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Early Childhood iPad Use and Effects on Visual Spatial Attention Span

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EARLY CHILDHOOD IPAD USE AND EFFECTS ON VISUAL SPATIAL ATTENTION SPAN

by

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Abstract

Despite the rising prevalence of mobile media in young children's lives, little research exists that examines the effects of mobile media use on early childhood cognitive development. This study will explore how mobile media use, specifically iPad use, in early childhood affects development of visual spatial attention span. Researchers will recruit 160 participants, ages 3 to 6, and categorize them into three groups: TV viewers only, interactive iPad users, and passive iPad users. Children will complete a computer task to measure the length of their visual spatial attention span. Parents will report on the average daily amount of media use, their child's top three most viewed or used programs and apps, and the pervasiveness of media use, as well as complete a demographics survey. Research assistants will rate the level of exogenous stimuli children are exposed to in their top three programs and apps. Researchers predict that iPad use will be associated with shorter visual spatial attention spans in comparison to TV viewing, due to longer amounts of use, higher levels of exogenous stimuli, and higher levels of pervasiveness. In addition, researchers hypothesize that interactive iPad use will correlate with the shortest visual spatial attention spans due to highest levels of exogenous stimuli and longest amounts of use. The results will help parents and educators to more effectively monitor young children's mobile media usage.

Infants on iPads? Toddlers on touchscreens? Introducing the new, instant quick-fix to backseat bickering and rowdy restaurant outings: mobile media. Since the release of the first iPad in April 2010, the rate of children with personal access to mobile media has accelerated rapidly. From 2011 to 2013, the percentage of tablet-owning families with children age 8 and younger jumped five-fold from 8% to 40% (Common Sense Media, 2013). Because of its portability and easy-to-use features, mobile media has become ubiquitous in many children's lives. Many parents are using it to occupy young children during daily routines such as running errands, riding in a car, and eating out, turning it into a common behavioral regulation tool (Radesky, Schumacher,& Zuckerman, 2015). From 2011 to 2013, the percentage of children 8 and under who have used mobile media for media activity or media viewing has increased from 38% to 72% (Common Sense Media, 2013). Parents have also introduced mobile media devices to toddlers. In 2013, 38% of children under 2 had used a mobile media device compared to 10% in 2011 (Common Sense Media, 2013). Within the same time frame, 2011 to 2013, tablet ownership has also increased among low-income families, from 2% to 20%; and the percentage of lower-income children who have used a mobile media device has tripled from 22% to 65%.

Overall, today's toddlers and young children have more access to more kinds of screens than ever before (Anderson & Pempek, 2005). However, despite this increasing prevalence in mobile media use among children, very little research exists on how interactive mobile media affect child development. Current research on effects of screen time on child development has focused on the effects of TV, even when TV viewing among children has decreased and mobile media use has increased (Common Sense Media, 2013). In light of this trend, it is imperative to research how early childhood use of mobile media affects development. This proposed study focuses on the amount, pervasiveness, and content of early childhood mobile media iPad use

from ages 3 through 6 and its effects on the development of sustained visual spatial attention span. In this study, the average daily media use signifies the amount of media use, the variety of locations of use indicates the pervasiveness of use, and the level of exogenous stimuli denotes the content of use. Researchers define visual spatial attention span as the maintenance of attention over time to specific stimuli in a visual environment.

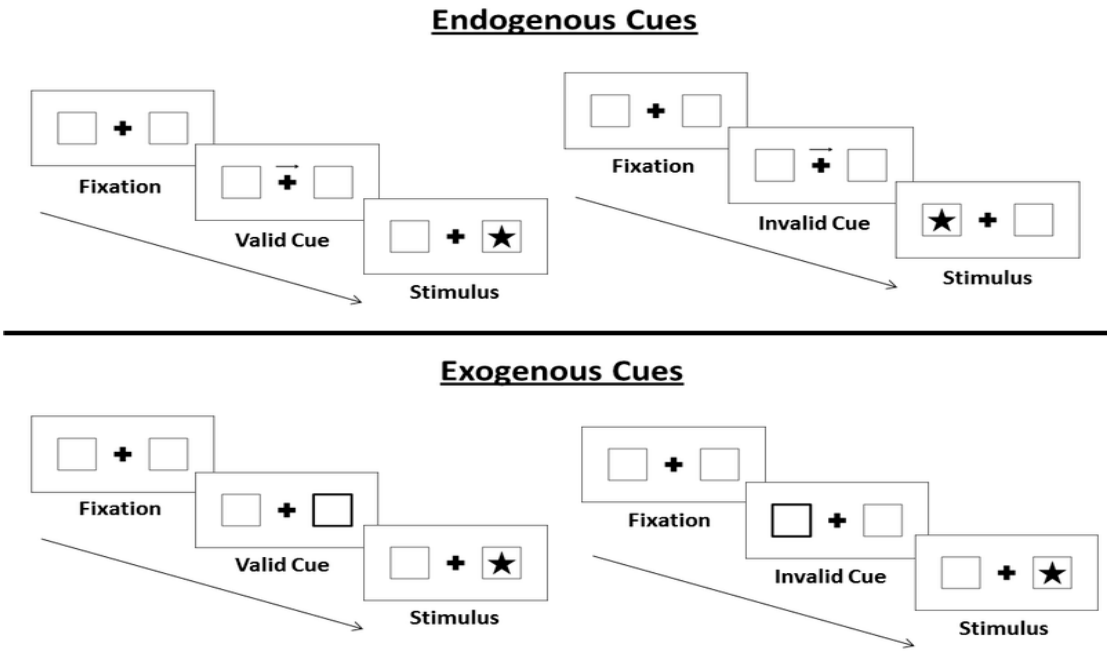
Attention Development

Because development of an attention span is crucial for early development, it is important to research the ways in which mobile media use may affect attention span. Young children's capacity to learn about the visual world is dependent on their ability to focus, prioritize, and control their attention (Kannass, Oakes, & Shaddy, 2006). Due to their undeveloped linguistic and motor abilities, young children rely on attention to manage the selection and gathering of information needed in order to learn about the world. Attention theory, specifically regarding the development of typical attention span, will shed light on how interactive mobile media may influence attention span development. This proposed study will focus specifically on visual spatial attention span.

Visual spatial attention span orientation can be either endogenous or exogenous (Chica, Bartolomeo, & Lupiáñez, 2013). Endogenous orienting of attention is top-down, or voluntary attention. Spatial attention is oriented endogenously when the observer chooses to orient his or her attention to specific, relevant stimuli, usually by the interpretation of a cue that directs attention to the target. In contrast, exogenous orienting of attention is bottom-up, or involuntary, stimulus-driven attention. Exogenous stimuli comprise multimodal salient stimuli external to the observer such as a moving or flashing target. Salient stimuli can exogenously capture the observer's attention even when he or she has not intended to direct attention to that target.

Michael Posner's spatial cueing paradigm illustrates endogenous and exogenous orienting of attention (Posner, 1980). In the paradigm, attention can be oriented either endogenously, using a spatially predictive central cue, or exogenously, using a spatially non-predictive peripheral cue, in order to detect a presented target. Figure 1 presents a model of the exogenous and endogenous cues used in the Posner paradigm. In this cueing paradigm, observers' ability to focus on the task and detect the target is significantly better when the target is presented at the cued location using endogenous cueing. Thus, the ability to intentionally and purposefully focus one's attention is associated with better awareness and focus.

Figure 1. Posner special cueing paradigm cues



As for the development of attention, in infancy, exogenous stimuli initially controls attention. However, as children develop and gain experience, endogenous stimuli come to influence their attention (Ruff & Capozzoli, 2003; Oakes, Kannass, & Shaddy, 2002; Wright et

al., 1984). Researchers have developed the exploration-to-search model to explain this sequence of attention development (Wright & Vlietstra, 1975; Huston & Wright, 1983). In the initial exploration stage, external, perceptually salient stimuli govern young children's attention. As children explore their environment, their ability to focus their attention is dependent mainly on novel, external stimuli that can capture and hold their attention. Stimuli high in perceptual salience that often attract and hold children's attention in early development include stimuli with novel movements, contrasts, surprises, complexity, and incongruity (Berlyne, 1958 as cited in Gola & Calvert, 2011). Mobile media, such as iPads, with their numerous entertaining and interactive apps and games, constitute perceptually salient, exogenous stimuli that are enticing and engaging to infants and young children. As a consequence, young children can intently focus on mobile media activities for long periods of time. However, existing research has not explored whether sustained visual spatial attention can be transferred from exogenous driven mobile media to more endogenous driven materials. This study proposes to examine the effect of mobile media use on attention, to determine if endogenous driven attention is deterred when children are continuously exposed to exogenous stimuli through frequent iPad use.

Endogenous attention develops within the "search" stage of the exploration and search model. In this stage, children transition to an active and selective search for information and engaging stimuli. They make a conscious decision to maintain their attention to specific stimuli regardless of its novelty or perceptual salience (Wright & Vlietstra, 1975; Huston & Wright, 1983). Ruff and Capozzoli (2003) address these two stages of attention as two attention systems: the first is highly influenced by novelty of objects and the second is mainly self-generated. They found that the transition to the second, higher-level system of attention occurs around 12 months of age when children begin to habituate more quickly to novelty. From 12 months onward, the

duration of attention based on the first system should decline as the second system of attention slowly develops, improving cognitive skills and increasing self-regulatory skills. The second system begins to strongly govern attention in the later preschool years.

Ruff and Capozzoli (2003) also found an effect on the type of attention based on age. In a study of 172 children at ages 10, 26, and 42 months old, researchers coded attention during play with toys as casual, settled, or focused. Overall, their results indicate a developmental transition in the processes underlying attention during children's play, such that casual attention decreased while focused attention increased with age. Researchers found that even when the youngest, 10-month-olds, were focused, they were more easily distracted than the older children. The oldest, 42-month-olds, were more focused, even in the presence of distracters. Kannass, Oakes, and Shaddy (2006) corroborate this research. They found that at 31 months of age, children who are effective at ignoring distracters are better able to maintain attention for longer durations during multiple object free play. The results also indicate that typically developing preschoolers across development are more effective than preschoolers with attention deficits at maintaining sustained attention in tasks. Therefore, at around 3 years of age, typical development should show children possessing more focused, sustained attention even when presented with distracters. In examining iPad use effects on attention, this study hypothesizes that due to the many exogenous interactive stimuli and constantly changing visual stimulation in iPad apps and games, children may not learn to inhibit visual distracters, which may slow their development of visual spatial attention span in circumstances without rapid exogenous stimulation.

Television Viewing and Attention Effects

The American Academy of Pediatrics (AAP) discourages the use of media for children two years old and younger (American Academy of Pediatrics, 2011). However, despite this clear

recommendation, infant and toddler media use remains prevalent (Radesky, Silverstein, Zuckerman, & Christakis, 2014). Many parents steadfastly believe that there are beneficial effects of early exposure to television and computers. A 2006 survey of 1,000 US families with children between 2 and 24 months old revealed that the leading justification parents gave for allowing infant video/DVD viewing is that such media use "teaches him/her something or is good for his/her brain" (Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009). Although current research has found educational television and videos to be ineffective for children 30 months and younger, this belief remains prevalent (Anderson and Hanson, 2013). Given the popularity of mobile media and parental beliefs in the benefits of early childhood media use, there is an urgent need for research on how mobile media use influences attention span development in young children.

A review of the current body of research on TV screen time effects on children reveals that a majority of studies found a negative association between amount of screen time and sustained attention span (Anderson & Hanson, 2013; Radesky, Silverstein, Zuckerman, & Christakis, 2014; Landhuis, Poulton, Welch, & Hancox, 2007; Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Zimmerman & Christakis, 2005; Hornik, 1981; Singer, 1980; Swing, Gentile, Anderson, & Walsh, 2010; Kumari & Ahuja, 2010). As an example, a general population longitudinal study tracking children's television viewing at ages 5, 7, 9, and 11 years found a positive association between hours of TV viewed in childhood and severity of attention problems in adolescence (Landhuis, Poulton, Welch, & Hancox, 2007). This association is significant even after controlling for gender, attention problems in early childhood, cognitive ability at 5 years of age, and childhood socioeconomic status. The results of this study indicate that childhood television viewing may contribute to the development of long-lasting attention

problems into adolescence. This association found between amount of TV use and subsequent attention problems leads to the hypothesis that amount of mobile media iPad use is positively associated with level of sustained attention problems. However, researchers' inability to assess whether preschool viewing had an impact on attention, due to lack of data retrieved from before age 5, poses a limitation to this study. Researchers are also unable to pinpoint which aspects of television viewing may have contributed to the attention problems, and whether or not type of programming, such as entertaining versus educational, had different effects on attention.

Because screen time for many children begins before the age of 5, researching preschool viewing impacts on attention is important. Zimmerman and Christakis (2005) examined the effects of such early toddler and preschool television viewing. They researched the effects of TV and video exposure at ages 2, 3, and 5, on children's cognitive outcomes at ages 6 and 7. Using data from the National Longitudinal Survey of Youth 1979 Children and Young Adults (NLSYChild), researchers drew a sample of all children who were approximately 6 years old. They recorded hours of television watched per day prior to 6 years old for the three following predictor variables: television viewing before 3 years of age, viewing from ages 3 to 5, and viewing at age 6. Researchers then assessed cognitive outcome measurements using the Peabody Individual Achievement Test and the Memory for Digit Span assessment from the Wechsler Intelligence Scales for Children. Their results indicate that television viewing before 3 years of age positively correlates with adverse cognitive outcomes on reading skills and comprehension, focus and attention, and memory at ages 6 and 7. These associations remained significant even after controlling for parental investment in cognitive outcomes, innate cognitive ability from parents, race, ethnicity, language spoken, income level, parent's education, number of people in the household, gender, participation in Head Start, and rural versus urban residence.

Radesky, Silverstein, Zuckerman, and Christakis' (2014) study corroborates this research. They found that media exposure is associated with later problems in language development, cognition, attention, executive functioning, and school achievement. They found these effects to be more pronounced with higher levels of media exposure and lower educational content of programs viewed. The researchers were also able to propose causes for these detrimental effects, positing that TV replaced enriching activities with adults and peers, reduced play and language-based interactions with parents, and resulted in less active and creative child play. If early infant and toddler exposure to TV has been shown to negatively affect cognitive outcomes, such research supports the hypothesis that early exposure to iPad mobile media, a more pervasive form of screen time, is also likely to have detrimental cognitive outcomes.

The research on the effects of toddler and preschool television viewing succeeds in identifying negative cognitive outcomes associated with greater amounts of media exposure. However, neither study examined what characteristics of TV specifically influenced cognitive effects, nor focused exclusively on attention outcomes. Christakis, Zimmerman, DiGiuseppe, and McCarty (2004) addressed this gap in the literature and theorized that the rapid sequencing of changes during television and video programming may influence neurological development. They hypothesized that early exposure to television during the critical periods of synaptic development, ages 1 and 3, would be associated with subsequent attention problems at age 7. The results of their study indicate that early television viewing is associated with subsequent attention problems. During the first few years of childhood, the brain has considerable plasticity and therefore may be overstimulated by rapid image and scene changes commonly found in TV. Such overstimulation can adversely affect brain development by affecting the number and density of neuronal synapses. Even though TV may be overstimulating, children find it

extremely engaging with its often rapidly changing images, scenery, and events and exercise exogenous attention to focus on the screen. Children may find reality to be less eventful or boring in comparison to life portrayed on TV with its attention-grabbing stimuli and fast-paced editing (Hornik, 1981; Singer,1980). Therefore, for children, watching large amounts of TV may lead to lower tolerance of slower-paced, more mundane tasks or tasks that require more endogenous attention. Children would thus develop shorter sustained attention spans when not engaged with screen time. A limitation to this study, however, is that content of television viewing is not addressed. It is possible that educational versus entertaining content may influence attention span. This proposed study will examine content of iPad use in terms of level of endogenous and exogenous stimuli in each app used by children in order to account for possible moderating effects.

Despite the large body of work that has found associations between screen time exposure and decreasing attention span, the association remains inconclusive because some studies have shown no association between the two variables. For example, Foster and Watking (2010) found no meaningful relation between television viewing and attention problems in children. Using data from the National Longitudinal Survey of Youth (N = 1,159), this study reexamined the link between television viewing at ages 1 and 3 and attention problems at age 7 that Christakis, Zimmerman, DiGiuseppe, and McCarty (2004) found. These researchers found that the association between early television viewing at ages 1 and 3 and risk of attention problems measured at age 7 is a nonlinear relationship such that the association is significant only for the 10% of the sample who watched 7 or more hours of TV per day. In addition, researchers found that when controlling for measures of maternal academic achievement and family income in the child's early life, the associations between television viewing and attention problems are no

longer significant, thus contradicting the Zimmerman and Christakis' (2005) results that suggested a significant effect even after controlling for these variables. Therefore, overall, the effects of media use and screen time on attention development needs to be further researched in order to draw a more reliable conclusion. Researching mobile media iPad effects is needed because it is the new most prevalent form of media use for children in the US.

Video Games and Attention Effects

While research on TV can inform future research on mobile media use, a large difference exists between TV use and mobile media iPad use. TV viewing is a passive activity whereas mobile media iPad use entails interactive engagement. An existing form of interactive media that has been around longer than mobile media is video games. While video game effects on development have not been as thoroughly researched as TV viewing, the following studies are important for examining the association between a form of interactive screen time use and children's sustained attention span. Swing, Gentle, Anderson, and Walsh (2010) used a sample of 1,323 middle childhood participants, ages 7 through 11, and 210 late adolescent/early adult participants to study the association between video games and attention problems across age. For the middle childhood participants, researchers collected parent-and-child reports regarding amount of video game exposure, and assessed attention problems using teacher-reports on behavior. As for the early adult/late adolescent participants, they self-reported amount of video game use and completed a battery of tests to assess their mental health status. Researchers found that the amount of time spent playing video games is positively associated with levels of attention problems for both groups. While the association between video game use and attention problems is similar in strength to the association with passive television viewing for both middle childhood and late adolescence and early-adulthood groups, in middle childhood the video game

association is more consistent than the television association in predicting attention problems. Thus, this research suggests that interactive forms of media are likely to have more prominent and predictable effects on attention span. In addition, due to the use of the two different age groups, the study also suggests that attention effects are observed across ages from middle childhood to early adulthood, and that such consequences may be long lasting or cumulative.

Kumari and Ahuja's (2010) findings on video game use effects on cognitive functions, including attention span, supports these results. In a study of children from ages 9 to 12, they found that heavy video game use is also associated with poorer performances on tests of attention span, creative imagination, and visual memory in comparison to light video game users. They proposed that these negative effects are found because children's video games, due to their constantly changing and interactive stimuli, demand that their viewers make constant attention shifts. This type of interaction with media does not require children to exercise sustained, prolonged attention to real-life events. These studies on video game use, however, similar to the television viewing studies, did not take into account the content of video game programming being used. Therefore, educational video games will possibly have different cognitive effects on children than entertaining video games.

Current iPad Research

While research on TV and video game screen time can inform and guide research on new mobile media, it is faulty to assume that TV, video games, and mobile media have the same degree of effects. Mobile media differs from other forms of media in several ways that may influence its effects on attention span. Unlike television, the iPad has multiple modalities and interactive capabilities (Radesky, Schumacher, & Zuckerman, 2015). In comparison to both TV and video games, iPads are also more pervasive and thus are ubiquitous in children's lives. They

are more easily accessible to children because they are portable and lightweight, and therefore can be brought to and used in a variety of settings and locations (Kucirkova, 2014). In addition, due to their touch screen function, iPads eliminate the need for external devices, such as a mouse and keyboard, that require certain levels of dexterity. IPads are also designed to accommodate a number of apps, many of which are created to appeal to children through child-friendly intuitive designs.

A review of current interactive mobile media research shows that little research has been done to study mobile media longitudinal effects on visual spatial attention span. The existing body of iPad research focuses instead on social emotional development effects and media use specifically as an educational tool. Radesky, Schumacher, and Zuckerman (2015) studied how parents are using mobile media as a behavioral regulation tool in order to keep them pacified and engaged during outings. These researchers explained, however, that although mobile media devices may be helpful in the short term for occupying children, overuse of such devices to pacify children could be harmful to later social-emotional outcomes. Children may be less likely to develop the internal mechanism of self-regulation if they are not given the opportunity to calm themselves down without the aide of a media device. Mobile media may have a similar association with attention span, such that if the child is exposed to mobile media as a behavior regulation tool in many different settings, the child will be less likely to develop sustained attention or focus on at-hand tasks and situations. Mobile media would serve as a constant distracter by offering constantly shifting stimuli that would prevent children from having to maintain sustained attention to any stimuli for too long.

In terms of research regarding iPad functioning specifically as an educational tool, studies have shown contrasting results for the effectiveness of interactive media on learning and

reading comprehension. In a study on mobile media book format effects on reading comprehension, children are found to comprehend significantly less when reading electronic books than when reading traditional book. Electronic book reading is associated with an increase in parent distraction talk about book format and technology use (Krcmar & Cingel, 2014). During electronic book reading, there is less parent talk focused on the plot and story elements. However, Kucirkova (2014) found a contrasting effect, such that iPad electronic books and interactive learn-to-read apps are associated with an increase in early literacy skills by providing additional practice with word and letter recognition and phonics. However, researchers found that this effectiveness of iPads is contingent on the context of use, such that teachers' ability to effectively link the iPad tasks to the curriculum is directly related to the learning potential of the iPad. Therefore, while iPad use may have the potential to produce positive cognitive effects, it is only when there is direct instruction and interaction with an adult or teacher that these effects are found. Everyday use of an iPad is likely to show no educational benefits, even with the use of educational apps, without the social interaction and instructive component. Using the iPad by oneself has not been shown to promote reading comprehension, most likely because the media form and the electronic book enhancements deter the child's attention to the story (Roseberry, Hirsh-Pasek, & Golinkoff, 2014). Building from this research of a decreased focus on story plot when reading stories on mobile media, other activities performed on the iPad, especially if not educationally focused, may associate with stimulating less sustained, focused attention in children.

Research on the educational effectiveness of the iPad has found that the touch screen is an innovative and unique feature. A touch screen allows young children easy access to mobile media use, as advanced motor skills are not required to operate an iPad that functions mainly

through finger-swipes and taps. Research conducted on whether or not what children learn from a touch screen can be replicated in real life has found that learning does not transfer from 2D objects and symbols to 3D counterparts for young children as easily as it does from within-dimension (2D/2D or 3D/3D) conditions (Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009). Using a sample of seventy-two fifteen to sixteen-month-old infants, researchers had infants either participate in a cross-dimensions condition, during which infants would observe an action on a 2D display and then be prompted to imitate the action on a 3D object and vice versa, or they would participate in a within-dimension condition, during which infants would imitate an action observed on a 2D screen on a similar 2D setup, or similarly with a 3D object. They found that the cross-dimension groups performed significantly worse than the within-dimension groups, suggesting a video deficit in transferring learning from 2D to 3D and vice versa. Although attention effects are not examined in this study, similar to learning, attention may not transfer from 2D interactions to 3D interactions. If attention span thus does not translate from media use to reality, persistent iPad use may result in children's attention span being contingent on immediate reward and engaging stimuli, both of which are characteristics not commonly found in other daily activities such as school work or social play.

IPad Use and Attention

While the previous studies have addressed children's attention while using a mobile media device, they have not addressed what elements of the iPad have made them so appealing to young children, and thus more frequently used. Christakis (2014) explored why iPad apps and interaction in general can capture the attention of young children and lead to excessive mobile media use. He theorized that tablet and iPad games are similar to interactive toys with which babies learn cause and effect by receiving the reward of making something happen by pressing a

button. He describes it as the rewarding feeling of "I did it!" Christakis (2014) claims that it is both edifying and potentially addictive for a child when they derive pleasure from touching a screen and making something happen, and thus they can remain attentive to the iPad for long periods of time. However, Christakis (2014) fails to address whether sustained attention fostered during iPad use translates to different activities and tasks apart from mobile media that often do not offer an immediate reward.

Current research on mobile media and iPads overall has shown that context of interactive mobile media is significant in determining media effects on children, and that content of media use has the potential to influence such effects. However, in the majority of studies that have researched the effects of media use on attention, data on content of programs viewed, such as educational versus entertaining, are not recorded or factored into data analysis. Therefore, it is important that such variables be assessed in this study's research on the effects of mobile media use in early childhood. In addition, while most of the studies reviewed did examine iPad use in early childhood, there is a gap in the literature of long-term cognitive effects of using these devices extensively during early years of life. According to Radesky, Schumacher, and Zuckerman (2015), researching effects of mobile media use for infants, toddlers, and preschoolers is especially vital because such effects are potentially more prominent for these younger groups going through major developmental periods in their lives. This study will address the literature gap of early childhood iPad use effects on cognitive development, specifically visual spatial attention span.

Proposed Study

In this cross-sectional correlational study, researchers will investigate how mobile media use in early childhood affects development of visual spatial attention span in young children.

Specifically they will examine how the interactivity, accessibility, and portability of iPads influence the amount of mobile media use, and how that amount in turn affects attention span. In addition, researchers will collect data on the content of media use by looking at the levels of exogenous stimuli present in most frequently used apps and viewed TV programs. They will recruit a sample of children ages 3 to 6 who began media use at age 3 or younger, and categorize the sample into three groups within their age range: TV viewers only, interactive iPad users, and passive iPad users. Children from all groups will arrive at the lab where they will take an attention test while parents fill out questionnaires regarding child media use. Parents will report information on average weekly amount of iPad or TV use, most frequently used iPad apps or viewed TV programs, and context and location of iPad use. Parents will also complete a survey of family background and history to control for confounding variables. Researchers will assess the length of visual spatial attention span for each child upon completion of the attention test, and then perform data analysis to detect associations between parent-reported media use variables and length of sustained attention. In order to see potential long-term effects of iPad use on attention, researchers will compare data from the different ages to assess possible trends.

IPads are designed to be portable, lightweight, easy to use, and easily accessible in nearly every location. These new devices have thus become prevalent in children's lives as parents find them to be an easy method of occupying their child whether at home or out of the house. Researchers hypothesize that increased use of the iPad in various contexts outside of the home, coupled with its enticing interactive features and engaging stimuli, will correlate with increased amounts of iPad use. Increased amounts of iPad use in early childhood may be associated with higher levels of sustained attention problems. In addition, content of apps used in terms of level of exogenous factors is also likely to influence attention. Researchers predict that interactive iPad

use is more likely to have more exogenous stimuli, which could lead to higher levels of attention problems due to constant contact with exogenous stimuli, which in turn hinder the development of endogenous attention needed for sustained attention in tasks apart from mobile media. In contrast, passive iPad use is likely to correlate with lower levels of exogenous stimuli. Researchers hypothesize that an increased amount of iPad use coupled with interactive use high in exogenous stimuli will have a greater negative effect on sustained attention.

The variables of amount, context, and type of use will differentiate iPad use from TV in terms of amount of hours spent with each form of media, where and how each media form is used, and interactive or passive use of the media. Researchers predict that these factors will correlate with the strength of effect each media form has on attention span. They also hypothesize that because of these variables, even passive use of iPads could have greater effects on attention than passive viewing of TV due to more frequent use in various contexts. Researchers will use the data collected on the content of iPad app use in terms of level of exogenous stimuli in order to detect differences in attention span between passive iPad use and interactive iPad use. Finally, researchers predict that mobile media iPad use effects on length of visual spatial attention span will be found at all ages throughout early childhood.

Proposed Method

Participants

Researchers performed a power analysis in order to determine the number of child participants needed for this study. First, they determined a medium effect size from previous research on television viewing effects on attention conducted by Landhuis, Poulton, Welch, & Hancox (2007). Using Cohen's (1992) power table, for a power of .8 with a medium effect size

and an alpha of .05, researchers established that this study will need 160 participants. These 160 participants will include children between the ages 3 and 6 living in two-parent households who began media use at age 3 or younger. There will be approximately 40 children in each age range: 3 to 3 years and 11 months, 4 to 4 years and 11 months, 5 to 5 years and 11 months, and 6 to 6 years and 11 months. Participants will have access to iPads or/and television within the home. Children with ADHD/ADD, autism, or other developmental or neurological delay diagnoses will be excluded from the study. All participants will also have normal visual acuity, or corrected to normal.

Participants will be recruited so that there are three groups of media users for each age range: passive iPad users, interactive iPad users, and TV use only users. Passive iPad users are defined as those who use the iPad as a program-viewing device without manipulation or utilization of the touchscreen during program duration. For example, children who watch YouTube videos or movies on the iPad are passive users. Interactive users are defined as those who utilize the touchscreen function to physically manipulate what is on the screen during the duration of app use on the iPad. For example, children who play games such as Angry Birds on the iPad where swiping motions on the touchscreen is necessary will be determined as interactive users.

Pew Research Center found that demographic groups that are most likely to own tablets include those in households earning at least $75,000 per year, adults with at least a college degree, those living in suburban areas, and parents with minor children living at home (Tablet Ownership 2013, 2013). Due to these statistics, researchers predict that the child participant base will be representative of these demographic groups. In addition, Pew Research Center found that there are no statistically significant differences in tablet ownership between members of different

racial or ethnic groups. To control for parent education level, only children whose parents have an undergraduate degree and no higher degree will be recruited. Of the child participants, approximately half will be female and half will be male. Participants will be recruited from a college town and therefore the average annual household income may be slightly higher than that of the general population. Participants will be recruited via flyers in pediatric offices, local preschools, daycare centers, elementary schools, churches, recreation centers, youth centers, local newspaper ads, and parks within a seven-mile radius of the university. In terms of compensation, each child will receive a toy upon exiting the lab. In addition, parents will be compensated $30 along with a booklet of coupons to local children boutiques and stores.

Materials

This study will include a visual spatial attention span assessment tool along with measurements for average amount of media use, age of child, context of media use, and content of media use.

Visual Spatial Attention Span. Children's visual spatial attention span will be assessed using the rapid serial visual presentation (RSVP) subtest from the Early Childhood Attention Battery (ECAB; Breckenridge, Braddick, & Atkinson, 2013). This subtest is a computer task that will be administered via a Dell laptop computer with a screen size of 28.7 centimeters by 21.7 centimeters. The laptop will be placed at a 35 centimeter viewing distance. Brightness, contrast, and luminance of screen for each picture will be kept constant for each trial. In this RSVP subtest, a continuous stream of picture stimuli will be presented on the computer screen. Each stimulus has a duration of 200 ms with an inter-stimulus interval of 1800 ms. The child will be asked to verbally report when any of the following five target animals appear: cat, dog, pig,

horse, and fish. The animal targets will be randomly interspersed among non-animal, familiar non-target items with monosyllabic names including car, bike, tree, hat, shoe, shirt, ball, doll, tooth, pie, juice, and slide. Figure 2 shows the stimuli that will be used in this computer task. Children will be shown the target animal images and told the names of the animals in order to ensure that they know what they are looking for. Children will take initial practice tests until they feel comfortable with fulfilling the requirements of this task.

Figure 2. Target and non-target stimuli

One hundred twenty non-targets and 30 targets will be presented over a 5-minute session. Two research assistants will record the child's verbal reports. Two researchers will keep record in order to increase the reliability of data collection. If a child misses four consecutive targets, they will receive a prompt to pay attention. The number of correct responses, commission errors, and prompts will be recorded. Commission errors are determined as responses to non-targets. Overall score on this assessment will be calculated by number of correct responses minus number of commission errors and prompts. The higher the overall score, the higher the level of visual sustained attention (see Appendix A for the RSVP subtest model). Breckenridge, Braddick, and Atkinson (2013) found the ECAB to have good reliability ($r = 0.75$) and good convergent validity ($r = 0.77$).

Amount of Media Use. Caregivers will report how many hours their child uses an iPad on a typical weekday and a typical weekend day. A composite score will be calculated to find the average daily amount of iPad use. This average daily amount of iPad use will be calculated by multiplying the weekday response by five, the weekend day response by two, adding the two results, and then dividing by seven. Parents who report that their child uses the iPad for more than 16 hours per day will be dropped from analysis, because such responses have been found to be non-credible (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004; Zimmerman & Christakis, 2005). The same question formatting will be used to determine TV use by replacing the word "iPad" with "TV."

Pervasiveness of Media Use. Pervasiveness of iPad use and TV use will relate to the settings in which children have access to media and how often children use media in these settings. Caregivers will record how often the child uses the iPad or views TV outside the home, in the car, at a restaurant, during social gatherings, and while waiting for services either in a line

or in a waiting room. Responses will be recorded using a Likert scale from 1-4 (1- *never*, 4– *always*; See Appendix B for exact measure of context of media use). Composite scores will be calculated by taking the average of the scores. Higher scores are indicative of more pervasive use of media in daily life. In addition a factor analysis will be preformed to make sure all of the items for this measure are measuring the same thing.

Content of Media. Content of media use will refer to the level of exogenous stimuli in the TV programs children watch and in the programs or apps children use on the iPad. Caregivers of the TV-use-only group will report what three TV programs their child most frequently watches. Caregivers of iPad use groups will report what three programs and apps their child most frequently uses. Research assistants who have been trained in research ethics and have shown high inter-rater reliability in identifying exogenous stimuli will access the programs and apps and determine their level of exogenous stimuli using a Likert scale from one to four (1- no exogenous stimuli, 4- all exogenous stimuli). Composite scores for the content of use will be calculated by taking the average of the three scores.

Age. Caregivers will report the current age of the child to the nearest month, for example, 3 years and 9 months old. Caregivers will choose year and month options from a drop down menu. The year drop down menu will include the numbers 3, 4, 5, and 6. The month drop down menu will include numbers 1 through 11.

Demographic Information. Caregivers will complete a demographic background survey, the responses of which will be used to control for the following covariates: gender, race and ethnicity, socioeconomic status, gestational age of child at birth, birth weight, maternal use of alcohol or tobacco during pregnancy, language spoken in the home, amount of media use within the last week, and starting age of media use (see Appendix C for the complete survey).

These covariates are controlled for in previous research on media use and attention effects (Radesky, Silverstein, Zuckerman, & Christakis, 2014; Zimmerman & Christakis, 2005), and therefore are also predicted to be influential in this study on iPad use and attention . Gender of the child will be a dichotomous variable of male or female. For race and ethnicity, the following choices will be available: White (non-Latino), Latino, Asian/Asian American, Pacific Islander, African American/Black, Native American/Alaskan Native, or Mixed. Socioeconomic status will be determined by reported annual household income. Caregivers will record the gestational age of their child at birth in months, birth weight in pounds to the nearest ounce, whether the mother used alcohol or tobacco during pregnancy (any or none), and language spoken in the home (English vs. non-English). For determining amount of media use in the last week, parents will report how many hours their child used the iPad or viewed TV within the past week, As for calculating starting age of use, caregivers will record at what age, to the nearest year, did their child start using the iPad or view TV.

Procedure

Upon arriving at the laboratory and after parents provide informed consent and child participants provide assent, the child will enter a room with a one-way mirror where he or she will engage in a five-minute socialization period with a research assistant. After the socialization period the research assistant will explain the ECAB visual sustained attention computer task instructions.

While the child is completing the ECAB subtest, caregivers will stay behind the one-way mirror. First, they will report to research assistants the three most frequently used iPad apps or viewed TV shows by their child. Then, caregivers will enter the following predictor variable

information into a computer: current age of child, average weekday and weekend day media use, and context of use. Following that data collection, parents will complete the demographics survey. Children who complete the attention assessment before parents have completed their surveys will be given a toy to play with in the lab room until parents are finished.

At the end of the session, participants will be fully debriefed and children and parents will be compensated.

Ethics

Due to the increasing prevalence of young children's iPad and mobile media use, it is imperative to study the effects of these new media devices on children's attention span. Very little research has been done to date on the long-term cognitive effects of mobile media use in early childhood. This proposed research will attempt to address these gaps in the literature. This study will use a sample of one hundred and sixty children from ages three to six. Although these children are a protected population, it is necessary to have a sample of children within this age range in order to understand how mobile media use influences attention span in early childhood, and how such effects may persist throughout those years. An increase in amount of iPad mobile media use has been found in early childhood (Common Sense Media, 2013), and therefore it is crucial to study this target population. Safeguards will be put in place to protect this population, such as enforcing that all participation be voluntary. Participants will be the children of the caregivers who respond to flyers calling for participants for the study. Caregivers will be required to give informed consent and children will be required to give assent before any testing takes place. Therefore, both the adult and child will have to agree that they want to proceed with the study.

After the child and adult give their assent and consent, they will partake in the minimal risk study. All data collection will be anonymous. Parents and children will be assigned matching numbers upon arrival at the lab, so that parent survey data and child test data can be paired during data analysis. No names or identifying information will be collected other than gender and ethnicity of the participants. Because of the expected diversity in the sample group, gender and ethnicity will not allow for participant identification. After receiving their number assignments, the children will perform an attention test. The test will take place on a computer. The child merely has to respond to the changing picture prompts on the screen and verbally exclaim when he or she sees an animal picture. The distractor prompts will consist of pictures of daily household objects including a car, bike, tree, hat, shoe, shirt, ball, doll, tooth, pie, juice, and slide. The target prompt will include five animals: cat, dog, pig, horse, and fish. These prompts are low risk because they are objects and animals a child is familiar with and may encounter on a daily basis.

While the child is taking the test, parents will remain outside the room behind a one-way mirror, completing a survey on media use and family background and history that asks for no sensitive information. Therefore, these surveys are also minimal risk. If the child is in distress about being away from his or her parent, the parent will be allowed to stand at the back of the room. Parent placement will be noted and accounted for in data analysis for possible confounding effects, if such a situation were to occur. This protocol adds additional protection for the children by working to minimize and prevent any distress they may have. Furthermore, no deception will be involved in this study. The procedure will consist only of an attention test completed by the child, and the measurement and demographics surveys by the parent. Upon completing the study tasks at the end of the lab session, participants will be fully debriefed and

compensated. There are expected to be no long term-consequences on the child or parent upon completion of their participation.

Because of the dearth in research on this topic, there are few empirically based recommended guidelines for caregivers on how to regulate mobile media use for young children. The benefits of conducting the proposed research include using the results to help create guidelines for parents, teachers, and pediatricians on the best and most appropriate way to monitor mobile media use for children in early childhood. This study will give crucial insight into how mobile media use affects visual spatial attention span in early childhood. Because young children's capacity to explore and learn about their visual world is dependent on their ability to hold their attention, it is important for caregivers to understand the potential consequences and risks of mobile media use on children's visual spatial attention span development (Kannass, Oakes, & Shaddy, 2006). Therefore, the benefits of this study outweigh the potential risks.

Analytics

Before testing the hypotheses, researchers will perform descriptive analyses in order to check for normality of data and heteroscedasticity of errors. If the data is not normally distributed, researchers will appropriately transform the data. If the errors are heteroscedastic, researchers will perform the appropriate nonparametric tests. For the purposes of this proposed study, researchers will assume normality of data and homoscedasticity of errors. Therefore, researchers will present the results from the appropriate parametric tests. In addition, researchers will control for the following covariates in each test: gender, race and ethnicity, socioeconomic status, gestational age of child at birth, birth weight, maternal use of alcohol or tobacco during

pregnancy, language spoken in the home, amount of media use within the last week, and starting age of media use.

Researchers will perform a multiple regression with level of pervasiveness, a continuous predictor, participant group, a contrast-coded predictor, and amount of media use as the dependent variable. As both predictors are continuous, a multiple regression is appropriate. Researchers will use a multiple regression to test the hypothesis that, while controlling for level of pervasiveness, iPad use groups correlate with longer amounts of media use in comparison to TV use groups. This analysis will also test whether an interaction between participant group and level of pervasiveness exists due to higher levels of pervasiveness correlating with longer amounts of media use.

Researchers will conduct another multiple regression with amount of media use, level of pervasiveness of use, content of use, and age, all continuous predictors, and with participant group, a contrast-coded predictor. The continuous dependent variable will be visual spatial attention span. This analysis will test the hypothesis that, while controlling for age, the content of media use correlates with length of visual spatial attention span. This analysis will also test the hypothesis that participant group correlates with length of visual spatial attention span, even while controlling for amount of media use. In addition, because longer amounts of media use are expected to correlate with shorter visual spatial attention spans, this analysis will test whether an interaction exists between the amount of media use and participant group. Furthermore, this analysis will test the hypothesis that the interactive iPad user group, in combination with an interaction of high amounts of media use, high levels of pervasiveness, and high levels of exogenous stimuli will have the strongest correlation with shorter visual spatial attention spans relative to all other groups.

Predicted Results

First, researchers will perform a typical log transformation on the RSVP data and conduct an outlier analysis. Any outliers will be removed from data analysis. Next, researchers will calculate composite scores for the following predictor variables: pervasiveness of use, content of use, and amount of use. For each subsequent analysis, consistent with previous literature on media use and effects on attention, researchers will control for the following covariates: gender, race and ethnicity, socioeconomic status, gestational age of child at birth, birth weight, maternal use of alcohol or tobacco during pregnancy, language spoken in the home, amount of media use within the last week, and starting age of media use (Zimmerman & Christakis, 2005; Radesky, Silverstein, Zuckerman, & Christakis, 2014).

In order to first establish that iPad use correlates with longer amounts of media use in comparison to TV, researchers will perform a multiple regression using the following predictor variables: participant group and level of pervasiveness. The predictor variable participant group consists of the following three groups: interactive iPad users, passive iPad users, and TV viewers. The dependent variable in this analysis will be the amount of media use. Researchers predict that there will be a significant main effect such that when controlling for level of pervasiveness, participant group will have an effect on amount of media consumption. Both groups of iPad users are expected to demonstrate longer amounts of media use than TV use. This prediction is based on what is known about how iPads are designed to increase their appeal to children. IPad's touchscreen interactive interface eliminates the need for more advanced dexterity to manipulate external devices when using a media device, thus allowing for easier child use and access (Kucirkova, 2014). Also, iPads are exclusively designed to accommodate

numerous apps, many of which are created to appeal directly to children. These features would increase the appeal of iPad use and encourage longer use in comparison to TV viewing. Researchers also expect to find an interaction between the variables such that the level of pervasiveness moderates the relationship between participant group and amount of media used. For example, interactive iPad users with higher levels of pervasive media use will have used media for longer amounts of time, whereas interactive iPad users with lower levels of pervasive media use will have used media for shorter amounts of time. This prediction that iPad user groups spend more time with media is based on research that has found that iPads' portability and easy-to-use features increase the likelihood for higher consumption levels among children (Radesky, Schumacher, & Zuckerman, 2015). In addition, iPad user groups are more likely to have more time with media because of parents' tendency to use iPads as a behavioral regulation tool (Radesky, Schumacher, & Zuckerman, 2015).

In order to test for the predictor variable effects on visual spatial attention span, researchers will perform a multiple regression with the following predictor variables: participant group, amount of media use, level of pervasiveness of use, content of use, and age. The dependent variable will be visual spatial attention span. Researchers first expect to find a negative correlation between the amount of media use and length of visual spatial attention span, such that longer amount of media use will be associated with shorter visual spatial attention span. Previous research on TV use and attention has shown a similar association, such that increased amounts of TV viewing is associated with higher rates of attention problems (Landhuis, Poulton, Welch, & Hancox, 2007; Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004).

In addition, researchers hypothesize that the multiple regression will reveal a main effect between age of the child and content of media use. They expect that controlling for age of the

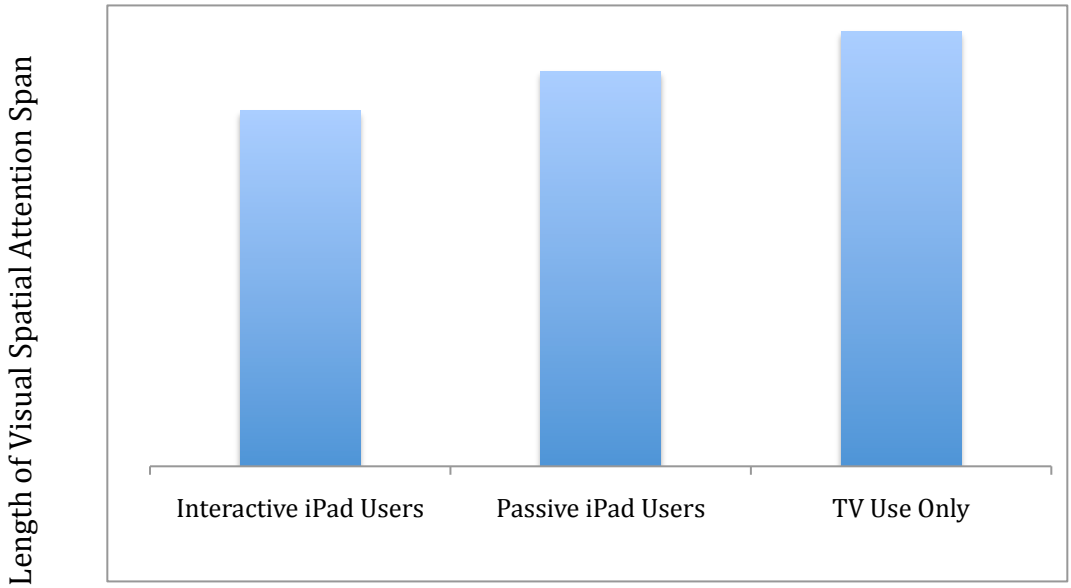
child, content of use will correlate with visual spatial attention span such that higher levels of exogenous stimuli will correlate with shorter visual spatial attention spans. This prediction is based on attention development theory research that has found that stimuli with high levels of exogenous stimupi—novel movements, contrasts, surprises, complexity, and incongruity--can hamper children's abilities to learn to inhibit visual distracters (Ruff and Capozzoli, 2003). Kannass, Oakes, and Shaddy (2006) also found that children who are effective at inhibiting responses to distracters are able to maintain longer attention span. Researchers also hypothesize that there will be no interaction between age and content of use such that the relationship between high levels of exogenous stimuli and shorter visual spatial attention span will remain constant for all ages. There will be no decrease in the effects of exposure to exogenous stimuli with age. This prediction is grounded in attention development theory that states that around 3 years of age, typical development should show children exhibiting more focused, sustained attention even when presented with distracters (Kannass, Oakes, and Shaddy, 2006). Children at 3 who are exposed to high levels of exogenous stimuli through media use are less likely to be able to inhibit distracters and thus would not develop sustained attention. If children continue to engage with exogenous stimuli as they age, they will not develop the skills to inhibit visual distracters and thus will continue to have short visual spatial attention spans. Researchers also predict that the interactive iPad user group will correlate with the highest levels of exogenous stimuli relative to the other two groups. This prediction is based on research on video games that has shown that interactive media incorporate perceptually salient and constantly changing stimuli that demands viewers to make constant attention shifts (Kumari and Ahuja's 2010). This type of interaction with media in turn prevents children from exercising sustained, prolonged attention to real-life events.

Noting the association between participant group and amount of media use, researchers hypothesize that there will be a main effect between the two variables and how they influence visual spatial attention span. Controlling for amount of media consumption, researchers expect participant group to correlate with the length of visual spatial attention span such that interactive iPad user groups will exhibit the shorter visual spatial attention spans relative to passive iPad users and TV users. Researchers's prediction is based on knowledge of the prior established association between interactive iPad use and exposure to higher levels of exogenous stimuli that have been shown to lead to shorter visual spatial attention spans (Kumari and Ahuja's 2010). Researchers also expect an interaction between amount of use and participant group that influences visual spatial attention span. Longer amounts of use will correlate with shorter attention span, and participant group will moderate this relationship. Researchers predict that longer amounts of use combined with either of the iPad user groups will be associated with shorter visual spatial attention spans relative to longer amounts of use combined with TV users. They also hypothesize that of the three participant groups, the interaction between longer amounts of use and interactive iPad group users will have the strongest association to shorter visual spatial attention spans. This prediction is based on research that has found a correlation between iPad use and high levels of pervasiveness in children's lives, as well as research that has significant correlations between longer amounts of interactive media use and shorter visual spatial attention spans (Radesky, Schumacher, & Zuckerman, 2015; Kumari & Ahuja, 2010; Zimmerman & Christakis, 2005).

Overall, researchers predict that the multiple regression will reveal that the interactive iPad user group, in combination with an interaction of high amounts of media use, high levels of pervasiveness, and high levels of exogenous stimuli, will have the strongest correlation with

shorter visual spatial attention spans relative to all other groups. Figure 3 shows the predicted lengths of attention span for each participant group.

Figure 3. Media Use Effects on Visual Spatial Attention Span



Overall, researchers predict that the multiple regression will reveal that the interactive iPad user group, in combination with an interaction of high amounts of media use, high levels of pervasiveness, and high levels of exogenous stimuli, will have the strongest correlation with shorter visual spatial attention spans relative to all other groups. Figure 3 shows the predicted lengths of attention span for each participant group.

Discussion

The ability to maintain a sustained attention span is crucial to a young child's capacity to learn about the visual world around them (Kannass, Oakes, & Shaddy, 2006). Young children rely on attention to gather and manage the information they need to navigate and learn about

their environment. The development of such sustained attention begins in early childhood and can be fostered or hindered by environment and upbringing. Childhood media use is one factor that affects children's attention span. As the entertainment industry becomes more technologically advanced, media is becoming more portable and easily accessed. With the rise of mobile media since 2010, children are increasingly gaining more access to media at increasingly younger ages (Common Sense Media, 2013). Despite the rising prevalence of mobile media in children's lives, few guidelines exist to inform parents and educators how to monitor or use such technology with young children. Researchers expect that this study will give insight to caregivers on how mobile media use, specifically iPad use, in early childhood affects visual spatial attention span.

Researchers predict that in comparison to TV viewing, early exposure to iPad use will be associated with shorter visual spatial attention spans. This effect will be constant across ages 3 through 6, such that visual spatial attention span deficits do not normalize over time and children do not become resilient to iPad and media use effects. This finding will be present even while controlling for a number of potential confounding factors such as gender, race and ethnicity, socioeconomic status, gestational age of child at birth, birth weight, maternal use of alcohol or tobacco during pregnancy, language spoken in the home, amount of media use within the last week, and starting age of media use.

Two explanations support this predicted result. One explanation addresses children's amount of media use such that longer amounts of media use are associated with attention problems in children (Landhuis, Poulton, Welch, & Hancox, 2007). Researchers predict that children who use iPads are using media for overall longer amounts of time than those who watch TV exclusively. Because iPads are portable, they can be taken and used in multiple settings.

They have become one of the most convenient behavioral regulation tools for parents, who will allow their children to use mobile media in order to pacify them during routine outings and social events (Radesky, Schumacher, & Zuckerman, 2015). Children thus have access to the iPad in more contexts than TV such as during car rides, restaurant outings, and in waiting rooms, thereby leading to longer amounts of use and exposure to media. In addition, when parents use mobile media as a behavioral regulation tool, children will be less likely to develop sustained attention on at-hand situations or tasks. Children will learn to rely on media devices for entertainment and distraction instead of learning to sit still, self-regulate, and focus on their immediate surroundings regardless of their appeal.

Another explanation for the strong association between iPad use and shorter attention spans involves level of exogenous stimuli exposure. Researchers expect that in comparation to TV use, iPad use will correlate with higher levels of exposure to exogenous stimuli. In contrast to TV, the iPad has multiple modalities and interactive capabilities (Radesky, Schumacher, & Zuckerman, 2015). With iPad use, children are exposed to continuously shifting and interactive stimuli that drive and direct their attention. Because of the numerous exogenous interactive stimuli and constantly changing visual stimulation in iPad apps and games, children may not develop the ability to inhibit visual distracters, and thus face problems in the development of focused visual spatial attention span in circumstances without rapid exogenous stimulation. Notably, researchers hypothesize that interactive iPad use will correlate with the shortest visual spatial attention spans, due to the highest levels of exogenous stimuli associated with interactive media coupled with high levels of pervasiveness and longer amounts of use.

This will be the first study to test the hypotheses of iPad use effects on visual spatial attention span in early childhood. Because this study marks the start of research on iPad use

effects on attention, a correlational study design is necessary to first establish an association between shorter visual spatial attention span and iPad use. However, because of the correlational design, causal inferences cannot be drawn from the observed associations. Frustrated parents who want to keep their child occupied and calm may end up giveing their children who have shorter visual spatial attention spans more access to mobile media. To mitigate this limitation, researchers will exploit the longitudinally of the data set and control for the starting age of media use to be 3 years old or younger for all participants. Attention span first begins to develop at 3 years old (Ruff & Capozzoli, 2003). Therefore, starting media use at this age or younger increases the likelihood that participants will have similar initial attention spans, thus supporting the hypothesis that iPad use has negative effects on attention. However, there are characteristics associated with parenting styles and parents who allow their children to use excessive amounts of media that could account for the relationship between iPad use and attention effects. For example, more neglectful or preoccupied parents might allow their children to use more media. This study is not designed to control for parenting style or domestic environment, and therefore future research should include these measures in their analyses.

Another limitation that warrants consideration is the parent-reported measure used for amount of iPad use. Parental report of media use may not be an accurate measure of the true amount of media use. Although prior research using parental report of television viewed has not resulted in bias findings in either direction, future research could assess amount of media use through more direct means such as through direct observation of participant viewing, daily time-use diaries that also include the shows and apps actually used, or mobile media programs that track and log iPad use (Christakis, Zimmerman, DiGiuseppe, & McCarty, 2004). However, even

if the measurement is merely inaccurate, the effect of random measurement error is to bias the results toward the null.

A similar limitation would be in regards to the dependent variable, visual spatial attention span, which will be measured using the RSVP subtest from the Early Childhood Attention Battery. While previous research has found RSVP tasks to be accurate measurements of visual spatial attention span, the test that children will take in this study is a brief instrument of measurement (Breckenridge, Braddick, & Atkinson, 2013). A more thorough assessment of outcomes including a variety of outcome measurements could reduce measurement error and increase the ability to detect an effect.

Despite these limitations, this study can have important implications. The existing guidelines on media use recommended by the American Academy of Pediatrics are established solely on research on TV effects on childhood development (American Academy of Pediatrics, 2011). With the rise in young children's mobile media use, knowing the effects of mobile media and iPad use can help inform and update recommended guidelines for early childhood media use. Parents, educators, caregivers, and pediatricians need to know how mobile media use should be monitored and the potentially lasting implications of such use on their children's cognitive development. Researchers expect that this study will add visual spatial attention effects to the previously studied consequences of excessive mobile media use, including poor socialization and potentially poor educational achievement (Radesky, Schumacher, & Zuckerman, 2015; Roseberry, Hirsh-Pasek, & Golinkoff, 2014). However, because the first iPads were released in 2010, it is not possible for this study to examine whether such effects of mobile media use extend into adolescence and beyond. Future research is needed to track cognitive and social implications of mobile media use into adolescent development. A longitudinal study following mobile media

users from early childhood into adolescence can directly track these individual developmental changes over time, adding crucial research to the understanding of mobile media use effects.

Overall, while there may be many factors that influence attention span, the results from this study could help parents and caregivers to take preventative action with respect to shorter visual spatial attention span in children. Eliminating the use of mobile media as a behavior regulation tool and setting time limits and reduced weekly limits to mobile media use can lower children's risk of developing shorter visual spatial attention spans. Because attention span is crucial to a young child's development and learning, any improvement that can be made to children's attention span is meaningful.

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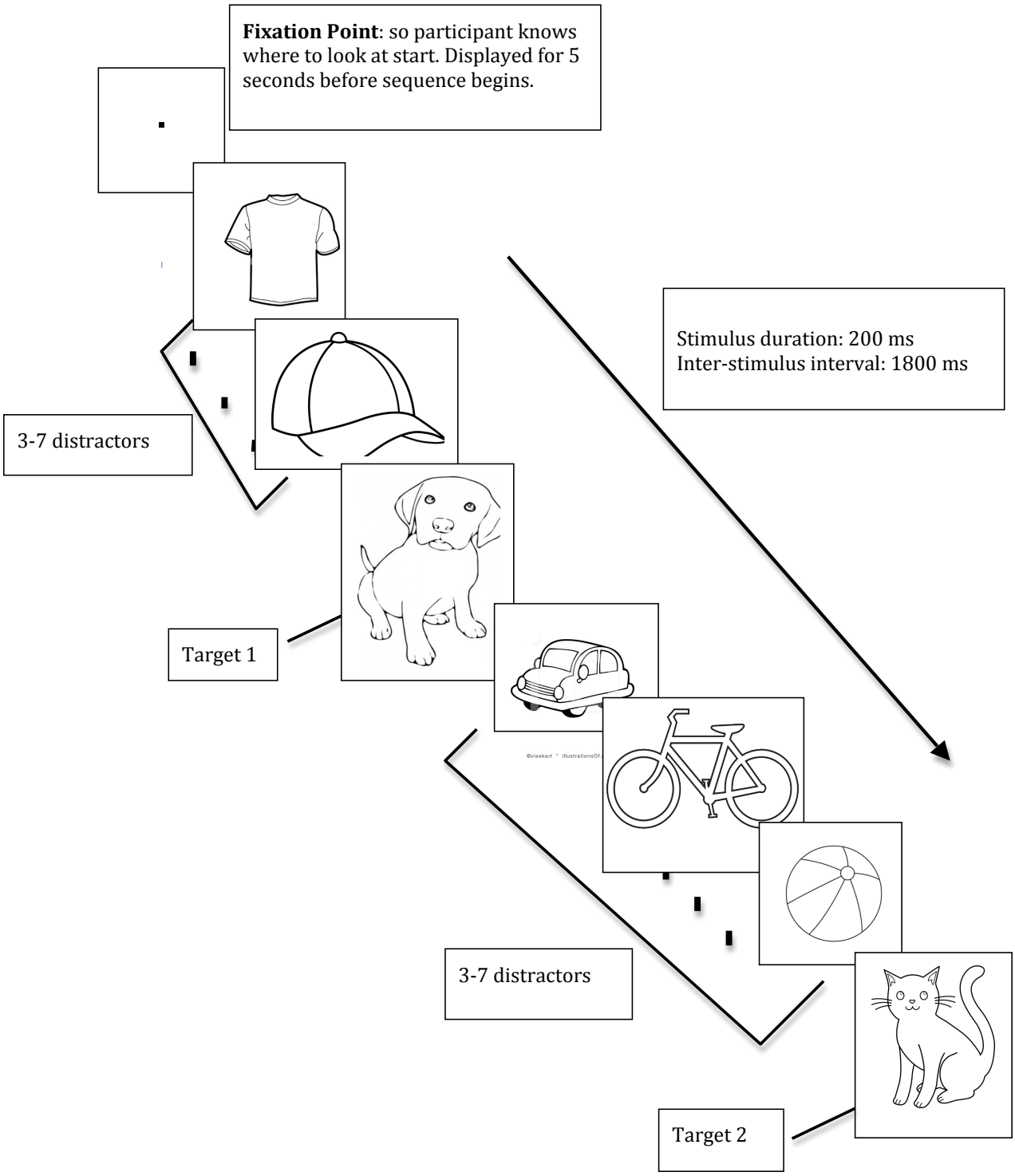
Appendix A
RSVP Visual Spatial Attention Span Subtest Model



Appendix B
Pervasiveness of Media Use Measure

Please answer the following questions in regards to your child's media use. 1= never 4=always

For iPad-users:

a. How often is the iPad used outside the home?
   1 2 3 4
b. How often is the iPad used in the car?
   1 2 3 4
c. How often is the iPad used when eating out in restaurant?
   1 2 3 4
d. How often is the iPad used during social gatherings?
   1 2 3 4
e. How often is the iPad used while waiting for services?
   1 2 3 4

For TV-users

a. How often is TV viewed outside the home?
   1 2 3 4
b. How often is TV viewed in the car?
   1 2 3 4
c. How often is TV viewed when eating out in restaurant?
   1 2 3 4
d. How often is TV viewed during social gatherings?
   1 2 3 4
e. How often is TV viewed while waiting for services?
   1 2 3 4

Appendix C
Demographics Survey

1. Select your child's gender:
    a. Male
    b. Female

2. Select your child's race/ethnicity:
    a. White (non-Latino)
    b. Latino
    c. Asian/Asian American
    d. Pacific Islander
    e. African American/Black
    f. Native American/Alaskan Native
    g. Mixed

3. Enter your average annual household income:
    _____

4. Enter the gestational age of your child at birth in months:
    _____ months

5. Enter the birth weight of your child in pounds to the nearest ounce
    _____ lbs. _____oz.

6. Did the mother use alcohol or tobacco at any time during her pregnancy?
    a. Yes
    b. No

7. What is the language spoken in the home?
    a. English
    b. Non-English

8. In the past week, how many hours did your child view TV/use the iPad?
    _____ hours

9. At what age, to the nearest year, did your child start viewing TV/using the iPad?
    _____ years old