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Toddlers and Technology: An Examination of how the Digital Surround may be Related to Prototypic Vocabulary Development and Social Interactions during Play

Hannah Biarnesen Hutcheson
University of Arkansas, Fayetteville

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Hannah Hutcheson
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_____
Fran W. Hagstrom, Ph.D.
Thesis Director

_____
Kimberly Frances Frazier, Ph.D.
Committee Member

_____
Jennifer Henk, Ph.D.
Committee Member

Abstract

This study sought to examine how the digital technology that surrounds young children may be related to prototypic vocabulary development and social interactions during play. Twenty-six families in the Northwest Arkansas region with children between 15-36 months of age participated in the study. Thirteen children attended a campus preschool, six children attended a grant-funded local preschool, and seven children, all from the Northwest Arkansas area, were part of an earlier home-based study. The materials for the study included a developmental-technology use questionnaire and the MacArthur-Bates Communicative Development Inventories. Archival videotaped play sessions with the seven home-based children utilized a "Little People™ Apptivity™ Barnyard" play set and an iPad with a corresponding app to the barnyard set were used for a secondary analysis of social interactions during play. Data was analyzed across education setting (campus, local, home) and by type and amount of technology reported to be used in the home. Results suggested that parental values reduce a child's experience, if not their exposure, to technology use; that the digital surround of today's world is expansive and not exclusive; that, perhaps, children from varying degrees of technological homes differ in communicative development; and that development may be dynamically changing in ways that differ from or are not currently reflected by normative measures.

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world; it is in Christ Jesus, and in and through Him, I “live and move and have [my] being” (Acts 17:28 New International Version).

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Toddlers and Technology: An examination of how the digital surround may be related to prototypic vocabulary development and social interactions during play

Play has long been understood as one of the fundamental components to healthy child development, but play has and is changing as society is being reshaped in the digital age. Consistent with the ways that the industrial revolution changed the era of children in the workplace, placing more value on the healthy development of children, digital technology is reshaping fundamental aspects of the everyday life. Child play, recognized as pivotal for cognitive development, is part of this reshaping.

A cultural position on play is necessarily dynamic in that cultures are constantly evolving. Consequently, shifts in culture are in part propelled by the introduction and increasing adoption of new tools and technologies in everyday life. As Rideout (2014) points out in her recent research, every time a new medium is introduced, there is the potential to turn it into an educational tool for children. Without doubt, the nature of play is evolving in large part due to the explosiveness of digital technology. Children are drawn to televisions, computers, and mobile technology. It is a part of their culture. Since playing in the life of a child is a culturally bound activity, it is important to understand that as cultures embrace this wave of technological advancements, play will naturally shift around that.

This gives rise to a logic problem that guides research and informs this study. Specifically, if play is a developmental activity that supports cognitive, linguistic, and social development; and if play is inherently social and cultural; and if the social and cultural environment that surrounds today's children is digital; then the world's digital envelope cannot be ignored. Thus, the impact that technology has on play and how that impact affects child development needs to be explored. This is the crux of this investigation, one that can contribute

to the current much-needed evidence of how the digital cultural environment is impacting children in their early developmental years.

Review of the Literature

This review of the literature will examine play as a developmental phenomenon that has the potential to cross the biological and cultural notion of human development. In addition, digital environments will be framed as what surrounds children in homes and the community. The impact of this on play, social interactions, and vocabulary growth will be explored.

Play, Development, and the Social Surround

The Importance of Play

The National Association for the Education of Young Children (NAEYC) published a position statement that includes 12 principles of child learning and development. The key elements suggest that domains of children's development, including physical, social, emotional, and cognitive, are closely related; that early experiences profoundly impact the development of individual children since there are optimal windows of time for development and learning; that development and learning are influenced by and occur in multiple social and cultural contexts; and that play is an important vehicle for children's social, emotional, and cognitive development, as well as reflection of their development (Bredekamp & Copple, 1997). The importance of play in the development of children is reinforced by the American Academy of Pediatrics. Referring to The United Nations High Commission for Human Rights' position, they reiterate that play is such a crucial factor to normal child development that it is a right of every child (Ginsburg, 2007). Indeed, the pool of literature that exists in the fields of education, human development, and psychology attests to the recognition of play as a central aspect of children development.

Play and Development

Play has been an important topic for researchers in the area of early childhood development. Piaget (1962) established play as a necessary developmental activity. At the time of his writings, play focused on objects and manipulation of those objects. Piaget established that for a child between 0-2 years old, they learn about the world around them through their senses and motor abilities. Repetitive play helps children establish the permanence of an object, even when it is out of sight, and helps them to understand the systematic nature of their world (Piaget, 1962).

Bruner's work and philosophies supported this aspect of Piaget's work. Bruner believed that learners play a very active role in their own learning. Similar to Piaget, he posited that there is an ordinal or step-wise shift in play over the course of development. This begins with physical manipulation of objects; proceeds to iconic learning, in which the object previously manipulated is represented through an icon or image; then finally, through symbolic learning, in which objects are externally represented through symbols such as words, formulas, or another such methods (McLeod, 2008).

A third major theory about play and development is that of Vygotsky (1933/1967), which is the basis for a wide range of learning approaches. He saw play as a prototype for lifelong shared problematic activities associated with learning and cognition. Rather than the ordinal development described by Piaget and explored by Bruner in his early writing, Vygotsky and those who work from his paradigm suggest that play is fundamentally social, beginning in early childhood as children connect with others and integrate social rules into shared interactions (Nicolopoulou & Cole, 1993). It remains social and connected to what socially surrounds children even when play is an individual, isolated activity because social others and past shared interactions are internalized appropriations that have become ways of thinking (Rogoff, 1990;

Wertsch, 1994). As such, and in contrast to Piaget, Vygotsky and those who continue to utilize his theories see activities such as play as situated in and structured by the social and cultural surroundings of the child.

Play as Culture

Conceptualizing play as culture involves asking questions about how children experience childhood and how parents may wish them to experience childhood, versus treating children as mere recipients of a program or a set of ideas. Play allows children to understand and explore the "social rules" of the culture(s) in which they live. The aim of seeing play through a cultural lens is to equip children's lives to be woven into the urban and rural cultures in which they are growing up. According to PLAYLINK's "Play as Culture", culture is expressed in our free time, and should be freely expressed in any environment. Play for a child should not be limited to specially designated areas, such as parks or playgrounds, because children appear to have the ability to be imaginative, creative, and play anywhere utilizing anything that may be around them (Ashton & Lewis, 2002). Play has been described as a freely chosen, personally directed, intrinsically motivated, and culturally influenced activity (Hughes, 1999).

This concept of play as culture is key to the theory of distributed communication that has emerged from the research of Hengst (2015) and her research group. They argue that childhood development and learning does not occur through a rigid system of explicit teaching, learning, practicing, and generalizing but rather develops as a history of participating in activities time and time again. Language and particularly the discourses that link this to social contexts are inevitably imbedded in all forms of activity and accrued as the child playfully participates with social others. Simply speaking, a child is inevitably learning language any time they are participating in an activity, and especially when they are partaking in a commonly reoccurring

activity. This theory fits inside the framework known as the cultural-historical activity theory (CHAT). Wertsch (1985) in his review of such theory claims that one of activity's most important characteristics is that "it is not determined or even strongly circumscribed by the physical or perceptual context in which humans function. Rather, it is a sociocultural interpretation or creation that is imposed on the context by the participant(s)" (1985, p. 203). Applied in this way, play activity can be considered a vehicle by which children may learn language, cultural norms, and social appropriateness as they themselves facilitate the "rules" so to speak by which the learning is occurring.

Play and the Social Surround

Home and family. According to Ivac and Marjanovic (1986), it is through play that children are given the opportunity to practice their social skills and exercise the learned behaviors acquired through daily living. By entering the 'arena of play', children are invited to explore their culture and, in turn, explore the culture of other children with whom they are playing. Rettig (1995) adds that through play children learn an important sense of individualism that allows them to differentiate between themselves and others and come to recognize that such differences are okay. The lines between self and other even in play are somewhat blurred in today's digital world since dolls and stuffed toys may speak when activated by your walking through the toy isles of stores; push/pull toys have embedded responsive sensors; and television and movie characters have apps connected to games. This technology is a part of what socially surrounds today's children and as such is or can be part of their world of play.

Perhaps the largest and most revealing recent data collection regarding the infusion of technology in the everyday lives of children comes from a nationwide study conducted by Common Sense Media (2013). The study's 1,463 survey responses provide insight into the lives

of the typical American household regarding technology and its use in modern homes. These were gathered from parents of children up to 8 years of age via address-based sampling and random-digit-dial telephone surveys. The families were of Caucasian, African-American, and Latino nationalities and were recruited from regions spanning all over the United States. Some of the findings from their data collection are that American children's use of mobile technology was significantly higher in 2013 than in 2011. In 2013, 40% of children were using tablets, such as iPads, versus only 8% in 2011; 78% of children had "ever used" a smartphone, versus only 38% in 2011; and 50% of children had used apps, versus only 16% in 2011.

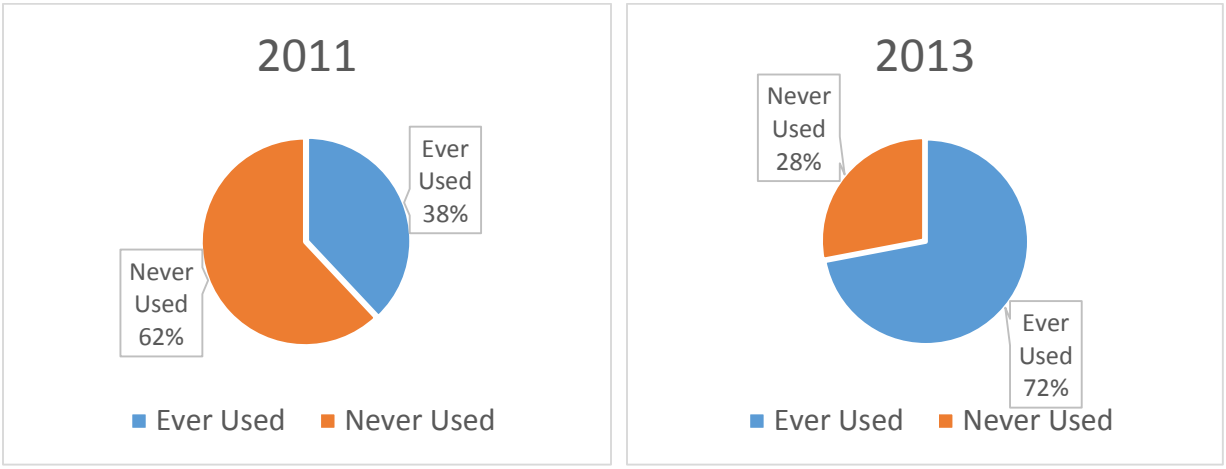

Figure 1. Children 8 & Under: Mobile Device Use. These figures illustrate the increase in mobile device use (including smartphones and tablets) for children ages 8 and under between 2011 and 2013.

Interestingly, a separate survey which examined the effect of media on parenting styles found that approximately 15% of parents reported being "very" concerned about their child's media use; approximately 30% of parents reported being "somewhat" concerned about their child's media use (Wartella, Rideout, Lauricella, & Connell, 2013). As the iPad was not developed until 2010 (Apple Press Info, 2010), this data demonstrates a profound growth pattern in children's media use in homes, and it is safe to assume that these numbers have only continued to grow, as handheld media use has only continued to grow in recent years. While

nationwide data resulted from both of these studies, regional information that would provide insight into how technology is present and/or used by typical Arkansas families in the northwest region is not available.

Schools and special services. Mobile media and digital technology are not only in homes. They are making their way into classrooms and therapy rooms across America at exponential rates. America's newest generations are growing up with technology as "the norm" as more children are exposed to and handling technology at younger ages than ever before (Common Sense Media, 2013). A 2014-2015 survey reported that nearly 60% of the instructional devices in use in American schools are laptops, notebooks, or tablets, and that 86.7% of school districts who responded to the survey allow students and staff to connect personal devices to their district network (Annual Technology Survey Snapshot, 2015). For young children with speech or language delays, it is now known that early intervention is a key component that increases their chance to succeed by school age and beyond (Karoly, Kilburn, & Cannon, 2005; Cohen, 2002; McLean, Lee, & Cripe, 1997). Because the window for early intervention is such a small window with many more time intensive needs than interventionists, digital applications linked to television shows such as Sesame Street, Dora the Explorer, and other child-centered entertainment have been developed as digitally-linked tools for learning (https://itunes.apple.com/us/developer/sesame-street/id339077104). At the same time, reflecting the opposite perspective, organizations such as the American Pediatric Association has recommended no screen time for children under the age of two years and only limited exposure after this until children enter school (Brown, 2011).

It is also becoming more common for clinicians to use the iPad in the therapy setting, and information is growing as to why this is so. One review of mobile technology in the speech-

language therapy setting concluded that iPads (and similar devices) are not only tools that clinicians need to be prepared to use upon entering the work force, but that they are in fact the 'it factor' that spans generations" (Atticks, 2012, p. 84). Another study done by Fernandes (2011) describes iPads as revolutionary for speech-language pathologists because of their affordability, convenience, and user-friendliness. This conclusion was based on survey responses from over 300 speech-language pathologists about their use of iPads. Over 50% of speech-language pathologists interviewed in that survey reported to be already using iPads in therapy. As of this report, iPads are being explored as AAC devices for children with autism and other disabilities (Flores et al., 2012), as a means to expand utterances for children diagnosed with ASD (Murdock, Ganz, & Crittendon, 2013), and to promote symbolic understanding (Allen, Hartley, & Cain, 2015). Fernandes (2011) also states that clinicians report using them as primarily as motivational tools, but also for language, articulation, voice, and fluency therapy, and for articulation assessments.

Like clinicians, parents seem to agree that iPads are motivating factors in the home. When surveyed, 44% of parents said they were very or somewhat likely to give a smartphone or tablet device to a child as a reward (Wartella et al., 2013). While this number was still lower than the likelihood of a parent rewarding their child with a book or television (69% for both activities) or a toy or activity (84%), information from other studies (e.g., Common Sense Media, 2013) remind us that the use of mobile technology in the home is fairly new yet largely on the rise.

Child Development and Technology

Questioning What We Know

While digital technology has certainly changed the ways families, adults, and children occupy their time in the 21st century, it is not the first technology to be questioned with regard to

child development. There is a significant accumulation of research that explored the impact of television that can perhaps provide valuable perspective to current questions and/or concerns.

From Television to Today's Digital World

Today's digital world is populated by technology that is interactive and responsive to the actions of users. There are rules that underlie the interactivity, and much like natural language use, children appear to seamlessly use these to navigate even before they consciously recognize, name, or talk about them. This digital world is quite different from the early beginnings of technological presence in the everyday life of American homes.

Television

When televisions were released to the public in the early 1950s, it did not take long for them to become a staple in homes for entertainment and news. Programs for children have also been in existence for nearly as long. In 1990, The Children's Television Act, the first congressional act regulating children's television, was passed. One of the most important terms stated is that each network must publish at least three hours a day of "educational programming" (Children's Television Act, 1990). As networkers raced to provide this content over the next decade, little was known about how "educational" this content was for very young children. Research began to show that for children at least four years of age, television programs could be a positive and reinforcing medium of learning important information that would prepare them for school (Calvert & Kotler, 2003; Linebarger, Eskrootchi, Doku, Larsen, & Kosanic, 2001; Wright et al., 2001). By 2003, however, this 'educational content' also included DVDs and videotapes aimed at children 1-18 months of age; the first television show aimed at children 12 months of age; entire cable networks dedicated to children between 0-24 months; and a booming industry aimed at selling computer games and specialized keyboard toppers to children as young as nine

months of age (Rideout, Vandewater, & Wartella, 2003). Though the American Academy of pediatrics does not recommend any screen time at all for children under the age of two, studies are consistently finding that exposure within this age group is high (Brown, 2011). This is likely due to the high number of American homes that contain these devices, and thus, this number is likely to remain high.

From Television to Media

The widespread acceptance of television in America demonstrated how new technology could become an integral part of a culture and change the way upcoming generations use their time and interact with their world. Today, children between 0-2 years old, and their parents, are targeted as key consumers of media and television (Brown, 2011). In 2009, the Nielson Co. reported that television watching was at an 8-year high for children between the ages of 2-11. Their findings reported that children between the ages of 2-5 consumed over 32 hours a week of television, DVD, DVR, VCR, and gaming consoles. School-aged children, ages 6-11, were only slightly below this number, taking in about 28 hours a week (McDonough, 2009). Common Sense Media's 2013 report states that media via television, while it has decreased since 2011, is still the front-running option for children's media intake.

These statistics are consistent with findings from a past study done by this author (Smith, 2014). The previous study surveyed parents about their child's media use. While the original intention of the study was to split children, ages 15-36 months, into two groups, 'low tech' (child is limited in how much they interact with technology) and 'high tech' (child essentially has free reign in their technology use), a pattern emerged that required the addition of a third group, 'television kids'. These children in the third category were restricted in their use of mobile technology, i.e., games and apps on smartphones and tablets, but were permitted to use the

television frequently. Included in this category were children who used tablets and smartphones, but only to watch television shows.

Questions Raised by Television and Media Research.

Parent, teachers, and professionals have questioned, since the advent of widespread television and again with media use, the impact of screen time on the development of children. Results have been in consistent but reviewing the finding that have emerged may be informative for current research on technology and possible impacts on child development.

Television viewing. Some television viewing has been found to be beneficial to certain children in specific SES groups and at specific ages. For example, a program such as *Sesame Street* may be beneficial in helping children from lower SES learn and has shown to help those children achieve higher scores in school (Huston, Anderson, Wright, Linebarger, & Schmitt, 2001). However, evidence also exists that shows that even 1-2 hours a day of unsupervised television viewing can have significant negative effects on a child's academic achievement, particularly concerning reading (Strasburger, 1985; Rice & Woodsmall, 1988). Additional findings have shown that children between 2-24 months who even have a television in their rooms hear 770 fewer words per hour from an adult (Dervin, 2013).

Digital screen time. It is evident that use of media, in homes, schools, and clinical settings, is explosive; however, empirical research on infants' ability to learn from technology is limited. Barr suggests that touchscreen devices may be more effective than other 2D media at enhancing learning due to its interactive makeup and to the fact that its functioning is contingent on the responsiveness of the user, but this hypothesis has not been tested (2013). It has been widely researched and documented that children learn more from an interactive, live, face-to-face demonstration than from a 2D demonstration, such as from a television or touchscreen (e.g.,

Barr & Hayne, 1999; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009; Simcock & DeLoache, 2006; Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009). Research has shown that children at 15 months of age have difficulty transferring a learned task from 2D → 3D and vice-versa, though they tend to be able to imitate fairly well when the task is 2D → 2D or 3D → 3D (Zack, Gerhardstein, Meltzoff & Barr, 2013). Language cues do not appear to help facilitate this transfer of learning between dimensions at young ages (Zack et al., 2013). It has been suggested that there is a high demand on cognitive resources during symbol use, as well as when processing language cues at 15 months of age, which may attribute to these findings (Zack et al., 2013; DeLaoache, 1991, 1995; Fernald, McRoberts, & Swingley, 2001).

Digital Play

Digital play as just a part of everyday life has given rise to concerns similar to those associated with television and media screen time. Yet it can be seen from the research on 2D and 3D technology the impact on development was not clear and with the addition of digital devices may be even less clear. Specifically, given the pervasiveness of television watching, be it on smart phones, gaming devices, tablets, or computers, technology now integrates what was a passive activity with play possibilities in multiple, linked ventures. This has generated a socially constructed environment that surrounds children and that is available to even very young children that calls for understanding play differently, such as CHAT developmental theory re-conceptualized Piaget's ordinal perspective. This re-visioning, while it does not negate a developmental or biological perspective, lends itself to a cultural-historical activity analysis in order to understand possible impacts of the digital environment on child development.

Recently, Smith (2013) explored the underpinnings of digital representations to the development of young children and their play. Her conclusions were that when a child is able to

recognize an object, they are able to begin forming an internal representation of these objects composed of geometric shapes. This helps a child begin to engage in pretend play, which is when the child uses an object to represent another object. Consistent with Piaget and other developmental researchers, Smith suggested that even if the early manipulation of objects is digital, the pretend play that follows is an important marker of future language development in a child. Therefore, if a child cannot recognize objects, they are less likely to engage in pretend play, which means that they are at higher risk of experiencing developmental language differences (Smith, 2013).

Madray and Catalano (2010) wrote a review for the Curriculum Materials Center (CMC) that summarized research that establishes the vital link between play and learning. Using this as a base, they then focused on providing teachers with ideas to help incorporate play into teach across a multitude of subjects. They reported that games and other playful materials are among the most popular types of learning methods with students. When children engage in these playful resources, especially children around school-age, they are shaping their "conscious or unconscious development of motor skills, social, self-help, cognitive, problem-solving, leadership, [and] multi-skill building" (p. 12) for a wide array of school subjects. Play suggested by Madray and Catalano was both technological, e.g., using a computer game like "Math and the Cosmos" to improve math skills for older students, and low-technological, e.g., utilizing familiar games such as Monopoly or Candyland to develop basic skills such as turn-taking, shapes and patterns, and color recognition in younger students.

One topic associated with play that Madray and Catalano (2010) addressed was pretend play. This topic has been one of particular interest to researchers since it emerges at particular developmental times and involves symbolic behaviors. In his extensive study of the everyday

lives of young children across cultures, Tudge (2008) found that while objects and places associated with play may vary, all children play and within this play, pretend. Griffin's (1984) research on pretend play was more focused. She investigated how children, when they participate in shared make-believe, blend verbal and social skills in the developmental process. Welsch (2008) expanded on the topic of pretend by investigating the ways that young children in the classroom can build on story lines in books in peer play. All of this suggests that for a child, play with real objects be they toys or books used alone or with others is a crucial component for both linguistic and social development.

Rethinking Physical versus Digital Play

The benefits of physical play have been widely known and accepted for decades. It has been found to promote healthy brain development and healthy and active bodies (Shonkoff & Phillips, 2000; Frost, 1998; Tamis-LeMonda, Shannon, Cabrera, & Lamb, 2004). It teaches a child how to work in a group, negotiate, problem-solve, and self-advocate (Blasi, Hurwitz & Hurwitz, 2002; Erickson, 1985; Pellegrini & Smith, 1998; McElwain & Volling, 2005). It gives a child a safe place to role-play as adults or work out real-life situations (Hurwitz, 2002; Isenberg & Quisenberry, 1988; Barnett, 1990; Flaxman, 1999; Smith, 1995; Burris & Tsao, 2002). Maybe most simply, it is a fundamental part of childhood (Ginsburg, 2007).

Recent research has examined the importance of a very young child's ability to manipulate objects to help them develop visual object recognition (Smith, February 2013). A 12 month-old child's arms are very short, so when they hold and manipulate objects within their grasp, they are viewing those objects at a close range. This is beneficial to a 12 month-old child whose ability see is good, provided that the object in view is within close range, but whose motor abilities are still very immature (Smith, December 2013). For the young child, physically being

able to manipulate objects and turn them around in their hands, examining the objects from all sides, is linked to helping that child store the item in their memory and help them recognize the learned object amongst clutter on future occasions. Smith explains that a child sitting leads to them holding an object, which leads to them seeing the object, which in turn leads to them learning about the object. From this standpoint, the manipulation of physical objects is crucial for normal child development.

Encouragingly, Wartella et al. (2013) have found that while parents are using media and technology as a tool for managing daily life at home, they are using books, toys, and other tools more often. This recent study finds that parents are more likely to assign children to the aforementioned physical tasks to keep them occupied than a television, and they are more likely to put them in front of a television than a mobile device. This demonstrates that while our culture is indeed changing, parents seem to realize the value in traditional, physical play for their child.

Summary and Questions of the Study

Existing literature demonstrates that play is a developmental necessity and that it is culturally bound. It also reveals that a relatively new method of play, which is play via technological devices, is expanding at rapidly increasing rates. This was initially demonstrated with television as a medium. Research reveals that very young children, and their parents, are being catered to with a plethora of technology based educational materials. However, research also questions the wisdom of exposure and use of technology for children at young ages. Some research (Smith, 2013) align with well recognized developmental theories such as those of Piaget (1962) and Vygotsky (Wertsch, 1988) that claim it is important for infants to hold and manipulate objects in order to develop early cognitive skills. Additionally, Hengst (2015) proposes that children are invariably learning and developing through physically repeating a

socially cultural activity time and time again. This calls into question the impact that play occurring in digital forms is having on the development of children as it becomes a cultural standard. Conversely, little is known about the differences, if any, that may be emerging in children who are not saturated in the same digital culture. This gives rise to a series of questions that may contribute to our understanding of child rearing expectations, child intervention, and child education practices. The specific questions of the study are as follows.

Questions of the Study

1. What is the digital surround of families in Northwest Arkansas?
2. Are there differences in the vocabularies and linguistic understanding of children who are being raised in different digitally intense/non-intense homes?
3. In what ways do children from different digitally intense/non-intense homes communicate and interact differently during planned play with real and digital toys?

Methodology

Participants

Fifty families in the Northwest Arkansas (NWA) region who had children between 15-36 months of age were sought through nomination and posted notices at the campus child development center and a local school with funded programs. For the purposes of this study, the campus child development center is referred to as Preschool A, and the local funded school is referred to as Preschool B. Both settings were located in Fayetteville, Arkansas. A second pool of data was home-based archival material of children from seven families not connected with either of the settings but living in Northwest Arkansas. This group of children is referred to in this study as the Home group.

Materials

Materials for this study included a development and technology-use questionnaire (see Appendix A) and the MacArthur-Bates Communicative Development Inventory (CDI), which is a published norm-referenced parent report regarding current and emerging vocabulary and communication patterns in their child. Three versions of the CDI were used. The CDI-I was used for children 15-18 months of age and asked about the words that children understood and said, as well as early pragmatic and play. The CDI-II was used for children 19-30 months of age and asked about the words, phrases, and sentences used, as did the CDI-III, used for children 31-36 months of age. The archival material, in addition to the questionnaire, included a "Little People™ Apptivity™ Barnyard" play set that support play with real objects and an iPad with a corresponding app to the barnyard set for digital play.

Procedures

A first step in the procedure was to find sites for data collection. The directors of the campus child development center and a local preschool with students supported through grant funding were contacted about the study. The purpose and methods of the study was discussed with the directors and requests were made for nominations of families who fit the study requirements, as well as the opportunity to post an announcement about the research project on the school grounds (see Appendix B). The researcher arranged to be at the developmental school and preschool on specific days and times to be available to meet with parents, answer questions, and complete consent forms. As parents committed to the project, the researcher was also available to assist with the completion of the developmental questionnaire (see Appendix A) that provided demographic information as well as inventory the types and uses of technology within the home, and to clarify completion of the MacArthur-Bates Communicative Development Inventories. This information was used to answer the first two questions of the study. Packets of

materials that included a description of the study, informed consent materials, the developmental and technology questionnaire, and the MacArthur-Bates Communicative Development Inventories were prepared by the researcher. Each item in each packet was numbered so that it was clear which materials went together. A different series of numbers was used to signify age group and location of the data collection. No personal identifying information was collected. Written and verbal instructions asked that the signed consent be placed by participants in an envelope, then sealed and placed back into the research packet to be returned with the completed questionnaire and CDI protocol. These packets were delivered to the directors of the developmental center and preschool who had agreed to allow the collection to take place at their schools. The packets were given to teachers for distribution and the researcher was available on site during child pick-up times to answer questions and/or collect packets.

Analysis

The developmental questionnaire and CDI was coded as paired data using the code number assigned to each packet and on each form within a packet. Analysis of the data began after the first participant's packet was returned and was ongoing throughout the study. The developmental questionnaire was used to categorize families as highly technological, low technological, or television only groups based upon how much technology was available in the home and how their children who attend the preschool were allowed to use that technology. The amount of exposure and time spent engaging in technology was calculated by adding the time by categorized group for a total that was then divided by the number of participants in that group. This provided an average amount of time as well as a range of times for children in each setting. The data was compared among the two preschools and the home group. The CDI was scored according to published protocol. The results of the CDI were analyzed by type of home and by

allowed use of technology. Due to the limited number of participants in each age group and technology group, statistical analyses could not be completed. Results are both quantitative using the percentiles of the norm referenced CDI and qualitative using the questionnaire that included open-ended responses.

Results

This section reports on the results for each of the three questions of the study. It begins with a section on the demographics of who actually participated in the study as this differs from the numbers and sites projected in the proposal. It is followed by results for each of the specific questions of the study. These results are descriptive in nature since statistical analysis could not be obtained due to the small numbers of participants in each group.

Demographics

Twenty-six families from the Northwest Arkansas region participated in this study. Thirteen families send their child to the campus preschool, six families send their child to the grant-supported preschool, and seven families were part of an archival data set. Again, for the purposes of this study, the campus preschool will be referred to as preschool A, and the grant-supported preschool will be referred to as preschool B. Forty children fell into the CDI age ranges at preschool A, which means the participation response was 32.5%; and 34 children fell into the CDI age ranges at preschool B, which means the participation response at that location was 17.6%. Additionally, archival data that involved seven families from the Northwest Arkansas region was collected in these children's homes. This archival data was used to assist in answering question one and question three of the study.

Grouping of the participants for analysis. Information about the presence of technology in the home and the child's use of this technology, obtained from the developmental

questionnaire, was used to group data for analysis. Families were divided into one of three 'technology groups': low technology (low tech), TV only (TV), or high technology (high tech). The natural break between the low tech children and the high tech children was one hour maximum of technology use for low tech children per day, and two hours minimum for high tech children. If a range of time was given by the parent, the average time for that range was used to calculating time spent with technology. The average time for children in the low tech category was 25:30 minutes/day with the times ranging from 0-55 minutes per day. The average time for children in the high tech category was 1:58 hours per day with the times ranging from 1:07-3:30 hours per day. Additionally, a child was classified as low tech if they are allowed to watch or manipulate digital technology for an hour or less a day. A child was classified as high tech if they used more than one hour a day of technology. A child was classified as TV if their primary technological input was some mode of television watching (e.g., an actual television, a tablet, a smartphone, a gaming consul).

Question One

The first question of this study asked about the digital surround of families in Northwest Arkansas. For the purposes of this study, 'digital surround' is defined as the technological experience cultivated in an individual home. It is both an accumulation of the various modes of technology that surround children in their homes and of the various modes of technology utilized by children in their homes, as well as time spent with that technology.

Responses on the developmental questionnaire were used to answer this question. Specifically, the amount of time and type of technology used in the home by the family was considered and analyzed in order to gain an idea of what sort of digital surround exists in homes in Northwest Arkansas. To answer this question most accurately, data was taken from the 19

most recent developmental questionnaires (the ones obtained from both preschools) and from the seven archived questionnaires. Thus, 26 questionnaires in all were used to compile these results.

Technology exposure in the home. The first analysis for this question looked at the digital surround according to setting. It should be noted that if parents explicitly reported engaging in technology-based activity while their child was not around (e.g., asleep, at daycare, only at work), that time was not counted toward the amount of time children were exposed to in their homes. The amount of exposure for each child was added for a total that was then divided by the number of children in that group. This provided an average amount of time as well as a range of times for children in each setting. The data was compared among the two preschools and the home group. The average time for preschool A, where n=12, was 40.4 hours, with a range of 10.5 – 77 hours per week. The average time for preschool B, where n=6, was 31.3 hours, with a range of 10.5 – 52.5 hours per week. The average time for the home group, where n=7, was 42.9 hours per week, with a range of 13.5 – 71.3 hours per week. The following graph illustrates the average time of technology exposure for each kind of setting:

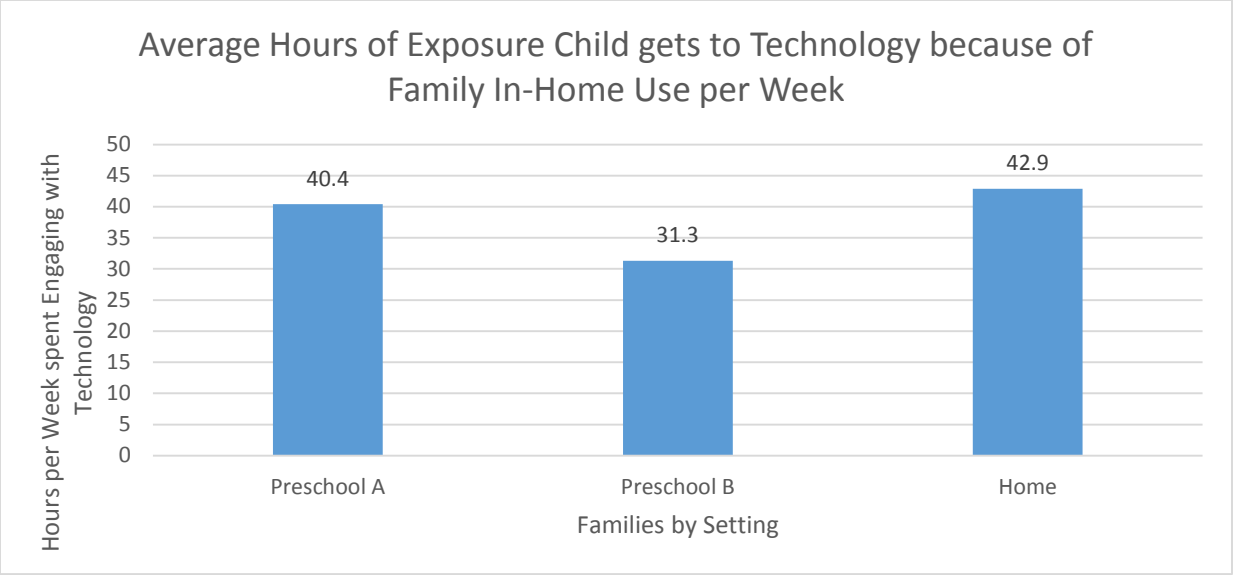

Figure 2. Average Hours of Child Exposure to Technology because of Family In-Home Use per Week. This graph demonstrates the average hours that families from each setting engage with technology per week.

Time spent engaging with technology. Data conveying time spent with technology was also analyzed according to the type of technology with which they engaged. Parents were asked to indicate how much time they spent, if any, with the following kinds of technology: smartphone, tablet, desktop or laptop computer, gaming consul, handheld gaming device, television, or video camera. Similar technologies were grouped together to form five categories, which are as follows: category 1, television; category 2, smartphone and tablet; category 3, laptop and desktop; category 4, gaming consul and handheld gaming device; and category 5, video camera. Again, if the parent reported that they do not use said technology around their child, then it was not included in the data. The following graph displays how parents reported engaging with technology in their homes while their child was present:

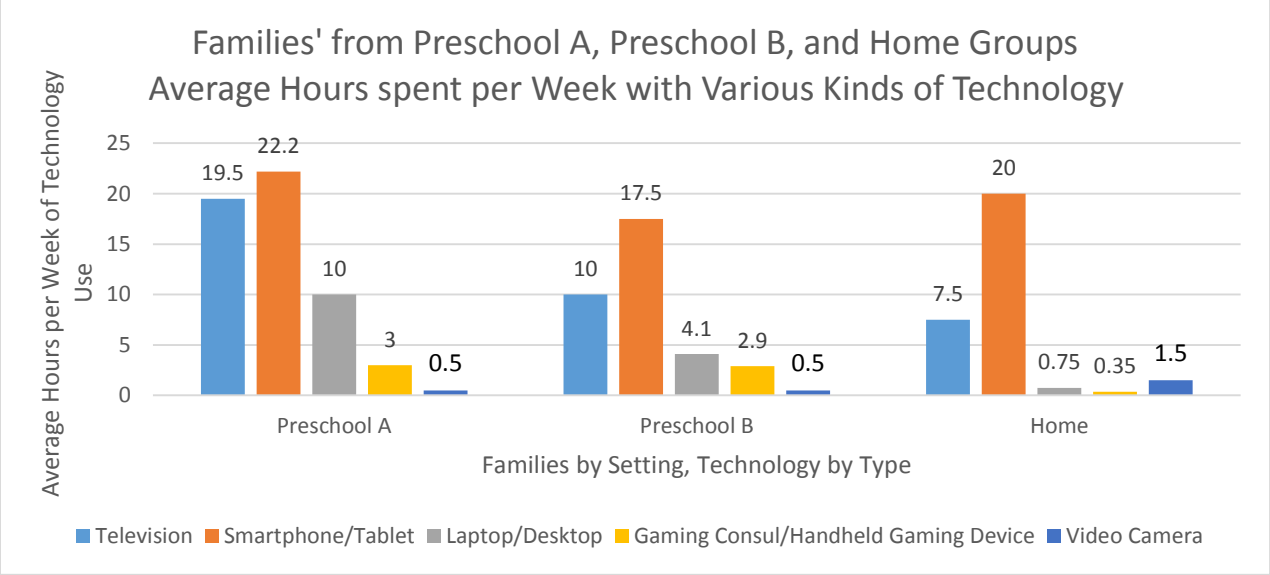

Figure 3. Families' from Preschool A, Preschool B, and Home Groups Average Hours spent per Week with Various Kinds of Technology. This graph demonstrates what kind of technology families from various settings engaged with during the week, and how much time they spent with each kind of technology.

Parents of the newer data collection were also asked at what age they believed technology was appropriate to introduce their child to technology. The following graph shows the various responses received from the nineteen parents who filled out the surveys:

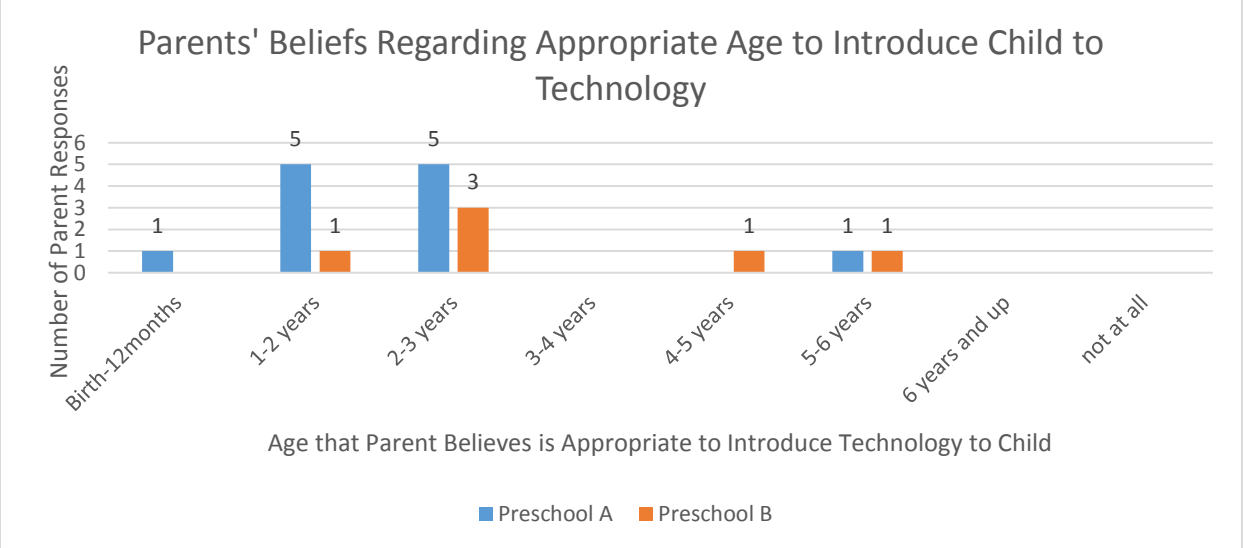

Figure 4. Parents' Beliefs about Appropriate Age to Introduce Child to Technology. Graph demonstrates the number of responses received per age category concerning parents' beliefs about the appropriate age to allow child to begin using technology in the home.

Question Two

Vocabulary Results

The second question of this study asked if there were differences in the vocabularies and linguistic understanding of children being raised in dissimilar digitally intense versus non-intense homes. The first part of this question's answer will address the vocabulary data from all versions of the CDI by educational setting and by technology group. The second part of this question's answer will address the linguistic development of these children, divided into respective age groups, and thus, respective CDI forms. All data was taken from the CDI forms filled out by the parents. The CDI characterizes via parent report the child's receptive and/or expressive vocabulary inventory as well as their interactive and/or linguistic vocabularies. The CDI-I Words and Gestures was given to families with children 15-18 months; the CDI-II, Words and Sentences was given to families with children 19-30 months; and the CDI-III was given to families with children 31-36 months. Data from a total of 19 children was used to answer this question. Three children were in the 15-18 month old age range while six children where in the 19-30 month old age range and ten children were in the 31-36 month old age range. The guidelines for calculating percentiles is outlined in the CDI technical manual. The most accurate method, which involves "…interpolating between percentiles and assigning an exact percentile…", was used (Fenson et al., 2007, p. 31).

Vocabulary for three age groups by setting. This data was first analyzed according to educational setting to display results among age groups and between preschool settings. Preschool A only had one child in the 15-18 month category. That child's vocabulary percentile was 28.5. Three children made up the 19-30 month group from preschool A. The average for that group was 40.3, with the percentile range being 21-50. Nine children made up the 31-36 month

old category for preschool A. The average for this group was 46, and the percentile range was 20-70.

Preschool B had two children in the 15-18 month category. The average vocabulary percentile within this group was 31, with a percentile range of 19.25 – 42.75. Three children were placed in the preschool B 19-30 month category, where the average was 65.3, with a percentile range of 48-98. One child qualified to be placed in the 31-36 month category from preschool B. That child's vocabulary score was 19.

The following graph displays the reported percentile averages categorized by age groups and comparing preschool A and preschool B:

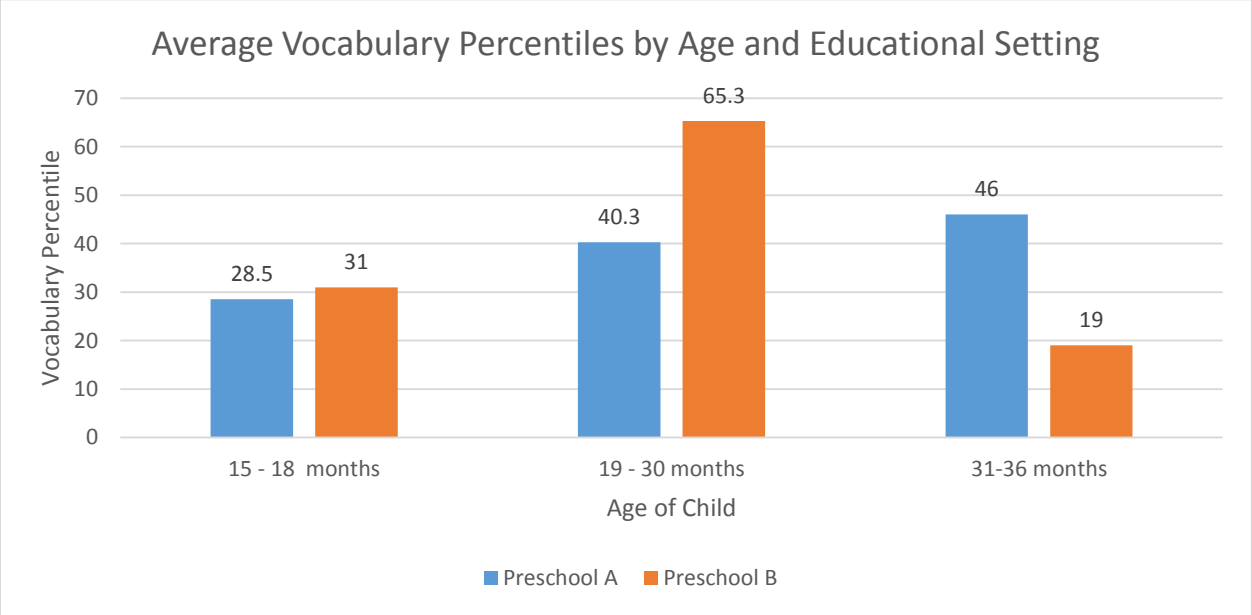

Figure 5. Average Vocabulary Percentiles by Age and Educational Setting. Displays percentiles for vocabulary scores between different preschools, where Preschool A is the campus preschool and Preschool B is the government-funded preschool. Separated by age groups.

Vocabulary for three age groups by technology group. Additionally, the data was analyzed according to technology group to describe variations between children from homes that had different amounts of digital saturation. Normative charts in the technical manual were used to determine percentiles and ranges. Data is displayed for each of the

three groups of children at each of the two preschools. (see Figure 6 below) The percentile range for preschool A was 24-48; the percentile range for preschool B was 19-59.7:

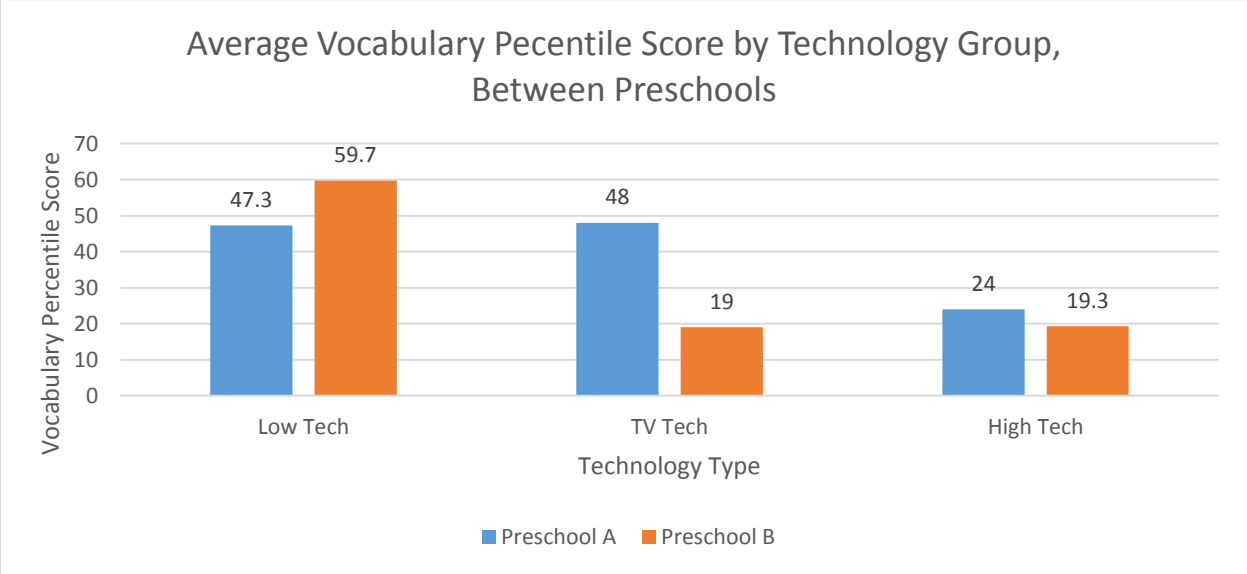

Figure 6. Average Vocabulary Percentile Score by Digital Surround, Between Preschools. Chart indicates vocabulary percentiles scored for each individual child on their appropriate version of the CDI, separated by technology group.

Analysis of Linguistic Understanding.

In addition to the analyzing vocabulary, the linguistic understanding of each child was analyzed using age-based percentiles established as normative data by the test makers. This data was taken from Part 2 of the CDI regardless of version, which provides questions to target the child's communicative-linguistic development.

CDI-I Words and Gestures. Three children, combined from both preschools, were within the age range to be evaluated using the CDI-I Words and Gestures normative profiles. These children included two 15 month-olds, one male and one female, in the low tech category, and one 17-month-old female in the high tech category. The following table illustrates these children's scores on the Part 1: Early Words section of the CDI-I.

Table 1. 15-18-month-olds' scores for "Early Words" category of CDI-I: Normative Phrases Understood, Imitating, and Labeling.

CA/G*	TG*	NAESU*	PNPU*	I*	PPAA*	L*	PPAA*
15m / M	Low	3/3	65	Yes	84.8	Yes	84.8
15m / F	Low	3/3	22.5	Yes	78	No	60
17m / M	High	3/3	83.6	Yes	79.5	Yes	70.5

*See Table 2.

Table 2. Abbreviations and explanations for Table 1.

CA/G	Child's Age/Gender
TG	Technology Group
NAESU	Number of Affirmative Early Signs of Understanding
PNPU	Percentile for Normative Phrases Understood
I	Imitating
PPAA	Percent of Peers with Affirmative Answers
L	Labeling

Figure 7 (see below) shows the percentiles of children from low and high tech homes on earlier developing, later developing, and total gestures milestones, all of which are indicative of ways that young children are developing language beyond just vocabulary.

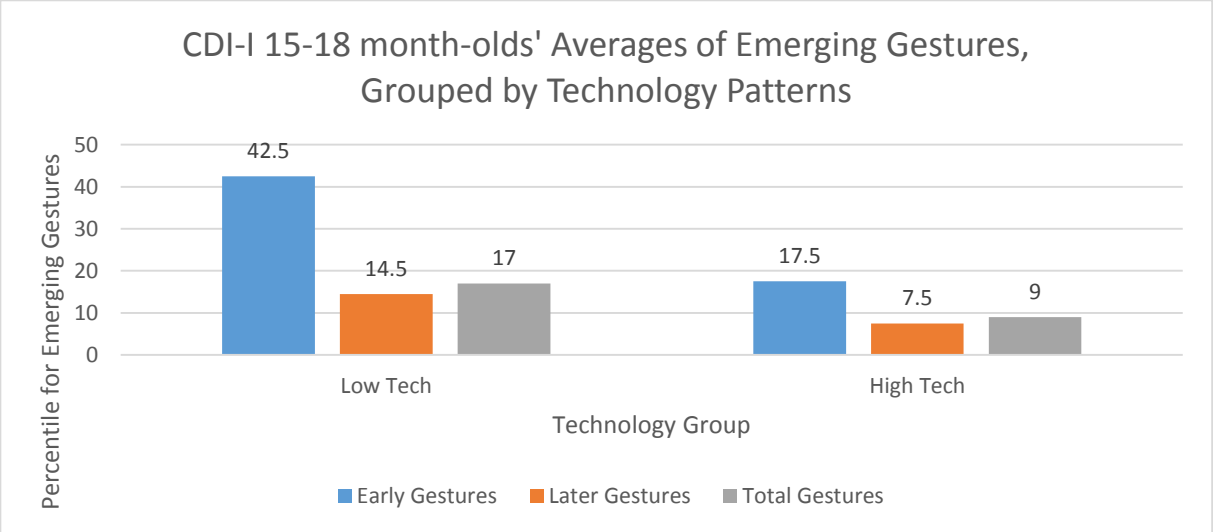

Figure 7. CDI-I 15-18-month-olds' Averages of Emerging Gestures, Grouped by Technology Patterns. This graph illustrates three children's percentiles regarding early developing, later developing, and total gestural use in relation to other children of the same age.

As can be seen, of the three children between 15-18 months of age, children from low tech homes achieved higher percentiles for early, later, and total gestures. These results should be interpreted cautiously due to the limited number of children and should not at this point be generalized to a larger population.

CDI-II Words and Sentences. Six children were in the age range covered by the CDI-II, Words and Sentences normative profiles. Three children were from preschool A and three were from Preschool B. Based on the technology surveys from Preschool A, two children were placed in the low tech group, a 19 month-old male and a 23 month-old female, and one child was placed in the TV group, a 26 month-old female. The parent of the 19 month-old male in the low tech category only filled out Part 1 of the CDI, that is, the vocabulary checklist. Therefore, only the 23 month-old and the 26 month-old females' scores from preschool A were used in this portion of the analysis. From preschool B, the parents of three children completed the CDI-II. All the children were female and were in the low tech category. Their ages were 20 months, 26 months, and 28 months. All three of these children's scores were included in this analysis.

Part 2 of the CDI-II, the linguistic understanding portion, evaluates how a child is using words, word endings, word forms, and evaluates the complexity of a child's current speech based on MLU production. Section 1 of Part 2 deals with word endings; specifically, what kind of word endings is the child already using? The following table illustrates this data for these two participants:

Table 3. CDI-II, Part 2, Word Endings. Table demonstrates the kinds of word endings being used by five children evaluated with the CDI-II, and the percentage of children of their same age reported to give affirmative answers.

Preschool	WORD ENDINGS	Is child using this kind of ending? Percentile of kids same age with affirmative answer:			
	Age/Gender/Tech Group	Plural	Possessive	Progressive	Past Tense

Preschool A:	23mo F – Low Tech	Yes; 69.2	Yes; 75	Yes; 60.6	Yes; 33.7
	26mo F – TV Tech	Yes; 78	Yes; 79	No; 64	No; 48
Preschool B:	20mo F – Low Tech	No; 41.9	No; 47	No; 27.4	No; 11.1
	26mo / F – Low Tech	Yes; 78	Yes; 79	Yes; 64	No; 48
	28mo / F – Low Tech	Yes; 85.7	Yes; 85.7	Yes 82.1	No; 58.3

Other data from Part 2 concerned word forms, additional word endings, combining words, M3L (the mean MLU of the child's three longest sentences heard by the parent recently) and complexity of sentences. The following table addresses these final linguistic concepts addressed by the CDI-II.

Table 4. CDI-II Scores for Word Forms, Word Endings, Combining, M3L, and Complexity. Representation of five children's scores in these categories as reported by parents on the CDI-II.

Preschool	A/G/TG*	WFP*	WEP2P*	C/PAAFP*	M3L*	CP*
Preschool A:	23mo F – Low Tech	25-35	5-60	Yes, child is combining / 84.6	55	57.5
	26mo F – TV Tech	25	72.5	Yes, child is combining / 95.7	62.5	57.5
Preschool B:	20mo F – Low Tech	50	40	No, child is not combining / 70	N/A	32.5
	26mo / F – Low Tech	86	85	Yes, child is combining / 95.7	69	98
	28mo / F – Low Tech	30	55	Yes, child is combining / 97.6	45	50

*See Table 5.

Table 5. Abbreviations and explanations from Table 4.

A/G/TG	Age/Gender/Technology Group
WFP	Word Forms Percentile
WEP2P	Word Endings, Part 2
C/PAAFP	Combining/Percentile of Affirmative Answers for Peers
M3L	Child's M3L Percentile (mean MLU for 3 longest sentences)
CP	Complexity: Percentile

CDI-III. The third version of the CDI was used to evaluate children between 31-36 months of age. Nine parents completed CDI-III forms for the purpose of this study, eight from preschool A and one from preschool B. The CDI-III contains a vocabulary checklist component, a sentences/syntax component, and a using language component. It also has a component evaluating these children's MLU; however, that component has not yet been normed and was not used for analysis in this study.

The figure below displays the average percentiles on the linguistic portion of the CDI-III, as well as the average scores categorized by technology groups. All 31-36 month-old participants, from both preschools, are represented in Figure 8.

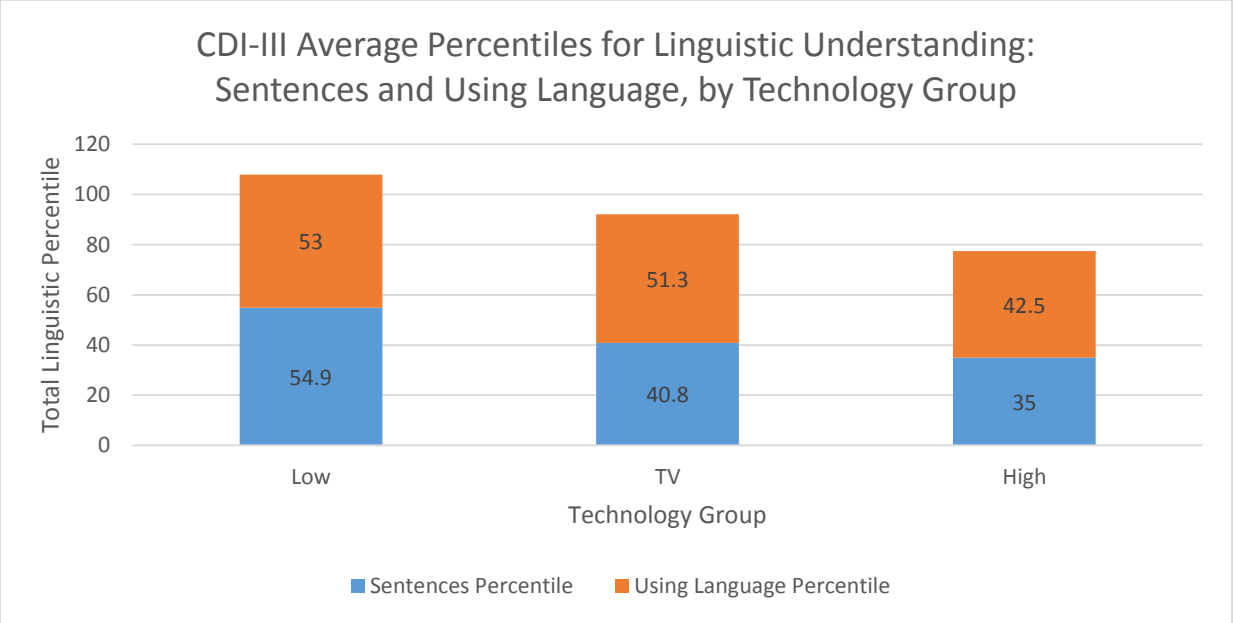

Figure 8. CDI-III Average Percentiles for Linguistic Understanding: Sentences and Using Language, by Technology Group. This chart is used to show the varying percentiles for the

linguistic understanding portion of the CDI-III, as well as to classify these scores by technology groups.

Question Three

The third question of this study addressed ways in which children from homes of varying degrees of digital intensity play differently with real and digital toys. Results for the first question, which characterize the digital surround, were used to reanalyze the archival data of families in home settings on the questionnaire and the play behaviors of seven children. Information on the surrounding digital culture at home was obtained through parent report on a developmental questionnaire that included reports of time spent with various forms of technology. Data was elicited through play studies in the children's homes during a previous study done by this author (Smith, 2014). The play studies utilized both real and digital toys. The researcher and child engaged with a "Little People™ Apptivity™ Barnyard" play set for 15 minutes. Following that, an iPad in the bottom of the barnyard set was switched on and a "Little People™ Apptivity™ Barnyard" app was activated. Digital play ensued for the next 15 minutes.

The digital surround. Questionnaire data from the previous study was reanalyzed for digital surround using the classification of groups described above for study question one. Participants were divided into one of three technology-use groups, based upon parent's report of amount of time spent and modality of technology engaged with by the child in the home. Using the same criteria as described the grouping of the preschool children, these home setting children were classified as low tech, high tech, and TV.

Two children, one male and one female, fell into the low tech group. Their ages were 26 months and 27 months, respectively. The families of these children set firm limits on technology exposure within the home. According to the questionnaires filled out by the parents, these two

children totaled an average of an hour a week between them engaging with various forms of technology.

Two children, one male and one female, were placed into the high tech group. Their ages were, respectively, 29 months and 20 months. These children's families placed minimal to no boundaries on the child's engagement with technology. According to the questionnaires, these two children averaged seven hours a week of digital technology use between the two of them.

Three children, all males, were grouped into the TV group. Their ages were 22 months, 29 months, and 30 months. The families of these children limited their child's technology exposure to television viewing only, some of this utilizing a tablet or other device rather than a stand-alone TV. According to the questionnaires, these children averaged 10 hours a week of television viewing between the three of them, whereas the rest of their digital use was virtually nonexistent.

Analyses of Child Video Data

Once the children were characterized by digital surround, a re-analysis of video-taped play was completed. This data was analyzed from two perspectives: first, by calculating verbal and vocal communication when playing with real and digital toys, and then by amount of time spent with technology by both child and family in the home.

Analysis of verbal and vocal communication when playing with real and digital toys. The children's verbalizations and vocalizations during videotaped play with real and digital toys was coded using Dore's Primitive Speech Acts (1975; Appendix F). Verbalizations and vocalizations were first calculated for each individual child within their respective technology group. Following that, averages were calculated separately for verbalizations and vocalizations of each technology group. Figure 9 (see below) reflects the findings from this analysis.

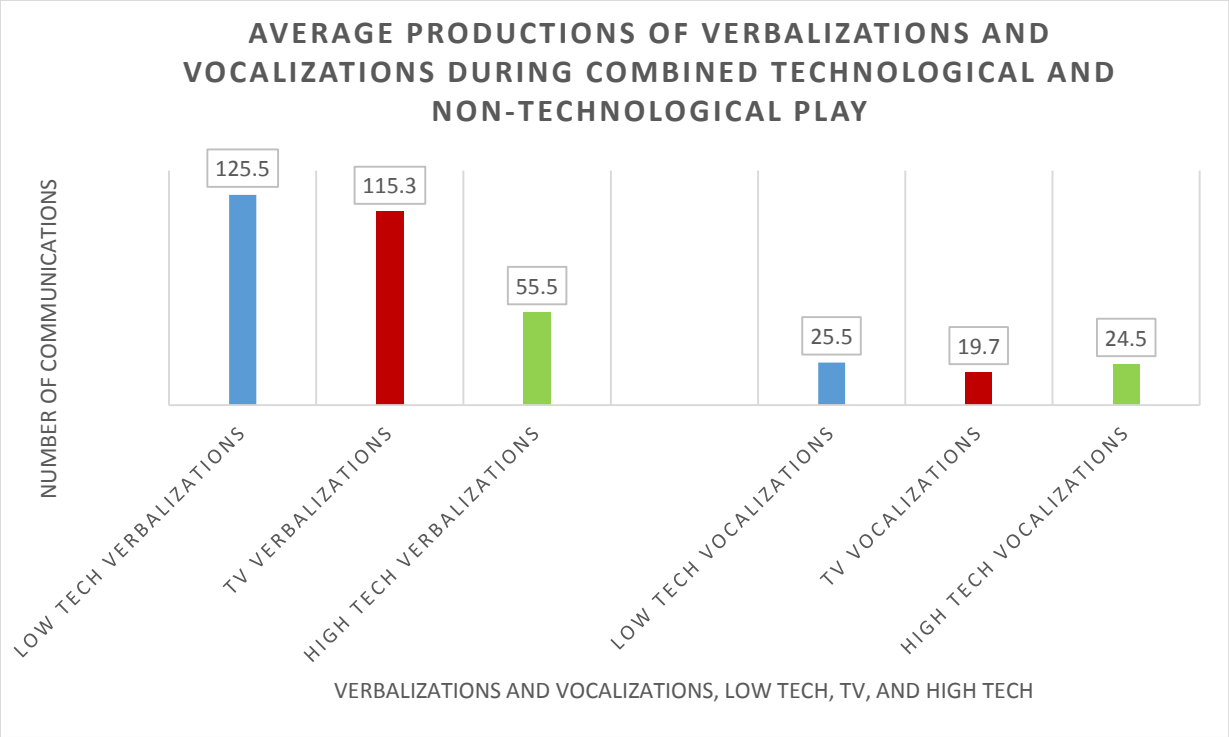

Figure 9. Average Productions of Verbalizations and Vocalizations during Combined Technological and Non-Technological play in the individual 30-minute play session. This graph displays the average number of verbalizations, and then vocalizations, demonstrated per each technological group from low, to TV, to high tech, across the entire 30-minute play session.

This figure shows that children in the low tech group produced the greatest number of verbalizations and vocalizations among the three groups during the 30-minute play sessions. The children from the TV group produced the second-most verbalizations and the fewest vocalizations during the 30-minute play session. The children from the high tech group produced the fewest verbalizations and the second-most vocalizations during the 30-minute play session. Communication patterns were somewhat different for the children from the different digitally intense homes. Specifically, vocalization patterns were similar across the three categories; however, children from low technology homes produced doubled the number of verbalizations than did the children from high technology homes across the 30-minute play session.

To further illustrate these results, Figure 10 shows specifically how many verbalizations and vocalizations were used during which kind of play, whether physical or digital.

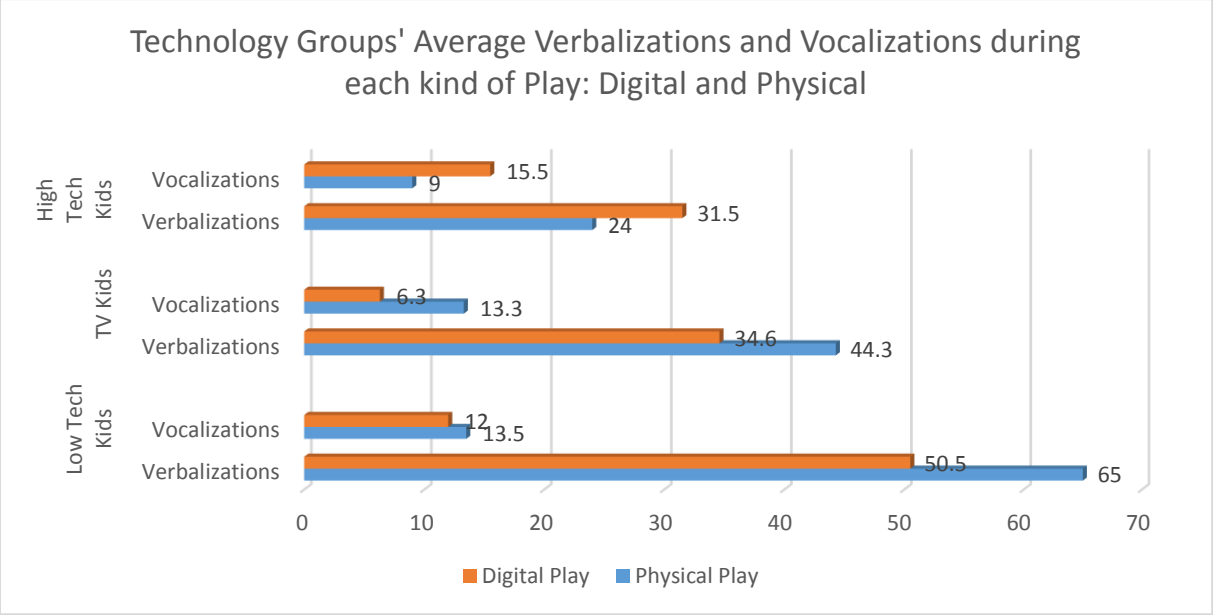

Figure 10. Technology Groups' Average Verbalizations and Vocalizations during each kind of Play: Digital and Physical. This chart shows how many verbalizations and vocalizations were produced during each kind of play, digital play and physical play. It demonstrates the differences between the three technology groups.

Figure 10 adds further depth to Figure 9 by demonstrating how the verbalizations and vocalizations were broken down by play session. Figure 10 visually illustrated that, low tech children and TV children in this study on average produced more verbalizations and vocalizations during physical play. High tech children on average produced more verbalizations and vocalizations during digital play. This could be because high tech children were more accustomed to the technology; thus, they engaged with the researcher more during that form of play. The researcher observed that for the low tech children, especially, the iPad seemed to carry a shock factor, and they often appeared stunned at what they had seen. Most of their comments, from that point, were essentially asking the researcher to turn the iPad off and on again. The high tech children, however, were more interested in accessing other features of the iPad that they knew were there, such as the camera function and the text messaging function. Their vocal

interactions with the researcher were often requests to find these items on the iPad. In these cases, the researcher would attempt to redirect to the app, but would allow the child to navigate the iPad if the child requested to do so.

Analysis based on time spent with technology. The second aspect analyzed in this question was amount of time spent with technology by both child and family in the home. This was analyzed in order to gain more information about the digital surround of families in NWA. Figures 11 and 12 display both child and parental reported technology use at home.

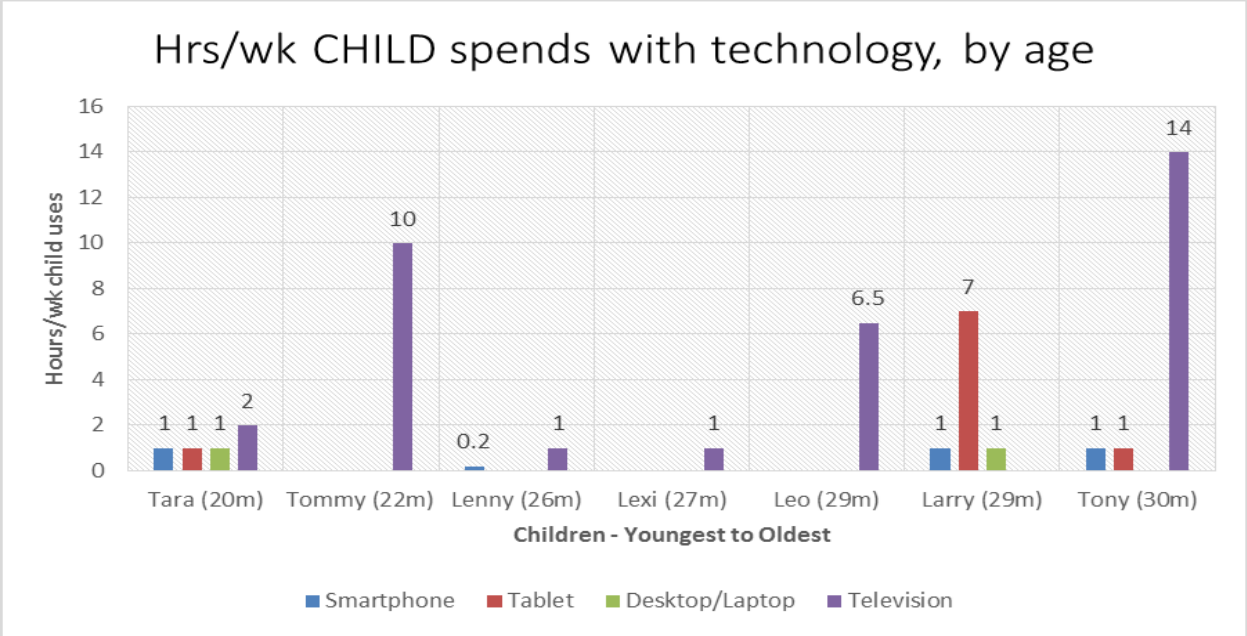

Figure 11. Hours per Week Child Spends with Technology, by Child's Age. This graph illustrates what kind of technology children in this study use, and how much time is spent with that technology per week in the home.

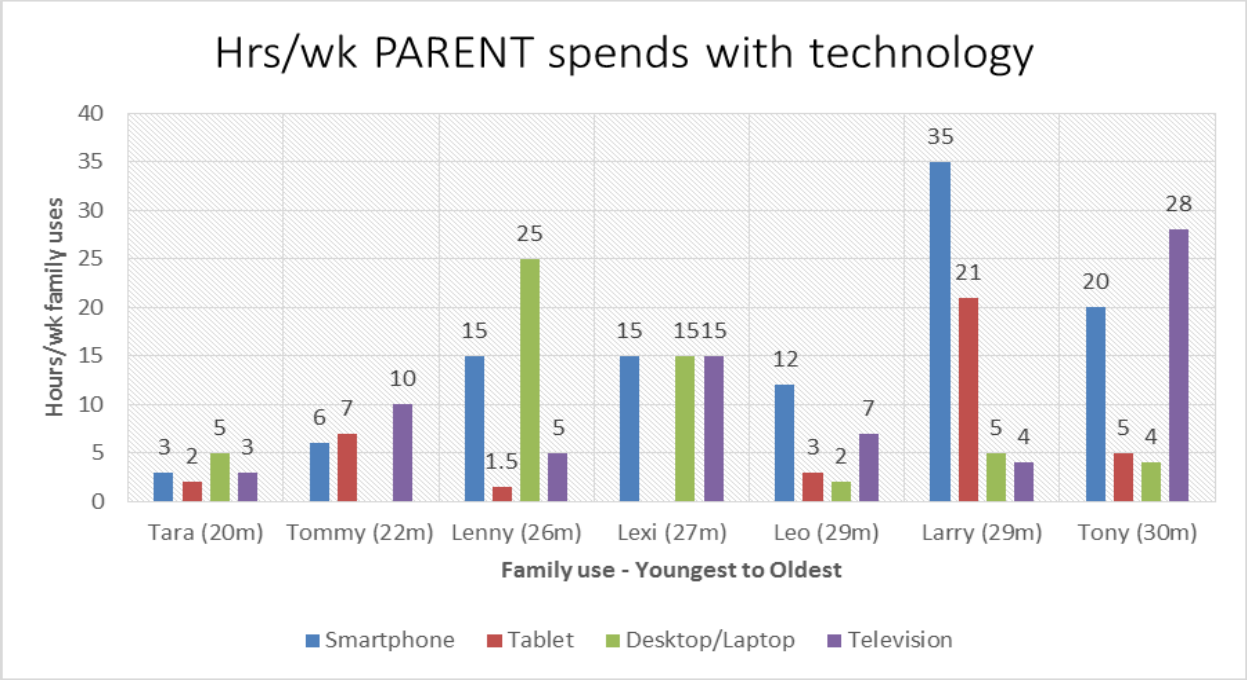

Figure 12. Hours per Week Parent Spends with Technology, by Child's Age. This graph illustrates what kind of technology families in this study use, and how much time is spent with that technology per week in the home.

As can be seen from these figures, a wide variety of technology is used in homes with the parents of children above 20 months of age using more than those with younger children. The use of technology by children did not follow the patterns of use by the parents. This suggests that the digital surround may not in itself predict the involvement of young children with technology.

Discussion

Technology and culture is rapidly evolving, and as it evolves, the lives of all of us - including very young children - are dynamically changed. This study sought to explore these changes by gathering data using parent report materials, specifically a developmental-technology questionnaire, which is qualitative, and the CDI, which is standardized and norm references. An observational component was added by reexamining archival video data of children from high and low tech permissive home engaging in play with real and digital objects.

As can be seen from the results of this study, even when technology is widely used in the home, parental values reduce experience, if not exposure, to its use. Children from high and low technology homes engaged in interpersonal interaction during real object and digital play, but differed in how often they used verbal versus vocal communication. The recognition of this is important for understanding how the shift of technology in our daily environments- our digital surround – produces a different developmental picture for the next generation of children.

Several important points emerge from this study. The first of these concerns the digital surround. As can be seen from the data, all homes in this study have a digital surround. Some of these homes are more intensely digital with products that range from desktop or laptop computers to tablets and smart phones to gaming and social media devices. Some homes have far fewer 'technology items' but, even with the most minimal number of devices, utilize the larger digital community, for example, Wi-Fi in public places and/or libraries, schools, etc. Interestingly, the average hours spent per week with technology by the families (Figure 2) were not drastically different, the average time ranging from approximately 31 hours a week to 43 hours a week. Additionally, parents from all three settings (preschool A, preschool B, homes) spent an overwhelming majority of technology time with either television, tablet, or smartphone (Figure 3). Therefore, the results from this study suggests that the digital surround is expansive and not exclusive. These findings are consistent with the reviewed literature, which states that we Americans, on average, consume 11 or more hours a day of electronic media, and we particularly do it through via multimodal means and while multitasking (Turrill, 2015). This begs the question of what, then, does make the difference?

Parents and their parenting decisions appear to make the difference. The evidence for this was clear from responses to the questionnaire that asked at what ages children should be

allowed to access and use technology. The majority of families from this study thought 1-3 year olds can be safely exposed to technology. This can be compared to the guidelines of the American Pediatric Association that recommends that children not be exposed to any screen time whatsoever until after the age of two (Brown, 2011). This research cannot identify the impact of this position statement on the re-voice/decision of parents. However, the differences in responses to the developmental and technology questionnaire by the three sets of parents does suggest that the parents who sent their children to a grant supported program may be more aware of these guidelines than parents of children in the campus child development center, though that conclusion can certainly not be drawn definitively. In turn, this suggests that not all parents are aware of the same information/recommendations. Given the result of this study, if the digital surround supersedes the home environment, it may be more predictive of how development is dynamically changing, even at the individual level, in our society and in ways that differ or are not currently reflected by normative measures.

The second question of the study sheds more light on this as vocabulary as a cognitive measure and interaction/social engagement as an additional measure that could be expected to differ across varied digitally intensive home environments. The results suggest similar patterns for children of different digital surrounds across vocabulary and word/symbolically based interactions. When children were compared across technology groups, the children from the low tech groups achieved higher scores than the children from the other two groups (figures 6-10). This would coincide with earlier findings from other studies such as from Smith (2013), Dervin (2013), and Zach et al. (2013), whose studies demonstrate that live, physical play and interaction is conducive to appropriate language development, and that televised media consumption often leads to a lesser vocabulary intake, and eventual lower achievement in school. However, the role

of the digital surround versus active involvement with technology is still muddled. Both Piaget (1962) and Vygotsky (1967) might claim that the lack of real world action makes at an early age the digital surround less impactful. Hengst (2015) might very well agree as her research depended on social others as the medium for creating a basis for action, most specifically a storied and specific skill at recreating socially shared action via story. A window to this perspective is partially available from the analyses of this study. Most of all, this research suggests that digital natives may be a window to the worlds of tomorrow that those of us raised on books and cartoons cannot fully conceptualize.

Limitations of the Study

There were several limitations that impact the results of this study. The first limitation, and one of the most significant, is the small participant size, and the limited geographical locations of these participants. All participants were residents of the same region of Arkansas, and 19 of the 26 participants attended preschools in the area. Assessing children with such similar backgrounds place this study at a disadvantage in terms of generalizability to a broader population. It also suggests that attending a preschool can give a child an advantage, if the preschool is considered to be quality (Phillips & Adams, 2001). While preschool A seems to cater to a higher SES by its tuition rate and lack of scholarships, and preschool B offers a sliding pay scale program and thus makes attendance more feasible to a wider variety of people, both provide caregivers who are capable, warm, and who immerse the children in language and learning opportunities, making them quality preschools to attend. Additionally, more participants will be needed to add further depth and validity to the study. Future studies with additional participants will increase the reliability of these results.

Another limitation was family factors that were not accounted for in the developmental questionnaire. Some of the responses on the questionnaires indicated factors such as multiple languages spoken in the homes, or divorced parents. In the case of a child growing up in a bi- or even multi-lingual home, early language development scores for a mono-linguistic test could be skewed if the English language is a more recent language for the child (i.e., the child only hears English at his preschool). In the case of a child growing up in a home with divorced parents, the technology questionnaire may be inaccurate, as the parent reporting may not be able to report on the full scope of the child's technology exposure.

Additional time to collect data would have allowed for a greater breadth of preschools to reach out to. It would have allowed the researcher to also diversify the types of preschools included in the study, from high-quality, research-backed teaching, to preschools on the opposite end of that spectrum. Additional time would also have probably seen more parents return their packets. While the packets did not take more than approximately 30 minutes to complete, it is likely that certain parents would have benefitted from a written or electronic reminder to return the packets.

A final limitation is subjectivity to the data analysis process. The researcher was blinded from the participants' and families' identities; however, on vague responses (particularly on the developmental questionnaire), the researcher had to make a decision and embrace consistency. For example, multiple parents reported that they used their smartphones "a lot" during the day, instead of providing specific hours. On these occasions, the researcher assigned 3:30/day as that value. This value was picked because of 3-4 other parents who reported using their phones "a lot…probably 3-4 hours." While this allowed consistency, it is likely variant somewhat from actual that parents actual use.

Future Directions

Clearly, children who were exposed and used technology versus those who were new to it participated differently, though not less, with social others. Additionally, this study showed that young children are exposed to a plethora of digital technology, regardless of whether or not the children are physically allowed to use it themselves. This study also shows that parents have firm beliefs about what is appropriate for their child concerning exposure to technology. It would be interesting to further explore parents' reasoning behind why they believe a certain age is appropriate for technology exposure. Interestingly, some parents reported believing that a child should not be exposed to technology until a later age, but they then reported that they already let their young child use technology. This would suggest that, for parents, the pull of the digital surround is stronger than one would wish to admit; and while parents have their beliefs regarding what is right for their child, they are not always able to stand by it, due perhaps to societal pressure, child interest, or a number of other reasons. This study opens a window of questions rather than a well-defined structure of answers. As seen from the limitations, the way forward to is increase the number and diversity of families who help researcher map the digital surround and key developmental markers – vocabulary, social interaction, and cognitive change – to better understand how children develop their thinking problem-solving, and attending patterns in the 21st century, or actually over the next decade. The specifics are not as essential as understanding the components and possible trajectories. Truly, this is a developmental question that begs to be pursued and dynamically reconstructed as technology itself reconstructs society.

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Appendix A

Developmental Questionnaire

1. How old is your child? _____Date of Birth_____ [ ] Male [ ] Female
2. Is your child meeting developmental milestones? Provide any information you would like to describe your child's development.

3. Are there other children in the family, if so, what are their ages? _____
4. List three of your child's favorite activities.
   1)
   2)
   3)
5. Does your child attend day care or a preschool program? [ ] yes [ ] no
6. If they attend one of these, is technology used there? [ ] yes [ ] no
7. What age do you feel is appropriate to introduce technology to children?
   [ ] Birth-12 months [ ] 1-2 years [ ] 2-3 years [ ] 3-4 years
   [ ] 4-5 years [ ] 5-6 years [ ] 6 years and up [ ] Not at all
8. Please fill out the following table on technology use in your home:

OBJECT(S)	WHERE IN THE HOME IS/ARE THE OBJECT(S) USED?	HOW OFTEN IS/ARE THE OBJECT(S) USED BY THE FAMILY? (HOURS/DAY)	HOW OFTEN IS/ARE THE OBJECT(S) USED BY THE CHILD? (HOURS/DAY)
SMARTPHONE (IPHONE, DROID, ECT.)			
TABLET (IPAD, KINDLE, SAMSUNG GALAXY, ECT.)			
DESKTOP COMPUTER/ LAPTOP			
GAMING CONSUL (WII, XBOX, ECT.)			
HANDHELD GAMING DEVICES (GAMEBOY, PS2, ECT.)			
TELEVISION			
VIDEO CAMERA			

9. If your child uses a smartphone or tablet, please elaborate on how your child uses that device (i.e., games, to watch shows, camera, plays with texting app, etc.).

10. Has your child ever been referred for or received one or more of the following services: Audiology, speech-language therapy, occupational therapy, physical therapy, behavioral management, counseling, etc.?

11. Is there any other information that you would like to give me about your child and his or her play and/or development?

Appendix B

Does your child like to play?

You and your child may want to participate in research at the University of Arkansas that seeks to better understand the ways that experience with technology impacts social play!

Two ways to participate!

1. Parents can decide to just fill out two questionnaires.
2. In addition, your child can be videotaped while playing with real toys and digital toys.

Total participation time is 30 minutes for each or approximately one hour for both.

Please contact [redacted] at [redacted] or [redacted] to sign up or to receive more information about the study!

Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson	Child Play Study [redacted] Hannah Hutcheson

Appendix C

Instructions for Informed Consent – Technology and Play Research Project

Researcher: [redacted]
Faculty Mentor: Fran Hagstrom
IRB Protocol # 15-12-431

Thank you for volunteering for this project. Please sign the two consent forms. Keep one copy for your records and place the other in the white envelope addressed to [redacted]. If you would like use to share the results of the vocabulary scale with you, please make a note of this on the informed consent that you put in the white envelope. Place this white envelope, the completed questionnaire, and the completed vocabulary inventory in the manila envelope.

Again, thank you for considering this project. We appreciate your time and commitment to research that informs our understanding of child development.

Appendix D

Informed Consent

Title: The Impact of Technology on Play Interactions in Early Childhood

Researcher(s):
[redacted], Graduate Student
Fran Hagstrom, Faculty Advisor
Program in Communication Disorders
Graduate School & International Studies
303 Graduate Education Building
Fayetteville, AR 72701-1201
479-575-4910
[redacted]; fhagstr@uark.edu

Administrator(s):
Ro Windwalker, CIP
Institutional Review Board Coordinator
University of Arkansas Research Compliance
University of Arkansas
109 MLKG Building
Fayetteville, AR 72701-1201
479-575-2208
irb@uark.edu

Description: The purpose of this study is to explore the impact of technology on the social interactions of young children during play. Fifty families whose children are between 15 to 36 months of age will be sought for this study. The materials for the study will include a developmental questionnaire; the MacArthur-Bates Communication Inventory; an iPad with digital play apps; and physical play objects that match those in the apps. There are two ways to participate in this study. In the first way, the participation will be limited to parents providing information about their child/children by completing a developmental questionnaire and the MacArthur-Bates Communication Inventory. These can be completed in 30 minutes. A second and additional way to participate it to allow your child to participate in a 30-minute videotaped session as they play with digital and non-digital toys. This will take place at the parent's choice of location. This can be the home or various child centered locations at the University of Arkansas, such as the Jean Tyson Child Development Study Center or the Speech and Hearing Clinic. The only people who will be present will be the parent(s), the child, and the researcher.

Risks and Benefits: There are no known risks associated with this study. This study would add to the literature on the effects of playing on childhood development, and would explore the specific effects regarding physical versus technological playing on a child.
Voluntary Participation: You can decide any time that you and your child would like to withdraw from the study. All information and video recording will be destroyed.
Confidentiality: All information will be kept confidential to the extent allowed by applicable State and Federal law and University policy. Code names will be used for all data collection and no identifying information will be used in any publication or report resulting from this research.
Right to Withdraw: Your participation in this research is completely voluntary. You are free not to participate in the project and to withdraw from the study at any time.

Informed Consent: (please print)

I, _____, have read the description, including the purpose of the study, the procedures to be used, the potential risks, the confidentiality, as well as the option to withdraw from the study at any time. Each of these items has been explained to me by the investigator. The investigator has answered all of my questions regarding this study, and I believe I understand what is involved. My signature below indicates that I freely agree to participate and have my child participate in this study and that I have received a copy of this agreement from the investigator.

I agree to participate in this study. [ ] Yes [ ] No

I agree to allow my child to participate in this study. [ ] Yes [ ] No

_____ _____
Parent/Guardian Signature Date

Appendix E

Office of Research Compliance
Institutional Review Board

January 22, 2016

MEMORANDUM

TO:	Hannah Hutcheson Fran Hagstrom
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	15-12-431
Protocol Title:	*The Impact of Technology on Play Interactions in Early Childhood*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 01/21/2016 Expiration Date: 01/07/2017

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 75 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

Appendix F

PSA Coding Sheet

Case:_____Age in months:_____ [ ] Low Tech [ ] High Tech

Dore's Primitive Speech Acts				
The Act	Ve	NV	Vo	
Greeting				
Calling				
Requesting an action				
Requesting an answer				
Answering				
Labeling				
Protesting				
Imitation				

Child: Physical Toys

Dore's Primitive Speech Acts				
The Act	Ve	NV	Vo	
Greeting				
Calling				
Requesting an action				
Requesting an answer				
Answering				
Labeling				
Protesting				
Imitation				

Researcher

Child: Tech Toys

Dore's Primitive Speech Acts				
The Act	Ve	NV	Vo	
Greeting				
Calling				
Requesting an action				
Requesting an answer				
Answering				
Labeling				
Protesting				
Imitation				

Researcher

Dore's Primitive Speech Acts				
The Act	Ve	NV	Vo	
Greeting				
Calling				
Requesting an action				
Requesting an answer				
Answering				
Labeling				
Protesting				
Imitation				