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Mobile Technology Use and School Readiness in Low-Income Preschoolers

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MOBILE TECHNOLOGY USE AND SCHOOL READINESS IN LOW-INCOME PRESCHOOLERS

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ABSTRACT

MOBILE TECHNOLOGY USE AND SCHOOL READINESS IN

LOW-INCOME PRESCHOOLERS

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Once a luxury, mobile devices are now utilized by most members of society, including those in even the poorest communities. Unfortunately, little research has examined the effects of mobile media use in young children, and even less on young children from low-SES communities. Past research on television, and preliminary research on mobile technology, suggests that mobile media may affect school readiness, and that the direction and strength of this relation could depend on the content and context of the use. The current study examined the relation between mobile media use and a composite school readiness measure that included preliteracy, emergent math, and executive functioning, in a sample of low SES preschoolers. We found that weekly mobile media time significantly predicted poorer school readiness skills, which was predicted given the scarcity of high-quality apps for preschoolers. This relation was especially clear in regard to preschoolers' executive functioning, which had not been previously examined. While the effects of content and context of the usage were examined, few relationships emerged, perhaps due to measurement issues. The main results are concerning because children in this sample already have poorer school readiness than the general U.S. population, and their parents report considerable screen use. The results support efforts to

limit screen time of preschoolers and are a step towards understanding the complicated relation between achievement and mobile technology use in preschoolers.

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CHAPTER 1

INTRODUCTION

For the past decade, the use of mobile technology has increased exponentially. Although smartphones and tablets have made life easier, from transportation to communication, we know little about the consequences of this technology. In particular, little research has addressed how this new technology impacts young children's school readiness, although it has become a significant part of their everyday lives. While substantial research has addressed television, mobile technology differs in important ways in terms of content, structure, and function. Mobile technology could either interfere with or promote academic development, so we need to better understand the factors that make this technology a risk or beneficial factor.

Mobile Technology: A Help or a Hindrance?

The American Association of Pediatrics recommends that children aged 2 - 5 only spend one hour per day in front of a screen (2016). In addition, they suggest that parents should monitor this time and interact with their children, to help them understand how what they are seeing relates to their world. But children interact with screens much more than is recommended. Common Sense Media reported that 42% of children younger than 8 have their own tablet, and they spend an average of 2 hours and 19 minutes a day on screens (Rideout, 2017). The most common activity of children aged 0 to 8 in 2017 was watching online videos, most frequently on YouTube (Rideout, 2017). In fact, 73 percent of the children surveyed were using mobile devices to watch online videos, and only 28 percent used the devices to read books (Rideout, 2017). Other mobile technology activities include apps that might or might not be educational or age-appropriate (Hirsh-

Pasek et al., 2015). Although we have the recommendation from the American Association of Pediatrics, we don't know how disregarding the recommendation impacts children's development.

Mobile technology is different than other forms of media due to its small and mobile nature, which makes devices available to use across locations, including away from home. In addition, mobile technology has the potential to be more interactive than traditional media, with, for example, app characters speaking to and responding to children's actions, and presenting material based on children's choices or responses. Also, mobile technology can be more active than traditional media, requiring the child to, for example, make decisions, follow rules, sort objects, or plan out future moves. Finally, mobile technology potentially has the ability to scaffold to the child's ability, unlike television which does not change based on the child.

When children are watching and interacting with media, then obviously they are not spending that time on other activities, like shared book reading or interacting with peers that could be important to development, including to school readiness. This trade-off is the basis of the displacement theory of media (Neuman, 1991). This theory draws on the notion that there is a certain amount of discretionary time, and by engaging with media, you make sacrifices in other areas of your life (Neuman, 1991). Overall, this theory has empirical support. Media use is associated with sedentary behavior and linked to a variety of problems in youth like decreased academic performance, lowered self-esteem, and unfavorable health outcomes (Tremblay et al., 2011). In addition, a body of studies suggests a negative association between overall mobile technology use and academic performance in adolescents and undergraduates (e.g., Jackson et al., 2008;

Jacobsen & Forste, 2011; Pieró-Valert et al., 2014). This literature suggests that there might be an overall negative association between media use and school readiness in younger children.

At the same time, a more nuanced view is likely necessary to fully understand the effects of mobile media. The quality of the media use is likely important, and studies have found that even the displacement of other positive activities depends on factors like the type or content of the media and the environment in which the media is being used (e.g., Hofferth, 2010; Huston et al., 1999). For example, in one study, more time playing video games or watching television was associated with less time spent reading for pleasure for children aged 6- 12, but computer use was not associated with this decrease in reading (Hofferth, 2010). Theory about children's learning is consistent with the notion that the relationship between mobile technology use and achievement may vary depending on content and context.

Theory suggests that, in reasonable quantities, mobile technology has the potential to benefit the development of important school readiness skills. Children learn best when tasks 1) are scaffolded and adjust to their knowledge level; 2) provide active, hands-on learning; 3) offer repeated, varied practice; 4) give specific, constructive feedback; and 5) are engaging (e.g., Hirsch-Pasek et al., 2015; Kim & White, 2008; National Research Council, 2009). High quality, educational apps could provide all of these features, in an entertaining format, that teaches the child important school readiness skills. In fact, in several studies, the use of educational apps that match these characteristics significantly increased school readiness skills of low-SES children compared to the use of other apps that did not (Arnold et al., 2020; Griffith et al., 2019). In sum, there are reasons to expect

that mobile technology use could either interfere with or promote early academic development, but far more research is needed to evaluate if and how mobile technology use is related to preschoolers' school readiness.

School Readiness

School readiness is a broad construct that includes academic, social, and emotional development (e.g., Raver & Knitze, 2002; Zins et al., 2004) and each of these have been shown to be important for student success. On the academic front, preliteracy, emergent math, and developing executive functioning skills are all foundational aspects of children's academic future and are the focus of the current study. In terms of preliteracy skills, phonological awareness and print knowledge serve as a foundation for later reading (American Academy of Pediatrics, 2014; Lonigan et al., 2008) that strongly predicts long-term academic achievement (e.g, Lonigan et al., 2000; Stainthorp & Hughes, 2004; Wagner et al, 1997). Similarly, emergent math skills are a particularly powerful predictor of both later academic interest and overall academic achievement (Duncan et al., 2007; Fisher et al., 2012). In addition, executive functioning skills in preschool and kindergarten are associated with children's preliteracy and emergent math skills (McClelland et al., 2007; Shaul & Schwartz, 2013). Preliteracy, emergent math, and executive functioning skills are clearly linked to future success, and therefore it is important to examine how mobile technology impacts these skills.

Socioeconomic Context: Universal Exposure to Mobile Technology, but to What Effect?

Understanding the impact of screens on school readiness is especially important with respect to children in low-income families. The well-researched opportunity gap

between low-SES and high-SES children exists as early as kindergarten (Loeb & Bassok, 2007). This gap is so pronounced that children in kindergarten from low-SES score, on average, at least half a standard deviation lower on academic achievement measures than children from higher-SES families (e.g., Bradley & Corwyn, 2003; Duncan & Magnuson, 2005; Galindo & Sonnenschein, 2015; Nores & Barnett, 2014). Especially discouraging is the fact that this early achievement gap predicts later gaps in academic skills, especially in math, literacy, and attention (Duncan et al., 2007). This gap has not changed in the decades since it was recognized, and once children start behind, they rarely catch up (García & Weiss, 2017). A major factor in this gap is that children from low-SES homes have less access to educational content in their homes (e.g., Miller et al., 2014; Mol & Neuman, 2014). A promising approach to addressing this problem could be to provide educational content to these families via mobile technology.

Historically the SES achievement gap has be exacerbated by inequities in access to educational technology, for example, computers and the internet. However, there is now universal exposure to mobile devices for young children in low-income families, such that almost all low-SES children use mobile devices (e.g., 96.6% in Kabali et al., 2014). In fact, children from low-income homes were actually found to spend an average of 36 minutes more on mobile media each day than those from higher-income homes (Rideout, 2017). However, though there now exists universal access to mobile technology, inequalities in the quality of the exposure remain. For example, children in low-income homes are far less likely to have quality educational apps (Rideout, 2013). Because of the intractable achievement gap and the persisting difference in quality of

mobile technology experience, this study focuses on low-income families as it aims to add to the research on mobile technology and achievement.

Previous Research

Few studies have focused directly on the impact of mobile media on young children's development, and therefore we have very little direct evidence regarding how mobile media may impact children's school readiness. However, the few studies that have examined mobile technology and achievement are consistent with theory suggesting overall negative effects of this screen time. In the only study of this relationship in preschoolers, Hutton et al. (2019) recently found poorer preliteracy scores in preschoolers who used more than one hour of any type of screen per day. However, only high-income children were included in this sample; they suggest that the associations may be even stronger in low-income families, but this hypothesis remains unexamined. In addition, a 2019 meta-analysis by Adelantado-Renau et al. found that increased screen time was negatively associated with academic performance. However, only five articles out of the 58 reviewed looked at mobile media specifically, and all of those focused on adolescents instead of young children. This further shows that research with preschoolers and mobile media is severely lacking.

While there is a dearth of research on the relation between mobile technology and school readiness skills with preschoolers, there is indirect evidence from other screen media (especially TV) that suggests the possibility of a negative overall relation. For example, the relation between TV watching and preschoolers' school readiness has been examined (e.g., Felter, 1984; Neuman, 1991; Schmidt & Anderson, 2007), with some research including low-income families. This literature suggests that, overall, there tends

to be a negative relation between screen time and achievement. For example, Clarke and Kurtz-Costes (1997) found that TV viewing time was associated with poorer school readiness skills in low SES preschoolers. More recently, the same TV finding was replicated by Ribner et al. (2017), who found that this negative relation was even stronger for those in poverty. Similarly, past research on the impact of media on executive functioning skills has focused mostly on television. One study found that 4-year-olds' exposure to adult television programs was associated with poorer executive functioning (Barr et al., 2010). These relations suggest that screen usage does affect low-income children's school readiness, and while TV is different than mobile technology, it is plausible that a similar relation exists.

Missing Context in the Literature

Beyond the overall negative relationship between media use and school readiness, research has also pointed to the importance of the quality of media content, as well as the context in which it is used, particularly with respect to parenting. With respect to content, Wright et al. (2001) found that educational TV programing in small amounts was associated with increased school readiness and language skills of young children, while general programming was associated with poorer skills. A research group that performed and summarized three experimental laboratory studies on television's impact on executive functioning skills found that 10-20 minutes of watching fantasy based cartoons, compared to watching a realistic show, an educational show, or having no media experience, resulted in lower executive functioning (EF) in 4-6 year olds (Lillard et al., 2011). This indicates that media use and EF are linked, and that media content can impact its influence on developing skills. With respect to parenting, active parent-child co-

viewing of educational television increases its academic benefit (e.g., Reiser et al., 1984, 1988). These studies show that the content and the context of use must be considered. However, the literature has not fully investigated these contextual factors, particularly in the context of mobile technology.

Content and Quality of Apps

It stands to reason that the content of mobile media matters in terms of children's academic development. Past research with TV, as described above, indicate that the effects of TV are moderated by educational content, which could be the case for mobile devices and their apps. A small number of recent studies have indicated that mobile technology can positively impact school readiness in preschoolers, with specific educational apps. Dore et al. (2019) showed that children can learn and retain novel vocabulary from an interactive app at age four. Other home-based studies have also shown that interactive apps that are educational in nature, compared to entertaining, can benefit preliteracy skills (Arnold et al., 2020; Griffith et al., 2019). These studies indicate that mobile technology does have the potential to be a learning tool. With respect to the impact on executive functioning skills, a recent laboratory study found that 2-3-year olds were able to delay gratification and had improved working memory after playing with an educational app, but not after watching a cartoon (Huber et al., 2018). This suggests that the interactive component of mobile technology could lend itself to helping improve EF skills. However, more research is needed to establish firm links between educational content of mobile technology and school readiness, including studies that focus on learning in the home.

Parental Monitoring of Screen Content

An important aspect of parenting is the monitoring of media use, which could moderate the relation between screen use and school readiness. If parents are monitoring the content of screen time, they are likely improving its quality. Monitoring children's content on mobile technology is challenging and potentially especially important due to the private nature of these devices, which don't allow for the monitoring to happen incidentally. Compared to TV, video games, or even computers, smart phones and tablets are harder to monitor due to their small and mobile nature. In the past, parents could see what children were watching on television by just being in the same room. With mobile technology, more purposeful, closer monitoring is needed to be aware of children's activities. Such monitoring is expected to be associated with higher quality experiences. Gentile et al. (2014) found that parental monitoring of elementary aged children's media was related to their school performance. This establishes a link between monitoring and school performance in older children, but research is needed specifically on mobile technology use and preschool-age children.

Parents' Rules

The rules that parents or caregivers set for their children may also impact the role mobile technology has on their children's school readiness. Rules could moderate the relationship between media use and school readiness, or media use could mediate the relationship between rules and school readiness. Specifically, parental rules about screen time might moderate the relationship between screen time and academic performance if they are improving the content that the child is interacting with. On the other hand, if the rules limit how much children use media, and amount of use influences academic outcomes, then a mediational model is appropriate. Several studies have found that

setting rules about TV watching time can decrease TV time for children and adolescents (e.g., Barradas et al., 2007; Ramierz et al., 2010). Our work has found that parents were more likely to have rules about amount rather than content, and so given the hypothesized overall negative relation between screen use and school readiness, we therefore posit that rules about amount of mobile screen use will be associated with stronger school readiness, with decreased media use mediating this effect.

YouTube Use

Further complicating the relationship between mobile technology and achievement is that, in addition to interactive apps, children have access to video streaming. Most commonly this is through YouTube, a video sharing service that allows anyone to upload any type of content. Among children aged 0 to 8 years, 73% have watched YouTube type videos, on average for 17 minutes a day (Rideout, 2017). In a review of YouTube by Common Sense Media (Coon, 2019), they recommend parental supervision because it is very easy for inappropriate content to appear, even during innocent searches, or as recommended videos (2019). While YouTube does contain educational and kid- friendly content, it also has a large amount of age inappropriate content (Coon, 2019). In addition, unlike video services like Netflix or Disney+, YouTube is free to download and watch, which makes it available and enticing to low-income families. The parental oversight discussed above could be particularly relevant to the effects of YouTube; if children are free to use mobile devices with little to no supervision, they may access to content that is neither educational nor age appropriate.

The Present Study

Research was needed to examine the relationship between school readiness and mobile technology use, including YouTube. The current study examined the following hypotheses:

1. Overall, greater mobile media would be associated with lower school readiness in early childhood.
2. If the mobile media use is described as educational, the associations between mobile screen time and school readiness would be more positive than if the mobile media use is not educational.
3. If the parental monitoring of their children's mobile media use is high, the associations between mobile screen and school readiness would be more positive than if less monitoring takes place.
4. If parental rules about child usage amount are present, this would lead to less use of mobile technology, and be associated, in turn, with increased school readiness.
5. YouTube use would have a negative relationship with school readiness. In addition, this relation would be more positive in the context of parental monitoring.

CHAPTER 2

METHOD

Participants

Participants were 72 children aged 4- and 5-years-old and their primary caregivers. The data collected for this study were gathered from two different studies evaluating the effects of educational apps on academic skills in early childhood, specifically for low-income families. Twenty-two participants were first recruited as part of a pilot study that examined the effects of a variety of high-quality educational apps on early academic skills. The remaining participants were recruited for a study that examined the effects of a particular educational app on the same early academic skills in low-income families. The sample was limited to those who were comfortable participating in English.

The pilot sample was recruited through birth records and through connections at local Head Start centers in western Massachusetts. To be eligible, the annual income of families had to be below $48,000, which is 195.12% of the 2017 federal poverty level of $24,600 for a family of four. In the second study, participants were recruited from local Head Start centers, other Western Massachusetts centers that serve low-income families, and Facebook advertisements. To be eligible, families were required to have a reported income of below 150% of the poverty line, as it was set by the Federal Register by the Department of Health and Human Services in 2017. This cut off is used to determine which children in Massachusetts get safety-net health coverage (Mass Health), and children in the Head Start programs are all required to be under the federal poverty line.

Procedure

The procedures relevant to the current project were identical in the two studies. Families completed pretest assessments, either in their own homes or at the Springfield UMass Center, before the educational apps were introduced. Before participating, measures and tasks were explained to the caregiver, and informed consent was obtained. Children and their caregivers completed separate tasks and assessments with doctoral students who had extensive training and experience. Specifically, parents were interviewed regarding demographic variables and their children's media use, and children were administered tests of their academic achievement. For compensation, families in the pilot study received an iPod, and families in the second study received $50 for this visit. Both studies were approved by the University of Massachusetts' IRB.

Measures

Demographics. Parents provided demographic information including income, education, and ethnicity.

Media Use. Experimenters asked parents a variety of questions about their children's media use, including use of and their favorite content for smart phones and tablets.

Weekly Media Use. Caregivers were asked about their children's average screen media use on weekdays and weekends across media types. A weekly mobile media screen time was then computed that included both smart phones and tablets.

Educational Content. Parents were asked to name their children's favorite apps or activities on both tablets and smart phones. After answering, they were then prompted with "any others you can think of?" once. When parents named specific apps, these apps were scored based on number of stars Common Sense Media gave them on their

educational rating. Common Sense Media is the leading independent rater of children's media due to their thorough reviewing and reviewer training process, and other past studies have relied on their ratings as well (e.g., Arnold et al., 2020; Blackwell et al., 2014; Kabali et al., 2015). This study gave any app that had a score of 3 stars or better an "educational" rating. When parents gave non-specific answers (e.g., "math app," "baby care," or "brain games") this content was coded as educational if they used any of the following words: "educational," "learning," "numbers," "letters,", "math," or "reading." Given that very few educational apps were mentioned, this information was summarized to simply indicate if the parents described their as using any educational content or not.

Parental Monitoring. Parents were asked to indicate the extent to which they agree to the statement "I closely monitor my child's use of screen time." Parents could answer "Strongly Disagree", "Somewhat Disagree", "Somewhat Agree", or "Strongly Agree." Due to the large number of responses endorsing "Strongly Agree", a dichotomous variable was created that coded parents as either strongly agreeing or not.

Parent Rules about Screen Time Amount. Caregivers were asked if they have any rules to limit the amount of screen time their child is allowed. If they said yes, they were asked what their rules were. If the parent mentioned imposing limits on their child's screen time, they were coded as having rules about amount. If they did not have rules or had more general rules like "Must complete homework first," they were coded as not having rules about amount.

YouTube Use. If caregivers mentioned that their children used YouTube anywhere in the interview, the children were coded as a YouTube user.

School Readiness. To assess a child's school readiness, a composite score was created by averaging the z-scores of three well known measures of preliteracy, emergent math, and executive functioning, to create a composite school readiness score for each child. In building this composite, age-adjusted (i.e., IQ-scale) scores were used for the preliteracy and math scores, whereas raw scores were used for the EF measure.

Preliteracy Skills. The Test of Preschool Early Literacy (TOPEL; Lonigan et al., 2007) is a well validated and normed preliteracy test. It measures print knowledge, vocabulary, and phonological awareness, providing a standard score (national mean = 100, *SD* = 15) for overall preliteracy skills. The TOPEL has high concurrent validity in relation to other tests of print knowledge, expressive vocabulary, phonological awareness, and overall reading ability (*r*s = .59 to .77) and is predictive of kindergarten to first grade reading skills (Lonigan et al., 2007). Reliability estimates range from .86 to .96 (Hayward et al., 2008).

Emergent Math Skills. Children were assessed on early math skills using Form A of the Test of Early Mathematics Abilities-3 (TEMA-3; Ginsburg & Baroody, 2003), which measures math performance in children 3 to 8 years old. This test measures knowledge of formal and informal math concepts, including relative magnitude, counting, calculation, and number facts. The TEMA-3 includes a wide range of items at the early stages of math development, with a particular emphasis on the critical skill of numeracy e.g, identifying numerals and counting the number of objects on the page). Ginsburg and Baroody (2003) have demonstrated the TEMA-3's validity in both its relation to other standardized measures and its ability to identify children who are struggling in math. A normed standard score (with a mean of 100 and a standard

deviation of 15) is calculated for an overall score. The test-retest reliability of the TEMA-3 is estimated to be .82 (Ginsburg & Baroody, 2003).

Executive Functioning. Children's impulse control and working memory were assessed using the Bear Dragon "Simon Says" task (Reed et al., 1984). In this task, children are asked to either perform or to inhibit performing a series of common actions. First, the experimenter makes sure that the child can follow all directions needed (e.g., "Touch your ears," "Cover your eyes," "Touch your elbow," etc.). Then, the child is exposed to two puppets, a bear and a dragon. Children are told that the bear was good and they should follow all of the good bear's directions and that they shouldn't follow the bad dragon's directions. Then the child is assessed on their understanding of the rules with a practice trial for each the bear and the dragon, and a rule check. There are 5 bear trials and 5 dragon trial total, alternating each time. For each trial, children scored 1 point if they correctly completed the action, 0 points if they incorrectly did not do the action, and 0.5 points if they used some sort of strategy that indicated they were thinking in the correct way. For example, this strategy could be vocalizing "I should do this," or a half action, where they start to move towards the correct action, but stop. The highest score a child can get is 10 points, one point for each correct trial.

CHAPTER 3

RESULTS

Descriptive Statistics

One participant had considerably higher (+ 4.18 *SD*) mobile technology use (53 hours a week), meaning their mobile media use was very atypical for the sample. This outlier was dropped from all analyses, making the final sample size 71 participants. See Table 2 for descriptive data of media use and school readiness scores. Mobile technology use alone, on average, was above the recommended total screen time recommendation of one hour a day (mean hours per week = 9.68), and amount of use ranged widely, from 0 to 39 hours per week. Parents reported a wide variety of rules for their child's technology use including rules about amount, rules about nighttime use, and rules that were conditional on the child's actions. See Table 5 for some examples.

Consistent with the systemic disadvantages associated with living in poverty, children scored below the population average on preliteracy (M = 94.27, SD = 12.41) and emergent math skills *(*M = 92.44, SD = 12.98). The composite school readiness scores appeared to be approximately normally distributed. Fewer than half of the families used educational apps (46.5%) or had rules about child’s amount of use (46.3%). Most parents strongly agreed that they closely monitored their child’s screen time (57.7%). And finally, almost half of the parents reported that their children spent time on YouTube using mobile technology (46.5%).

Potential Covariates in Predicting School Readiness

In order to determine which variables to control for in the primary analyses, potential covariates (caregiver education, single-parent status, child sex, and time spent

watching television) were evaluated by examining their relation with school readiness. Correlational analyses found that caregiver education is related to school readiness (r = .27, p = .023) and thus was controlled for in the primary analyses. Caregiver education and weekly mobile media use did not have a significant relationship (r = -.11, p = .365). Single-parent status, child sex, and television watching were not used as covariates. An independent sample t-test found that there is no difference in school readiness for children with single parents (M = - .069) compared to children whose parents had a live-in partner (M = .088), $t(69)$ = .81, p = .42. Likewise, there was no difference in school readiness for girls (M = -.068) and boys (M = .029), $t(69)$ = -.23, p = .82. Finally, there was no significant relationship between hours of TV watched per week and school readiness (r = -.06, p = .61).

Mobile Media and School Readiness

Regression analysis examined the first hypothesis that weekly mobile media use would negatively predict school readiness skills. Consistent with this hypothesis, when controlling for parent education, increased weekly mobile media time significantly predicted poorer school readiness skills (β = -.26, SE_β = .11, p = .022). For readers interested in the relations between media use and the three components of the composite school readiness measure, correlations are presented in Table 3.

Educational Content and School Readiness

Regression analysis examined whether educational apps were related to school readiness skills controlling for parental education, and found no significant relation with the school readiness composite score (β = .15, SE_β =.12 , p = .21). Then, regression analysis examined the second study hypothesis that educational content would moderate

the relationship between mobile media and school readiness. There was no significant interaction of mobile media use and whether the use was educational (coded as = 1) or not educational (coded as = 0) on school readiness scores (interaction β = .04, SE_β = .18, p = .83).

Parental Monitoring and School Readiness

Regression analysis examined whether parental monitoring would predict school readiness skills controlling for parental education and found no significant relation with the school readiness composite score (β = .002, SE_β =.004, p = .96). Regression analysis examined the third study hypothesis that parental monitoring of media use would moderate the relationship between mobile media and school readiness. There was no significant interaction of mobile media use and whether parents' reported monitoring on school readiness scores (interaction β = .09, SE_β = .25, p = .72).

Parental Rules and School Readiness

Firstly, regression analysis examined whether parental rules would impact school readiness skills without taking mobile media use into account but still controlling for parental education and found no significant relation with the school readiness composite score (β = .002, SE_β =.004, p = .99). The fourth hypothesis of this study was that mobile media use would mediate the relation between parental rules about media amount and school readiness. However, there was no significant relation between whether or not parents had rules about amount and the child's media use (β = -.04 , SE_β = .12, p = .73), nor was there a relation between having rules about amount and school readiness (β = .05, SE_β = .12, p = .69), and thus there was no mediating relationship.

YouTube Use and School Readiness

Finally, regression analysis examined the hypothesis that YouTube use would predict school readiness skills. When controlling for parent education, YouTube use did not significantly predict school readiness skills (β = -.14, SE_β = .12, p = .24). In addition, regression analysis examined whether parental monitoring moderated this relationship, and found no significant interaction (β = .20, SE_β = .20, p = .33).

Mobile Media and Executive Functioning

Given the significant relation between mobile technology use and EF specifically (β = -.26, SE_β = .12, p = .022), and the sparse research base on the relationship between these, we evaluated our study hypotheses with EF as the outcome variable, for exploratory purposes. For each analysis, we controlled for age because the measure we used (Bear Dragon) does not control for it. We found that children who used educational apps had better EF scores than those who did not, even when controlling for parent education and age, (β = .34, SE_β = .11, p = .003). All other findings were non-significant. Mean school readiness scores within all of the contextual variables are presented in Table 4.

CHAPTER 4

DISCUSSION

The present study examined the relation between mobile media use and school readiness in a sample of diverse, low-SES preschoolers. The children in our study used mobile media for an average of 1 hour 38 minutes per day, which is more than Common Sense Media's average of 1 hour 13 minutes per day for children in low-income homes (Rideout, 2017). Given the use of parent report, this usage could even be underestimated. Their preliteracy and math school readiness scores were lower than national averages, which is expected for children facing the structural disadvantages associated with living in poverty (e.g., Bradley & Corwyn, 2003; Duncan & Magnuson, 2005; Galindo & Sonnenschein, 2015; Nores & Barnett, 2014).

Principal Findings

Regarding our primary question of whether school readiness and mobile media use would be related, consistent with our predictions we found that increased mobile use was related to decreased school readiness. This result extends previous findings of a negative relation between screen time and school readiness, but which had mostly focused on television and low-risk children (e.g., Barr et al., 2010; Hutton et al, 2019; Ribner et al, 2017). To our knowledge, this study is the first to find a significant relation between mobile media use and school readiness with preschoolers from high-risk families. Strengths of this study include that our school readiness measures were robust, valid measures that are considered state-of-the art by the field. Another strength is that the sample was a diverse group of preschoolers from low-income families, who are at risk for academic underachievement, but have been underrepresented in research. Our

results are concerning because children in this sample already have lower school readiness than the general U.S. population, and their parents report considerable screen use. The results support efforts to limit screen time of preschoolers.

We also conducted exploratory analyses examining the relation between components of school readiness and mobile media use. There was no significant relation between emergent math and mobile media time; the relation between preliteracy and mobile media approached significance and was significant when not controlling parent education. We found a significant negative relation between mobile media use and executive functioning. These findings are particularly interesting given the dearth of research on early media use and EF. We know from research on television that fast-paced fantastical content decreases EF (Lillard & Peterson, 2011), and that commercial television is worse than non-commercial television (Nathanson et al., 2014). Many apps are fast-paced and may be frequently interrupted by ads, so it makes sense that EF could be negatively affected by mobile media. At the same time, educational apps can foster EF (Huber et al., 2018), so future research should examine this relation much more closely, seeing exactly what kind of apps impact EF and how.

We also predicted that the content of the mobile media and parents' rules and media monitoring would affect this relation. These hypotheses were largely unsupported; school readiness was stronger in children who used educational apps at a level that approached significance, and the use of educational apps did predict stronger EF, but other findings were not significant. We suspect that this may be a function of not measuring these constructs well enough. To code whether apps were educational or not, we relied on the parents remembering their children's favorite apps, and when most could

not, we had to code apps based on their descriptions; many were not specific enough to code well, and parents often seemed unaware of the apps their children most used. In terms of parental monitoring, parents mostly reported that they monitored their children's content, but monitoring could be very different for each parent, and the question was likely not specific enough. Further, their inability to report on specific apps used calls into question their monitoring reports. When asking about rules, we did not ask how rules were enforced, and our information only allowed a blunt coding of whether there were any rules or not. Also contrary to hypotheses, watching YouTube use did not predict school readiness. Possible reasons for this non-finding include poor parental report, and/or large variation in the amount or content of YouTube watching.

In addition, caregiver education had a positive association with school readiness, and although this study did not find a significant relation between caregiver education and mobile media use, implications remain. Parents who have extra schooling could be providing their children with enriching experiences outside of media, which could bolster their school readiness. It would be helpful to understand how a child's time is spent outside of the media use, and the effects when media use displaces this time. Depending on the content of the media, and how enriching the time would have been spent, media use could have different effects. More research needs to be done to examine this concept.

Though not the focus of this paper, we were also surprised to find no significant negative relation between television use and school readiness, which is in contrast to a large body of previous literature (e.g., Clarke & Kurtz-Costes, 1997; Ribner et al., 2017). We are not sure why our finding differs. It is possible the impact TV has on children has changed due to the prevalence of other technology in our society, or an increased

awareness of the importance of television content on children's development. Alternatively, we may have simply committed a Type II error. More research needs to be done to investigate this.

Study Limitations

This study had several limitations, mostly with regard to the measures used. All media use measures relied on parent report, and thus biases may have been present. Parents could have underestimated the amount of media the child interacts with and overestimated their amount of parental monitoring and enforcement of rules. The measurement of rules and content were blunt – more detailed measures should be used in future studies. Our sample size was adequately powered for detecting medium-sized main effects, but a larger sample would lend more confidence to interaction analyses. In addition, this study did not examine the social/emotional development aspect of school readiness, which as an important part of school readiness.

Future Directions

Future research needs to examine the negative relation between school readiness and mobile media in more depth. Both longitudinal and experimental studies will be important to further understand the context in which mobile media impacts school readiness. More specific research should be done to examine both the overall mobile media use and how it impacts the learning process, especially in regard to different aspects of school readiness. The executive functioning aspect was the only component that reached significance, although preliteracy approached significance. In addition, social and emotional development should be considered when measuring school readiness in future studies, given the possibility that screen time could interfere with, but

possibly promote, social development. There needs to be better measurement of content and context this relationship happens, especially in terms of educational content and parental monitoring and rules. For example, future studies could employ device tracking to directly monitor children's use of mobile devices. In addition, future studies should take into account whether multiple technologies are used at once (i.e., watching TV while playing a game on a mobile device). This will make it easier to assess and categorize the content and patterns of mobile media use.

Summary

The present study provided the first examination of the relation between mobile media and school readiness in a sample of preschoolers from low-income homes who are at risk for academic underachievement. A negative relation was found, which was predicted given the lack of high-quality apps available. This relation was especially clear in regard to a preschooler's executive functioning, which points to the importance of considering EF in future work. Much more research needs to be done to understand the impact of mobile technology, continuing to look at the content and context in which the child uses the mobile technology.

Table 1. *Demographic Characteristics*

Characteristic	
Mean Child Age in Months (*SD*)	58.11 (6.23)
Child Gender (% female)	59.2%
Child Race	
Caucasian (%)	20.0%
Latino/Hispanic (%)	34.3%
African American (%)	18.6%
Asian (%)	2.9%
Multiracial or Other (%)	24.3%
Caregiver Education Level	
Not Graduated High School (%)	11.3%
High School Diploma/GED (%)	33.8%
Some College (%)	31.0%
Associate degree (%)	11.3%
Bachelor's degree (%)	7.0%
Master's degree (%)	5.6%
Median Household Income	$25,500

Table 2. Media Use and Achievement Scores

Mean Hours of Weekly Mobile Media Use (*SD*)	9.68 (8.92)
Mean Weekly TV Hours (*SD*)	11.16 (8.50)
School Readiness Measures	
Mean TOPEL (*SD*)	94.27 (12.41)
Mean TEMA (*SD*)	92.44 (12.98)
Mean Bear Dragon (*SD*)	8.34 (2.24)
Have Rules about Amount (%)	46.3 %
Use Educational Apps (%)	39.4%
YouTube Use (%)	46.5%
High Parental Monitoring (%)	57.5%

Table 3. Correlations between Media Use & School Readiness

	Mobile Media Hours	TV Hours	Overall School Readiness	TOPEL	TEMA	Bear Dragon
Mobile Media Hours	--	.30*	-.26*	-.21†	-.14	-.26*
TV Hours		--	-.06	-.01	-.04	-.11
Overall School Readiness			--	.88**	.81**	.72**
TOPEL				--	.66**	.47**
TEMA					--	.29*
Bear Dragon						--

* = $p < .05$, ** = $p < .01$, † $p < 0.10$

Table 4. Mean School Readiness Scores for the Contextual Variables

	Educational Apps		Parental Monitoring		Rules About Amount	
	M_{yes}	M_{no}	M_{more}	M_{less}	M_{yes}	M_{no}
School Readiness	.22	-.14	-.02	.04	.02	-.02
TOPEL	96.07	93.09	94.12	94.47	93.5	94.42
TEMA	93.43	91.79	92.34	92.57	93.52	91.47
BEAR Dragon	9.27*	7.73*	8.22	8.50	8.40	8.33

* = $p < .01$

Table 5. Examples of Parental Rules

Type of Rule	Number of Rules*	Key Examples
About Amount	25	"No more than an hour a day of tech use" "2-3 hours or less" "No more than 5 hours"
About Nighttime Use	7	"Everything by 8:30 is off" "TV until asleep" "No phone 1 hour before bed"
Conditional on Child's Actions	16	"Homework packet needs to be done first" "If he behaves/does chores, he can use device" "Same amount on tablet as outdoor/other play time"
About Monitoring	11	"Near an adult, loud enough to hear" "Keep track of YouTube watching" "Mom puts it on"
Vague or Unclear	7	"No use for long periods of time" "Stop watching inappropriate content" "Taking turns"

*Parents sometimes described more than one rule

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