviors, such as autonomy support (e.g., sensitivity to children's rhythm) provided the strongest link to the development of working memory and conflict resolution, even after accounting for children's IQ and maternal education. Such parental behaviors are posited to be important for the development of self-regulation, providing children with strategies and opportunities to practice self-control with support.

Television and Parent-Child Interactions

Although there is evidence for the direct effects of television on children's developmental outcomes, what may be more important are the indirect of effects of television on children through the parent. When the television is on, infants and toddlers are vulnerable to television's distracting effects (Schmidt et al., 2008). Parents have the potential to buffer such effects by turning off the television or by helping children focus on the task at hand. However, parents can only do so if their own behavior is not comprised in the presence of television. Studies have shown that, not surprisingly, when adult programs are on, there is a reduction in the quality of parents' interactions with their children. Kirkorian and colleagues (2009) examined the quality of interactions among 12-, 24-, and 36-month-old children and their parents in the presence of an adult-directed program. When the television was on, there was a reduction in parental verbal interactions, responsiveness, and general active involvement with their children relative to when the television was off. This effect over time could have long-term consequences, especially among children who live in heavy TV households. The amount of such background television exposure, but not foreground television, has also been negatively associated with the level of high quality engagement, even when the television was not on (Hanson, Demers, Pempek, Kirkorian, & Anderson, 2010). What is unclear is whether such interactions are caused by television exposure or whether television is an indicator of a type of family that generally watches a lot of television and engages in fewer social interactions.

Such exposure effects are also found for programs designed for young children. In the original study on which this dissertation is based, Pempek and colleagues (2011) found that although parents used the video content to engage with their children, there was an overall reduction in the quality and quantity of parent-child interactions when the TV was on for all children. However, parents who received *Sesame Beginnings* videos to watch with their children over a two week period showed that the more they coviewed the baby videos in the home, the more likely they were to actively engage with their children in the laboratory during a 30-minute play session, indicating that the parents learned something from the baby videos. This was not true for the group of parents who viewed *Baby Einstein* videos. In addition, *Sesame Beginnings* parents were also more likely to engage in higher quality interactions after viewing the video. Parents in both groups used the videos while viewing as a means to interact with their children based on the affordances of the video; during *Baby Einstein*, parents tended to label objects, and during *Sesame Beginnings*, parents tended to sing and dance with their children. Other studies have found similar results regarding infant-directed programs on parent-child interactions. Parents tend to be less interactive, talkative, and responsive to their children when child-directed programs are on (Courage, Murphy, Goulding, & Setliff, 2010; Nathanson & Rasmussen, 2011).

Language and Parent-Child Interactions

Although the number of words heard in the home is an important predictor of children's language abilities (Hart & Risley, 1995), the quality of the linguistic interactions and supports may be an even more influential factor on children's language outcomes (Hudon, Fennell, & Hotftyzier, 2013; Rowe, 2012). For example, one study found, controlling for SES and input quantity, the quality of parents' language (e.g., new words) was positively correlated with children's vocabulary skills (Rowe, 2012). Other aspects of parent language are also important for children's language development, such as the amount of child-directed speech (as opposed to overheard speech; Weisleder & Fernald, 2013) and conversational turn-taking experiences (Zimmerman, Gilkerson, Richards et al., 2009).

In addition, non-linguistic parental behaviors are crucial to children's language development. Parents' who scaffold their infants' attention to objects have been shown to have infants' with a greater facility with language later on (Schmidt & Lawson, 2002). The frequency of such scaffolding at 5 months, for example, is related to language comprehension at 12 months (Tamis-Lemonda & Bornstein, 1989). Maternal verbal sensitivity is another important factor that is related to children's later language comprehension, especially for children who have poorer language skills (Baumwell, Tamis-LeMonda, & Bornstein 1997). Rich verbal scaffolding, while children are engaged in problem solving tasks, is positively related to language and executive function skills in later childhood (Dieterich, Assel, Swank, Smith, & Landry, 2006; Landry, Miller-Loncar, Smith, & Swank, 2002; Smith, Landry, & Swank, 2000). Such maternal language supports provide children with models about how to solve problems and think about the world.

Television and Parent Language

Television's presence does not only influence children, but also their parents. A number of experimental studies have corroborated this hypothesis, indicating that when the television is on, there is a reduction in both the overall amount of parental language directed at children and the complexity of parent language (Pempek, Kirkorian, & Anderson, 2014; Lavigne, Hanson, & Anderson, 2015; Tanimura, Okuma, & Kyoshima, 2007). This effect was found for background television (Pempek, Kirkorian, & Anderson, 2014) and for foreground television (Lavigne, Hanson, & Anderson, 2015). However, although the number of total words, new words, and average utterance length decreased when foreground television was on, the number of new utterances per word, a marker of language quality, was greater when the TV was on. Thus, the finding for foreground television is slightly more nuanced, suggesting that while watching child friendly programs, parents' language may be richer, albeit, less.

Conclusion

Altogether, the research suggests that television can have a powerful effect on children's outcomes through the parent. By distracting the parents, television can hinder important developmental interactions between parents and their children. However, there is no research to-date that has directly examined the potential mediating effects of parent-child interactions on the relationship between television exposure and child outcomes. This dissertation study will be the first to do so.

Overview of the Current Study

Employing a longitudinal design, my dissertation followed a cohort of children and their parents who participated in an earlier study that examined the influence of infant-directed videos on parent-child interactions (Pempek, Demers, Hanson, Kirkorian, & Anderson, 2011) when the children were either 12- to 15-months-old or 18- to 21-months-old. For the original study (Pempek et al., 2011), infants were randomly assigned to one of three media conditions: A *Sesame Beginnings* video group, a *Baby Einstein* video group, or a no video control group. All parents received TV viewing diaries to record their children's television exposure over a two-week period before coming into the laboratory. Children in the video group also received two DVDs from their respective series to watch in their homes during this time. Both of these video series were directed at fostering parent-child interactions through coviewing. *Sesame Beginnings* targeted parents, demonstrating fun ways to interact with their children on a daily basis through song sung by Muppet and human characters. In contrast, *Baby Einstein* videos were montages of nature scenes and animated toys set to classical music.

After this two-week exposure period, parents and their children were scheduled for a 30-min free play session at the UMass Child Study Center in Springfield. Parents were instructed to act as they would if they had a half-an-hour to spend with their child. There were magazines and toys available for the parents and children. One week later parents and their children came back to the Child Study Center for a 30-min TV viewing session and a 15-min no TV post-viewing session. Children in the video groups watched one of the videos that they viewed at home, whereas children in the control group watched one of the *Sesame Beginnings* videos. The control group allowed the researchers to examine familiarity effects of the videos on parent-child interactions. Findings from this study indicated that although parents used the video content to engage with their children, there was an overall reduction in the quality and quantity of parent-child interactions when the TV was on.

For my dissertation, these same children were tested again at 6 to 9 years of age on executive functioning, academic, and language assessments during the first half of the laboratory visit (study 1). Research has shown that these cognitive outcomes may be particularly susceptible to television's harmful effects (Anderson & Pempek, 2005). During the second part of the session, children were videotaped while watching *Bill Nye* *the Science Guy*, a science-based educational program, and were tested on comprehension of the program (study 2).

Study 1 used the videotaped parent-child observations and the media diaries during infancy as well as the cognitive tests at 6 to 9 years of age to assess the influence of early television exposure on children's later executive functioning, academic, and language skills. The ways in which television exerts its effects on children—either directly on the child or indirectly through the parent—was examined through multiple convergent measures. Television exposure has the potential to have a direct negative influence on children's development. Alternatively, given the importance of parent-child interactions for children's development, television exposure may have a greater impact when it interferes or reduces the quality of parent-child engagement during infancy thereby influencing later child outcomes. The effects of program content (background or foreground television) and the coviewing context were investigated as both have been shown to influence television's effects on children.

As a post hoc analysis, I assessed whether children's executive functioning skills mediated the relationship between infant television exposure and later academic skills. Although there is evidence to suggest that children's executive functioning skills are related to children's academic success (e.g., Blair & Rezza, 2007) and that infant television is related to executive functioning skills (Barr et al., 2010), there are no studies that have looked at the relationship among all three factors.

Study 2 used the videotaped parent-child observations during infancy and the assessment of children's comprehension of *Bill Nye* to investigate whether the early coviewing context between parents and their children during infancy influences later learning from television. The early home environment is an important socialization factor that determines children's later media habits and preferences (Anderson, et al., 2001; Huston, et al.,1990; Lee, Bartolic, & Vanderwater, 2009; Wright et al., 2001). At home, parents teach their children how to use media and the reasons for media use through their own behaviors and habits (Huston & Wright, 1996; Rideout & Hamel, 2006; St. Peters, Fitch, Huston, & Wright, 1991; Vandewater et al. 2007). When parents actively coview with their children and mediate the viewing experience by labeling, questioning, and elaborating on content, children can adapt this active and cognitively engaged viewing style, which has the potential to facilitate learning from television when viewing alone.

Research Questions

Research Question 1: Is there an influence of infant television exposure on later executive functioning skills at age 6 to 9 years of age? Is this relationship mediated by parent-infant interactions? (see Figure 1 for the statistical diagram)

Research Question 2: Is there a relationship between early television viewing during infancy and later academic achievement? Is this relationship mediated by working memory?

Research Question 3: Is there an association between early infant television exposure on children's later linguistic abilities at age 6 to 9 years of age? Is it mediated by parent language?

Research Question 4: Does early infant television coviewing influence children's later TV comprehension? Is this relationship mediated by parent-child interactions while viewing?

CHAPTER II

METHOD

Design

This study is based on a longitudinal observational design. Children were first observed between 12 and 21 months of age (2005 – 2008). Assessment of parent-child interactions, parent language, and media exposure during infancy are the primary predictors of children's later cognitive and learning outcomes at 6 to 9 years of age (2013—2014). Key control variables included child age, sex, IQ, maternal education, current media use, and parent-child interactions (no TV).

Participants

Children who participated in Pempek and colleagues' (2011) study were recruited for this dissertation project. For the original study, children (N = 152; 80 12-month-olds, 74 females) were either 12- to 15-months-old or 18- to 21-months-old. Eighty-one percent of them were Caucasian, 5% were Hispanic, 3% were African American, 9% were multiracial, and 2% were 'Other' as noted by their parent. Parent education ranged from a 10th grade to graduate level (M = 15.27 years, SD = 2.30).

For the second wave of data collections, children were 6 to 9 years old (M = 7.57 years, SD = 0.73). Eighty-two percent were Caucasian, 6% were Hispanic, 6% were African American, and 7% were noted as 'Other'. An additional 14 participants, who were dropped from the original study[2], were also recruited. For the current study, 54% (n = 89; 52 females) returned to participate in the second wave of data collection. Most of

[2] Children were dropped from the final analysis for Pempek et al., (2011) for a variety of reasons: they did not complete both lab visits, the same parent did not participate in both sessions, or they were dropped because the child aged out. For these families, children's missing data were imputed.

the children returned to the UMass Child Center in Springfield to participate. Three of the families did not visit the laboratory because they had moved long distance, but completed the surveys. In addition, two families met the researchers at the Children and Media Lab at UMass in Amherst, and one family was visited in their home in upstate New York. Approximately 35% (n=58) of the original subjects did not respond and/or could not be located, and 11% (n=19) of them were contacted but not interested in participating again.

Returning and Non-returning children did not significantly differ on any of the variables measured during infancy: mother's education level, parent-child interactions, parent language, or television viewing variables (see Table 1). In addition to these returning participants, 11 pilot subjects were recruited, using the UMass Amherst Psychology Department's child recruitment database, to test the materials and procedure. Their data was not used in the analysis.

There were three rounds of recruitment (summer 2013, fall 2013, spring 2014). Beginning with the oldest children, letters were sent to parents describing the current study and notifying them that a research assistant would follow-up with a phone call to answer any questions they may have. For interested families, a two-hour appointment was scheduled at the family's earliest convenience at the UMass Child Study Center in Springfield, MA. At the end of the laboratory visit, families received approximately $50 ($25 per hour) and a prize as a token of appreciation.

Setting and Apparatus

Testing took place at the UMass Child Study Center. For the television viewing session, children watched the program in the experimental room (3.40 m by 2.94 m) that was set up like a traditional living room with a comfortable armchair, a large pillow, a coffee table, coloring books, markers, paper, magazines for parents, and a 21-inch television and DVD player. This layout was identical to the original the Pempek et al. (2011) study. A digital camcorder beneath the television and a microphone in the experimental room recorded the TV viewing session. The adjacent observation room (3.42 m by 2.29 m) had a large one-way mirror (1.35 m by 1.60 m) that looks into the experimental room. The observation room contained a second digital camcorder that was manipulated by the researcher to record the children in the experimental room. The researcher switched between the two video cameras to capture the best angle of the children watching the program. Both camcorders were channeled into a computer, using the software program, *Wirecast*, to record the session.

Stimuli

For the television viewing session, children watched an 11-min edited segment of *Bill Nye the Science Guy*, a science-based television program that aired in the 1990s, targeting children 6 to 11 years of age. The segment focused on how forensic science is used to help solve crimes. Since *Bill Nye* aired in the early 1990s, it was unfamiliar to most children.

Procedure

For the current study, children and their parents visited the Child Study Center in Springfield, MA for a two-hour session. Upon arrival, parents were given a consent form describing the study and its procedures. If children were 7 years old or older, child assent was verbally obtained. After answering any questions from the families, the testing session began. Parents were given questionnaires to fill out. If parents finished early, a variety of magazines were available for them to read.

Children started with the executive functioning tasks (30 min) followed by the vocabulary and block design subtests of the Wechsler's Intelligence Scale for Children-IV (20 min). A snack break was given at the midway point. After the break, four Woodcock Johnson III subtests were given to assess children's academic achievement (30 min). Children were then led into the TV viewing room to watch an 11-min episode of *Bill Nye the Science Guys* with their parent. Children were told that they were taking a TV break and that they would watch a show called *Bill Nye the Science Guy* for fun. Parents were asked to act as they would at home if they had an opportunity to watch with their child. There were magazines for adults, and paper and coloring books for the children to use. After viewing, children were asked a series of comprehension questions while the parents finished the paperwork.

To make the testing more engaging, children were given a 'game' map that marked the different tasks that the children had to complete. Once children completed each task, they were given a sticker as a reward to place on their map to show their progress. At the end of the session, children were allowed to choose their reward (e.g., small toy, pen, book, etc.). Families were debriefed and given payment for participating (approximately $50).

Parent Questionnaires

Basic information

The General Information Survey (see Appendix A) asked parents to report on basic family demographic data, children's general health, social behaviors, parent-child relationship, and neighborhood quality. This questionnaire was adapted from the National Survey of Children's Health (2007), which assessed the physical and mental health of children who are under 17 years of age. Of relevance, mother's education level was taken from this questionnaire.

Media Use Questionnaire

This survey was adapted from Common Sense Media's (2011) nationally representative survey on children's media use and from Linebarger et al.'s (2008) assessment of parent attitudes, rules, and restrictions around children's media use (see Appendix B). From this questionnaire, children's current media use was estimated from their parents' report.

The Disruptive Behavior Rating Scale (DBRS) – Parent Version

The DBRS(Barkley & Murphy, 1998, see Appendix C) is a parent questionnaire that assesses the degree to which school-age children exhibit symptoms related to attention deficit hyperactivity disorder based on a 4-point scale from 0 (never/rarely) to 3 (very often). This measure has high internal consistency (Cronbach's alpha = .94) and has moderate to high convergent validity with the ADHD subsection of the National Institute of Mental Health Diagnostic Interview Schedule (NIMH-DISC-IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000) and with the Behavior Assessment System for Children–Parent Report Scale (BASC-PRS; Reynolds & Kamphaus, 1992, Friedman-Weieneth, Doctoroff, Harvey, & Goldstein, 2009).

School-Age Children's Measures

NIH Toolbox: Executive function

The National Institute of Health's Toolbox is a free assessment tool for clinicians and researchers that focus on a variety of cognitive, emotional, and physical outcomes for 3 to 85 year olds. For this study, three computerized executive function measures [Flanker Inhibitory Control and Attention Test (Flanker), Dimensional Change Card Sort Test (DCCST), and List Sorting Working Memory task (WM)] were used on a laptop; an additional computer monitor was connected for the researcher to see the testing screen. The scores are standardized (M = 100, SD = 15) and adjusted for age, race, ethnicity, and parent education. The three tests (Flanker, DCCST, WM) have high test-retest reliability (ICC range .95, .92, .87) and convergent validity (r = -.48, -.51, .58), and low discriminant validity (r = .15, .14, .30) (Weintraub et al., 2013).

Flanker Inhibitory Control and Attention Test (Flanker)

This task assesses children's inhibitory control. Children are shown a target fish[3] in the middle of the computer screen that is flanked by two other fish. Children have to choose the direction that matches the way the middle fish is pointing by pressing the left or right arrow on the keyboard. On congruent trials, the flanker fish matches the target fish. On incongruent trials, the flanker fish is pointing in the opposite direction as the target fish, such that they have to maintain their focus on the target fish and inhibit their response to the flanking ones. There are 4 practice trials and 40 test trials. Scores are based on a formula that includes accuracy and reactions time (see the NIH Scoring and Interpretation Guide, 2012).

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[3] Fish are used for children 3 to 7 years of age, while arrows are used for children 8 years plus.

Dimensional Change Card Sort Test (DCCST)

The DCCST measures children's cognitive flexibility or ability to shift between different strategies. Children were trained to recognize specific patterns that differ in shape and color (yellow balls and blue trucks) on 10 practice trials. At test, they were given 30 additional trials where they were shown a target picture (yellow ball or blue truck) and two additional pictures (yellow ball and blue truck) and had to match on one dimension (e.g., color) then eventually switch to the other dimension (e.g., shape). Scores are based on reaction time and accuracy on pre-switch, post-switch, and switch trial.

List Sorting Working Memory (WM)

This task gauges children's ability to store, manipulate, and update information. Children see and hear a series of items (animals and food) flashed on the computer screen and have to recall and sequence the items in size order. As children progress through the task, the number of items within a recalled list gets longer (up to seven items). Scores are obtained by summing the number correct across 13 possible lists.

Intelligence

The vocabulary and block design subtests of the Wechsler Intelligence Scale for Children (WISC-IV) was used to assess children's intelligence. The combination of these two subtests is highly correlated with the full-scale IQ score (Sattler & Dumont, 2004).

Woodcock Johnson III (WJ-III)

The WJ-III is a standardized measure of children's cognitive and achievement abilities and is widely used in developmental research with children as young as 2 years of age. Children completed the following subtests of the WJ-III: passage comprehension (fill in missing key words in a passage), story recall (listen to and recall story details), math fluency (solve arithmetic problems in 3 min), and academic knowledge (social studies, science, and humanities). The reliability of these subtests ranges from .81 to .94, and the tests have good criterion validity with other achievement measures (Shrank, McGrew, Woodcock, 2001).

TV comprehension

To assess children's ability to learn from television, children were asked a series of comprehension questions regarding the Bill Nye segment viewed that were divided into identification-, definition-, recall-, and process-based categories. All answers were transcribed and coded separately by two researchers. Cohen's Kappa indicated a high amount of agreement (κ= .86). If there were discrepancies in coding, the researchers met and discussed the best answer.

Attention to television

Procedures drawn from Anderson and Levin (1976) were used to code children's attention to the television. Adobe Premiere software logged children's look onsets and offsets to and away from the television program. From this assessment, the number of looks, the average look length, the longest look, and the total amount of time spent watching the television program were obtained for each child. To assess inter-observer reliability, two different trained research assistants coded twenty-five percent of the videos. The intraclass correlation coefficient for percent amount of attention to *Bill Nye the Science Guy* was .98.

Relevant Methodology from the Original Pempek et al. (2011) Study

Procedure

To assess how baby videos influence parent child interactions, participants were randomly assigned to a video condition (Baby Einstein (BE), Sesame Beginnings (SB), or a No Video control condition) at 12 to 21 months of age. For two weeks, children in the BE or SB condition were asked to view two videos from their respective series. All parents were asked to keep a TV viewing diary for the two-week period prior to coming to the laboratory. Afterwards, parents and children came to the laboratory for 30 min where they were observed interacting without television (No TV session). The experimental room was furnished like a living room with toys for the children and magazine and newspapers for the parent. One week later, children visited the laboratory again for a 30 min TV viewing session (TV session) followed by a 15 min No-TV session (Post TV session).

Measures

Parent-child Interactions During Infancy

To gauge the quality of parent-child interactions, one of four types of parent engagement was noted for every 10-second interval for the no-TV session, TV session, and Post-TV session: 1) active engagement—attentive and responsive to child, 2) passive engagement—responding to child, but attention is directed elsewhere, 3) monitoring—watching their child, but does not interact, and 4) not interacting with their child. Based on these ratings, a weighted average was calculated to capture the variability in the amount of parental engagement [(2*Active) + (1*Passive)+ (1*Monitor) +(0*Not Interacting)] for all three sessions.

To assess inter-observer reliability, two different trained research assistants double coded twenty-five percent of the videos. The videos were chosen at random and were coded throughout the duration of the research project. The intra-class correlation coefficient was 0.91 for level of parent-child interactions.

Infant Television Viewing Diary

Parents completed a two-week television viewing diary for their infant. For every 15-minute increment between 6AM to 11PM, parents had to note whether the television was on, who was watching, and whether it was a child-friendly program or not. From the diaries, we gauged what children were watching (background vs. foreground TV programs), how much children were watching, and with whom they were watching. Parents kept separate records for general TV exposure versus when the child was exposed to the videos. Only general TV exposure is considered in these analyses.

Quantity and Quality of Language

These measures were used for the Lavigne et al., (2015) study that assessed how early television exposure influences parent language directed at their infants[4]. Based on Hoff and Naigles (2002), parent language during infancy was transcribed from the video observations for the No TV, TV, and Post TV sessions (see Lavigne et al, 2015 for more details). Each line of transcription represented a parent utterance. From these transcriptions, total number of words per minute, total new words per minute, and total utterances per minute were created as language quantity variables, while number of new words per utterance (New words/utterance) and the mean length of an utterance (MLU) were used to assess language quality. The quantity variables were divided by the

[4] The N for the Lavigne et al. (2014) study was 128. The final N for the current study was 79.

duration of the observation session to obtain a per-minute estimate: No TV (30 min), TV (length of video ~30 min), and Post TV session (15 min). These language variables are predictive of children's language outcomes (Hoff & Naigles, 2002). New words per utterance was a novel variable created by Lavigne et al. (2014) as another way to gauge language quality even if there was an overall decrement in language quality. This variable was computed by dividing total number of novel words by total utterances. Twenty-five percent of the video observations were double coded to assess inter-rater reliability. Intraclass correlation coefficients ranged from .91 to .99.

An open-ended comprehension question to *Bill Nye* (i.e., What happened on the show today?) was used to estimate children's current language abilities at 6 to 9 years of age. The same procedure described above was used to estimate the number of words, total new words, total utterances, number of new words per utterance, and the mean length of utterances, with the exception that a per minute estimate was not obtained for the language quantity variables because it was in response to a question, rather than constrained by session time as it was for parent language. Intraclass correlations ranged from .90 to .99.

CHAPTER III

RESULTS

<u>Research Question 1: Is there an influence of infant television exposure on later executive functioning skills at age 6 to 9 years of age? Is this relationship mediated by parent-infant interactions?</u> <u>(see Figure 1 for the statistical diagram)</u>

It is hypothesized that there will be a negative influence of television exposure during infancy on children's EF skills later on, and that this effect will be mediated by parent-infant interactions, such that early TV exposure will negatively influence these interactions, which will in turn exert a negative influence on children's EF outcomes.

Analytic Approach

For this analysis, the independent variable is the amount of television exposure during infancy, the mediating variable is early parent-infant interactions (with TV), and the dependent variables are children's executive function outcomes during middle childhood. Television content was divided into coviewing foreground television (FTV coview; *M* = 10.38 hours per two weeks, *SD* = 10.18) and coviewing background television (BTV coview; *M* = 11.02 hours per two weeks, *SD* = 12.25). Parent-child interactions during infancy in the presence of television (PCI-TV: *M* = 1.20, *SD* = 0.40, *min* = 0.14, *max* = 1.96) were assessed during the original Pempek et al. (2011) study. The outcomes of interest are attention deficit symptoms as measured by the Disruptive Behavior Rating Scale (DBRS: *M* = 9.22, *SD* = 7.74, *min* = 0, *max* = 42) and children's executive functioning skills at age 6 to 9: working memory (WM *M* = 103.46, *SD* =14.65), cognitive flexibility (Dimensional Change Card Sort Task *M* = 104.90, *SD* =

16.97), and inhibition (Flanker task *M* = 97.39, *SD* = 11.59). Executive function scores are standardized with a mean of 100 and standard deviation of 15.

Results are presented in a series of steps (see Table 2 for the chart on the analytic approach). First, relevant covariates for each outcome variable were tested to assess whether it accounted for a significant amount of variability; if it did, then the covariate was kept in the model. Key control variables depended on the specific outcome variable, but analyses generally considered sex (dummy coded 0 = girls, 1 = boys), age (*M* = 7.57 years, *SD* = 0.74), WISC-IV Vocabulary[5] (*M* = 11.84, *SD* = 2.74), maternal education (a proxy for SES; *M* = 15.75 years, *SD* = 2.36), current media use at age 6 to 9 years (M = 3.95 hours per day, *SD* = 2.51), and parent-child interactions without television (PCI-No TV: *M* = 1.59, *SD* = 0.29, *min* = 0.33, *max* = 1.99). Parent-child interactions without television (PCI-No TV) was used to control for parenting differences in order to capture how television influences parent-child interactions above and beyond their typical interaction style.

Second, to examine whether early television exposure predicted later outcomes, the following models were tested to discern what aspect of television exposure was most influential:

*Y = bo + b1 * Viewing Alone + b2 * Total Coviewing with Parents + b3 * Percent of Total Viewing that Consists of Coviewing*[6]. This formula provides us with insight into whether effects are due to total television exposure (Viewing Alone + Total Coviewing)

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[5] WISC-IV Vocabulary is scaled with a mean of 10 and standard deviation of 3.

[6] If a parent-child interaction variable was used in the model, then the coviewing variable only considered the participating parent. If the PCI variable was not included, then total coviewing among either parent was used. In general, the results were similar or trended in the same direction regardless of which coviewing variable was used.

or aspects of the coviewing context (i.e., the total amount of coviewing versus the quality of viewing as assessed by the percent of viewing that is coviewing). The formula above was then used to probe whether content differences (FTV versus BTV) mattered:

*Y = bo + b1 * FTV Viewing Alone + b2 * FTV Coviewing + b3 * Percent of FTV Coviewing*

*Y = bo + b1 * BTV Viewing Alone + b2 * BTV Coviewing + b3 * Percent of BTV Coviewing.*

Third, the parent-child interaction in the presence of TV (PCI-TV) variable was included to test whether this variable mediated early infant television exposure's association with later cognitive outcomes. To examine the potential direct or indirect effects of coviewing television on EF outcomes, PROCESS, was employed, which is a software application for SPSS that estimates the indirect effect using bootstrap sampling (Hayes, 2013; Preacher, Rucker, & Hayes, 2007). In a mediation model, the independent variable is hypothesized to have causal effects on the mediating variable, which then influences the dependent variable. If mediation analysis was not an appropriate method, then multiple regression followed to investigate potential moderating effects of television exposure and parent-child interactions during infancy on later childhood cognitive outcomes.

Residual analyses were conducted to determine whether assumptions of ordinary least squares regression were met, and data were transformed if needed.

Missing Data

Due to the sample size ($N = 89$), missing data could be problematic. Multiple Imputation (MI), a common practice with longitudinal studies, was used to estimate missing data points. This technique generates values for missing data based on predictions by existing values in the dataset, which create unbiased parameter estimates and standard errors that can be analyzed by standard statistical packages (Schafer & Graham, 2002; Singaray, Stern & Russell, 2001). Ten imputed datasets were estimated to compute the pooled results (see Table 3 for a comparison of the original and imputed means and the N for each variable).

To test whether the missing data were at random or missing in a systematic way, Little's Missing Completely at Random Test was conducted and was found not to be significant (X^2 (90)= 0.00, p > .05) indicating that the data are not missing in a systematic way.

Because the imputed results did not drastically differ from the original results with missing data, only the latter are presented. Imputed results are only mentioned when there was a substantial difference in effects.

Attention Deficit

DBRS

The DBRS was used to investigate whether the current data replicate past research that has found an association between attention deficit symptoms and TV viewing. Higher scores on the DBRS indicate more attention problems (see Table 4 and 5 for correlation matrix of the DBRS scores, covariates, and predictors). Sex was the only covariate (dummy coded as 0 for girls and 1 for boys; $b = 3.74$, $SE = 1.62$, $r^2 = .06$, $p = .024$) that significantly accounted for variance in the DBRS score, indicating that on average boys scored 3.74 points higher on the DBRS. For television exposure, total coviewing was marginally significant ($b = -0.10$, $SE = 0.06$, $r^2 = .07$, $p = .096$).

Coviewing foreground television during infancy (*b* = -0.27, *SE* = 0.09, r^2 = .08, *p* = .004) yielded a significant and negative relationship with children's DBRS score; this was not true for coviewing background television (*b* = -0.03, *SE* = 0.08, r^2 = .001, *p* > .05). Thus, more coviewing of child-friendly's programs during infancy predicted fewer attention problems in middle childhood.

Mediation

A mediation analysis was conducted to investigate whether parent-child interactions mediated the relationship between coviewing foreground television during infancy and later attention deficit symptoms. There was no indirect effect found (Hayes, 2013, Model 4, using 10,000 bias corrected bootstrap samples, *b* = - 0.003, SE = 0.01, 95% CI [-0.04, 0.02]).

Moderation

To assess potential early effects of television viewing on later attention deficit-related outcomes, we examined whether parent-child interactions during infancy moderated television content's effects (PCI-TV, FTV coviewing, and the interaction terms) in relation to later attention deficit symptoms, controlling for children's sex. The amount of FTV coviewed negatively predicted DBRS scores in middle childhood (*b* = -.22, *SE* = 0.08, r^2 = .08, *p* = .005). The PCI-No TV x FTV interaction term was not significant.

The data were not normally distributed. Therefore, the outcome variable was transformed by squaring it to correct for normality; results remained the same (*b* = -0.05, *SE* = 0.014, r^2 = 0.11, *p* = .001). This transformed model accounted for 17% of the variance in the DBRS score.

In summary, parent-child interactions during infancy did not mediate the relationship between coviewing during infancy and later DBRS scores. That said, there was a negative relationship found between the amount of FTV coviewing and attention deficit symptoms, such that the amount of FTV viewed by the infants with their parents was associated with fewer reported attention problems later on.

Executive Functioning Skills

Principal Components Analysis

To reduce the potential of a Type 1 error, a principal component analysis (PCA) was conducted on the executive functioning variables to determine whether they could be combined to create a single and more parsimonious variable. PCA is an exploratory technique with no distributional assumptions and allows one to create the most efficient composite score(s) among a set of variables such that the maximum amount of variance can be explained by transforming the original variables into unique composite scores. The regression method was used to compute component scores.

The first, and only component, to reach an eigenvalue greater than 1, accounted for 46.58% of the variance (*Eigenvalue* = 1.40). The amount of variance in working memory explained by this factor solution was low ($r^2 = .22$) and therefore was not included in the composite variable. The second component (*Eigenvalue* = 0.93) largely consisted of working memory with a factor loading of 0.83, indicating that working memory could be a stand-alone variable. The PCA analysis was re-run with only DCCST and Flanker scores. The new composite variable for DCCST and flanker task accounted for 66.5% of the overall variance (*Eigenvalue* = 1.33) with both factor loadings equaling .82; this score was used to represent an inhibitory and cognitive flexibility factor.

Working Memory

Scores for working memory (WM) are fully adjusted for children's age, ethnicity, race, and parent income; higher scores are related to better performance on the working memory task. Child vocabulary (b = 1.73, SE = 0.56, r^2 = .11, p = .003) explained variability in working memory scores and was kept as the only covariate in the model (see Table 6 and 7 for correlation matrix for EF scores in relation to the control and predictor variables).

For television exposure, total coviewing explained a marginal amount of variance in working memory (b = -0.18, SE = 0.09, r^2 = .04, p = .053) and was negatively associated with working memory performance, controlling for child vocabulary. Neither the FTV coviewing nor the BTV coviewing formulas yielded anything of significance, but both trended in the same negative direction indicating that it was total coviewing that mattered.

Mediation

We tested whether parent-child interactions mediated the effects of coviewing television on children's working memory. There were no indirect effects of coviewing television on working memory through parent-child interactions (Hayes, 2013; Model 4, using 10,000 bias corrected bootstrap samples, b = - 0.0021, SE = 0.07, 95% CI [-0.053, 0.02].

Moderation

Controlling for child vocabulary, neither parent-child interactions nor the interaction term with total coviewing was significant.

In the final model, controlling for child vocabulary, for every hour of television coviewed, there was a marginal – 0.17 decrease (*SE* = 0.09, $r^2 = .04$, $p = .053$) in children's later working memory scores (the imputed dataset yielded similar results ($b = -0.17$, *SE* = .09, $p = .054$). The final model, including child language, accounted for about 13% of the variance in working memory, suggesting that, holding child language constant, the amount that parents and infants coviewed together was related to poorer working memory later on regardless of content.

<u>Cognitive Flexibility and Inhibition</u>

Neither any of the covariates nor any of the television variables were associated with the EF composite variable (see Table 6 and 7 for the correlation matrix among the EF composite score, covariates and predictors). No further analyses were conducted.

Summary

Early parent-child interaction did not mediate the effects of television, nor was it directly related to children's attention and executive functioning skills later on. In contrast to past research, the DBRS was negatively related to the amount of FTV coviewed with parents during infancy; that is, greater amount of FTV coviewed was related to fewer attention deficit symptoms. In addition, poorer working memory was related to greater amounts of coviewing television regardless of content.

Research Question 2: Is there a relationship between early television viewing during infancy and later academic achievement? Is this relationship mediated by working memory?

It is hypothesized that early infant television exposure has a negative relationship with later academic achievement. However, we posit that working memory mediates this early TV exposure-academic achievement link, such that infant TV exposure has a negative relationship with working memory, which in turn, negatively influences later academic skills (see Figure 2).

Analytic Approach

Television exposure has been linked to poorer working memory and academic outcomes (e.g. Armstrong & Sopory, 1997; Hancox, Milne, & Poulton, 2005). This relationship between TV and academic skills is often qualified by differences in program content, such that quality educational programming is related to more positive outcomes than general entertainment television among preschool-aged children and older (e.g., Wright et al., 2001). The current set of analyses examined whether this relationship holds for early infant television viewing with later academic outcomes. In the analyses described above, we found that the amount of early coviewing influenced children's working memory at age 6 to 9 years of age. Given this, we therefore asked whether the TV-school link was mediated by children's working memory (see Figure 2 and Table 8 and 9 for correlations among academic outcomes, working memory, and TV factors). That is, the hypothesis was tested that early television exposure disrupts the development of working memory, which in turn affects, children's academic skill.

The scores for Story Recall (*M* = 92.94, *SD* = 3.52), Passage Comprehension (*M* = 83.95, *SD* = 18.84), Math Fluency (*M* = 90.05 *SD* = 4.09), and Academic Knowledge (*M* = 92.11, *SD* = 7.34) are normed by age and represent the relative proficiency (RPI) of the child, which is used as a diagnostic tool to assess children's academic level. Specifically, the RPI score represents the success rate of that particular child on a task compared to her average peer group when they would achieve a 90% success rate. For context, a score of 92 to 95 out 90 is about average or age appropriate.

Similar to the previous EF analytical approach, we analyzed the data with and without the imputed data. The original data is reported unless there was a significant discrepancy with the imputed dataset. For each analysis, a control model [sex, child IQ[7] (*M* = 10.72, *SD* = 2.10), mother's education level, and current media use] was built for each academic outcome variable and only those variables that accounted for a significant amount of variability were kept. The same three step approach (step 1 covariates entered, step 2 mediator entered, step 3 TV exposure variables entered, see Table 2) was used for this analysis.

Academic Skills

WJ-III Story Recall

Sex (dummy coded 0 for girls: b = -3.08, SE = 0.67, r^2 = .13, p < .001) and mother's education (b = 0.34, SE = 0.14, r^2 = .07, p = .02) were significant predictors of story recall. For television exposure, both the amount of background television coviewed during infancy (b = -0.10, SE = 0.03, r^2 = .07, p = .003) and foreground television

[7] Child IQ is the average of the WISC-IV scaled scores for block design and vocabulary. Both are scaled with a mean 10 and standard deviation of 3.

coviewed (*b* = -0.09, *SE* = .04, r^2 = .03, *p* = .032) predicted less story recall; therefore total amount of coviewing was used (*b* = -0.06, *SE* = 0.02, r^2 = .09, *p* = .003), indicating that there was a small and negative effect of early TV coviewing on story recall.

Working memory did not mediate the TV-academic relationship (Hayes, 2013, Model 4, using 10,000 bias corrected bootstrap samples, *b* = - 0.007, SE = 0.005, 95% CI [-0.02, 0.005]). In addition, working memory did not moderate the relationship between infant TV viewing and story recall (*b* = -0.02, *SE* = 0.04, r^2 = .003, *p* = .60).

Residual analyses showed that the assumption of normality was violated and the data were transformed by raising the outcome to the 5th power; the transformed findings were comparable to the reported results. In addition, the imputed results were similar.

WJ-III Passage Comprehension

Mother's Education (*b* = 2.71, *SE* = 0.80, r^2 = .10, *p* = .001) and IQ[8] (*b* = 2.10, *SE* = 0.91, r^2 = .081, *p* = .024) were found to be significant covariates for passage comprehension. For television, what mattered most was the percent of television exposure that was coviewed together which yielded a marginally significant result (*b* = -17.29, *SE* = 9.16 r^2 = .03, *p* = .063). The assumption of normality was violated and was therefore transformed by raising the outcome to the 6th power; the results remained the same.

There was no indirect effect of percent of coviewing through working memory (Hayes, 2013, Model 4, using 10,000 bias corrected bootstrap samples, *b* = - 14.41, *SE* =

[8] The analysis was conducted without IQ and the results were similar.

8.078, 95% CI [-12.61, 2.89]), nor did it moderate the relationship between percent of television coviewed and passage comprehension (*b* = 0.14, *SE* = 0.11, r^2 = .02, *p* = .20).

WJ-III Math Fluency

None of the early television exposure variables predicted children's later math scores nor was there an indirect effect or moderating effect of working memory mediate any early effects.

WJ-III Academic Knowledge

Sex (dummy coded 0 for girls: *b* = -6.051, *SE* = 1.33, r^2 = .08, *p* <. 001), mother's education (*b* = 1.11, *SE* = .36, r^2 = .15 , *p* < .001), and child IQ[4] (*b* = 1.16 , *SE* = .31, r^2 = .11 , *p* <.001), were included as control variables and accounted for 34% of the variability in children's academic knowledge at age 6 to 9 years of age. The total amount of early background television coviewing negatively predicted children's academic knowledge (*b* = -0.14, *SE* = .05, r^2 = .05, *p* = .012). This was not true for early foreground exposure (*b* = -0.03, *SE* = .08, r^2 = .00, *p* = .67). The outcome was transformed by cubing it to meet the assumption of normality; results were unchanged.

Again, working memory did not mediate this relationship (Hayes, 2013, Model 4, using 10,000 bias corrected bootstrap samples, *b* = - 0.008, SE = 0.015, 95% CI [-0.064, 0.008]), nor did it moderate the relationship (*b* = 2.06, *SE* = 2.35, r^2 = .01, *p* = .38)

Summary

Working memory did not mediate the relationship between early television exposure and later academic achievement. However, there were direct relationships between academic scores and the content and context of TV exposure. Specifically, the amount of general coviewing was related to poorer story recall, the amount of background television coviewing predicted less academic knowledge, and the percent of TV time that was coviewed was related to poorer passage comprehension.

Research Question 3: Is there an association between early infant television exposure on children's later linguistic abilities at age 6 to 9 years of age? Is it mediated by parent language during infancy?

It is hypothesized that the amount of overall infant television exposure will be negatively associated with children's later language abilities, and that parent language during infancy will mediate this relationship, such that early infant television exposure will have a negative relationship with parent language, which in turn, will negatively influence children's later language skills.

Analytic Approach

In this section, the relationship among early infant television exposure, parent's language during infancy, and children's later language abilities at age 6 to 9 was investigated. First, a set of control variables was assessed. The covariates included age[9], sex, mother's education, and current media use. For the child language quantity and quality variables, the percent of attention to Bill Nye (M = 78.54, SD = 25.29) was also considered as a covariate because the amount of attention paid to the show would affect children's ability to answer the open-ended question, on which these two language variables are based. Next, parent language factors were entered into the model. Then, infant television exposure variables were evaluated, using the same approach as mentioned previously, to narrow down which aspect of television matters. Finally, the relevant parent language by television exposure interaction terms were entered.

[9] Age was only tested as a potential covariate for children's language quality and child quantity variables; the other language outcomes variables are adjusted for children's age.

Predictors were only retained if they accounted for significant variability in the outcome variable. Outcomes of interest included children's variables related to language production (vocabulary, language quality, and language quality) and receptive language skills (story recall and passage comprehension).

Again, multiple imputation was conducted (see Table 10 for a comparison of the means between the original and imputed dataset); the non-imputed data is reported unless there were discrepancies between the original and imputed dataset.

Principle Component Analysis (PCA)

To reduce the number of predictors used, PCA was conducted separately for child and parent language variables that included total words, total utterances, new words, mean length of utterances, and new words per utterance (see Table 11 and 12 for child and parent language variable correlation matrices). For each component derived from PCA, a score based on the regression method was computed for each participant and used in the analysis. The scores are scaled for a *Mean* = 0 and a *SD*= 1.

Child Language

For the five child language variables (see Table 16 for descriptive statistics), taken from the free recall of the *Bill Nye* TV excerpt, 96% of the variance was accounted for by two components. The first component, with an *eigenvalue* of 3.01, accounted for 60% of the original variance, while the second component had an eigenvalue of 1.81. Total words, utterances, and new words loaded onto the first component with correlations of .99, .97, and .97 respectively; this component signifies a child language quantity composite score. New words per utterance and MLU loaded onto the second component with correlations of .94 each; this component indicates a child quality of language composite score.

Parent Language

For parents, there were 15 language variables that were included in this principle component analysis (words per minute, utterances per minute, new words per minute, new words per utterance, and MLU for the No TV session, TV session, and post TV session). There were 3 components with eigenvalues greater than 1 (Component 1 = 6.45 accounting for 42.97% of the original variance, Component 2 = 4.26 with 28.38% of the original variance, and Component 3 = 1.62 with 10.81% of the original variance). The parent language variables that loaded onto the three components reflected a No-TV parent language *quality* variable, a No-TV parent language *quantity* variable, and a TV parent language *quantity* variable.

Child Language Quantity

Age significantly accounted for 6% of the variance in child language quantity (b = 0.33, SE = 0.15, r^2 = .06, p = .027). Parent language during infancy factors did not predict this outcome variable. For the television exposure variables, the amount of coviewing foreground television was positively associated with children's language quantity (b = 0.03, SE = .01, r^2 = .07, p = .02). However, one outlier drove this finding and, after removing the outlier, the results were no longer significant. Examining the imputed data confirmed this null finding with and without the outlier. It should be noted that the samples of child language based on the free recall protocol were very limited and so the null finding is of relatively little impact given prior research showing the importance of parent language directed at children during toddler years.

Parent Mediation/Moderation

There was no evidence of parent language during infancy mediating or moderating the relationship between infant TV exposure and child language quantity.

Child Language Quality

None of the potential control variables or any of the television exposure variables accounted for a significant amount of variability in the quality of children's language. However, the quantity of parent language during infancy positively predicted children's later language quality ($b = 0.35$, $SE = 0.11$, $r^2 = .12$, $p = .003$). For the imputed results, this effect was marginal ($b = 0.25$, $SE = 0.13$, $p = .066$). Again, it should be noted that estimates of child language quality were based on limited samples of language based on the Bill Nye recall protocol.

Parent Mediation/Moderation

There was no evidence of parent language during infancy mediating or moderating the relationship between infant TV exposure and child language quantity.

Child WISC Vocabulary

Mothers' level of education ($b = 0.27$, $SE = 0.12$, $r^2 = .044$, $p = .029$) and parent-child interactions (no TV; $b = 2.00$, $SE = 0.96$, $r^2 = .045$, $p = .040$) accounted for 9% of the variance in children's vocabulary scores and were used as control variables. Neither of the parent language during infancy variables predicted child vocabulary.

The percent of TV time that was coviewed during infancy negatively predicted children's vocabulary scores ($b = -2.74$, $SE = 1.16$, $r^2 = .059$, $p = .021$). For every percent unit increase in time spent viewing was coviewed, children's vocabulary scores decreased by 2.74 points.

Parent Mediation/Moderation

There was no evidence of parent language during infancy mediating or moderating the relationship between infant TV exposure and child language quantity.

WJ-III Story Recall[10]

Sex (dummy coded girls = 0; *b* = -3.02, *SE* = 0.72, r^2 = .13, *p* <.001) and mother's education (*b* = 0.31, *SE* = 0.15, r^2 = .07, *p* = .044) explained 20% of the variability in story recall. The quantity of parent language during infancy positively predicted children's recall scores (*b* = 0.75, *SE* = 0.36, r^2 = .07, *p* = .04), while the reverse was true for the total number of hours spent coviewing during infancy (*b* = -0.05, *SE* = .02, r^2 = .06 , *p* = .018). The data were not normally distributed and was transformed by raising the outcome to the 5th power. Findings were the same using this transformations and also when examining the imputed data.

Parent Mediation/Moderation

There was no evidence of parent language during infancy mediating or moderating the relationship between infant TV exposure and child language quantity.

WJ-III Passage Comprehension[3]

Mother's education (*b* = 2.67, *SE* = 0.84, r^2 = .10, *p* = .002) and Child IQ (*b* = 2.18, *SE* = 0.97, r^2 = .08, *p* = .028) were the only control variables included. The percent of infant TV exposure that was coviewed was negatively related with children's later passage comprehension scores (*b* = -14.43, *SE* = 8.38, r^2 = .025, *p* = .009). Parent language quantity was positively related to children's passage comprehension scores (*b* = 16.00, *SE* = 5.99, r^2 = .001, *p* = .009). This relationship was qualified by a percent of

[10] Controlling for IQ produced similar patterns of results.

coviewing TV exposure by parent language quantity interactions (b = -23.44, SE = 8.51, r^2 = .08, p = .008) (see Figure 3).

Residual analysis showed that the assumption of normality was violated so the outcome was transformed by cubing it. With this transformation, the interaction became marginal (p = .064), and with the imputed data, it was no longer significant. The most parsimonious model that converged across transformations[11] and imputation left the two control variables, Mother's Education (b = 2.71, SE = 0.80, r^2 = .10, p = .001) and IQ[12] (b = 2.10, SE = 0.91, r^2 = .081, p = .024), and the percent of TV coviewed remained significant (b = -17.29, SE = 9.16 r^2 = .03, p = .063).

Parent Mediation/Moderation

There was no evidence of mediation or moderation by parent language during infancy.

Summary

In terms of infant television exposure, content did not seem to matter for children's language development insofar as similar effects were found for child-directed and adult content. What did matter was the time spent coviewing for children's vocabulary, story recall, and passage comprehension, such that there was a negative relationship between coviewing during TV exposure and the outcome variables. Parent language quality was positively related to children's language quality, whereas parent language quantity was predictive of story recall (see Table 17 for a summary of findings).

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[11] Transformed the outcome by raising it the 6th power to achieve normality in the final model.

[12] The analysis was conducted without IQ and the results were similar.

<u>Research Question 4: Does early infant television coviewing influence children's later TV comprehension? Is this relationship mediated by parent-child interactions while viewing?</u>

It is hypothesized that the number of hours coviewing foreground television exposure during infancy will positively predict children's later TV comprehension skills, and that the quantity of parent-infant interactions (PCI) while coviewing foreground television exposure will mediate this relationship.

Analytic Approach

The following analysis investigated how early infant television coviewing is associated with later TV comprehension skills. It is posited that early active parental coviewing, where the parent models and guides the infant through the viewing experience will be internalized over time. Through experience with parent questioning, labeling, pointing, etc., it is hypothesized that the child creates an active cognitive approach to watching television, resulting in better retention and recall of information gleaned from the television as the child gets older.

Covariates for this analysis included child age, sex, mother's education, current media use, IQ, and the amount of attention paid to the Bill Nye segment. The amount of television coviewed during infancy was the main predictor of interest, but also of importance was whether general exposure was associated with comprehension using the equations in the prior analyses. The main predictors were the amount of parent-child interaction while viewing FTV during infancy and the infant television exposure variables. The outcomes were based on children's comprehension scores after watching a segment of *Billy Nye the Science Guy*. The comprehension questions were combined based on the type of question and divided into three different categories: facts (e.g., name 3 parts of a finger print), inference (e.g., how do forensics scientist solve mysteries?), and process-based questions (e.g., how did she find out who drank her soda?). Within each category, the total correct was used as the outcome (see Table 18 for descriptive statistics and Table 19 and 20 for correlation matrices of the outcomes versus the covariates and predictors).

Fact-based Questions

For fact-based questions, age ($b = 0.60$, $SE = 0.15$, $r^2 = .14$, $p < .001$) and IQ ($b = 0.20$, $SE = 0.05$, $r^2 = .13$, $p < .001$) were significant predictors of the number of recalled facts. The amount of PCI while coviewing during infancy positively predicted ($b = 0.55$, $SE = 0.27$, $r^2 = .04$, $p = .045$) the number of fact-based correct answers, but hours of television viewed during infancy was not a significant predictor. However, for the imputed data, only the relationship between current age and the number of correct answers later on was significant ($b = 0.60$, $SE = 0.15$, $p < .001$). PCI-TV during infancy, was not a significant predictor ($b = 0.44$, $SE = 0.29$, $p = .14$). There were no mediating or moderating affects of early parent-child interactions while coviewing on children's later comprehension.

Inference-based Questions

For inference-based questions, mother's education ($b = 0.14$, $SE = 0.07$, $r^2 = .06$, $p = .032$) was the only significant covariate. The total number of hours of TV viewed alone during infancy ($b = 0.03$, $SE = 0.02$, $r^2 = .04$, $p = .079$) marginally predicted the outcome, but appeared to be mainly driven by total FTV viewed alone during infancy (*b*

= 0.05, *SE* = 0.03, r^2 = .04, *p* = .076). A similar relationship was found for the imputed data: only mother's education (*b* = 0.15, *SE* = 0.06, *p* = .024) significantly predicated the number of inference-based questions correctly answered, and total FTV viewed alone (*b* = 0.05, *SE* = 0.03, *p* = 0.08) had a marginally positive relationship. Again, parent-infant interactions while viewing did not have a mediating or moderating effect.

Process-based Questions

For process-based questions, age (*b* = 0.73, *SE* = 0.22, r^2 = 0.09, *p* = .001) and sex (*b* = -0.98, *SE* = 0.32, r^2 = 0.09, *p* = 0.003) were the only significant predictors, and the percent of infant FTV coviewed was marginally significant (*b* = -0.91, *SE* = 0.49, r^2 = 0.03, *p* = .065). The residuals were not normally distributed so the outcome was squared to meet the assumption. With this transformation, the percent of infant FTV coviewed was no longer marginally significant. There were no mediating or moderating effects of parent-infant interactions while viewing.

Summary

We assessed how early coviewing influenced children's later comprehension, but found little evidence for such a relationship. However, due to the small sample, power is an issue; post-hoc power ranged from 0.41 to 0.53.

CHAPTER IV

DISCUSSION

Over the past decade, correlation-based studies indicated that the earlier children are exposed to television, the worse is their cognitive and language outcomes later on. Experimental studies have corroborated these findings by demonstrating that the presence of television reduces parent-child interactions, parent language, children's play behaviors, and attention (Courage, Murphy, Goulding, & Setliff, 2010; Pempek et al., 2011; Schmidt et al., 2008; Setliff & Courage, 2011). This dissertation study is the first to investigate a potential mechanism through which television exerts its effects on children, by examining whether early parent-child interactions mediate these relationships. Unlike past longitudinal research that have examined TV effects based on surveys of parents, this study uses rich assessments of television exposure as well as observations of parents and children.

Early social interactions between parents and children are crucial in fostering children's cognitive development (Vygotsky, 1978). Through high quality social interactions, caregivers actively support infants' burgeoning cognitive abilities through scaffolding, and over time, children internalize these lessons and can perform these functions independently. Accordingly, any factor, such as television, that can disrupt parents' engagement with their children during infancy has the potential to cast an indirect influence on children's development. Following this logic, the current study investigated whether television exposure during infancy influenced children's later attention and executive functioning skills, academic abilities, and language outcomes and whether this influence was mediated by the quality of parent engagement.

The results from this dissertation study indicate that coviewing television during infancy has a direct negative association with children's executive function skills, academic achievement, and language during middle childhood, such that the more children coviewed with their parents during infancy, the more likely they were to exhibit poorer working memory, academic performance, and language skills. Contrary to the proposed hypotheses, parent-child interactions or parent language did not mediate this relationship.

No indirect effects

There are a couple of plausible explanations for why we did not find an indirect effect of television. First, it could be that the hypotheses were wrong and that parent-child interactions and parent language, do not, in fact, mediate television's effect on children. That is, television may *directly* influence children's development over time. Regarding children's attention and executive functioning skills, the *scan-and-shift* hypothesis suggests that the fast-paced nature of television programs—with its rapid cuts and editing techniques, constant character and scenes changes, etc.—influences the neural wiring during early brain development and engenders an attentional style that continually seeks out stimulation (Jensen et al., 1997 as cited in Nikkelen, Valkenburg, Huisinga, & Bushman, 2014). Christakis and colleagues (2012) have tested this hypothesis with mice by immersing 10-day old "infant" mice in an environment that was auditorily and visually stimulating (simulating the experience of television) for 6 hours each day for 42 days. They found that the 'media enriched' mice exhibited more attention-deficit related symptoms, such as risk taking and hyperactivity, relative to a group of control rats that did not receive such stimulation. In addition, other research assessing children's language skills indicates that when the television is on, it reduces children's language-related behaviors, such as self-directed speech and social behaviors (Kirkorian et al., 2009), and it also reduces children's ability to hear language in general (Neuman, 2005 as cited in Schaffer & Kipp, 2010) and their ability to focus their attention (Schmidt et al., 2008).

Another possible explanation could be that although parents were less engaged and talkative to children while TV was on in the laboratory, these parent measures did not indicate that individual differences in the degree to which this happened mediated or directly influenced children's outcomes. Because TV's reduction in these behaviors is a large effect on nearly every parent-infant dyad (Anderson & Hanson, 2017), individual differences may not be as important as the general impact of TV in suppressing parent-infant interactions.

Alternatively, our measure of parent-child interactions during infancy may not have been the best way to operationalize such a construct. This measure was a result of collapsing across four unique parenting engagement styles (active, passive, monitoring, not interacting). This method was used to be consistent with how our laboratory has conceptualized parent-child interactions in the past. However, it could be that some important nuances of parents' behavior were washed out by the statistical noise carried out by the other behaviors.

Attention and Executive Functioning Outcomes

DBRS

It should be noted that this is the only 'beneficial' finding that was found for early television exposure in this dissertation study. In contrast to other studies that have found a positive relationship between television viewing and children's attention deficit symptoms (i.e., the more TV exposure, the more ADHD symptoms; Christakis et al., 2004; Johnson, Cohen, Kasen & Brook, 2007; Landhuis & Poulton, 2007), the opposite result was found in our study indicating that the more parents and children coviewed foreground television (FTV), the less likely children were to exhibit attention deficit related symptoms as measured by the DBRS. This indicates that for each hour of FTV coviewed, there was a -.22 point decrease in children's DBRS scores.

One reason for this discrepancy with past research could be that prior studies tend to examine total television exposure and do not take into account potential content or context differences. In the current study, total television exposure did not predict DBRS scores, as past research would suggest; rather it was coviewing and FTV that mattered. This finding could indicate that those parents who tend to coview FTV more with their infants may help their infants focus their attention to relevant content and help them navigate between viewing and engaging in other activities. Or, it could alternatively mean that parents with children with fewer attention problems are more likely to coview FTV during infancy as an enjoyable activity. The latter interpretation assumes that attention deficit symptoms measured during the early school-age years may also have been present during infancy; research suggests there are markers in infancy to support this interpretation (e.g., Gurevitz, Geva, Varon, & Leitner, 2014). However, because the design is correlational we cannot infer the direction of causality.

Inhibition and Cognitive Flexibility

Surprisingly, early infant television viewing was not predictive of the composite measure of inhibitory control (flanker task) and cognitive flexibility (dimensional change card sort task) as past research has suggested. Upon further examination of the research, it was found that inhibitory control and cognitive flexibility as measured by tasks like the Dimensional Change Card Sort Task used in the current study (e.g, Wisconsin Card Sort Task), have a weak association with ADHD symptoms, whereas, working memory has a much stronger and more reliable relationship (Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010; Willcutt, Doyle, Nigg, Faroane, & Pennington, 2005).

The length of time between television exposure and EF testing, as well as age-related differences between the current study and previous studies, could also account for discrepancies in results. In the current study, infant television exposure was assessed at 1 year of age and their EF skills were obtained about 6 years later. In other studies that assess actual child behavior, the duration of time ranges from only a couple of years to no gap in time. For example, Lillard and colleagues (2011, 2015) assessed the immediate effects of specific TV shows that varied on pacing (e.g., Spongebob versus Martha Speaks) with 4-year-old children using an EF composite score consisting of a head-toes-knees-shoulders task, tower of Hanoi, and an audio working memory task, and separately by a delay of gratification task. One of the most noticeable differences between this study and the current dissertation study is that testing occurred as soon as the TV program ended. It could be that television's effects on inhibition and cognitive flexibility are short lived. Or, it could be that with development, as EF skills become more consolidated, there is less variability over time (Miyake & Friedman, 2012).

Lastly, differences in findings could be due to the fact that there is no lasting effect of infant television viewing on children's inhibitory ability and cognitive flexibility. Anderson et al. (1977) investigated the pacing issue by editing the same episode *of Sesame Street* into a fast-paced or slow version, and they did not find any differences among 4 year olds on measures of impulsivity or task persistence. This approach is more convincing than Lillard et al.'s (2011, 2015) study because it uses the same program but manipulates the pacing, whereas Lillard uses different programs that, while they differ in pacing, they differ on things other than pacing.

Working Memory

The current study found that the amount of parent and infant coviewing is negatively associated with children's later working memory, regardless of content. This cognitive skill may be particularly vulnerable to television's effects due to the form of television. As Lang et al. (2013 as cited in Lillard et al., 2015) noted, television comprehension requires processing on two levels: the formal features of the program (i.e., the way the information is conveyed through production techniques) as well as the narrative. Therefore, the more complicated the form (e.g., new characters, new objects added to a scene, more cuts, etc.), the fewer resources available to process the message. Research has demonstrated that the more cuts and edits in a video montage, the more gaze shifts, which signals more piecemeal, bottom up processing. Aligned with this reasoning, Lillard and colleagues (2015) posit that the fantastical and fast-paced nature of some television programs increase working memory demands and potential for cognitive overload, which can ultimately lead to a depletion of children's EF abilities. With each scene change or appearance of a novel person or object, children must process this new information, while trying to piece together the narrative. Over time, television exposure, and possibly the cognitive overload it causes, could lead to the atypical development of working memory.

Moreover, this effect could be exacerbated by the amount of time that children coview with their parents because it displaces time that is spent without the television on. Research has shown that parents are distracted and less responsive to children in the presence of television (Schmidt et al., 2008); as parents and children watch more television together, parents may not be providing the necessary support children's working memory requires to develop properly in the face of over stimulation.

Lastly, television's presence could influence children's working memory abilities even if they are not watching, but it is on in the background. Infants show difficulty learning with just music playing in the background (Barr, Shuck Salerno, Atkinson, & Linebarger, 2010). Television could potentially be more disruptive than radio because it has both an audio and visual component. Even among adults, background television interferes with adults' working memory (Armstrong, Bolarsky, & Mares, 1991). In one study for example, undergrads were randomly assigned to read a science article in the presence or absence of background television. The researchers found that recall of the material was reduced if the television was on, suggesting that its presence interfered with processing the material.

Taken together, we can speculate that, in general, television exposure negatively affects children's working memory and interferes with parents ability to help their children; therefore, the more they coview together, the more likely that children's working memory will be affected.

Academic skills

Television exposure has been linked to poorer academic achievement among school-age children (e.g., Borzekowski & Robinson, 2005; Fetler, 1985; Hancox, Milne,

& Poulton, 2005; Neumann, 1988), and more recently, this finding has been extended to children under 3 years of age. Early infant television viewing, for instance, has been associated with poorer math skills and reading recognition and comprehension later on (Pagani, Fitzpatrick, Barnett, & Dubow, 2010; Zimmerman & Christakis, 2005). Historically, researchers posit that this link is due to the displacement of reading and other important school-enhancing activities. However, more recent studies indicate that early TV exposure directly effects children's cognitive development, such as the development of working memory, which in turn influences later academic outcomes (Zimmerman & Christakis, 2005; Lillard et al., 2015). Working memory has been linked to academic achievement in math (e.g., Bull & Scerif, 2001) and reading comprehension (e.g., Cain, Oakhill, & Bryant, 2004). Given that the presence of television influences even adults' working memory abilities (e.g., Armstrong et al., 2001), it could be that the link between TV exposure and academic skills is mediated by working memory, such that early TV exposure during infancy negatively influences the development of children's working memory, which in turn affects later academic outcomes.

In the current study, parent and infant coviewing negatively predicted working memory ($r = -.22$, $p < .05$), story recall ($r = -.26$, $p < .05$), and Academic Knowledge ($r = -.23$, $p < .05$). Working memory positively predicted all of the academic outcomes (Story Recall $r = .29$, $p < .05$, Passage Comprehension $r = .45$, $p < .05$, Math Fluency $r = .22$, $p < .05$, and Academic Knowledge $r = .34$, $p < .05$). However, working memory did not mediate the relationship between early television exposure and later academic achievement. Instead, the overall amount of coviewing was related to poorer story recall, the amount of background television coviewing predicted less academic knowledge, and the percent of TV time that was coviewed was marginally related to poorer passage comprehension.

Because the amount of television viewing without the parent (i.e., viewing TV alone) was not significantly related to academic outcomes, it indicates that these associations may not be due to the direct effects of watching television as the *scan and shift hypothesis* suggests. Rather, results imply that it could be a displacement issue while coviewing television. For this study, what parents and children are doing while they are coviewing in the home is not clear. It could be that parents and children are just in the same room while the television is on, and not actively viewing together, as is suggested by the fact that total coviewing includes adult programs (i.e., BTV coviewing), which the adult is presumably watching. Thus, the more parents and children coview, the less likely they are to engage in quality interactions outside of television.

Child Language

There has been a persistent link in the literature that associates infant television viewing with language deficits. It was hypothesized that television exposure during infancy would reduce parent language, which in turn, would influence later child language outcomes. Although we did not find any mediating effects of parent language on the relationship between early television exposure and children's later language skills, there was evidence of a direct effect of early TV viewing.

The quantity, but not quality, of parent language during infancy positively predicted children's later language quality, vocabulary, and story recall. That is, the amount that parents spoke to their infants (when the television was not on) was associated with a greater vocabulary, more complex language, and better story recall at age 6 to 9.

Thus, it appears that the sheer amount of verbal input matters more during infancy rather than hearing relatively complex language. This corroborates past research on children's language development (Hart & Risley, 1995; Hoff & Naigles, 2002). Hoff and Naigles (2002) found that the total number of words and number of different words heard predicted children's lexical production. Weisleder and Fernald (2013) found that child-directed speech, and not just overheard speech, was positively associated with children's expressive vocabulary. This effect was mediated by infant language processing efficiency, suggesting that the amount of child-directed speech heard increased children's ability to process language, which in turn influenced their vocabulary skills. Overall, it appears that young children with talkative parents have more opportunities to hear spoken language and are therefore more linguistically advanced. Complexity and quality of language may matter once infants have acquired a substantial vocabulary to map onto (Rowe, 2012).

In this dissertation study, school-age children's language quality and quantity were not associated with television exposure during infancy. This most likely is due to the speech sample used in the study created by transcribing children's response to the following question, "What happened on the show (Bill Nye)?".

A direct negative relationship was found between coviewing television and children's scores on the standardized language measures for vocabulary and story recall. That is, the current study found that what mattered most was context (i.e., coviewing during infancy). For children's vocabulary knowledge, the effect of the percent of time coviewing was quite large (*b* = -2.74) [13], whereas for story recall, the amount of time spent coviewing was small (*b* = -.05) [14].

Interestingly, the amount that parents talked to their children while the TV was on, did not significantly predict any child language outcomes as hypothesized. This most likely is due to the fact that across parents, there was a general reduction in how much the parents spoke in the presence of television; this reduction was related to how attentive parents' were to the television program (Lavigne et al., 2015). Given the finding that parents' talkativeness (with No TV) was most predictive of children's language outcomes, one explanation for this relationship between infant television coviewing and children's poorer language outcomes is that the more parents and children watch together, the less time they spend interacting without the television on. Thus, the more time spent coviewing together, the fewer words children hear from their parent. With television, infants and parents are less engaged and attentive to each other (Kirkorian et al., 2009), which may result in poorer quality language interactions. For example, Zimmerman et al. (2009) found that it was not television exposure per se, but how television exposure influenced adult-child conversational turn taking that influenced language outcomes.

Prior studies corroborate the finding that early television viewing under the age of 2 years is associated with poorer language outcomes (e.g., Zimmerman, Christakis, & Meltzoff, 2007; Linebarger & Walker, 2006; Chonchaiya & Pruksananonda, 2008). For

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[13] WISC Vocabulary: *M* = 10, *SD* = 3.

[14] The RPI score represents the success rate of that particular child on a task compared to her average peer group when they would achieve a 90% success rate. For context, a score of 92 to 95 out 90 is about average or age appropriate.

example, Chonchaiya and Pruksananonda's (2008) study revealed that children with language delays were more likely to watch television earlier and watch more television than a control group of children. Specifically, they found that if children began watching television earlier than 12 months and for more than 2 hours per day, the children were 6 times more likely to have language delays.

Other studies have shown that this relationship between early infant viewing and language outcomes is moderated by content; this, however, was not found in the current study. Linebarger and Walker (2005) used viewing diaries at 3-month intervals from 6 months to 30 months to examine the relationship between early television exposure and language outcomes. Programs, such as *Dora the Explorer*, were positively associated with greater vocabulary and expressive language, whereas, other programs, such as *Teletubbies,* were negatively associated with vocabulary and expressive language. One reason for this discrepancy with past studies may be due to age differences of participants. In the current dissertation study, the age ranged from 12 to 21 months, a developmental point at which children cannot comprehend much from television, and therefore, most of television can be considered background television. Prior studies had age ranges that extended well beyond our age range, and into the realm of time when television becomes comprehensible to children and therefore are more likely to learn words from programs. In addition, most of the other studies do not consider coviewing. We found that television content did not matter per se, but the total amount and context of coviewing did.

Comprehension of *Bill Nye the Science Guy*

Since very young children lack the cognitive skills and experience necessary for using media, it was posited that parents scaffold media experience, helping their children to comprehend and learn. Barr and colleagues (Barr, Zack, Garcia, & Muentener, 2008; Fidler, Zack, & Barr, 2010; Barr & Wyss, 2008) found that parents who scaffolded their infants' television viewing experience by asking questions and commenting, had children who were more likely to pay attention and interact with the program. Over time, it was speculated that children would internalize these interactions and engender a cognitively active viewing approach to television. This would lead to better narrative comprehension. Consequently, it was hypothesized that early television viewing with parents would predict better television comprehension at 6 to 9 years of age.

However, in this analysis of children's television comprehension, there were no significant relationships found between the amount of coviewing during infancy or parent engagement while viewing television and children's later comprehension outcomes. Although there were some marginal relationships found in the data, once the imputed data was considered, only the control variables remained significant. One of the main reasons for these findings may be due to statistical power. A post hoc power analysis indicated that these findings had low power, which ranged from 0.41 to 0.53.

Conclusion

Overall, a negative relationship was found between television coviewing during infancy and later cognitive outcomes during middle childhood including working memory, story recall, passage comprehension, academic knowledge, and vocabulary. These associations indicate that the more time children and parents spend in front of the television, the poorer children fared cognitively. These relationships, by and large, did not apply to total amount of television exposure, per se. This is a twist on conventional wisdom that emphasizes the benefits of coviewing television for children.

Assessment of the quality of parent-child interactions and parent language in the presence of television did not mediate or moderate any child outcomes. Although parent-infant interactions and language were reduced because of television (Lavigne et al., 2015; Pempek et al., 2011), the actual behaviors while viewing in the laboratory were not predictive of later child outcomes. Thus, the mechanism by which infant television viewing exerts its effects on children's cognitive development remains unclear. The current study, however, offers a clue—that it has something to do with the amount of time spent coviewing. It appears that this association is driven by the sheer amount of time spent coviewing rather than the overall amount of time spent with television. This suggests that the effects are not due to actually watching television as the *scan-and-shift* hypothesis suggests. Rather, the time spent coviewing during infancy displaces time spent with the parent outside of the television context. This is especially true in our study given the age of the participants (12 months to 21 months) since these young children at home were most likely with or very near their parents most of the time (i.e., not by themselves playing in a different room as an older child may be allowed to do).

What is the takeaway message for parents?

Be mindful of media use in the home. Turn off the TV, especially if no one is watching. Although there are benefits of coviewing television for preschool-aged children and older, there is no research to show that these benefits extend to infants and toddlers. With very young children, quality time is best spent with the television turned off and spending time together or engaging with media known to have substantial benefits for children, such as reading (Alloway, Williams, Jones, & Cochrane, 2014; Robb, Reichert, & Wartella, 2009).

Limitations

One of the main limitations of this study is the small sample size. When the original Pempek et al. (2011) study was carried out, a follow up study was not a consideration; therefore, we lost touch with many of the families. The sample size limited not only statistical power to detect some effects as previously mentioned, but also the kinds of questions that could be asked. For example, a more complete model in most of the analyses would consider both background and foreground effects together. However, such an analysis was not possible due to issues of overfitting. When a regression model is overfitted, results may be due to the idiosyncratic nature of the data set and will therefore fail to be replicated because it is not representative of the true population (Babyak, 2004).

Another limitation of this study is that it is correlational in nature, and therefore we cannot infer a causal connection between early TV coviewing and later cognitive outcomes. We can only find relationships consistent or inconsistent with particular causal hypotheses. Even when a relationship is consistent, however, it is possible that alternative hypotheses might predict the same relationship. In general, although we found a negative association between the amount of coviewing television during infancy and cognitive outcomes, we do not know the direction of causality. It is possible that there is something unmeasured about the early home environment associated with coviewing that leads to poorer working memory, academic skills, and language outcomes. It is also possible that children with poorer cognitive skills tend to watch more TV with their parents during infancy. Parents might, for example, use the television as a way to manage their children given that behavioral problems often accompanies cognitive and academic difficulties (e.g., Arnold, 1997). Thus, causal inferences must be entertained only with caution.

Lastly, the TV viewing diaries used in this study provided rich detail about infant television exposure over the course of two weeks, identifying program content as well as the coviewing context. The diary data are above and beyond what is typically used as an assessment of TV exposure, which is usually gauged by asking, "How much TV does your child watch per day?" (Anderson & Hanson, 2009). That said, what parents and children did while they coviewed in the home remains unknown. It could be that some parents are actively engaged with their children over the television program, or it could be that parents and children are just in the same room doing their own things; such differences in what parents do (or not do) with their children while viewing can influence television's impact.

The TV mediation literature suggests that there are three general strategies (restrictive mediation, active mediation, and coviewing) that parents use to regulate and control their children's television consumption, and these different strategies result in different child outcomes (Nathanson, 2001a). Restrictive mediation occurs when parents limit how much time children spend with TV and what they can watch; this type of mediation is related to less media consumption media and reducing negative TV content effects (Collier, Coyne, Rasmussen et al., 2016; Nathanson, 2001a). Active mediation occurs when parents intentionally discuss and talk about TV content to promote critical thinking among children; this type of mediation is generally related to enhancing the educational value and/or comprehension of content (Collier, Coyne, Rasmussen et al., 2016). Coviewing occurs when parents and children are simply watching the television together. Coviewing, in this sense, is generally associated with more media consumption and negative outcomes for children (e.g., Collier, Coyne, Rasmussen et al., 2016), with a few exceptions (e.g., Salomon, 1977). Although there can be some beneficial effects of simply coviewing with young children, it is through active mediation where there is substantial evidence of learning[15]. Taking this literature into account, we can see that it is important to consider parents' TV strategies to monitor and control their children's media consumption because these behaviors can differentially influence TV's effects on children. The parent mediation literature makes an important distinction that our home viewing diaries did not: there are different TV viewing strategies that parents employ, and this literature clearly shows that active mediation has benefits for older children's learning and comprehension, but that parents' presence while TV viewing may not be as beneficial. For this dissertation study, unfortunately, parent mediation styles were not included in these analyses. This is an important consideration when looking at parent-infant coviewing and child outcomes in the future.

Future Directions

Future studies should consider how new media technologies, such as smart phones, influence children's cognitive abilities. Parents and children have access to more media content and platforms than ever before. Some research indicates that smartphones

[15] It should be noted, however, that these findings are currently limited to parent mediation as it occurs among much older children than the infants observed in the first phase of the present study.

may be more problematic than the traditional form of television because they can be taken anywhere (car, restaurant), and that this technology may be even more disruptive and distracting for the parents than television (Radesky, Kistin, Zuckerman et al., 2014).

APPENDIX A

GENERAL INFORMATION SURVEY

Please answer the following questions. *Whenever a question asks about "your child", it is referring to the child who is participating in this study*.

1) Person completing this form:

Mother ____ Father____ Other (please specify):________________

2) How many years of education have you and your child's other parent *completed*? For example, this would be 12 if you completed high school, 13 if you completed one year of post high school training, 14 if you completed an associate's degree, 16 if you completed college, and so on.

You: _____ Other Parent: ______

3) Household employment status (Place an "X" in one slot)

______One parent working ______Two parents working _____No parents working

4) Annual Household Income (Place an "X" in one slot)

_____ Less than $30,000 _____ $30,001 to $50,000 _____ $50,001 to $75,000

_____ $75,001 to $100,000 _____ More than $100,000

5) Number of parents in the household (Place an "X" in one slot)

_____ Two-parent household ______ Single-Parent Household

6) What is your child's ethnicity? (*Please check all that apply*)

______ White/ Caucasian ______ Latino/Latina ______ Black/AA

______ Am. Indian/ Native Am. ______ Asian Other ___________

7) Child's birth date __________________________

8) What are the ages of other children in your home? (*Please write ages in the spaces below.*)

_______ Male ______ Male ______ Male ______ Male

_______ Female ______ Female ______ Female ______ Female

9a) How tall is your child? __________(in inches)

9b) How much does your child weigh? _________(in pounds)

10) In general, how would you describe your child's health? Circle one.

Excellent Very Good Good Fair Poor Don't know

11) Does your child have any problems with his/her vision that can not be corrected with glasses or contact lenses?

Yes No

12) Does your child have hearing problems?

Yes No

13) Does your child have any physical health problems (e.g., asthma, diabetes)?

Yes No

a. Please describe: ____

14) Does your child have a developmental, behavioral, or emotional disability?

Yes No

a. Please describe: ____

15) Does your child have a learning disability?

Yes No

a. Please describe: ____

16) What grade is your child in? PreK K 1st 2nd 3rd 4th

17) Since starting school, has your child repeated any grades? Yes No

18) How would you describe your child's school performance in….(Circle one)

a. Reading:	Excellent	Very Good	Good	Fair	Poor
b. Writing:	Excellent	Very Good	Good	Fair	Poor
c. Math:	Excellent	Very Good	Good	Fair	Poor

19) During the past week, on how many nights did your child get enough sleep for a child his/her age?

_________# of nights or _________ Don't know

20) During the past week, on how many days did your child exercise, play a sport, or participate in physical activity for at least 20 minutes that made him or her sweat and breathe hard?

_________# of days or _________ Don't know

21) In your neighborhood, are there:

a. Sidewalks and walking paths?	Yes	No
b. A park or playground area?	Yes	No
c. A recreation center, community center or Boys or Girls club?	Yes	No
d. A library or bookmobile?	Yes	No
e. Litter or garbage on the street or sidewalk?	Yes	No
f. Poorly kept or rundown homes?	Yes	No
e. Acts of vandalism such as broken windows or graffiti	Yes	No

22) Would you agree or disagree with the following statements?

a. People in my neighborhood help each other out.

Definitely Agree Somewhat Agree Somewhat Disagree Definitely Disagree

b. We watch out for each other's children in my neighborhood.

Definitely Agree Somewhat Agree Somewhat Disagree Definitely Disagree

c. There are people I can count on in my neighborhood.

Definitely Agree Somewhat Agree Somewhat Disagree Definitely Disagree

d. If my child were outside playing and got hurt or scared, there are adults nearby who I trust to help.

Definitely Agree Somewhat Agree Somewhat Disagree Definitely Disagree

e. How often do you feel your child is safe in your community or neighborhood?

Always Usually Sometimes Rarely Never

f. How often do you feel your child is safe at school?

Always Usually Sometimes Rarely Never

APPENDIX B

MEDIA USE

Please tell us about your (*parent)* media use.

1) Circle any of the following items that you have in your household

TV set	Laptop/desktop Computer	Cable or satellite TV
Portable DVD player	Regular DVD player	Digital Video Recorder/Tivo
iTouch or iPod	Kindle or other e-reader	iPad or similar tablet device
High-speed internet (Cable, wireless or DSL)	Video game player (Xbox, Play station, Wii)	Handheld video games (Gameboy, PSP, Nintendo DS

Other:____

2) On a typical day, how much time per day do YOU (parent) spend…

	In minutes
a. Watching your own TV shows on a TV set	
b. Using a computer	
c. Listening to music	
d. Reading books, magazines, or newspaper for pleasure (including electronic versions)	
e. Playing video games on console like Xbox, Play station, or Wii	
f. Playing games on cell phone, iPod, or iPad	
g. Watching videos or TV shows on a handheld device like a cell phone, iPod, or iPad	
h. Using apps, other than games, on cell phone, iPod, or iPad: ______________	

3) What type of cell phone, if any, do you have? (Circle one)
   a. A 'smartphone' (you can send emails, watch videos, access the internet on it)
   b. A regular cell phone (just for talking and texting)
   c. I don't have a cell phone

4) One thing people talk about when it comes to cell phones and iPads is 'apps.' How confident are you that you know what an app is? (Circle one)
   a. I know what an app is
   b. I have an idea what an app is, but I'm not totally sure
   c. I don't know what an app is

5) Approximately how many apps, if any, have you downloaded onto your cell phone, iPod, or iPad type of device?

None   Fewer than 5   5-10   20-30   More than 30

6) Approximately how many of the apps that you've downloaded were for your children? (Circle one)

Most of them   About half of them   Less than half of them   Only a few
None

7) Do you ever use your cell phone for the following: (Circle as many that apply)

Texting Listening to music Playing games Email Using apps

Watching videos Watching TV shows Using Facebook Taking photos

Using the internet for something other than email, Facebook, apps, or videos:________________________________

The questions below are about your child's media use.

8) In a typical day, how much time does your child spend…

	In minutes
a. Watching TV on a TV set (not including time spent watching videos or DVDs)	
i. How much of this time is spent viewing with a parent?	
b. Watching DVDs or video tapes	
i. How much of this time is spent viewing with a parent?	
c. Watching videos or TV shows on a handheld device like a cell phone, iPod, or iPad	
i. How much of this time is spent viewing with a parent?	
d. Listening to music	
i. How much of this time is spent listening with a parent?	
e. Reading or being read to	
i. How much of this time is spent reading with a parent?	
f. Playing video games on console like Xbox, Play station, or Wii	
i. How much of this time is spent playing video games with a parent?	
g. Playing games on a computer (laptop or desktop)	
i. How much of this time is spent playing video games with a parent?	
h. Playing games on a handheld game player like a Gameboy, PSP, Nintendo DS	
i. How much of this time is spent playing video games with a parent?	
i. Playing games on cell phone, iPod, or iPad	
i. How much of this time is spent playing video games with a parent?	
j. Watching videos or TV shows on a computer (NOT a DVD player)	
i. How much of this time is spent viewing with a parent?	
k. Using educational software on a computer (not games)	
i. How much of this time is spent with a parent?	
l. Doing homework on a computer	
i. How much of this time is spent with a parent?	
m. Doing anything else on a computer (photos, graphics, social networking, other activities)?	
i. How much of this time is spent with a parent?	
n. Using other types of apps on cell phone, iPod, or iPad _______________________	
i. How much of this time is spent with a parent?	
o. How much time does your child spend watching educational children's programs (e.g., the Electric Company, Cyberchase)?	
p. How much time does your child spend watching child entertainment programs (e.g., Spongebob, iCarly)	
q. How much time does your child spend watching adult educational programs (e.g., Mythbusters, Man vs. Wild)?	
r. How much time does your child spend watching adult entertainment programs (e.g., Dancing with the Stars, American Idol, How I met your Mother)?	

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

Always Most of the time Some of the time Hardly ever Never

10) Which of the following items, if any, does your child have in his/her bedroom (Circle as many that apply):

TV set DVD player or VCR Video game console
Computer/laptop

Internet access Radio Portable video game
None of these

11) Has your child ever used a cell phone, iPod, iPad, or similar device to do any of the following activities (Circle as many that apply):

Watch videos on cell phone, iPod, or iPad Watch TV on cell phone, iPod, or iPad

Play games on cell phone, iPod, or iPad Use apps on cell phone, iPod, or iPad

Read books on cell phone, iPod, or iPad Other__________________________

None of these

12) Please indicate how often your child:

	Several times a day	Once a day	Several times a week	Once a week	Less than once a week	Has never done this
a. Reads or is read to						
b. Watches DVDs or videotapes						
c. Watches TV						
d. Uses the computer						
e. Reads books on Kindle, Nook, or similar e-reader						
f. Plays video games on console like Xbox, Play station, or Wii						
g. Plays games, uses apps, or watches videos on cell phone, iPod, iPad, or handheld gaming device						

12h) How many books does your child have for his/her use? _______________________

13) How often, if ever, does your child use the following kinds of apps on cell phones, iPod, iPad, or similar devices:

	Often	Sometimes	Hardly ever	Never
a. Educational games, like puzzles, memory games, math, or reading				
b. Games that are just for fun				
c. Creative apps for things like drawing, making music, or creating videos				
d. Apps based on a character (he/she) knows from a TV show				
e. Other types of apps:___________________________				

14) How often, if ever, does your child do any of the following:

	Often	Sometimes	Hardly ever	Never
a. Watch educational shows on TV like Electric Company or Animal Planet				
b. Watch kids' entertainment shows on TV like Spongebob and iCarly				
c. Watch general audience shows like American Idol or Modern Family				
d. Watch adult TV shows like CSI or Grey's Anatomy				
e. Use the DVR or VCR himself to record own shows				
f. Uses educational games or programs on computers				

15) Does your child ever have homework from school or not? (Circle one) Yes No

16) When your child does homework, how often, if ever, is the TV on in the background? (Circle one)

Most of the time Some of the time Only once in a while Never

17) How often, if ever, does your child like to use more than one type of media at a time, for example, play a handheld game while he/she is watching TV or listening to music while he/she is using the computer?

Most of the time Some of the time Only once in a while Never

18) Has your child's pediatrician ever talked to you about your child's media use? (Circle one) Yes No

19) Do you have rules regarding how much time children can spend using media (Time) or about what types of content that they can use (Content)?

	Do you have TIME rules?	Do you have CONTENT rules?
a. Watching Television	Yes No	Yes No
b. Playing on the Computer	Yes No	Yes No
c. Playing on the Internet	Yes No	Yes No
d. Playing Video Games	Yes No	Yes No
e. Reading books	Yes No	Yes No
f. Using Apps	Yes No	Yes No
g. Listening to music	Yes No	Yes No
h. Using the phone	Yes No	Yes No

20) If you have time rules around media use, what are they?

____

21) If you have rules about media content, what are they?

____

22) In your opinion, does TV help or hurt your child's learning? (Circle one)

Mostly helps learning No effect on learning Hurts learning

23) In your opinion, do computers help or hurt your child's learning? (Circle one)

Mostly helps learning No effect on learning Hurts learning

24) In your opinion, does the internet help or hurt your child's learning? (Circle one)

Mostly helps learning   No effect on learning   Hurts learning

25) In your opinion, do video games help or hurt your child's learning? (Circle one)

Mostly helps learning   No effect on learning   Hurts learning

26) In your opinion, do books or magazines help or hurt your child's learning? (Circle one)

Mostly helps learning   No effect on learning   Hurts learning

27a) To the best of your recollection, at what age (in years/ months) did your child begin to regularly watch TV and/or videos?

____(years) and ____ (months)

27b) Has your child ever seen Sesame Street?   _____ Yes   _____No

If you answered YES to #27B, please answer the following questions:

28) At what age did your child begin watching Sesame Street? _____________ (in years and months)

29) If your child no longer watches Sesame Street, how old was your child when he/she stopped?

___________(in years and months).

30) During the period your child watched Sesame Street, how often would he/she view Sesame Street?

a. once a month
b. 1 to 3 times a month
c. 1 to 2 times a week
d. 3-4 times a week
e. almost everyday

31) Has your child ever seen the video series, *Sesame Beginnings?* _____ Yes   _____No

If you answered YES to #31, please answer the following questions:

32) At what age did your child begin watching *Sesame Beginnings*? _____________ (in years and months)

33) If your child no longer watches *Sesame Beginnings*, how old was your child when he/she stopped?

___________(in years and months).

34) During the period your child watched *Sesame Beginnings*, how often would he/she view *Sesame Beginnings*?

f. once a month
g. 1 to 3 times a month
h. 1 to 2 times a week
i. 3-4 times a week
j. almost everyday

35) How many *Sesame Beginnings* videos do you own (if any)? ____________

36) Has your child ever seen the video series, *Baby Einstein?* _____ Yes   _____No

If you answered YES to #36, please answer the following questions:

37) At what age did your child begin watching *Baby Einstein*? _____________ (in years and months)

38) If your child no longer watches *Baby Einstein*, how old was your child when he/she stopped?_____(in years and months).

39) During the period your child watched *Baby Einstein*, how often would he/she view *Baby Einstein*?

k. once a month
l. 1 to 3 times a month
m. 1 to 2 times a week
n. 3-4 times a week
o. almost everyday

40) How many *Baby Einstein* videos do you own (if any)? ____________

41) Children's television preferences come and go over time. Below is a list of popular programs from 2007 to 2011. Please indicate whether or not your child watched the following programs when he/she was between _2 to 5 years old_ (to the best of your knowledge).

When my child was _2 to 5 years_, he/she watched the following program (Please mark with an "X")….

		A lot	Sometimes	Not at all	I don't know
1	Jake and the neverland				
2	Kick Buttowski				
3	Spongebob				
4	TUFF Puppy				
5	KCA CutDown 2011				
6	Power Rangers				
7	HM School for Tools				
8	Choo Choo Sould				
9	Phineas and Ferb				
10	Icarly				
11	Supah Ninjas				
12	Big Time Rush				
13	Brain Surge				
14	Victorious				
15	Tom & Jerry				
16	The boy who cried woolf				
17	Suite Life ON Deck				
18	Shake it Up				
19	Wizards of Waverly Place				
20	Planet Sheen				
21	Tasty Time with Zefronk				
22	Fanboy & Chum Chum				
23	Fairly Odd Parents				
24	Dance-A-Lot Robot				
25	Back at the Barnyard				
26	Drake and Josh				
27	Penguins of Madagascar				
28	Happy Monster Band				
29	Lou and Lou				
30	Hannah Montana				
31	Mighty B!				
32	Bunnytown				
33	Ned Declassified				

34	Tak and the Power of Juju				
35	Jimmy Neutron				
36	This is Emily Yeung				
37	Charlie and Lola				
38	Johnny Bravo				
39	Scooby Doo				
40	Zoey 101				
41	Courage the Cowardly Dog				
42	Cat Scratch				
43	Suite Life of Zack and Cody				
44	That so Raven				
45	Arthur				
46	Backyardigans				
47	Barney & Friends				
48	Blue's Clues				
49	Bob the Builder				
50	Bubble Guppies				
51	Caillou				
52	Cat in the Hat				
53	Clifford the Big Red Dog				
54	Curious George				
55	Dinosaur Train				
56	DoodleBops				
57	Dora the Explorer				
58	Dragon Tales				
59	Electric Company				
60	Fetch!				
61	Go, Diego Go				
62	Hanny Manny				
63	Imagination Movers				
64	It's a Big Big World				
65	Lazytown				
66	Little Einstein				
67	Martha Speaks				
68	Max and Ruby				
69	Mickey Mouse Clubhouse				
70	Miss Spiders Sunny Patch				
71	My Friend Tigger and Pooh				
72	Ni Hao Kai-Lan				
73	Olivia				
74	SAO: Three Healthy Steps				
75	Sesame Street				
76	Sid the Science Kid				
77	Super Why				
78	Team Umizoomi				
79	Thomas and Friends				
80	Wild Kratts				

81	Wonder Pets				
82	Word World				
83	Wordgirl				
84	Wow! Wow! Wubbzy				
85	Yo Gabba Gabba				
86	Other:________________				
87	Other:________________				
88	Other:________________				

42) Concerns about Media: *Please place an 'X' in the box that best describes how concerned you are about the following…*

	Not at All	A Little Bit	Somewhat	Quite a Bit	A Great Deal
a) Violence on TV/Videos					
b) Adult Content on TV/Videos					
c) Bad Language on TV/Videos					
d) Addictive nature of Computer Games					
e) Violence on Video Games					
f) Adult Content on Video Games					

g) Which of the following activities regularly cause arguments between you and your child? Please check all that apply.

- ❑ Watching TV
- ❑ Using the Computer
- ❑ Playing Video Games
- ❑ Playing Gameboys
- ❑ Going to Bed
- ❑ Using the Phone
- ❑ Helping around the House
- ❑ Watching Videos
- ❑ Using the Internet
- ❑ Reading
- ❑ Listening to Music
- ❑ Other (tell us): _______________

43) ATTITUDES: *Please place a check in the box that best describes your attitude.*

43a) A child having a TV in his/her bedroom is:

- ❑ Mainly a good thing
- ❑ Neither a good thing nor a bad thing
- ❑ Mainly a bad thing

43b) How satisfied are you with what is available for your child on TV?

- ❑ Very Satisfied
- ❑ Somewhat Satisfied
- ❑ Neither Satisfied nor Dissatisfied
- ❑ Somewhat Dissatisfied
- ❑ Very Dissatisfied

43c) How important is the Internet to your child's education?

- ❑ Very Important
- ❑ Somewhat Important
- ❑ Not Important and Not Unimportant
- ❑ Somewhat Unimportant
- ❑ Very Unimportant

43d) How satisfied are you with what is available for your child on the Internet?

- ❑ Very Satisfied
- ❑ Somewhat Satisfied
- ❑ Neither Satisfied nor Dissatisfied
- ❑ Somewhat Dissatisfied
- ❑ Very Dissatisfied

43e) In regard to the Internet, the most important role of a parent is…?

- ❑ As a guide for good content
- ❑ As a checker for inappropriate content
- ❑ Neither
- ❑ Other (Tell us): __________________

43f) How often do you use video game ratings in selecting games for your child?

- ❑ Every Time
- ❑ Most of the Time
- ❑ Sometimes
- ❑ Not Very Often
- ❑ Never
- ❑ Didn't know there were video game ratings

43g) How satisfied are you with video game ratings?

- ❑ Very Satisfied
- ❑ Somewhat Satisfied
- ❑ Neither Satisfied nor Dissatisfied
- ❑ Somewhat Dissatisf

44) The following questions are for parents who participated in our previous study that examined the influence of baby videos (*Sesame Beginnings* or *Baby Einstein*) on young children. Based on your experience participating in our previous study when your child was 12 to 21 months of age...

a) Did participating in the previous study change the way you interacted with your child?
YES or NO

b) If participating in the previous experiment did influence how you interacted with your child, please describe how it changed:

____

45) For the prior experiment, my child and I watched:
Sesame Beginnings or *Baby Einstein*

46) Please indicate how strongly you agree with the following statement:
"I really liked the video series."

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree

47a) Did you continue to watch the video after completing the prior study?
YES or NO

b) If you continued watching the videos, how often would your child watch it?

1-3 times/month	1-2 times/week	3-4 times/week	Almost everyday

c) If you continued watching the videos, at what age did your child stop watching the videos? __________ (in years and months)

APPENDIX C

DBRS

Please circle the number next to each item that best describes the behavior of your child participating in this study **during the past 6 months.**

Item	**Never or Rarely**	**Sometimes**	**Often**	**Very Often**
1. Fails to give close attention to detail or makes careless mistakes in his/her work	0	1	2	3
2. Fidgets with hands or feet or squirms in seat	0	1	2	3
3. Has difficulty sustaining his/her attention in tasks or fun activities	0	1	2	3
4. Leaves his/her seat in situation in classroom or in other situations in which seating is expected	0	1	2	3
5. Doesn't listen when spoken to directly	0	1	2	3
6. Seems restless	0	1	2	3
7. Doesn't follow through on instructions and fails to finish work	0	1	2	3
8. Has difficulty engaging in leisure activities or doing fun things quietly	0	1	2	3
9. Has difficulty organizing tasks and activities	0	1	2	3
10. Seems "on the go" or "drive by a motor"	0	1	2	3
11. Avoids, dislikes, or is reluctant to engage in work that requires sustained mental effort (such as schoolwork)	0	1	2	3

12. Talks excessively	0	1	2	3
13. Loses things necessary for tasks or activities	0	1	2	3
14. Blurts out answers before questions have been completed	0	1	2	3
15. Is easily distracted	0	1	2	3
16. Has difficulty awaiting turn	0	1	2	3
17. Is forgetful in daily activities	0	1	2	3
18. Interrupts or intrudes on others	0	1	2	3

APPENDIX D

TABLES AND FIGURES

Table 1: Comparison of Returning and Non-Returning Participants on Key Variables

	Returned		Not Returned	
	Mean	STD	Mean	STD
Mother's Education	15.53	2.26	15.22	2.63
Total TV Exposure	29.96	19.53	32.72	22.05
Total FTV Exposure	15.65	11.96	16.72	13.27
Total BTV Exposure	14.32	15.08	16.00	15.32
TV alone	8.56	10.21	6.82	8.10
BTV Coviewed	11.02	12.25	13.59	13.41
FTV Coviewed	10.38	10.18	12.31	11.55
PCI - No TV	1.59	0.29	1.58	0.30
PCI - TV	1.20	0.40	1.23	0.32
PCI - Post TV	1.64	0.30	1.61	0.32
PL-No TV: Word per min	43.14	15.84	46.18	18.90
PL-No TV: Utterance per min	13.38	4.69	13.87	5.02
PL-No TV: New words per min	8.06	2.01	8.22	2.76
PL-No TV: New word per min utterance	0.65	0.19	0.62	0.16
PL-No TV: MLU	3.23	0.51	3.29	0.53
PL-TV: Word per min	25.78	12.53	28.53	13.46
PL-TV: Utterance per min	8.46	4.13	8.99	4.14
PL-TV: New words per min	6.32	2.06	6.64	2.19
PL-TV: New word per min utterance	0.86	0.35	0.83	0.32
PL-TV: MLU	3.10	0.61	3.20	0.68
PL-Post TV: Word per min	45.76	17.44	47.93	18.43
PL-Post TV: Utterance per min	13.95	5.02	14.53	5.32
PL-Post TV: New words per min	11.37	3.07	11.78	3.53
PL-Post TV: New word per min utterance	0.90	0.34	0.87	0.30
PL-Post TV: MLU	3.32	0.84	3.34	0.89

Note. There were no significant differences between groups.
PCI = Parent-child interactions, PL = Parent language

Table 2: Steps for Hierarchical Linear Regression

	EF Skills	Academic Skills	Language Skills
Step 1		**Potential Control Variables (varies based on specific outcome)**	
	~ Age		~ Age
	~ Sex	~ Sex	~ Sex
	~ Mother's Ed	~ Mother's Ed	~ Mother's Ed
	~ Current Media Use	~ Current Media Use	~ Current Media Use
	~ Child Vocabulary	~ IQ	~ IQ
	~ Parent-Child Interactions (No TV)		~ Parent-Child Interactions (No TV)
			~ Attention to Bill Nye
Step 2		**Mediator/Moderator**	
	Parent-child interactions (TV)	Working Memory	Parent Language
Step 3		**TV Exposure**	
	*Y = bo + b1 * Viewing Alone + b2 * Total Coviewing + b3 * Percent of TV Exposure that Consists of Coviewing*		
	*Y = bo + b1 * FTV Viewing Alone + b2 * FTV Coviewing + b3 * Percent of FTV Coviewing*		
	*Y = bo + b1 * BTV Viewing Alone + b2 * BTV Coviewing + b3 * Percent of BTV Coviewing*		

Table 3: Comparison of the Means between the Original and Imputed Datasets

	Original Data					Imputed Data		
	N	Min	Max	Mean	SE	N	Mean	SE
Covariates								
Age	89	6.00	9.00	7.57	0.08	89	7.57	0.08
Sex	89	0.00	1.00	0.42	0.05	89	0.42	0.05
Mother's Education	89	12.00	21.00	15.75	0.25	89	15.75	0.25
Current Media Use	89	1.00	12.63	3.95	0.27	89	3.95	0.27
Child Vocabulary	86	6.00	19.00	11.84	0.29	89	11.83	0.28
Child IQ	86	6.50	16.00	10.73	0.23	89	10.73	0.22
Infant PCI-No TV	88	0.33	1.99	1.59	0.03	89	1.59	0.03
Mediator								
Infant PCI-TV	84	0.14	1.96	1.20	0.04	89	1.19	0.04
Predictors (2 weeks)								
Total TV	89	2.25	102.25	29.96	2.07	89	29.96	2.07
Foreground TV	89	0.00	50.25	15.65	1.27	89	15.65	1.27
Background TV	89	0.00	73.50	14.32	1.60	89	14.32	1.60
TV - alone	89	0.00	66.00	8.56	1.08	89	8.56	1.08
FTV - alone	89	0.00	25.25	5.27	0.61	89	5.27	0.61
BTV - alone	89	0.00	57.50	3.29	0.79	89	3.29	0.79
Total Amount of Coviewing	89	2.00	98.50	21.40	1.79	89	21.40	1.79
Background TV Coviewed	89	0.00	59.00	9.28	1.24	89	9.28	1.24
Foreground TV Coviewed	89	0.00	48.00	10.38	1.08	89	10.38	1.08
Percent of Coviewing TV	89	0.22	1.00	0.73	0.02	89	0.73	0.02
Percent Coviewing BTV	89	0.00	1.00	0.48	0.03	89	0.48	0.03
Percent coviewing FTV	89	0.00	1.00	0.52	0.03	89	0.52	0.03
Outcome Variables								
DBRS	89	0.00	42.00	9.22	0.82	89	9.22	0.82
Working Memory	83	68.12	143.82	103.46	1.61	89	103.44	1.51
Dimensional Card Sort	83	63.69	129.41	104.90	1.86	89	104.93	1.75
Flanker Task	83	71.52	126.78	97.39	1.27	89	97.35	1.19
EF Composite	83	-2.46	2.44	0.00	0.11	89	0.01	0.11

Table 4: Correlation Matrix for the DBRS and Covariates

	1	2	3	4	5	6
1 DBRS (Time 2)						
Covariates (Time 2)						
2 Child Age	0.21					
3 Sex	0.24*	0.09				
4 Mother's Ed	0.04	-0.07	0.11			
5 Media Use	0.12	0.14	-0.17	-.033**		
6 Child Vocabulary	0.06	0.01	0.04	0.21	0.04	
7 PCI-No TV (T1)	0.18	-0.02	-0.02	0.05	-0.07	0.22*

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).

Table 5: Correlation Matrix for the DBRS and Predictors

	1	2	3	4	5	6	7	8	9	10	11
1 DBRS (Time 2)											
Mediator (Time 1)											
2 PCI TV	-0.04										
Predictors (Time 1)											
3 Total TV Exp	-0.19	0.00									
4 TV Alone	0.01	-0.08	.502**								
5 BTV Alone	0.05	0.08	.415**	.829**							
6 FTV Alone	-0.06	-.250*	.350**	.691**	0.17						
7 Total Coviewing	-.225*	0.05	.853**	-0.02	-0.02	-0.01					
8 FTV Coviewing	-0.04	-0.05	.720**	0.05	0.12	-0.06	.801**				
9 BTV Coviewing	-.322**	0.14	.548**	-0.10	-0.18	0.05	.694**	0.13			
10 % Coview	-0.05	0.19	-0.10	-.768**	-.516**	-.688**	.353**	.225*	.314**		
11 % BTV Coview	0.07	0.02	0.17	0.13	.272**	-0.13	0.12	.580**	-.498**	0.02	
12 % FTV Coview	-0.07	-0.02	-0.17	-0.13	-.272**	0.13	-0.12	-.580**	.498**	-0.02	-1.0**

*Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 6: Correlation Matrix for the Executive Function Outcomes and Covariates

	1	2	3	4	5	6
1 Working Memory						
2 DCCST Task	0.22					
3 Flanker Task	0.01	.329**				
4 EF Composite	0.14	.815**	.815**			
Covariates						
5 Media Use (T2)	0.12	0.01	-0.04	-0.02		
6 Child Vocabulary (T2)	0.32*	-0.09	-0.10	-0.11	-0.04	
7 PCI-No TV (T1)	0.07	-0.06	0.00	-0.04	-0.07	0.22*

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).

Table 7: Correlation Matrix for the Executive Function Outcomes and Predictors

	1	2	3	4	5	6	7	8	9	10	11	12
1 Working Memory												
2 EF Composite	0.14											
Mediator (Time 1)												
3 PCI TV	0	0.03										
Predictors (Time 2)												
4 Total TV	-0.21	0.02	0									
5 TV Alone	-0.02	0.04	-0.08	.502**								
6 BTV Alone	-0.07	-0.03	0.08	.415**	.829**							
7 FTV Alone	0.06	0.1	-.250*	.350**	.691**	0.17						
8 Total Coviewing	-.224*	0	0.05	.853**	-0.02	-0.02	-0.01					
9 BTV Coviewing	-0.17	0.02	-0.05	.720**	0.05	0.12	-0.06	.801**				
10 FTV Coviewing	-.216*	-0.04	0.16	.545**	-0.13	-0.18	0	.707**	0.16			
11 % Coview	-0.06	0	0.19	-0.1	-.76**	-.51**	-.68**	.353**	.225*	.342**		
12 % BTV Coview	-0.02	0.02	0.02	0.17	0.13	.272**	-0.13	0.12	.580**	-.45**	0.02	
13 % FTV Coview	0.02	-0.02	-0.02	-0.17	-0.13	-.27**	0.13	-0.12	-.58**	.455**	-0.02	-1.0**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).

Table 8: Correlations among Academic Achievement Scores and Covariates

	1	2	3	4	5	6	7
1 Story Recall							
2 Passage Comp.	.318**						
3 Math Fluency	0.07	.509**					
4 Acad. Knowledge	.410**	.584**	.359**				
Covariates (Time 2)							
5 Sex	-.36**	-0.14	-0.17	-.28**			
6 Mother's Ed	.221*	.321**	0.20	.354**	0.11		
7Media Use (Time 2)	-0.01	-0.20	-.248*	-0.15	-0.17	-.33**	
8 Child IQ (Time 2	0.11	.312**	0.11	.290**	0.20	0.09	0.03

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 9: Correlations among Academic Achievement Scores, Mediators, and Predictors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Story Recall														
2 Passage Comp.	.318**													
3 Math Fluency	0.07	.509**												
4 Acad. Knowledge	.410**	.584**	.359**											
<u>Mediator (Time 2)</u>														
5 Working Memory	.294**	.449**	.216*	.355**										
<u>Predictors (Time 1)</u>														
6 Total TV	-0.2	-0.07	0.02	-0.16	-0.2									
7 TV Alone	0.06	0.1	0.01	0.01	-0.02	.502**								
8BTV Alone	-0.01	0.11	0.03	0	-0.06	.415**	.829**							
9 FTV Alone	0.12	0.03	-0.03	0	0.06	.350**	.691**	0.17						
10 Total Coview	-.261*	-0.14	0.02	-0.2	-.22*	.853**	-0.02	-0.02	-0.01					
11 BTV Coview	-.245*	-0.09	0.04	-.230*	-0.16	.720**	0.05	0.12	-0.06	.801**				
12 FTV Coview	-0.16	-0.13	-0.02	-0.07	-.21*	.545**	-0.13	-0.18	0.0	.707**	0.16			
13 % Coview	-0.15	-0.19	-0.14	-0.07	-0.06	-0.1	-.76**	-.51**	-.68**	.353**	.225*	.342**		
14 % BTV Coview	-0.04	0.07	0.03	-0.07	-0.01	0.17	0.13	.272**	-0.13	0.12	.58**	-.45**	0.02	
15 % FTV Coview	0.04	-0.07	-0.03	0.07	0.01	-0.17	-0.13	-.27**	0.13	-0.12	-.58**	.455**	-0.02	-1.0**

Table 10: Comparison of the Means between the Original and Imputed Datasets

	Original Data			Imputed Data		
	N	**Mean**	**SE**	**N**	**Mean**	**SE**
Child Language (Time 2)						
WISC-IV Vocabulary	86	11.84	0.30	89	11.84	0.29
Total Words	85	42.73	4.51	89	42.66	4.31
Total Utterances	85	12.88	1.23	89	12.89	1.17
Total New Word	85	27.29	1.89	89	27.30	1.81
New Word per Utterance	85	2.37	0.08	89	2.38	0.08
MLU	85	3.26	0.11	89	3.25	0.10
Child Lang. composite - Quantity	85	0.00	0.11	89	0.01	0.11
Child Lang. Composite - Quality	85	0.00	0.11	89	0.01	0.11
Parent Language (Time 1)						
No-TV Words per min	79	43.16	1.77	89	43.17	1.58
No-TV Utterances per min	79	13.39	0.52	89	13.43	0.47
No-TV New Words per min	79	8.07	0.22	89	8.07	0.21
No-TV New Word per utter	79	0.65	0.02	89	0.65	0.02
No-TV MLU	79	3.23	0.06	89	3.24	0.07
TV Words per min	75	25.82	1.44	89	25.91	1.23
TV Utterances per min	75	8.47	0.47	89	8.42	0.42
TV New Words per min	75	6.35	0.24	89	6.33	0.22
TV New Word per utter	75	0.87	0.04	89	0.89	0.04
TV MLU	75	3.10	0.07	89	3.11	0.08
Post-TV Words per min	76	45.74	1.99	89	45.68	1.71
Post-TV Utterances per min	76	13.98	0.57	89	13.97	0.51
Post-TV New Words per min	76	11.35	0.35	89	11.37	0.31
Post-TV New Word per utter	76	0.89	0.04	89	0.91	0.04
Post-TV MLU	76	3.31	0.10	89	3.33	0.10

Table 11: Correlations among Children's Language Variables and Composite Scores

	1	2	3	4	5	6
1 Total Words						
2 Utterances	0.96**					
3 New Words	.096**	0.91**				
4 New Words per Utterance	-0.21	-0.40**	-0.13			
5 MLU	0.30**	0.07	0.37**	0.76**		
6 Child Lang. Quantity Composite	0.99**	0.97**	0.98**	-0.26*	0.26*	
7 Child Lang. Quality Composite	0.05	-0.18	0.13	0.94**	0.94**	-0.001

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 12: Correlations among Parent Language Variables and Composite Scores

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
No TV																	
1 Word/min																	
2 Utter/min	**0.93**																
3 New Word/min	**0.83**	**0.73**															
4 New Word/utter	**-0.52**	**-0.71**	-0.15														
5 MLU	**0.31**	-0.04	0.40	**0.48**													
TV																	
6 Word/min	**0.58**	**0.59**	**0.44**	**-0.33**	0.07												
7 Utter/min	**0.54**	**0.64**	**0.38**	**-0.47**	-0.15	**0.95**											
8 New Word/min	**0.54**	**0.50**	**0.55**	-0.14	0.19	**0.89**	**0.81**										
9 New Word/utter	-0.19	-0.37	0.10	**0.63**	**0.49**	**-0.57**	**-0.70**	**-0.39**									
10 MLU	0.10	-0.17	0.22	**0.54**	**0.80**	0.10	-0.17	0.21	**0.56**								
Post TV																	
11 Word/min	**0.69**	**0.66**	**0.58**	**-0.28**	0.19	**0.46**	**0.43**	**0.39**	-0.14	0.17							
12 Utter/min	**0.61**	**0.72**	**0.48**	**-0.49**	-0.13	**0.47**	**0.55**	**0.36**	**-0.35**	-0.20	**0.88**						
13 New Word/min	**0.54**	**0.45**	**0.58**	0.02	**0.36**	**0.31**	**0.25**	**0.36**	0.14	**0.35**	**0.86**	**0.68**					
14 New Word/utter	**-0.31**	**-0.49**	-0.14	**0.62**	**0.44**	**-0.30**	**-0.44**	-0.17	**0.52**	**0.56**	**-0.34**	**-0.68**	-0.04				
15 MLU	0.17	-0.08	**0.25**	**0.45**	**0.72**	0.03	-0.17	0.13	**0.47**	**0.86**	**0.30**	-0.14	**0.48**	**0.67**			
Composite Scores																	
16 Language Quantity	**0.87**	**0.83**	**0.79**	**-0.37**	**0.25**	**0.49**	**0.47**	**0.47**	-0.08	0.13	**0.92**	**0.85**	**0.83**	**-0.38**	0.22		
17 Language Quality	0.00	**-0.30**	0.22	**0.73**	0.84	-0.07	**-0.31**	0.11	**0.68**	**0.92**	0.04	**-0.37**	**0.32**	**0.76**	**0.88**	0.02	
18 Language TV Quantity	**0.58**	**0.61**	**0.42**	**-0.42**	-0.02	**0.97**	**0.96**	**0.90**	**-0.68**	-0.02	**0.39**	**0.44**	0.21	**-0.35**	-0.06	**0.43**	-0.18

Note. Bolded numbers signifies that $p < .05$

Table 13: Correlations among Parent and Child Language Variables

	1	2	3	4	5	6	7
1 Child Language Quantity							
2 2Child Language Quality	-0.001						
3 Child Vocabulary	0.07	.231*					
4 Story Recall	0.11	.219*	.415**				
5 Passage Comprehension	0.19	0.16	.443**	.318**			
6 Parent Lang. Quantity (No-TV)	0.07	.348**	.309**	.296*	0.09		
7 Parent Lang. Quality	0.04	-0.03	0.12	.271*	0.12	0.02	
8 Parent Lang. Quantity (TV)	0.05	.249*	0.16	0.04	0.02	.425**	-0.18

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 14: Correlations among Child Language Variables and Covariates

	1	2	3	4	5	6	7
1 Child Language Quantity							
2 Child Language Quality	0.00						
3 Child Vocabulary	0.071	.231*					
Covariates							
4 Child Age (Time 2)	.246*	-0.06	0.01				
5 Sex	-0.05	-0.10	-0.04	0.09			
6 Mother's Ed (Time 2)	0.02	-0.01	0.21	-0.07	0.11		
7 Media Use (Time 2)	0.03	-0.12	-0.04	0.14	-0.17	-.33**	
8 PCI-No TV (Time 1)	-0.05	0.15	.223*	-0.02	-0.02	0.05	-0.07

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 15: Correlations among Child Language Variables and Predictors

	1	2	3	4	5	6	7	8	9	10	11	12
1 Child Lang Quantity												
2 Child Lang Quality	0.00											
3 Child Vocabulary	0.07	.231*										
Predictors												
4 Total TV	0.11	-0.04	0.00									
5 TV Alone	0.05	-0.01	0.12	.502**								
6 BTV Alone	0.02	-0.11	0.10	.415**	.829**							
7 FTV Alone	0.06	0.12	0.08	.350**	.691**	0.17						
8 Total Coview	0.10	-0.04	-0.07	.853**	-0.02	-0.02	-0.01					
9 BTV Coview	-0.07	-0.03	-0.01	.720**	0.05	0.12	-0.06	.801**				
10 FTV Coview	.239*	-0.03	-0.09	.548**	-0.10	-0.18	0.05	.694**	0.13			
11 % Coview	-0.05	-0.06	-0.16	-0.10	-.76**	-.51**	-.68**	.353**	.225*	.314**		
12 % BTV Coview	0.13	-0.04	-0.04	-0.17	-0.13	-.27**	0.13	-0.12	-.58**	.498**	-0.02	
13 % FTV Coview	-0.13	0.04	0.04	0.17	0.13	.272**	-0.13	0.12	.580**	-.49**	0.02	-1.00**

Table 16: Descriptive Statistics for Child Language Variables

	N	Mean	STD	Min	Max
Total Words	85	42.73	41.61	3	313
Total Utterances	85	12.88	11.30	1	86
Total New Word	85	27.29	17.46	3	110
New Word per Utterance	85	2.37	0.74	1	5
MLU	85	3.26	0.97	1	6
Vocabulary	86	11.84	2.74	6	19
Story Recall	86	92.94	3.52	78	99
Passage comprehension	86	83.95	18.84	13	100

Table 17: Summary of Results

Outcome	Infant TV Exposure	Parent Factor
EF		
DBRS	Total Hours Coviewing FTV (negative)	No
Working Memory	Total Hours Coviewing (negative)	No
EF Composite	No	No
Academic Skills		
Story Recall	Total Hours Coviewing (negative)	
Passage Comp.	Percent of TV Coviewed (negative)	
Math Fluency	No	
Academic Knowledge	Total Hours Coviewing BTV (negative)	
Language Outcomes		
Child Lang. Quantity	No	No
Child Lang. Quality	No	Parent Lang. Quantity (positive)
Child Vocabulary	Percent of TV Coviewed (negative)	No
Story Recall	Total Hours Coviewing (negative)	Parent Lang. Quantity (positive)
Passage Comp	Percent of TV Coviewed (negative; marginal)	No

Table 18: Descriptive Statistics for Bill Nye Comprehension Questions

	N	Min	Max	Potential	Mean	Std. Dev.
Facts	86	1	6	9	2.74	1.15
Inference	86	0	6	7	2.87	1.46
Process	86	0	6	6	3.84	1.62

Table 19: Correlations between Bill Nye Comprehension Questions and Covariates

	1	2	3	4	5	6	7	8	9
1 Facts									
2 Open Ended	.260*								
3 Process	0.20	.219*							
Covariates									
4 Child Age (Time 2)	.392**	0.15	.302**						
5 Sex	0.05	-0.07	-.265*	0.09					
6 Mother's Ed (Time 2)	0.16	.244*	-0.01	-0.07	0.11				
7 Attention to Bill Nye (Time 2)	0.18	-0.01	0.17	0.02	0.21	.302**			
6 Media Use (Time 2)	-0.02	-0.20	0.12	0.14	-0.17	-.333**	-0.07		
7 Child IQ (Time 2)	.382**	0.18	0.01	0.04	0.20	0.09	0.07	0.03	
8 PCI No TV (Time 1)	0.10	0.00	0.17	-0.02	-0.02	0.05	0.20	-0.07	0.02

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 20: Correlations between Bill Nye Comprehension Questions and Predictors

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Fact													
2 Open Ended	.260*												
3 Process	0.20	.219*											
Mediators													
4 PCI-TV	0.17	0.04	0.05										
Predictors													
5 Total TV	-0.02	-0.06	0.12	0.00									
6 TV Alone	0.14	0.16	0.17	-0.08	.502**								
7 BTV Alone	0.13	0.12	0.14	0.08	.415**	.829**							
8 FTV Alone	0.08	0.13	0.11	-.250*	.350**	.691**	0.17						
9 Total Coview	-0.11	-0.16	0.04	0.05	.853**	-0.02	-0.02	-0.01					
10 BTV Coview	-0.03	-0.16	0.08	-0.05	.720**	0.05	0.12	-0.06	.801**				
11 FTV Coview	-0.14	-0.07	-0.03	0.14	.548**	-0.10	-0.18	0.05	.694**	0.13			
12 % Coview	-0.21	-0.19	-0.12	0.19	-0.10	-.768**	-.516**	-.688**	.353**	.225*	.314**		
13 % BTV Cov	0.06	0.04	0.16	0.02	0.17	0.13	.272**	-0.13	0.12	.580**	-.498**	0.02	
14 % FTV Cov	-0.06	-0.04	-0.16	-0.02	-0.17	-0.13	-.272**	0.13	-0.12	-.580**	.498**	-0.02	-1.00**

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Figure 1: Display of parent-child interactions as the mediator between infant TV exposure and later cognitive outcomes.

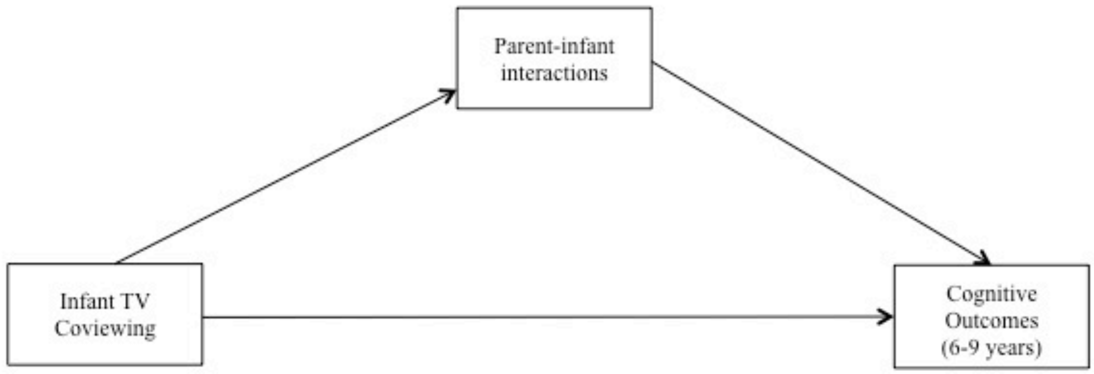


Figure 2: Mediation diagram for academic outcomes.

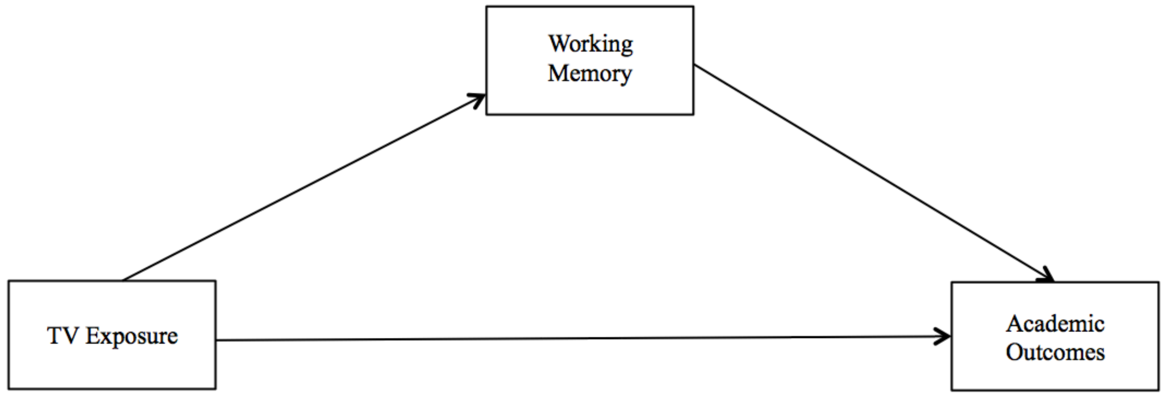
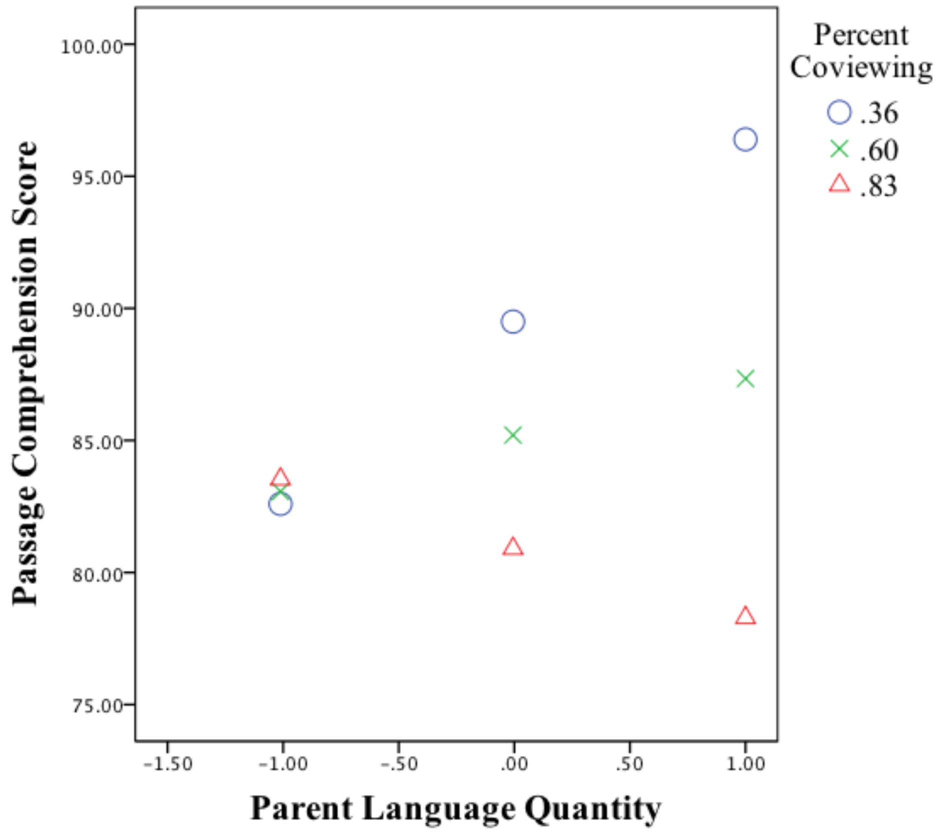


Figure 3: Graphical display of the interaction between percent coviewing and the quantity of parent language during infancy



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