A New Way to Co-Play with Media: Evaluating the Role of Instructional Prompts on Parent-Child Interaction Quality during Digital Application Usage

By

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CHAPTER I

Introduction

Adults' and children's social interactions around a shared activity such as reading or playing together can be crucial in what they each take away from it (Dickinson & Smith, 1994; Kuhl, 2007; Zimmerman et al., 2009). Specifically, when parents and children are willing to cooperate, be warm and positive, and equally contribute to the interaction, both parties benefit (Barry et al., 2008; Laible & Song, 2006; Mathis & Bierman, 2015). Shared interactions are particularly important for children in the preschool years, who are becoming more autonomous and curious, yet still rely on their parents to provide sensitive guidance and feedback to help enhance their understanding of new phenomena (Eisenberg et al., 2010; Hoff, 2006). Thus, the *quality* of interactions between a child and parent determines the effect a shared experience will have on a child's development (Rowe & Snow, 2019).

Researchers have measured different aspects of parent-child interactions when evaluating the effect of a shared activity on child outcomes. When parents and children are warm and reciprocal towards each other, children have stronger emotion regulation and exhibit lower peer aggression (Calkins et al., 1998; Grolnick, 2009; Kawabata et al., 2011). The number of conversational turns, or amount of back-and-forth conversation, between parents and children during a shared activity is a stronger predictor of language and neurological development than the sheer quantity of language that is present during the interaction (Romeo et al., 2018). Shared positive affect, such as smiling, laughter, and positive physical touch, strengthens the bond of parents and children when they read, play, or spend time together (Ensor et al., 2011; Landry et al., 2001). Moreover, positive affect shared between parents and 4-year-olds is associated with a

child's mental ability at age 4, IQ at age 6, and academic achievement at age 12 (Estrada et al., 1987). Adults who make a concerted effort to engage together with their child around an object or activity create a positive, responsive environment where the child can feel empowered to explore and grow (Hadley & Dickinson, 2019; Hirsh-Pasek et al., 2015).

In contrast, if parents are harsh or controlling with their child during a shared activity, children are less likely to learn and to engage with the activity again in the future (Grolnick, 2009; Landry et al., 2001). Likewise, if children act out or misbehave during shared experiences, parents exhibit more control and may decrease the amount of shared reciprocity and mutuality (Hoff-Ginsburg, 1991; Nathanson & Rasmussen, 2011). The likelihood of fruitful conversation, bonding, and strengthening the parent-child relationship decreases when either or both parties display harsh, negative behavior (Calkins et al., 1998). If the parent or child completely disengage from the shared activity, this can lead to a lack of motivation to cooperate or interact again in the future (Landry et al., 2001).

The parent-child behaviors that characterize a high-quality interaction can vary from activity to activity (Crain-Thorenson et al., 2001; Soderstrom & Wittebolle, 2013). For example, mutual conversation may be more important for a high-quality interaction during shared reading, while shared attention (e.g., eye contact, sharing emotional reactions) may be particularly important to watching a movie together. If children are skilled at learning within a given context, a high-quality parental response may offer less scaffolding and more autonomy-support than had their child been unskilled (Lauricella et al., 2009). Whether the parent believes a shared activity is valuable to their child's development also can influence the interaction and the quality of parental support (Lauricella et al., 2014; Rowe & Snow, 2019; Strouse et al., 2019; Vaala & Takeuchi, 2012). For instance, when parents view shared reading as important for their young

child's development, they are more likely to use positive and responsive behaviors during the interaction (Weigel et al., 2006). In contrast, parents may not have strong beliefs that other kinds of shared activities (such as meal time, grocery shopping, or using digital media) will meaningfully contribute to their child's development, leading to little shared interaction within these contexts (Nathanson, 2001; Strouse & Ganea, 2017).

In the section below, I describe how interactions differ in three parent-child shared contexts, as well as the variety of ways interaction quality has been measured from context to context. Then, I discuss how positive shared behaviors are key in one increasingly common context of daily life: the use of digital media. Finally, I consider potential methods of promoting high-quality interactions during joint media engagement experiences between parents and children, the primary focus of the present research.

Quality of Interaction in Various Contexts, and with Various Measures

Context. Vygotsky (1978) reasoned that children develop in a social world, and that their primary way of learning is during appropriate interactions with more experienced individuals, such as their parents. Vygotsky's concept of the zone of proximal development (ZPD) is a lens through which to consider the role of context on quality of interaction. For example, one child may excel in receptive vocabulary and story comprehension, allowing parents to interact with their child differently than with a child with less developed language skills. However, the language-advanced child may be less developed in spatial reasoning and cardinal value understanding. Parents who notice their child's less advanced "ZPD" in this area will provide more support during block building and math activities (Vygotsky, 1978). Besides the kind of activity, other factors related to the context are the parent's perception of their role in the

interaction, as well as the parent's and child's views of the activity's utility and potential for enjoyment (Fogle & Mendez, 2006; Haight et al., 1997; Miller, 1988; Strouse et al., 2019). To establish how the behaviors necessary for high-quality interactions can vary from context to context, three activities that are common for parents and preschool-aged children to do together will be considered: mealtimes, shared book reading, and shared toy play (Fletcher & Reese, 2005; Hirsh-Pasek et al., 2015; Hoff, 2010; Rowe, 2008).

In Western cultures, mealtime interactions expose children to behaviors and language that can influence their overall development (Hoff, 2006). As children become more interactive and independent in this context, parents tend to take less of an active, controlling role in the interaction, choosing to encourage children to step up and lead. There are implicit rules for turn-taking, responsiveness, and leadership during the interaction that may encourage or inhibit behaviors of both parents and children (Hall, 1993). When mealtime interactions between parents and children are consistently positive, longitudinal data have even demonstrated that these behaviors are likely to transfer to the next generation when the child becomes a parent (Fiese et al., 2006).

High-quality mealtime interactions are strongly associated with various language and social outcomes (Weizman & Snow, 2001). When parents view family meals as a time for children to grow and learn, they respond to their children with more opportunities for them to develop their vocabulary skills (Beals, 1997; Snow & Beals, 2006). High-quality interactions during meals can be focused on providing explanations, recalling the day's events, or increasing the strength of the parent-child relationship (Aukrust & Snow, 1998; Fiese et al., 2006). Children also benefit from overhearing other family members' mealtime conversations (Hoff-Ginsberg, 1991). In contrast, if adults believe meals are solely a time for eating, the amount of back-and-

forth conversation significantly decreases and no positive effects emerge (Dickinson & Tabors, 2001).

Interactions during shared toy play look very different (Hoff, 2006; 2010). During the preschool years, children from Western cultures begin to play in richer, more extended sessions than when they were toddlers (Howes & Matheson, 1992). During this time, young children prefer to play with their parents, in comparison to any other social partner (Haight & Miller, 1993; Wooldridge & Shapka, 2012). Parents and children situate play materials centrally so that both parties have equal access, promoting shared interaction (Hiniker et al., 2018). How parents and children interact with one another is critical in determining whether the toy play positively influences children's development and outcomes (Carpendale & Lewis, 2004; Nathanson & Rasmussen, 2011; Singer & Singer, 2005).

When parents and children play using warm, sensitive, and responsive behaviors, this provides more opportunities for exploration and honing skills in various realms of development (e.g., spatial, mathematics, language; Bjorklund, 2007; Hirsh-Pasek & Golinkoff, 2004). How parents engage with their child during play predicts how the child later interacts with their peers (MacDonald & Parke, 1984). Through using scaffolding behaviors (e.g., questioning, providing challenges, etc.) during an interaction, parents guide children to discover the function of the toy within the shared play context, as well as its features, to stimulate their child's cognition and learning (Carpenter et al., 1998; Hiniker et al., 2018; Rakoczy & Tomasello, 2005). In one study, adults taught an intervention method to direct children's attention and to scaffold guidance based on their child's abilities during play increased their responsiveness to their child. Subsequently, these children had larger breadth and depth of vocabulary than those not provided scaffolding during play (Hadley & Dickinson, 2019). In other research, mothers who were highly interactive

with their toddlers during dyadic free play further promoted their child's problem-solving skills when new physical toys were added (Hron-Stewart et al., 1990). Additionally, parents provided more contingent responses (i.e., personalized, direct responses to the individual child) and explanations during toy play when compared to other contexts, such as TV viewing (Nathanson & Rasmussen, 2011).

There is significant variation in the way that parents in Western cultures view the role of toy play in their child's development, as well as their own role during the interaction (Fogle & Mendez, 2006; Nathanson & Rasmussen, 2011). Some parents report that they believe that other contexts, such as book reading, contribute more to their child's development than play does. Parental behaviors and shared parent-child interactions are influenced by that belief (Haight et al., 1997). Parents who see their role as more central to play interactions produce behaviors ranging from helpful to intrusive, which will affect the quality of play interactions (Ispa et al., 2004; Nathanson & Rasmussen, 2011). In one study, mothers used more controlling directives toward their child during a shared toy play activity compared to shared mealtime and book reading (Hoff-Ginsberg, 1991). Hoff-Ginsberg concluded that these controlling behaviors lowered the quality of shared play interactions. Similarly, when mother-child dyads were observed playing with toys, mothers were significantly less responsive to their child than during shared interactions around puppet play or shared reading (Gros-Louis et al., 2016).

Parents' beliefs do not solely determine if shared play is a positive experience. Children have a natural desire to play, with and without toys, through which they are able to explore, imagine, and learn (Erickson, 1985). In Western cultures, the child is expected to have some level of independence during shared toy play: children who are encouraged by parents to have some control over a toy play interaction learn more, and parents' use of autonomy support

behaviors is associated with positive outcomes for children (Calvert et al., 2005; Landry et al., 1997; Wooldridge & Shapka, 2012). When adults acknowledge their child's feelings, provide thoughtful explanations around positive and negative behaviors, and avoid controlling language, children benefit from toy play interactions (Deci et al., 1994; Hadley & Dickinson, 2019). This is in sharp contrast to the mealtime context, in which both parents and children may not perceive interactions as requiring children's sense of autonomy (Beals & Snow, 2002). Even when children play alone, they are able to have imaginative and enjoyable experiences through which they are able to naturally strengthen their developing skills (Erickson, 1985; Ginsburg & Committee on Psychosocial Aspects of Child and Family Health, 2007).

Shared book reading, like toy play, is a common activity for parents and children in Western cultures (Strouse & Ganea, 2017; Wooldridge & Shapka, 2012). Parent's beliefs around shared book reading affect the interaction and help determine child outcomes (DeBaryshe, 1995; Fisch et al., 2002; Gros-Louis et al., 2016; Weigel et al., 2006). Many parents report they prefer book reading as a shared activity, see it as central to their child's development, and use it for bonding with their child (Cottone, 2012; Haight et al., 1997; Nowak & Evans, 2013; Strouse et al., 2019; Swain et al., 2017). Research surrounding joint book reading consistently notes the role of parent-child responsiveness and support as integral in creating a rich, beneficial interaction (Bingham, 2007). Specifically, when parents and children are reciprocal and positive during joint book reading, children's language and literacy development is significantly enhanced (Bus et al., 1995; Storch & Whitehurst, 2001).

Through a series of studies, Bus and colleagues (1997) found the shared affect and secure attachment behaviors between parents and children (i.e., maternal teaching, responsive support, etc.) were significantly, positively associated with children's early literacy skills (Bus et al.,

1997; Bus & van Ijzendoorn, 1997). Warm, shared interactions around books also foster children's positive literacy beliefs and behaviors (Baker et al., 2001; Bus, 2004; Sonnenschein & Munsterman, 2002). Mothers of low socioeconomic status given an intervention to promote responsive parenting during shared book reading increased their use of praise and encouragement, and offered more contingent responses to the child (Landry et al., 2012). Children's cooperation-based behaviors, joint engagement in the activity, and story-based reasoning and comments also significantly increased. In other studies, parental responsiveness during the shared reading interaction was directly linked to children's attention to text and frequency of literacy-based activities (Bus et al., 1997; Leseman & de Jong, 1998).

The quality of interactions during parent-child shared reading early in development can influence later interactions, as well. Parents who choose to read to their child during infancy use more sensitive parenting behaviors when their child is 5 years old, and children use more positive behaviors at preschool age (Jimenez et al., 2019). Similarly, parents' use of warm, positive behaviors with 18-month-old children was associated with prior shared book reading when the child was as young as 6 months old (Canfield et al., 2020). When parents are taught to use dialogic reading, an approach that teaches parents to prompt and contingently respond to their child during reading, both parents and children undergo positive behavior changes (Murray et al., 2016; Stuckelman et al., 2021; Zevenbergen & Whitehurst, 2003). Parents who engage in these interventions around child literacy outcomes retain these behavior changes up to 2 years later (Huebner & Payne, 2010).

There are notable context effects on parent-child behaviors in each of these shared activities (Bus et al., 1997; Hoff, 2006; Wooldridge & Shapka, 2012). Hoff-Ginsberg (1991) directly compared the three contexts to evaluate the impact of parent-child interactions on

children's language development. Significant context differences emerged: book reading contained the most reciprocal interactions and rich language exchanges compared to toy play and meals. Across multiple studies comparing the effect of interactions in some of these contexts on children's language development, book reading consistently has produced the richest interactions between parents and children (Choi, 2000; Gros-Louis et al., 2016; Hoff, 2006; Weizman & Snow, 2001).

Context effects have been evaluated for many important parent-child outcomes. Book reading consistently produced more reciprocal and warm language-building conversations (Hoff, 2006; 2010). Shared toy play is linked to higher amounts of joint engagement, and meal times encourage parents' and children's prosocial behaviors with one another (Aukrust & Snow, 1998; Fiese et al., 2006; Wooldridge & Shapka, 2012). However, newer contexts, such as parent-child interactions around digital media, do not have nearly as much research on the kinds of behaviors needed to produce similar positive outcomes. As the use of digital media becomes an entrenched part of the daily lives of many families, it is crucial that research continues to find ways to best foster quality of interaction around shared media to have a positive impact on families (Crain-Thorenson et al., 2001).

Measurement. There is no universal way of defining or measuring the quality of an interaction. Rather, various methods have been used to understand and analyze this outcome between parents and their young children (Hirsh-Pasek et al., 2015; Lauricella et al., 2014; Munzer et al., 2019; Nathanson & Rasmussen, 2011). For the sake of the current study, three *domains* will be considered as being the primary components for defining parent-child interaction quality, based on previous research: *quality of conversation*, *quality of shared*

engagement, and *quality of observable behaviors* (Hindman & Morrison, 2012; Mathis & Bierman, 2015).

In the domain of quality of conversation in shared contexts, research has looked at the effect of language exchanged between parents and children on child development (Hart & Risley, 1995; Huttenlocher et al., 1991; Weizman & Snow, 2001). Researchers who used the measure of *conversational turns* (amount of back-and-forth exchange between conversation partners) during story reading found that, when the number of conversational turns between adults and 4-year-olds was high, children had stronger language and cognitive skills (Romeo et al., 2018). Similarly, when parents and other adults in young children's lives are looking for ways to improve the quality of their interactions, previous research has recommended that they attempt the "serve-and-return" approach of offering children opportunities to respond, highlighting the importance of back-and-forth conversation for improving interaction outcomes (Shonkoff & Bales, 2011).

To evaluate the quality of interaction during a given activity, quality of conversation has also been operationalized as "fluency and connectedness", based on how parents and children use verbal and nonverbal expressions (Hirsh-Pasek et al., 2015). Results demonstrated that the presence of this variable between parents and 2-year-olds was a significant contributor to children's language development one year later (Hirsh-Pasek et al., 2015). Given that conversation is a large component of any interaction regardless of context, conversational quality will be an important contributing variable when evaluating the quality of family interactions around digital media.

The domain of engagement (sustained joint focus) between parents and children during an activity is consistently associated with positive outcomes (Adamson et al., 2012; Bus et al.,

1997; Hindman & Morrison, 2012; Mendelsohn et al., 2018). High mutual engagement in a shared activity creates an optimal environment for the child to grow and learn (Hirsh-Pasek et al., 2015). Quality of shared engagement has been measured through evaluating the amount of *joint visual attention* (shared focus, gaze following, etc.) between the parent and child during an interaction (Heidlage et al., 2020; Hindman & Morrison, 2012; Hustedt & Raver, 2010; Mathis & Bierman, 2015). Other studies have used the broader variable of *joint engagement*, or coordinated behaviors by the parent and child around a shared object or activity, as their primary measure (Adamson et al., 2012; Hirsh-Pasek et al., 2015; Munzer et al., 2019). Regardless of the way it is measured, quality shared engagement is strongly associated with positive adult-child behavioral outcomes and learning in early childhood (Bakeman & Adamson, 1984; Hadley & Dickinson, 2019).

The final domain, *other observable behaviors* during a shared activity (e.g., smiling, positive feedback, yelling), also can contribute to the quality of a parent-child interaction. Shared *mutuality* (responsiveness, cooperation, and reciprocal behaviors) and *positivity-based* behaviors (shared positive affect, warmth, physical touch, etc.) are strongly associated with children's socioemotional and cognitive development (Deater-Deckard & O'Connor, 2000; Ensor et al., 2011; Kawabata et al., 2011; Wade et al., 2018). Research has also highlighted the importance of responsive, sensitive parenting on child developmental outcomes (Bernier et al., 2010; Calkins et al., 1998). Children's positive affect and warmth in various contexts often elicit similar behaviors from the parent (Ensor et al., 2011; Landry et al., 2001; Lengua & Kovacs, 2005). In contrast, higher amounts of shared negative affect, parental control, or behaviors indicating disengagement during a joint activity are linked to worse child outcomes (Ganiban et al., 2011; Landry et al., 2001).

Observable behaviors are connected to shared engagement and conversation (Hindman & Morrison, 2012), and overlap has been reported between quality of conversation, quality of engagement, and quality of behaviors and their influence on parent-child outcomes (Hirsh-Pasek et al., 2015; Stuckelman et al., 2021). Furthermore, it is possible that the three domains of shared interaction could have a central construct underlying their relation with one another. As parent-child interaction is measured in newer shared contexts and future studies, evaluating all three of these domains should be central to characterizing the overall quality of an interaction and its impact on parent-child outcomes.

High-Quality Interactions in the Joint Media Engagement Context

One newer shared interaction context where quality is likely to play an integral role in promoting positive parent-child outcomes is *joint media engagement* (JME), when two individuals share an interaction around digital content (Takeuchi & Stevens, 2011; Ewin et al., 2020). Terms such as *co-viewing* or *co-play* have been used for shared experience between parents and children in specific digital contexts such as watching videos or playing digital games (Griffith & Arnold, 2017; Segal-Drori et al., 2010; Strouse et al., 2013; Valkenburg et al., 1999).

More than ever, families have consistent, easy access to digital resources (Rideout & Robb, 2021; Kabali et al., 2015). In a recent nationally representative survey, 98% of American 0-to-8 year-olds, including 95% of children from low-income families, had access to a smartphone or tablet (Rideout & Robb, 2021). Additionally, 72% of surveyed parents reported using JME behaviors at some point with their child, though regularity of JME interactions varied (Connell et al., 2015). As families continue to be inundated with digital media and technologies, the American Academy of Pediatrics recommended that for children between the ages of 2 to 5

years, parents share their children's use of media and technology as often as possible (AAP Council on Communications and Media, 2016).

Evidence for the benefits of parent-child JME is particularly strong for preschool-aged children (Ewin et al., 2020; Lauricella et al., 2014; Stuckelman et al., 2021; Troseth et al., 2020). The advantages of active parent-child co-viewing of educational media are frequently recognized (Nathanson, 2001; Reiser et al., 1984; Rice et al., 1990; Strouse & Troseth, 2014; Valkenburg et al., 1999). When mothers and their young children actively engage together while using touch screens (i.e., parents use scaffolding behaviors around content, providing sensitive prompts, etc.), children learn significantly more than when they use the touch screen alone (Zack & Barr, 2016; Fidler et al., 2010). Wood and colleagues (2016) reported high amounts of scaffolding behaviors used by parents when engaged with their child around a digital tablet activity, leading to strongly positive child learning outcomes. These results have also been replicated within the context of playing with digital toys, and reading eBooks (Lauricella et al., 2014; Sung, 2018; Troseth et al., 2020).

Certain kinds of media can positively influence parent-child behaviors and interactions (Beyens & Beullens, 2016; Sobel et al., 2017). Skaug and colleagues (2018) evaluated the mother-child interaction styles in three different contexts: joint tablet play, TV coviewing, and traditional shared toy free play. Mothers used significantly higher amounts of sensitive, warm behaviors towards their children during joint tablet play when compared to both traditional toy play and TV coviewing. Mothers also used significantly less hostile behavior towards their children during media interactions than when interacting with their child around free play with traditional toys (Skaug et al., 2018), possibly due to parents' increased involvement and controlling behaviors when there was little structure within the free play context (Nathanson &

Rasmussen, 2011). In contrast, the researchers noted that tablet play was significantly more structured due to the need for collaboration to succeed at the games and parents' use of scaffolding behaviors to aid their child's engagement (Skaug et al., 2018). These differences may also be connected to the relative novelty of joint tablet play, leading parents to be more sensitive and use high-quality behaviors to help their child learn (Lauricella et al., 2014). Similarly, Strouse and Ganea (2017) noted that toddlers exhibited significantly more positive affect toward their parents during shared eBook reading compared to traditional print book reading. Parents reported that children also were positively responsive, engaged in less conflict and provided encouraging feedback during JME with mobile games when parents provided guidance and used other helpful behaviors (Sobel et al., 2017). Parents offered the insight that encouraging healthy behaviors that are commonly used during other shared activities, such as reasonable limit setting, turn-taking, and role assignment, within the novel JME context led to more positive interactions where both the parent and child benefitted.

Why might parent-child interaction quality be particularly crucial in the context of joint media engagement? One reason is to promote children's learning from educational media. Without parent intervention, young children struggle to learn and transfer information from a screen to the real world, despite having no problem learning the same information if it is given face-to-face in other contexts (Anderson & Pempek, 2005; Troseth & DeLoache, 1998; Troseth et al., 2006). Objects on screens have significant perceptual differences from objects in the real world (they typically are much smaller, 2-dimensional, etc.) and, barring any parent instruction, children may fail to connect information on the screen with reality (Barr, 2010). Another reason that very young children may fail to make this connection is their experiences watching TV and videos (Troseth, 2003). Young children often see content on screens that contradicts with their

real world experience, such as talking animals or flying superheroes, and may conclude that a screen is not a reliable source of information. After toddlers received a different kind of experience in which a screen showed current reality (live video of themselves, shown playing on the family TV) and parents pointed out the connection, they readily applied information from the screen to solve a problem (Troseth, 2003). Even in the case when screens provide information that is more congruent with reality (e.g., during live video chat), children more readily comprehend on-screen information when parents support their understanding (Myers et al., 2016; Strouse et al., 2018, Troseth, Saylor, & Archer, 2006).

Because adults can easily identify objects and interpret events on a screen, they may not realize that young children need assistance. But parents play a critical role in helping children overcome the challenges of learning from digital media through use of scaffolding behaviors and sensitive, responsive parenting (Fidler et al., 2010; Strouse et al., 2013; Strouse & Troseth, 2014). Zack and Barr (2016) showed that even infants were able to transfer information from screens to the real world when mothers provided contingent responses, sensitive guidance, and verbal input. The researchers clustered these variables into a broader category called "interactional quality", and highlighted its importance when young children used screens (Zack & Barr, 2016). Because they know their children the best, parents are able to tailor their behavior patterns in any context to personalize an interaction to their child's development, and scaffold the interaction to promote the best learning (Takeuchi & Stevens, 2011; Wood et al., 2016). This is the way parents and children can turn ordinary book reading, game playing, and other shared activities into fruitful opportunities where both parties benefit (Blewitt & Langan, 2016; Landry et al., 2006). When parents and children together create a responsive, positive experience tailored to the child's cognitive ability, joint media engagement has yielded positive outcomes (Skaug et

al., 2018; Sobel et al., 2017; Strouse & Ganea, 2017). In previous research, parents have enhanced the JME interaction through prompting their child with content-relevant questions and connecting onscreen events to the child's own life (Strouse et al., 2013; Troseth et al., 2020).

Not all families take advantage of the joint media engagement context. Both parents and children can view interactions with digital content as a solo activity, rather than one meant to be shared (Hiniker et al., 2018; McNab & Fielding- Barnsley, 2014; Sung, 2017; Yen et al., 2018). Early research demonstrated that young children consistently consume media content without any kind of supervision, and this trend has been replicated in recent literature (Roberts et al., 1999; Seo & Lee, 2017). Children may become accustomed to being an independent user of digital media and may not be as willing to engage in shared media experience: Munzer and colleagues (2019) found that young children more frequently pushed their parent's hand out of the way, turned their body toward the device and away from the parent, and ended an interaction prematurely when using an electronic book compared to a traditional print book. Four- to six-year-old children also responded significantly less to attentional bids from parents during tablet play than when playing with physical toys (Hiniker et al., 2018).

Smartphones and tablets have also been found to serve as distractors or interrupters to otherwise high-quality family interactions (Barr, 2019; Reed et al., 2017). Young children are still developing their executive functioning skills, including attention regulation, and are susceptible to distracting features of media, such a loud sound effects or music, even when they are used during a shared interaction (Radesky & Christakis, 2016; Takacs et al., 2015; Welsh et al., 1991). Audiovisual and interactive features, such as audio effects, touch-activated "hot spots", or games, are known to interrupt parent-child reading of digital texts and lessen the amount of social reciprocity that is typically observed during shared reading (Bus et al., 2015;

Krcmar & Cingel, 2014; Parish-Morris et al., 2011; Sosa, 2016). Parents are susceptible, as well: in one study, Radesky and colleagues (2014) found that most caregivers were highly consumed with using a mobile device during mealtimes with their children at a fast-food restaurant. Parents who were absorbed in their device also used harsh parenting behaviors more often during the meal than those who did not use a device (Radesky et al., 2014). Even when passively on in the background, certain forms of media, such as television, can negatively impact the shared conversation and behaviors between a parent and child (Anderson & Pempek, 2005; Kirkorian et al., 2009; Schmidt et al., 2009).

The parent's and child's perceptions of and beliefs about digital media play significant roles in the kinds of behaviors that are exhibited when JME does occur. Parents see the utility of some forms of digital media, such as computers, for their child's development. In instances where parents and children use a parent-approved form of media, parents are more likely to use responsive behaviors during shared interactions (Nir-Gal & Klein, 2004; Rideout & Hamel, 2006). Parents can view digital media as either a way to entertain or distract their child or, in some cases, as harmful to their child's development (Cingel & Krcmar, 2013; Common Sense Media, 2013; Guernsey, 2007). Parents' views of digital media are in sharp contrast to those of children: preschoolers, in particular, express that media is more fun and helpful for their learning (Richter & Courage, 2017; Strouse et al., 2019).

Despite these differences between parent and child beliefs, parents more frequently dictate how media is used from day to day (Nathanson, 2001). Parents may use restrictive behaviors, such as harsh limit setting, to curb their child's use of media (Valkenburg et al., 1999). This can negatively impact children's perception of and behaviors toward digital content (Austin et al., 1999). Parents can be significantly more inexperienced in using digital media than

traditional media (such as print books) as the focus of a shared interaction (Ewin et al., 2020; Sosa, 2016). A parent's negative perception of or inexperience using digital media with their child can lead to greater apprehension toward using a piece of digital content in a shared context, as well as fewer quality behaviors if an interaction occurs (Wood et al., 2016; Yuill & Martin, 2016; Zosh et al., 2015).

Joint media engagement interactions include various potential benefits for parents and children. How the quality of the JME interaction has been discussed and measured varies from study to study (Lauricella et al., 2014; Munzer et al., 2019; Parish-Morris et al., 2011; Skaug et al., 2018). As parents and children continue to interact within an increasingly digital world, it is critical that methods and resources be created to support high-quality interactions within the JME context and the best outcomes for all involved.

How Do We Promote High-Quality Interactions during Joint Media Engagement?

Previous attempts to promote high-quality interactions around digital media have had varying success (Griffith & Arnold, 2019; Lauricella et al., 2014; Strouse et al., 2013; Wooldridge & Shapka, 2018). Yuill and Martin (2016) found that, when parent-child dyads incorporated eBooks into their bedtime reading interaction, shared warmth was significantly lower than when the same dyads used traditional paper books. Parents and children who read eBooks during bedtime rituals also exhibited physical behaviors that limited reciprocal interaction (e.g., turning away from one another, hoarding the tablet, etc.; Yuill & Martin, 2016). Hiniker and colleagues (2018) noted that certain common digital design features, such as activities or games primarily targeted for solo engagement, are likely associated with the lack of reciprocal behaviors in a JME context. In contrast, research indicates that when digital content is

designed to avoid intrusive features (for example, no touch-activated hot spots), parents and their 4- to 7-year-old children have significantly more expressive, responsive interactions (Cingel & Piper, 2017; Kim & Anderson, 2008; Korat & Or, 2010).

There have been effective parent-child interventions in the JME context. Strouse, O'Doherty, and Troseth (2013) trained parents to use *dialogic reading* methods when watching storybook videos with their 3-year-old children (Whitehurst et al., 1988). While co-viewing, parents were taught to pause the video, ask questions sensitive to their individual child's skillset, and expand on their child's responses. Parents and children could consider this approach somewhat unnatural, as TV and videos are often co-viewed with no pausing for conversation. Nevertheless, the training was effective: After four weeks of co-viewing at home, parents and children engaged in more reciprocal interactions and conversations around digital content, and children learned more story vocabulary and had higher story comprehension. Children whose parents were taught to use the dialogic reading method also performed better on measures of story comprehension when compared to children whose parents simply directed attention to the screen during coviewing.

In one condition, families used videos for children to watch in which an onscreen actress employed the dialogic strategies (Strouse et al., 2013). Results were not as strong as when parents employed dialogic reading while viewing, but were higher than when parents were instructed to only direct children's attention to information on the screen (but not ask questions). The onscreen actress-based condition likely was less effective because when a child answered her question, the actress could not respond. This responsive social component was noted as a key factor in producing optimal outcomes from both shared reading and JME interactions (Strouse et al., 2013).

In a later intervention, Troseth and colleagues (2020) incorporated a digital character named Ramone into an eBook to help parents learn to use dialogic reading with their children. Rather than giving parents elaborate training to use the dialogic reading scheme, Ramone provided a model of simple prompts on the pages of the storybook to springboard parent-child interaction during eBook readings. When low-income families were exposed to the eBook with Ramone, the amount of overall shared conversation, content-relevant talk, and cognitively challenging talk was significantly higher than for families who used a version of the same eBook without Ramone (Troseth et al., 2020). In another study, parents and children were asked to read the eBook with Ramone over two weeks at home to evaluate its impact on shared reading behaviors (Stuckelman et al., 2021). In comparison to families who used a version of the eBook without Ramone, parents and children exposed to Ramone significantly increased their use of responsiveness, reciprocity, and positivity while reading the eBook over the two weeks. Additionally, parents began to ask their own dialogic questions (Lurie, 2021). These behaviors extended beyond digital reading: families exposed to Ramone also produced more mutual and positive behaviors and parents used more conversational prompts when reading a print book during a post-test session (Lurie, 2021; Stuckelman et al., 2021).

In discussing how to promote interactive co-reading and JME, several researchers have reasoned that it may be unrealistic to expect busy families to complete extensive training programs, and scaling up effective programs involves costs and time challenges (Cates et al., 2016; Hindman et al., 2016; Vaala & Takeuchi, 2012). What families may need to deepen their shared interactions around digital media is a simple "nudge" in the right direction, such as that provided by Ramone in the eBook interventions (Lurie, 2021; Stuckelman et al., 2021; Troseth et al., 2020; York et al., 2019).

Nudges, or small, bite-sized pieces of information meant to promote certain behaviors, foster long-lasting behavioral change in both parents and children (Doss et al., 2019; Smythe-Leistico & Page, 2018). In one intervention, researchers incorporated brief tips about literacy activities during children's annual visits to the pediatrician. These tips significantly increased the number of home literacy activities between parents and children and improved children's receptive and expressive language skills (Golova et al., 1999; Mendelsohn et al., 2001; Sharif et al., 2002). Taking advantage of another typical family activity, Ridge and colleagues (2015) placed brief prompts around supermarkets in low income areas to promote increased adult-child dialogue, and unobtrusive researchers acting like normal supermarket customers observed and coded families' behaviors. The quality of shared conversations (including conversational turns and amount of questioning) significantly increased for all families exposed. The researchers also noted that this approach of incorporating prompts into public contexts can be cost-efficient for those facilitating similar kinds of interventions (Ridge et al., 2015).

Nudges in interventions often take the form of regular text messages, to make them convenient for families (Kraft & Rogers, 2015; Smythe-Leistico & Page, 2018). For instance, York, Loeb, and Doss (2019) texted parents of prekindergarten students nudges once a week for 8 months to encourage parent-child interaction around literacy activities. Some of the nudges suggested high-quality parent behaviors that could promote stronger parent-child interactions during everyday life, without adding stress for parents (e.g., "Bath time is great for teaching your child important skills…Start by asking: What are the things we need for bath time? Why?"). After engaging in this program, parents increased their overall involvement in their young child's academics, and children had higher literacy skills and engagement. Parents in this study also reported finding the nudges to be helpful reminders for their at-home interactions with their child

(York et al., 2019). By promoting more frequent shared educational activities (such as shared reading), active tips sent through a digital platform also can help parents understand and appropriately tailor questions to their child's skill level (Dizon-Ross, 2019; Mayer et al., 2015).

While nudges have been effective in increasing both the quantity and quality of parent-child interactions in traditional academic contexts such as shared reading (Doss et al., 2019; Mendelsohn et al., 2001; Snell et al., 2020; Weijers et al., 2021), limited research examines how nudges may influence the kinds of parent-child interactions that occur around digital media. Given the relative similarity of eBook reading to traditional shared reading and parents' beliefs about the importance of literacy activities (Bingham, 2007; Strouse et al., 2019; Stuckelman et al., 2021; Troseth et al., 2020), the effectiveness of adding prompts for shared eBook reading interactions may not generalize to other JME contexts (such as co-playing digital apps). Yet the use of digital media, like any other repeated daily context (mealtime, bathtime, grocery shopping), offers an opportunity to foster positive outcomes, such as parent-child bonding and child learning. Because parents may not hold strong beliefs about the value of scaffolding their child's use of digital media, the incorporation of suggestions (nudges) during joint media engagement might promote high-quality parent-child interactions in this context.

CHAPTER II

Study Overview

Past research demonstrates how valuable high-quality interactions are to produce good outcomes in the parent-child joint media engagement (JME) context, yet it also shows how infrequently these kinds of interactions occur (Ewin et al., 2020; Lauricella et al., 2014; Munzer et al., 2019). In prior studies, quality of JME interactions has been defined and measured in a variety of ways (Lauricella et al., 2014; Stuckelman et al., 2021). In the current research, I looked beyond the context of digital reading of eBooks to a less-obviously "educational" medium: a digital game application designed to promote prosocial behavior. In this work, I examined whether there is an underlying construct that should be evaluated when determining the quality of a JME interaction across contexts.

Given the promising results of research with parent-directed digital nudges, the aim of the current study was to determine whether a similar kind of feature within a digital co-play application could increase the quality of interaction between parents and their 4-year-old children (Stuckelman et al., 2021; York et al., 2019). This age was chosen due to the critical nature of parent-child interaction at this stage of development, as well as the amount of digital content currently targeted for 4-year-olds (Biringen et al., 2014; Estrada et al., 1987; Rideout & Robb, 2021) .

For my study, I used the OK Play digital application, an app that is centered around teaching children socioemotional themes through engaging educational activities (see okplay.co). The commercial version of the app was initially designed to promote parent-child interaction around various digital activities. The application's design is based on research examining shared

interaction around digital media, as well as children's learning from specific features incorporated into media content (Rasmussen et al., 2016; Russo-Johnson et al., 2017; Strouse et al., 2013; Troseth et al., 2020). The digital "nudges" feature that was manipulated in this study had been designed to provide parents information and suggestions on structuring interactions with their child around app activities (okplay.co).

This experiment also explored the presence of a latent variable, *interaction quality*, that underpins many specific behaviors (i.e., mutuality, positivity, joint engagement, etc.) that could occur during parent-child JME interactions. We expected that parent-child behaviors, measured as a latent variable, would be detected within this shared context, and that the presence of the nudge feature in the app used by some participants during the two-week period of the study would significantly increase the presence of this latent variable during parent-child interaction, compared to the interaction behaviors of those families not exposed to this feature.

Because families used a commercial app at home for two weeks, this study had a relatively high degree of ecological validity (i.e., how families really use digital content at home), but was not as tightly controlled as a study completed in a lab with a lab-designed product. For instance, the available activities within the application varied in whether co-play with a parent would be necessary: one activity ("Drawing") prompted children to pass the tablet to a partner, whereas another activity ("Stories") would be easier for a child to complete solo. While using the application at home parents might seriously consider the nudges in the app each time they co-played, or might swipe past them to get to the desired activity. For these reasons, the intervention might not have as strong an effect on parent-child interaction as in a more tightly controlled intervention.

Parent and child participants met with a researcher for a Zoom (video chat) pre-test session to play two OK Play app games without the nudge feature. Then some families were assigned to receive a version of the app with the nudge features to use for two weeks at home, while other families continued to use the no-nudge version of the same app for the same period. At the conclusion of the two weeks, families again participated by Zoom, playing the same two games as at the pre-test. These sessions were video recorded and coded for various parent and child behaviors, to evaluate the presence of the latent "interaction quality" variable, as well as any condition differences in pre- to post-test behavioral change.

CHAPTER III

Methods

Participants

Participants were 77 children 45 to 59 months old (M = 52.57 months, SD = 3.96 months, 37 females), 58 from the southern region of the US, 10 from the US Midwest, 7 from the western region of the US, 1 from the northeast region of the US, and 1 from the Ontario province of Canada, each with a parent (71 female). Participants were recruited from social media posts, state birth records, and the Child Studies Database housed in the Department of Psychology and Human Development at Vanderbilt University. No children had significant developmental delays and all were learning English as their primary language. Parents identified their children as European American (75%), African American (1%), Hispanic (1%), Asian (3%), belonging to a race not listed in the survey (1%), or belonging to multiple racial categories (17%). Most families (81%) had an annual household income of $75,000 or more and most parents (90%) had a bachelor's degree or higher. Due to the software constraints of the experimental version of OK Play, all families had to own an iPhone and/or iPad to use the application. See Table 1 for demographic descriptives by condition.

Seven additional families began the study but their data were not included in the analyses due to withdrawing from the study (5 families) or experimenter error (2 families). The research was approved by Vanderbilt's IRB and carried out with written parental consent.

Table 1

Demographic Details by Condition Group

	Control *M* (*SD*)	Experimental *M* (*SD*)
Age in years		
Parent	36.15 (7.07)	35.45 (6.74)
Child	4.45 (0.34)	4.31 (0.31)
	N (%)	N (%)
Parent-child dyads	39	38
Gender (Male/Female)		
Parent	4/35	2/36
Child	20/19	20/18
Recruitment location		
Southern US	33 (84.6%)	25 (65.8%)
Midwestern US	2 (5.1%)	8 (22.2%)
Western US	3 (7.7%)	4 (10.5%)
Northeast US	1 (2.6%)	0 (0.0%)
Canada	0 (0.0%)	1 (2.6%)
Parent Education Level		
Less than a 4-year degree	4 (10.3%)	4 (10.5%)
4-year College Degree	14 (35.9%)	13 (34.2%)
Professional or Graduate Degree	21 (53.8%)	20 (52.6%)
Did not report	0 (0.0%)	1 (2.6%)
Child Racial/Ethnic Identity		
European American	29 (74.4%)	29 (76.3%)
African American	0 (0.0%)	1 (2.6%)
Hispanic/Latino	0 (0.0%)	1 (2.6%)
Asian	0 (0.0%)	2 (5.3%)
Other Race (not listed)	1 (2.6%)	0 (0.0%)
Multiple races reported	9 (23.1%)	4 (10.5%)
Did not report	0 (0.0%)	1 (2.6%)
Household Income		
Under $15,000-$45,000	0 (0.0%)	2 (5.3%)
$45,000-$75,000	8 (20.5%)	4 (10.5%)
$75,000-$105,000	3 (7.7%)	11 (28.9%)
$105,000-$150,000	15 (38.5%)	12 (31.6%)
Above $150,000	14 (33.3%)	9 (23.7%)

Materials

OK Play Application. Families in both conditions were asked to download experimental versions of the OK Play application (okplay.co) specifically created for this study. Nudges were included in a previous commercial version but had been removed before data collection began. The experimental version included the nudge overlay, and the control version had no nudges. Both were built onto the "living" (continually updating) OK Play app.

OK Play (see Figure 1) includes multiple activities under a "Play" tab (drawing, picture taking, music creation, etc.) for parents and children to engage in together. Table 2 below offers detailed information about some of the different types of "Play" activities, which all provided targeted resources (information slides/nudges) for parents in the experimental group prior to beginning the activity. A few activities also suggest co-play *within* the activity itself (Table 2, right-hand column); if families in either group chose to play those activities, they received this information.

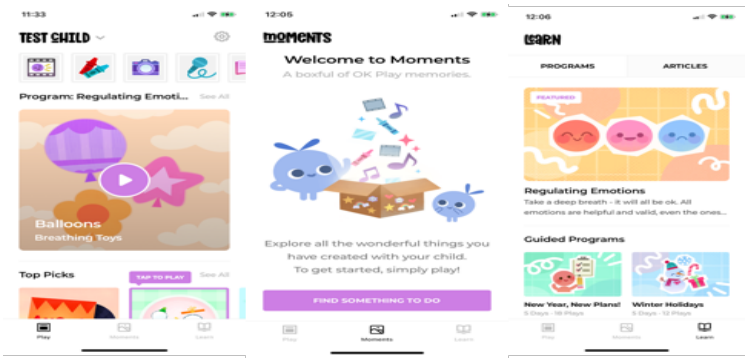
As the study progressed, more activities were added to the "living" application as the OK Play Company continued to make updates. Due to constraints of the experimental version used for this study, some of the newer activities were not available to be played without producing a glitch that removed the nudges. To fix this glitch, the experimental version was set to disable the function that allowed families to update the application when new activities were added to the home screen. Families in the control group also were not able to update after this glitch was resolved.

Additionally, under a "Learn" tab, there are articles and programs for parents suggesting ways to structure shared app activities and conversations around complex socioemotional topics.

Lastly, a “Moments" tab allows users to save their finished products from activities and reflect on the work that they did.

Figure 1

OK Play Homescreens



Notes. From left to right, the “Play” tab, the “Moments” tab, and the “Learn” tab of the OK Play application.

Table 2

OK Play Activity Descriptions and Co-Play Information

Activity type	Example Activity	General Activity Format	Is co-play prompted during the activity?
Drawing	Grow a Flower, Submarine, Ice Cream, Dance, Hug, etc	Taking pictures, using different colors to fill in shapes, to produce a story**.**	Yes ("Pass it to a partner.") However, not required to complete the activity
How to	How to Make an Angry Emergency, Tell a Tale, Bust A Move, etc.	How-to guides for crafts and a variety of other activities,	Yes. Parents must read the instructions
Stories	Doggy Art Show, Treehouse Club, Haha Haircuts, I <3 Candy, etc.	Create own story with drawings, pictures, songs	No
Scavenger Hunt	Give a Gift, Museum of Emotions, Fruit Emergency, etc.	Taking pictures of objects on the list (could be the colors of the objects, emotions).	No
Book Maker	Animal Babysitter, Hero vs. Villain, Plan a Party, etc.	Recording sounds/words (similar to Mad libs).	No
Movie Maker	Question Time, Cooking Up!, Emotion Update, etc.	Recording videos.	No
Music Maker	Hand Washing Song, Angry Song, Sound Bath, etc.	Recording singing and sounds.	No
Sparks	Silly Word Club- Pineapple, Spread Joy, Mapa's Circle- Pizza, Goodnight Hike, etc.	Stories that can be paused for conversation about the reading.	No
Breathing Toys	Birthday Cake, Balloons, Sunrise, Ferris Wheel, etc.	Breathing exercises that have a theme.	No

Note. This is not a comprehensive list of all activities contained within the application, as the OK Company added more throughout the duration of the study.

In the experimental version of the OK Play application, the four parent informational slides (nudges–see Figure 2) were programmed to appear before every activity, offering brief tips

on structuring the co-play interaction and conversation during the activity. (The commercial version only used nudges randomly across activities.) Four slide categories appeared in the following order: 1) “Get Ready” described the activity, to be “played with a partner”; 2) “Play Tip” shared useful information on engagement with the content; 3) “Extend the Play” suggested how to take the content beyond playing the app; and 4) “Parent Insight” gave parents explicit tips on how to promote shared interaction during the activity. In the current study, participants were unable to begin engaging in activities until they scrolled through all four informational slides. No slides appeared in the control version of the application. See Table 3 for more detailed descriptions of each nudge category.

Figure 2

Screenshot of Nudges

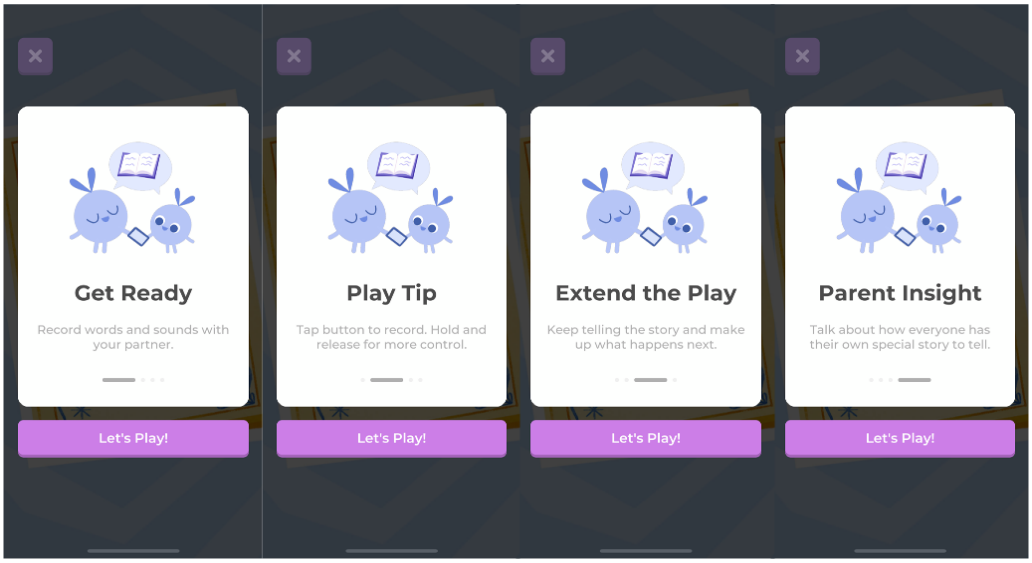


Table 3

Descriptions and Examples of Nudges from Experimental Version of OK Play App

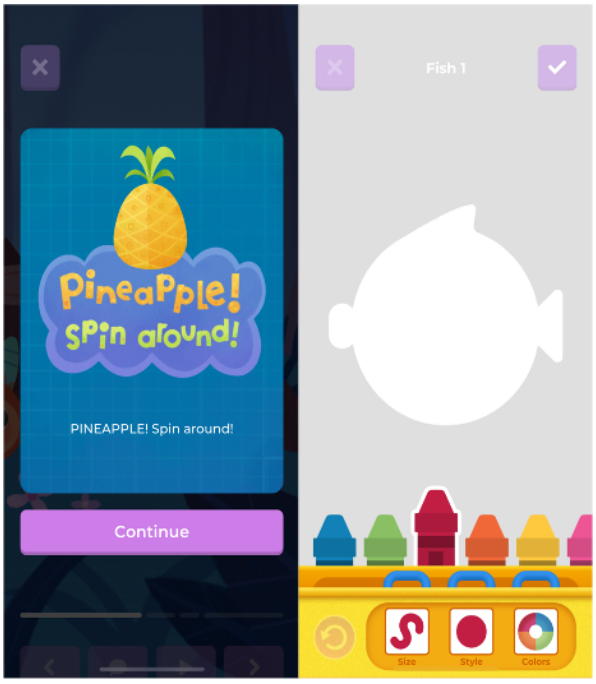
Nudge	Purpose	Examples
"Get Ready"	Gives parents a brief description of the activity; explicitly mentions playing with a partner.	"Giggle your way through goofy new hairdos!", "Take turns drawing with your partner", "Take a series of photos with your partner." etc.
"Play Tip"	Specific recommendations for parents on ways to interact during the activity.	"Get creative with your colors, shapes, and photos", "Try out a variety of colors for your silly styles", "Take some time to think about what your partner enjoys", etc.
"Extend the Play"	Ways to connect between the activity and the child's own life.	"Dress up as a pirate and head out on a pretend adventure", "Make up a story about your drawing", "Turn off the app and try a handmade gift exchange.", etc.
"Parent Insight"	Explains why the activity is important, or provides ways for parents to extend the activity-specific conversation to broader themes.	"Firefighter play puts kid in the role of powerful helper", "Talk about how you created the drawing using teamwork", "Understanding facial expressions helps in perspective taking", etc.

Pre- and Post-Test OK Play Activities. During the pre- and post-test, families were asked to play two games without any nudges: "Silly Word Club Pineapple" and "Drawing: Submarine". Silly Word Club: Pineapple, the first game families played, primarily consisted of a video that could be co-viewed or watched alone. Throughout the video, a character provided direct, audible suggestions for child behavior ("spin around whenever you hear the word 'pineapple'"). In this case, a child might do what the character says, and the prompt may have given parents an opportunity to step in and offer the child encouragement to engage in the behavior.

For the second activity, “Drawing: Submarine”, parents and children interacted with their device to create a shared drawing of a submarine, fish, and various other under-the-sea themed images. After a part of the drawing was complete (e.g., a submarine, a fish, a bubble, etc.), the application would explicitly prompt, through an audio recording, for the parent/child to “pass the drawing to your partner”. Upon receiving this instructions, the parent/child would pass the device to the other partner to add a new part of the drawing. At the end of the activity, parents and children could see all of the different parts of the image they drew combined into a final picture. This activity was more direct in the kinds of co-play behaviors that were viewed as needed to complete the drawing successfully. Using these two activity types allowed us to explore whether we would see changes in the non-explicit interactive activities like the “Silly Word Club: Pineapple” game and/or in the more explicit co-play activities like the “Drawing: Submarine” game. See Figure 3 for screenshots of the two activities.

Figure 3

Screenshots of Pre-/Post-Test Activities.



At-Home Recording Materials. Families used their own iPhone or iPad to play the app. They also used the "screen record" features of their device to capture on-screen activity during the two-week intervention play sessions. Due to technical limitations of video chat on the iPhone and iPad, participants had to use a separate device (e.g., laptop or another phone) for Zoom calls during the remote pre-test and post-test. These sessions were recorded by the researchers and the videos were uploaded to a secure Box server. Researchers guided parents to set up their video-chat cameras to best capture a view of the parent-child interaction during pre- and post-test, as well as how to create and send screen recordings during the two weeks in between.

Parent Survey. Two surveys were distributed to parents via REDCap: one during the pre-test before parents were exposed to the application, and one in the post-test after the study procedure was concluded. In the pre-test survey, parents were asked to fill out demographic information, as well as report their perceptions of the parent's role in child development, the importance of play in child development, and their opinions of digital media's influence on their child's development. The survey questions were taken from previously-used measures of parent views relevant to the study outcomes; Fogle & Mendez, 2006; Hembacher & Frank, 2020; Troseth et al., 2020).

The post-test parent survey included questions about the child's and the parent's enjoyment of the OK Play application, as well as any features that stood out as particularly favorable or unfavorable for the parent and child. Additionally, the parent was asked to describe how often the child used the application alone, with them, or with another family member, and who was the primary initiator of using the application. Parents had the opportunity to provide feedback on ways the application could be improved. Based on the family's assigned condition,

some parents were asked to provide their thoughts on the influence of the nudge feature on their and their child's experience with OK Play.

Design

Participants completed the same pre-intervention play session with the app, and then were randomly assigned to one of the two conditions (experimental, control) in which they did or did not receive 4 information slides (nudges) before every activity they chose to engage with while using OK Play during the next two weeks at home. Eight of the families who were assigned to the experimental group did not experience the nudges due to temporary errors within the experimental version of the OK Play app, which was discovered when the researchers reviewed their at-home recordings. These families were re-assigned to the control group to reflect their experience with the app, and replaced with 8 more families who were assigned to the experimental group, once the app had been fixed and as participant recruitment continued. Three additional families had inconsistent exposure to the parent slides due to glitches in the app but they remained in the experimental condition because they did experience some nudges. No significant differences emerged in the results between those families who experienced the errors in the app and those who did not. For the final sample, there were 39 families in the control group and 38 families in the experimental group.

Procedures

Parents and their children engaged in pre- and post-test sessions held over Zoom with two researchers, and then had the opportunity to use their condition-assigned version of OK Play for two weeks. The pre-test would reveal any baseline between-group condition differences, and the pre- to post-test design measured within-group growth during the intervention. For the home play sessions, families were asked to play with their assigned version of the application at least ten

times over the two weeks, and to submit recordings from each play session. The at-home play session recordings were not analyzed as part of this dissertation study, but will be evaluated in future research.

Before the pre-test, all parents received emails containing their personalized Zoom link for the study, a link to the REDCap pre-test survey, and a link to download the control version of the study application that did not contain nudges, for use in the pre-test. The REDCap pre-test survey also contained the consent form, and parents were instructed to contact the research lab with any questions or concerns. On the day of participation, parents and children joined a researcher-created Zoom room. If the parent had not filled out the consent form and demographics survey prior to the pre-test, they were asked to complete it before starting the procedure. Then the parent was asked whether they had downloaded the application on their device and (if not), the researcher helped them with the process of downloading. The experimenter then received assent from the participating child. After the assent process, parents and children were asked to play two preselected games on their device (the "Silly Word Club-Pineapple Spark" and "Submarine Drawing") as they normally would at home, either together or the child playing alone, whatever made the most sense for them. The play session was recorded via the Zoom application to be coded for baseline parent-child interactional quality. To conclude the Zoom visit, all families were told to close the OK Play application (so the experimenters could update their version), and experimental families were then walked through the procedure of updating the application to the version that included nudges. Families were instructed on how to use the screen recording and audio recording feature on their Apple device and were scheduled for the post-test session.

During the intervening two weeks, parents and children were told to use the OK Play application 10 times, for at least 10 minutes per session. Families were asked to screen and audio record each play session and to email a shareable link to the recording to the research lab and. After the researcher uploaded the video to a secure Box folder, parents were asked to delete the video from their device to leave space for future recordings. Throughout the two weeks, a member of the research team contacted families at specific intervals to check in, ensure they were following study protocols, offer needed technical assistance, and remind them about uploading audio and screen capture recordings. Because the home recordings did not include the kind of video needed for behavioral coding (that is, video of the families), the home recordings data will be considered in future studies.

Finally, parents were sent a personalized Zoom link for the post-test session before the study date. Upon joining the Zoom chat, the families were asked to close their OK Play application so the researchers could update it, and the experimental participants were switched back to the control (no-nudge) version. Then the parent and child played the same two games as during pre-test.. Finally, parents were asked to complete the post-test survey about their experiences and give feedback on their assigned version of the OK Play application. Families were then asked whether they would like to opt-in for a 3-month follow-up study, and were compensated for their time with a gift card.

Currently, the research team is collecting data for the 3 month follow-up. The procedure is identical to the post-test, with families playing the two preselected activities on the control version of the OK Play application. The main purpose of this extension (beyond the scope of my dissertation study) is to evaluate whether any behavior changes that may have emerged over the

two weeks of the "nudges" intervention would be retained after a longer period of time. A majority of families (96%) of the current sample have voluntarily opted in.

Measures

Interaction Quality.

I predicted that a latent variable, defined as *interaction quality*, could underlie a group of selected outcome variables related to parent-child behaviors. To evaluate whether prolonged use of the experimental OK Play application has an influence on the behaviors of parents and children while using said application, I examined three major domains, considered to be the key contributors to this latent variable: quality of conversation, quality of shared engagement, and quality of observable behaviors.

Quality of Conversation. To operationalize this domain, we measured how fluid and connected (Hirsh-Pasek et al., 2015) the parent and child conversations were during their pre- and post-test engagement with OK Play. Given that a large component of the parent-child interaction is the conversation that occurs (Rowe & Snow, 2019), we determined this domain to be necessary in the broader measurement of interaction quality. Using a measure of this variable from previous research, coders evaluated parent-child behaviors and talk during the pre-test and post-test play sessions on a 7-point Likert-style scale (Hirsh-Pasek et al., 2015).

Quality of Shared Engagement. We coded for the presence of *coordinated* joint engagement that parents and children exhibited during the pre- and post-test play sessions a 7-point scale, based on an adaptation of one item from a validated measure (Adamson et al., 2012). Coordinated joint engagement includes behaviors when the child and parent are seamlessly interacting with both the shared activity and their partner.

Quality of Observable Behaviors. Parents' and children's interaction behaviors were coded on a 7-point Likert-style scale from pre- and post-test Zoom video recordings of the play sessions using an adaptation of the Parent-Child Interaction System (PARCHISY; Deater-Deckard et al., 1997). This coding system has been validated for assessing target behaviors in free play activities, puzzle tasks, and, most recently, used for digital storybook reading (see Table 4 for descriptions of all coded behaviors used in the present study; Atzaba-Poria et al., 2017; Mullineaux et al., 2009; Stuckelman et al., 2021).

Table 4

PARCHISY Behavioral Codes used in Present Study

Parent	Child	Dyadic
Positive Affect (i.e., laughing, physical affection, smiling, etc.)	*Positive Affect* (i.e., laughing, physical affection, smiling, etc.)	*Reciprocity* (i.e., joint positive affect, turn-taking conversation, etc.)
Responsiveness to Child (i.e., verbal responses to child, behavioral responses to child, etc.)	*Responsiveness to Parent* (i.e., verbal responses to parent, behavioral responses to parent, etc.)	*Cooperation* (i.e., explicit agreement, joint decision making, etc.)
Positive Control (i.e., use of explanation, open-ended prompting, praise, etc.)		*Mutuality* (Composite of Reciprocity, Cooperation, Parent Responsiveness to Child, and Child Responsiveness to Parent)
		Positivity (Composite or Parent Positive Affect, Parent Positive Content, Parent Responsiveness to Child, Child Positive Affect, and Child Responsiveness to Parent)

Note: All variables and composites coded on a 7-point Likert scale.

Parent Beliefs Measures

Parents completed a short survey with questions that evaluated their beliefs in areas relevant to the current study. First, questions probed the parent's beliefs about parents' role in child development (Hembacher & Frank, 2020). For instance, if a parent believes they should be "hands-on" in their child's development, this could influence their behaviors during a joint media engagement activity with their child. Next, a series of questions from the Parents Play Belief Scale explored parents' belief in the positive role of play in their child's development (Fogle &

Mendez, 2006). Given that OK Play presents many activities in a game-like format, we included measures of how parents viewed the role of play, as this might influence how they engage with their children around a co-play digital application. Parents were also asked to report their child's media usage, their perceptions of the positive and negative features of digital media, as well as frequency of joint media engagement activities that occur in their household (Troseth et al., 2020). If parents believe digital media is useful to their child's growth, it is likely that the way they interact around a shared digital activity will be significantly impacted. For each belief measure, composite scores were created from the average of scores on related questions, as informed by previous research (Fogle & Mendez, 2006; Hembacher & Frank, 2020; Troseth et al., 2020).

Coding

Three pairs of coders (one pair each for connectedness of conversation, coordinated joint engagement, and PARCHISY behaviors) coded the pre-test and post-test play sessions. Because each of the two app activities (the "Silly Word Club-Pineapple Spark" and "Submarine Drawing") had different instructions and were different kinds of games, coders were instructed to separately code the interaction that occurred during each individual game rather than recording a global code for the entire interaction. The individual codes then were averaged across the two games for each session to create a composite for each pre- or post-test behavior.

All of the final composites used maintained the 7-point scale (1 = no presence of behavior, 7 = consistent presence of behavior) of the codings on which they were based. For the PARCHISY, two composites were used to capture broad behavioral constructs, and to simplify the factor loadings of the latent variable. First, we created a parent-child *mutuality* score (Ensor et al., 2011; Iacono, 2019) by averaging the individual *parent* and *child responsiveness* codes

(engagement with, as well as behavioral and verbal responses to, the partner, etc.), the dyad's *reciprocity* (joint positive affect, turn-taking conversation and behavior, etc.), and their *cooperation* (joint decision making, passing the device back and forth, shared agreement, etc.). Second, we created a positivity composite (Atzaba-Poria et al., 2014; Mullineaux et al., 2009) by averaging *parent positive control* (providing explanation, prompting the child, positive feedback, etc.), *parent positive affect* (smiling, physical affection, etc.), *parent responsiveness* (engagement with, as well as behavioral and verbal responses to the child, etc.), *child positive affect* (smiling, physical affection, etc.), and *child responsiveness to the parent* (engagement with, as well as behavioral and verbal responses to the parent, etc.). Additionally, using the joint engagement coding scheme, we averaged the child and parent coordinated engagement codes to create a composite for *coordinated engagement* (Adamson et al., 2012).

For each measure, two research assistants, blind to the study hypotheses, were trained to give evaluations of that set of behaviors for each game play session. Coders practiced by coding parent-child interaction videos from another study. They independently double-coded ~25% of participating dyads' videos to establish reliability (single-measures ICC; two-way mixed model; $r_{\text{mutuality}} = .95$; $r_{\text{positivity}} = .88$; $r_{\text{coordinatedengagement}} = .92$; $r_{\text{connectedness}} = .87$). The remaining 57 participant videos were coded by one of the two coders of each pair for the given measure.

Analytic Plan

For the current study, we utilized a Bayesian structural equation model (SEM) for multiple reasons. Foremost, because we believe a latent variable underlies certain indicators of interaction quality, SEM is the most appropriate analysis to detect whether factor loadings of these indicators onto the potential latent variable are significant. The relatively small sample size ($n = 77$) offered limited power to detect any effect, let alone the presence of a latent variable,

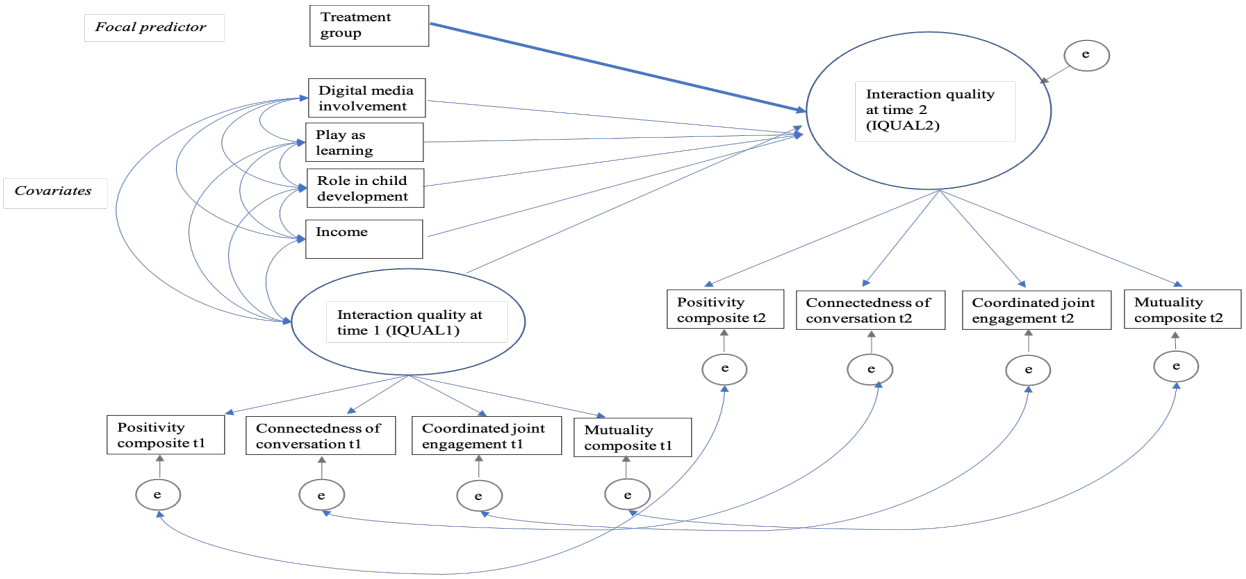
with a basic SEM approach. Given these parameters, a Bayesian SEM was the most appropriate and recommended approach to employ the strengths of SEM with a small sample size. Unlike more frequentist approaches where a null hypothesis is tested multiple times across individual study samples, Bayesian modeling allows for the consideration of prior research to inform the current model. The inclusion of prior knowledge allows for smaller sample sizes to be used and to provide enough power to detect latent variables, as well as any hypothesized treatment effects (Depaoli & van de Schoot, 2017; van de Schoot et al., 2014).

In choosing to do a Bayesian SEM for the current study, prior distributions ("priors") were created to inform the model and its predicted effects. Prior distributions are probability distributions that are informed by previous relevant research studies and show what we predict to be the most likely parameter values, with the center of the prior distribution representing the predicted effect or hypothesized value (e.g., Cohen's *d*) and variance representing the precision of our prediction of the population value of the parameter of interest (van de Schoot et al., 2014). Overall, we opted to take a conservative approach, given the relative novelty of the research, when choosing priors to *inform* the proposed model. The term "informative" indicates how previous research around a given variable contributes to our certainty about the overall prior distribution, its center value, and its dispersion. Within Bayesian SEM, priors have to be somewhat subjective, as they are chosen without full comprehensive data from all relevant previous research (due to lack of access to full datasets, age of publications, etc.). However, the priors for the current study were selected very carefully and considered over 20 previous studies around the variables of interest. Once priors were chosen for all variables of interest, Bayesian estimation takes into account both the priors and the observed data to yield posterior distributions for all of the parameters in the model (regression paths, factor loadings, covariances, etc.).

With this approach in mind, we proposed a model to evaluate the impact of the nudge feature on the hypothesized latent variable of interaction quality during the digital co-play parent-child interaction following the intervention. Other variables were included to further predict post-test interaction quality (family income level and interaction quality at pre-test; parents' digital media perception, views on the importance of play, and perception of their role in their child's development). Finally, we created a latent variable to be detected at two time points, interaction quality at pre-test and interaction quality at post-test. This variable was made up of four indicator variables (observed variables that are hypothesized to relate to the underlying latent variable) at their respective timepoints: mutuality, positivity, coordinated joint engagement, and connectedness of conversation. Positivity was selected as the fixed variable in detecting the latent variable and had a factor loading set at 1. Setting a fixed variable is traditionally done because the latent variable itself is neither observed nor measured by a specific scale. By fixing one of our indicators to 1, however, we link the latent variable to our indicator's scale, and that allows us to estimate the other variables' factor loadings. However, any of the indicator variables could have been used, as they all were on 7-point Likert-like scales, and we were still able to use the standardized estimate value for positivity to determine whether it had a significant factor loading. See Figure 3 for the full proposed model.

Figure 4

Full Proposed Latent Variable Model



Notes. For all variables that were proposed to contribute to the latent variable, error ("e") must be included to ensure accuracy in the factor loadings.

To choose a prior distribution for the main effect of treatment on interaction quality during post-test, we considered a total of 8 studies that looked at digital interventions used during parent-child shared activity: 4 showing positive associations between treatments and various relevant outcomes (Lauricella et al., 2014; Skaug et al., 2018; Strouse et al., 2013; Stuckelman et al., 2021), and 4 showing negative or null associations (Hiniker et al., 2018; Munzer et al., 2019; Ross et al., 2016; Wooldridge & Shapka, 2012). With these results in mind, we chose a prior that had a normal distribution with the center value as $d = 0$ to account for the fact that there is too much variability in past research to expect an effect in a positive or negative direction. Because of this, we also chose a standard deviation of 2.42 to have a somewhat weakly informative prior

around this relationship, as it is not too small a value and, therefore, too precise to allow for a large range of effects to be possible within our distribution.

When choosing priors for the covariates considered within the model, we took a conservative approach by opting to have larger variances, as we were less certain about the effects that would be observed in the current study. For instance, we looked at 5 studies concerning the effect of family income level on joint media engagement, and used a center value of 0 due to research being mixed (3 studies detecting positive effects, 2 studies detecting negative or null effects; Kabali et al., 2015; Radesky et al., 2014; Sarı et al., 2019; Troseth et al., 2020; Wright et al., 2001). For the effect of interaction quality during pre-test (IQUAL1) on interaction quality during post-test (IQUAL2), we chose a mean value of $d = .6$. Even though we predict a strong effect size with the latent variable ($d = .8$), we have to account for the fact that other covariates are being considered alongside the latent variable at pre-test and may contribute to a relation detected between IQUAL1 and IQUAL 2. Thus, we reduced the mean of the prior distribution from .8 to .6 to focus the result solely on the effect of IQUAL1 on IQUAL2 while controlling for the effects of other covariates. We expected parent's perception of digital media to have a moderate effect and chose a prior distribution centered at $d = .3$ to account for the other covariates (Nathanson, 2001; Strouse et al., 2019; Vaala & Takeuchi, 2012; Wood et al., 2016). For parents' perception of play, as well as their view of their role in their child's development, we expected weak effects based on prior research (Fogle & Mendez, 2006; Hembacher & Frank, 2020; Strouse et al., 2019; Wooldridge & Shapka, 2012), and centered each of these covariate prior distributions to account for this ($d = .1$). .

For the dispersion (standard deviation) of the prior distributions for the effects of all covariates, we selected a value of 2, based on the scale of the variables, and the range of slopes

that could plausibly be observed. This was based on recommendations (e.g., van de Schoot et al., 2014) that suggest the greatest possible slope value should be contained within 3 standard deviations from the center of the distribution. Because our outcome variable, interaction quality at post-test, uses a 6-point range (i.e., from 1-7), the maximum possible slope that could be observed for any predictor variable is 6. Thus, choosing a standard deviation of 2 resulted in prior distributions for the covariates that had the majority (99.7%) of the potential values fall between -6 and 6 and allowed for the full range of change.

For the factor loadings of the latent variable, we chose center values of 1 for all the contributing variables (i.e., mutuality, positivity, coordinated joint engagement, and connectedness of conversation). A value of 1 for each factor loading prior indicates perfect correspondence, or a high correlation, between the given indicator and the underlying latent variable. This was chosen because we expected, based on previous research that demonstrated strong relationships between various pairings of the indicators, that all four variables would equally and strongly contribute to the overall latent variable being detected, which translates to higher factor loadings within SEM (Ensor et al., 2011; Hindman & Morrison, 2012; Hirsh-Pasek et al., 2015; Mathis & Bierman, 2015; Romeo et al., 2018). For instance, Hirsh-Pasek and colleagues (2015) found a significant positive correlation between connectedness of conversation and joint engagement. Given these past studies, we also chose a dispersion value of 5 to create a more informative prior where we were confident that the factor loading value would likely fall in our distribution.

For the intercepts of all variables, we chose to defer to the default prior distributions of the statistical software used for these analyses (the *blavaan* package in R; v0.3-15; Merkle et al., n.d) to allow our predictions to include results in both directions: the latent variable had a center

value of 0 and a dispersion value of 10 at both time points, and the observed values had a center value of 0 and a dispersion value of 32. We used a similar approach with the variances and covariances to, once again, maintain relative conservatism given the novelty of the current research and the proposed model.

CHAPTER IV

Results

Fidelity of Implementation

On average, families in the control condition recorded approximately 8 play sessions over the course of the two weeks (M = 7.66, SD = 2.93, Range = 0 to 11 recordings), and families in the experimental condition recorded approximately 8 play sessions over the course of the two weeks (M = 8.43, SD = 2.50, Range = 2 to 12 recordings). A one-way ANOVA revealed there was no significant difference between the two conditions in the number of play session recordings submitted during the study.

Feedback Survey

On the post-test survey, the majority of families (62%) reported that their child always enjoyed playing with OK Play across the two weeks. However, only 40% of parents reported always enjoying playing the app with their child, with an additional 23% enjoying it as they became more familiar with the content. More than half (57%) of parents reported they were either “almost always” or “always” with their child while they were using OK Play. Parents also reported that they initiated the use of OK Play, on average, 75% of the time.

Of the families exposed to the nudges, 55% of parents reported that the nudges were either “sometimes” or “almost always” helpful. Interestingly, no parent reported that the nudges were “always” helpful; the remaining 45% said that the nudges were “not at all” helpful or helpful “once in a while”. Additionally, 55% felt the nudges were never distracting, while 5% reported they were always distracting. Ultimately, this feedback demonstrates that families who were exposed to the nudges had mixed feelings about their utility.

Individual Indicator Variable Results + Model Variable Correlations.

Before looking at the results of the final model, we decided to look at the four indicator variables (mutuality, positivity, coordinated joint engagement, and connectedness of conversation) to evaluate whether there were any condition differences at pre- and post-test. For each variable, we ran a one-way ANOVA with condition as the between-subjects variable. There were no significant differences detected between the experimental and control groups for any of the indicator variables at either time point. There were significant correlations between many of our indicator variables and survey measures. See Table 5 for indicator variable means by condition and Table 6 for Pearson's correlation coefficients for all model variables.

Table 5

Indicator Variable Means by Condition Group

	Control *M (SD)*	*Experimental* *M (SD)*
Pre-Test		
Mutuality	3.02 (0.66)	2.98 (0.57)
Positivity	3.19 (0.70)	3.20 (0.56)
Coordinated Joint Engagement	3.32 (0.81)	3.39 (0.85)
Connectedness of Conversation	4.15 (0.86)	4.38 (0.94)
Post-Test		
Mutuality	2.86 (0.67)	2.89 (0.74)
Positivity	3.01 (0.67)	3.02 (0.66)
Coordinated Joint Engagement	3.10 (0.88)	3.05 (0.90)
Connectedness of Conversation	3.97 (0.79)	4.28 (0.98)

Table 6

Pearson's Correlation Coefficients for Model Variables

	Mutuality D1	Mutuality D2	Positivity D1	Positivity D2	Coordinated D1	Coordinated D2	Connectedness D1	Connectedness D2	Parent Digital Co-Play Belief	Parent Play Support	Parent Role in Child Development	Income
Mutuality D1	1											
Mutuality D2	.663**	1										
Positivity D1	.941**	.664**	1									
Positivity D2	.671**	.910**	.736**	1								
Coordinated D1	.563**	.378**	.453**	.313**	1							
Coordinated D2	.563**	.378**	.453**	.313**	.563**	1						
Connectedness D1	.551	.420	.501**	.437**	.518**	.432**	1					
Connectedness D2	.544**	.627**	.511**	.602**	.415**	.600**	.710**	1				
Parent Digital Co-Play Belief	.051	.146	.085	.122	.236*	.180	.102	.112	1			
Parent Play Support	.232*	.211	.283**	.244*	.203	.241*	.141	.176	.285**	1		
Parent Role in Child Development	.225*	.126	.242*	.234*	.184	.151	.083	.126	.059	.528**	1	
Income	.062	.015	.041	.011	.056	.057	.070	-.056	-.113	-.013	-.052	1

Note. * $p < .05$, ** $p < .01$.

Latent Variable Model

To begin, diagnostics were checked to ensure that the estimated model converged well. R-hat statistics for all of the model parameters were close to 1 and did not exceed 1.05. This indicates that model estimates are reliable because we achieved convergence. Trace plots and histograms of posterior distributions were also evaluated, once again indicating that the model converged well.

Given our analytic plan, Bayesian SEM evaluates significance based on the highest posterior density (HPD) interval for a given parameter. When the posterior interval contains the value of 0, this indicates that there is not a significant effect of the parameter. When 0 is not contained in the interval, the result would then be considered significant.

Looking at the overall model fit of the posterior predictive model with the current study's data, results demonstrated that the posterior predictive p-value was relatively close to .5 and not less than .05 or greater than .95 (*ppp* = .326). Thus, the chosen model fits the data well. In detecting the latent variable at pre-test and post-test, each of the designated factor loadings for the chosen four variables were analyzed at their designated timepoint. We set the positivity variable to 1 to be able to identify the latent variable, while still being able to compare the standardized estimates for all four included variables. None of the Bayesian posterior intervals contained 0; therefore, mutuality, positivity, coordinated joint engagement, and connectedness of conversation were considered as having significant loadings. This result supported the presence of a hypothesized common latent variable at both of these timepoints that underlies the observed behaviors for the chosen 4 variables within the digital media co-play context.

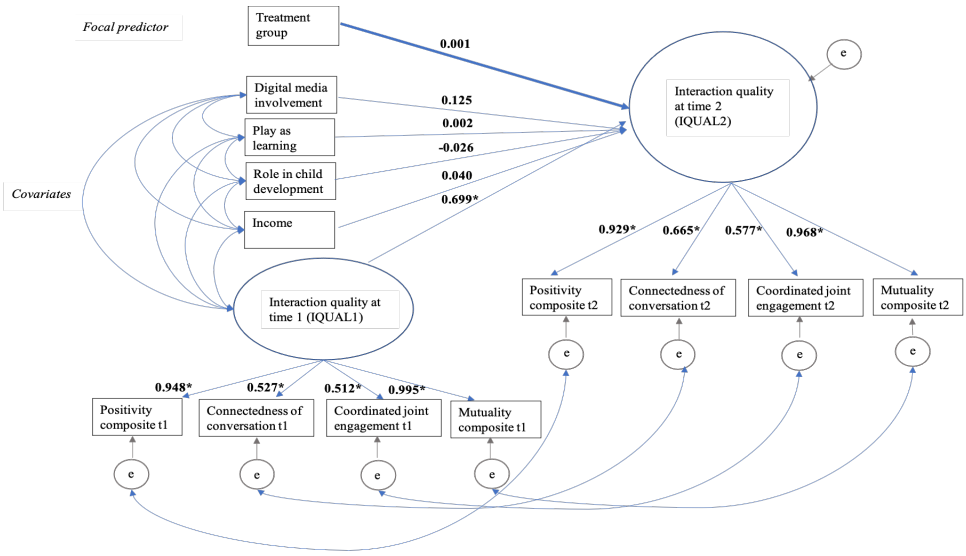
In looking at the effect of the nudge feature on post-test interaction quality, results indicated the HPD interval contained 0, meaning we did not detect a significant difference in

interaction quality between families who received the nudges and those who did not (β = 0.001, *SD* = 0.101, *HPD* = [-0.200, 0.201]). This result goes against the hypothesis that nudges would promote increases in the latent variable of interaction quality in families who were exposed to them.

Importantly, the HPD boundaries for the effect of pre-test interaction quality on post-test interaction quality did not contain 0, indicating a significantly predictive relation between interaction quality at pre-test and interaction quality at post-test (β = 0.701, *SD* = 0.093, *HPD* = [0.521, 0.889]). We did not include this effect in our hypotheses, yet is not surprising given that the overall app game context did not change between pre-and post-test and families did not provide any indication they were bored with the application. All other covariates within the model (i.e., parent digital media perception, parent perception of play, parent perception of role in child development, and family income) had HPD intervals that contained 0 and did not significantly predict the latent variable at post-test. See Figure 4 for the final updated model with standardized estimates for factor loadings and regression coefficients and Table 6 for all model parameters.

Figure 5

Final Model with Standardized Estimates



Notes. Overall model fit, *ppp* = .326. * = HPD interval does not contain 0 and is considered significant.

Table 7

Model Parameters

	Unstandardized Estimate (β)	Posterior *SD*	*HPD*	Standardized Estimate (β)
Interaction Quality Factor Loadings				
Pre-Test (IQUAL1)				
Positivity	1.000	N/A	N/A	0.948
Mutuality	1.060	0.047	[0.972, 1.242]*	0.995
Coordinated Joint Engagement	0.713	0.145	[0.432, 1.001]*	0.512
Connectedness of Conversation	0.782	0.141	[0.507, 1.055]*	0.527
Post-Test (IQUAL2)				
Positivity	1.000	N/A	N/A	0.929
Mutuality	1.104	0.068	[0.975, 1.242]*	0.968
Coordinated Joint Engagement	0.839	0.149	[0.547, 1.130]*	0.577
Connectedness of Conversation	0.976	0.133	[0.705, 1.238]*	0.665
Regression Analysis				
Main Effects				
Condition	0.001	0.101	[-0.200, 0.206]	0.001
Pre-Test Interaction Quality	0.701	0.093	[0.521, 0.889]*	0.699
Digital Media Perception	0.044	0.032	[-0.019, 0.107]	0.125
Perception of Play	0.002	0.138	[-0.272, 0.294]	0.002
Parent Role in Child Development	-0.047	0.188	[-0.417, 0.328]	-0.026
Family Income	0.009	0.020	[-0.030, 0.047]	0.040

	Unstandardized Estimate (β)	Posterior *SD*	*HPD*	Standardized Estimate (β)
Covariances				
Pre-Test Interaction Quality with				
Digital Media Perception	0.069	0.123	[-0.172, 0.324]	0.065
Perception of Play	0.070	0.033	[0.009, 0.140]*	0.246
Parent Role in Child Development	0.044	0.024	[0, 0.095]	0.214
Family Income	0.106	0.184	[-0.247, 0.480]	0.06
Digital Media Perception with				
Perception of Play	0.257	0.099	[0.084, 0.465]*	0.314
Parent Role in Child Development	0.030	0.067	[-0.098, 0.168]	0.030
Family Income	-0.555	0.529	[-1.641, 0.438]	-0.122
Perception of Play with				
Parent Role in Child Development	0.075	0.020	[0.039, 0.119]*	0.471
Family Income	0.013	0.140	[-0.262, 0.282]	0.011
Parent Role in Child Development with				
Family Income	0.007	0.100	[-0.194, 0.202]	0.008
Post-Test Positivity with				
Pre-Test Positivity	0.033	0.009	[0.017, 0.052]*	0.658
Post-Test Mutuality with				
Pre-Test Mutuality	0	0.005	[-0.009, 0.011]	-0.012
Post-Test Coordinated Joint Engagement with				
Pre-Test Coordinated Joint Engagement	0.203	0.068	[0.087, 0.356]*	0.385
Post-Test Connectedness of Conversation with				
Pre-Test Connectedness of Conversation	0.279	0.070	[0.160, 0.431]*	0.543

Notes. Positivity was the fixed variable for identifying the latent variable, so no posterior *SD* or HPD is reported as the unstandardized value is not being estimated. * = boundaries of highest probability density did not contain 0 and is considered significant.

CHAPTER V

Discussion

This dissertation explored whether a digital feature, parent-directed nudges, can influence the parent-child interaction that occurs around digital media. Parents and children were asked to use this co-play application, with or without nudges, for two weeks. For the purposes of this study, we hypothesized that a latent variable, *interaction quality*, underlay the various behaviors that were exhibited within this context, and that the presence of nudges within the co-play application would positively influence this variable. The latent variable was demonstrated within this context at both timepoints, and the latent variable at pre-test did predict the latent variable at post-test. However, the intervention had no impact on whether or not parents and children increased in interaction quality.

Although prior research has recognized the importance of high-quality interactions across various contexts, there has not been a universal way of evaluating interaction quality during joint media engagement (JME; Hirsh-Pasek et al., 2015; Hoff, 2010; Rowe & Snow, 2019). It has been measured as shared conversation, joint attention or engagement, an assortment of behaviors (e.g., warmth, reciprocity, mutuality, etc.), or some combination of these outcomes (Hindman & Morrison, 2012; Lauricella et al., 2014; Mathis & Bierman, 2015; Stuckelman et al., 2021; Troseth et al. 2020). The current analyses detected a latent variable that underlay the measures used for this study (mutuality, positivity, coordinated joint engagement, and connectedness of conversation). This result highlights the fact that the quality of an interaction is not defined by a singular construct but, rather, is a multi-dimensional variable that requires different indicators for

accurate measurement within the JME context (Ewin et al., 2020; Hindman & Morrison, 2012; Rowe & Snow, 2019; Skaug et al., 2018).

Although all four indicators were significant, they did not have equal factor loadings onto the latent variable: mutuality, positivity, and connectedness of conversation consistently had higher standardized regression coefficients than coordinated joint engagement did. It is possible that certain activities in the context of JME (such as shared play with a digital app) may not be as conducive as other shared contexts for joint engagement (Munzer et al., 2019). The somewhat solitary nature of interacting with a touchscreen for activities such as games may lead parents and children to not as easily share engagement or focus on the joint object (Cingel & Piper, 2017; Hiniker et al., 2018). In contrast, co-viewing a television program or engaging in shared eBook reading is easier for parents and children to maintain joint attention that leads to positive outcomes (Reiser et al., 1984; Strouse et al., 2013). The co-play application used in this study primarily has its users take turns and pass a tablet or smartphone back and forth. Therefore, consistent, coordinated joint engagement likely was not necessary for high-quality interactions in this context, and this specific indicator may not play as critical a role as the other three in explaining the quality of interactions in this context.

The application version with nudges integrated throughout the content had no significant effect on the latent variable of interaction quality between parents and children at post-test. This result went against my primary hypothesis, as well as the results of previous research on the effect of parent-facing nudges (Smythe-Leistico & Page, 2018; York et al., 2019). Multiple research studies have discussed significant changes in behavioral quality when small pieces of information were provided to parents and children in both physical and digital formats (Doss et al., 2019; Ridge et al., 2015; Stuckelman et al., 2021). In the current study, participants who had

parent nudges before every activity while using the OK Play application over two weeks did not change in the latent variable in a significantly positive or negative direction, though we did see slight decreases in the means of individual indicator variables from pre-test to post-test. Furthermore, there were no significant condition differences in the latent variable at post-test between families who received the nudges and those who did not.

There are several possible reasons for this overall null effect. The presence of the nudges within the OK Play application likely did not have as much salience for parents as nudges did in other interventions (Doss et al., 2019; Mayer et al., 2015). When nudges were sent via digital text messages, parents often received a notification that made it clear they had to attend to the nudge. This led them to more consistently read, process, and integrate the information within the nudge during their everyday behaviors with their child (Kraft & Rogers, 2015; Smythe-Leistico & Page, 2018). In another study, when an on-screen character offered verbal (and text-based) prompts during shared eBook readings, parents and children increased the amount and richness of conversation, as well as their positive and mutual behaviors towards one another. These prompts occurred immediately after the story narration on a page, and could not be skipped over by flipping to the next page (Stuckelman et al., 2021; Troseth et al., 2020). In contrast, the nudges in the OK Play app appeared before every activity, but were not compulsory nor formatted as notifications. Rather, parents and children could swipe through them by pressing a "Next" button without really taking the time to process the information. In the feedback from families exposed to the nudges, many parents reported that they or their child quickly learned how to skip through the information slides, and that impacted how often the nudges were actually read through. One parent said, "Noah knew how to skip the parent tips by selecting 'continue' very quickly until his game started so I didn't often see the parent tips." Another

reported, “Once she was going at it she just skipped all the prompts and kept doing her thing.” The nudges were not read aloud via narration, nor did they include any kind of interactive feature to make sure parents understood what they read in the tips. While these components certainly made the nudges less intrusive for families, the lack of robustness could have come at the cost of promoting positive changes in the quality of the joint interactions around the app.

Variations in JME activity certainly may play a role in the efficacy of an intervention. For the current study, we looked at co-play of a digital application, but this may not have been as natural for parents and children as JME with other kinds of media and technology. For example, while families from the Stuckelman and colleagues (2021) study had lower positivity (M = 2.96) and mutuality (M = 2.70) scores while reading a print book during their pre-test than families from the current study’s pre-test positivity (M = 3.20) and mutuality (M = 2.98) scores, the eBook intervention led those families to have higher positivity (M = 3.74) and mutuality (M = 3.51) scores at their post-test compared to the post-test positivity (M = 3.01) and mutuality (M = 2.89) scores of families who were exposed to nudges. Given that parents may have beliefs about the value of joint engagement during reading, it is highly possible that parents were more open to the skills and habits they learned during that intervention (Stuckelman et al., 2021). The difference between the current study outcomes and the results of previous research show that the game application co-play context is an unfamiliar one for many families and that concrete, required instruction and modeling could be more helpful than optional parent nudges (Strouse et al., 2013; Troseth et al., 2020). Future research should look into comparing different JME contexts more directly when considering the potential of a parent-child intervention.

One recommendation would be for future research to evaluate digital media that have nudge features that are, at least initially, less optional. To promote parental engagement with the

information, nudges might include verbal cues, questions to ensure parent comprehension, or strategies to make it harder to ignore the information. It is also important to consider the amount of repeated nudging that is required to appropriately tailor a co-play experience to the individual parent and child. Fewer, more compulsory nudges may be the balance that is needed to ensure the best outcomes from parent–child JME interactions.

Families were exposed to nudges for two weeks in their own homes and during their everyday lives. While ecological validity is a strength of the study, this context also could have led families to vary how they used the application throughout the exposure period. Parents and children in both conditions were instructed to use their condition-assigned application as they would normally at home. The application itself did not require co-play for all the activities. The content of the nudges gave parents ways to interact during the game, but certain activities did not naturally invite the co-participation of parents or other social partners. Without more explicit instructions, it is very possible that parents passed the device to their child without getting involved in the interaction themselves.

Joint media engagement (JME) between parents and children, while increasing, is still nowhere near as prominent as other shared activities, such as shared reading or co-play with physical toys (Dore et al., 2019; Strouse et al., 2019; Zosh et al., 2015). Given that many parents view interactions with digital media as a primarily independent activity, parents may not have been exposed to the nudges all 10 times they were asked to have the child play with the application (Hiniker et al., 2018; McNab & Fielding-Barnsley, 2014; Sung, 2017). On top of this, children may have used behaviors throughout the exposure period to limit social partners when using OK Play (such as turning away from the partner with the phone or tablet), as has been previously demonstrated with other kinds of digital media (Munzer et al., 2019). This lack of

consistency in co-play behaviors with the application could have contributed to the null effect of using OK Play on pre- to post-intervention change in the latent variable of interaction quality.

The predictive nature of the latent interaction quality variable at pre-test on the latent variable at post-test did emerge as significant. This result highlights that the quality of interactions between parents and children can remain consistent over time, depending on the context (Hoff-Ginsberg, 1991; Hoff, 2006). For example, parents and their young children tend to exhibit similar behaviors across shared reading interactions, with certain behaviors only changing as children's skills continue to grow (Bus et al., 1997; Lynch et al., 2006). Similarly, parents and young children who demonstrate a tendency to use mutuality-based behaviors use those behaviors consistently throughout the early years of development (Kochanska & Aksan, 1995). A combination of the relatively resilient nature of interaction behaviors and the mixed feelings that many parents have towards JME could have contributed to the consistency of interaction quality from pre-test to post-test (Nathanson, 2001; Strouse et al., 2019). Strouse and Ganea (2017) found that parents believed that print books were more educational for their child than electronic books, and that their child would enjoy using print books more. This belief directly impacted how parents and children read together with both print and electronic formats (Strouse & Ganea, 2017). Families' strong behavioral patterns around digital media, therefore, may call for more explicit information and interventions to promote significant, positive changes in the quality of a JME interaction.

Some technical constraints emerged as limitations during the course of the study. The two versions of OK Play that were created for the study were only compatible with Apple devices, limiting our sample to families who owned them. By the time a version compatible with other devices was available, data collection had progressed to a point where it would have been

difficult to change the procedure. Because Apple products are expensive, the participants may not have been representative of all socioeconomic groups. It is possible that an intervention with the same kind of nudges would have been more influential for those with devices other than Apple products. It is also possible that the use of other device types to play the app might have changed the results. Given the increasing prominence of mobile and tablet devices in children's lives, future research should evaluate whether family socioeconomic status, or the hardware and software provided by different devices, can influence parent-child interaction quality around co-play applications like OK Play (Kabali et al., 2015; Rideout & Robb, 2021).

Given the experimental nature of the OK Play application used in this research, there were also some bugs and glitches that caused the application to crash or negatively impact other features. No one programming problem emerged as the main cause of these bugs and glitches, so the application would be forced to restart at times. Parents and children who used either version of the application also reported issues when trying to screen record their play sessions: while recording, the audio level of the game would sometimes be lower. Thankfully, this was easily resolved when families used some form of headphone listening device when playing, a solution we suggested if the parent mentioned having this problem. However, this method of resolving the audio error may have impacted parent-child behavior around the application, as it could isolate the child if the parent did not also use a pair of headphones (Munzer et al., 2019). Because we had no clear indication of the number of families who may have had this error (some may not have mentioned it) and the ways in which it may have been resolved (i.e., with headphones or another potential approach), we did not exclude families who reported this audio issue from the final dataset. As mentioned in the results section, most families did report that

they often used OK Play together so this glitch may not have had a substantial negative effect on the frequency of parent-child co-play.

We had to switch some families, originally assigned to the experimental condition, into the control condition due to a particular bug: when families attempted to update the experimental application to play newer content, they received the version without prompts. Eight families ended up not having nudges and were switched to the control group. Three other families remained in the experimental condition due to having some home play sessions with nudges. Thankfully, those families who were switched to the control group were never exposed to the parenting slides at all and could be retained in the study. When informed of the programming problem, the OK Company programmers resolved this glitch by inhibiting the update feature in both versions of the application. This limited the amount of different content that parents and children could play together, which may have impacted the amount of co-play time that occurred across the two weeks and the potential behavioral changes that may have occurred from playing the version with nudges. Some families did mention this in their feedback, stating that they were confused by the lack of clear options of activities to engage (e.g., “I wanted to use more parts of the app”, “We weren't able to play all games”). The ultimate effect of these technological issues is difficult to parse out in terms of the exposure period, and future studies will evaluate the at-home recordings to understand the kinds of co-play behaviors that emerged with and without the nudges, as well as in the face of glitches and bugs.

The remote nature of the study that allowed for both wider recruitment reach and a naturalistic setting of the exposure period was both a strength and a limitation. Many families from across the country were able to participate and adhere to the study protocols without having to be physically present in a research lab setting. Rather, they just had to be present for two

Zoom video calls that allowed for the observation of behavior around the OK Play application. This accessible procedure led to a wider distribution of participants across the United States, as well as a diverse sample in terms of racial background and income level. The ecological validity of the study was high due to parents and children primarily using the application in their homes over the two-week exposure period. Outside of providing screen and audio recordings, the parents and children engaged with the app without any live observation from researchers that could have influenced the kinds of interaction behaviors that occurred.

Allowing parents and children to use the application in a naturalistic setting also led to an inconsistent adherence to the study protocol of engaging in at least 10 play sessions and submitting the screen recordings from the two week exposure period. Parents and their 4-year-old children have busy lives that can make it difficult to incorporate new activities. Therefore, families were still included even if they could not complete all 10 recordings (Hindman et al., 2016; Vaala & Takeuchi, 2012). We did not follow up with these families to ensure that they had the same amount of exposure to their condition-assigned OK Play application as families who sent in the required 10 recordings. It is important for future studies to request more detailed information from families on their frequency of application use to understand what the effect of differential exposure could mean for the outcome of the latent variable. Future research should also consider piloting the specific feature being tested through a single-session study to evaluate its efficacy before pursuing a more longitudinal, home-based intervention design that is susceptible to inconsistencies due to lack of experimental control.

Data collection for the current study took place later in the COVID-19 pandemic, which could have influenced the ways in which parents and children interacted with OK Play. During this unprecedented time, many parents have had to not only fill the role of caregiver but also

teacher, chef, entertainer, and many more. Thus, it is unsurprising that many parents are feeling burnt out and anxious about what the future may hold (Kerr et al., 2021). Expecting parents to be more proactive during the current study, with everything else they are managing, may have been unrealistic. Furthermore, given that the OK Play application, once again, did not have more robust features to ensure parent-child co-play, it is possible that participation in this study provided an opportunity for parents to have a break while their child played. In fact, during the course of the current study, the OK Company removed the nudge feature entirely from their application upon realizing, from their play testing, that the nudges were not effective in promoting the kinds of co-play experiences that were expected. This surrounding context of parenting during COVID-19 not only contributed to the actual development of the OK Play application but may help explain the null effect found for conditions differences and growth in the latent variable of interaction quality.

One final limitation worth discussing is that we evaluated the latent variable of interaction quality with families from Western cultures, a majority (~75%) of whom were of European American descent. Previous research has reported that parent-child behaviors and child outcomes can vary based on cultural background and values (Coatsworth et al., 2018). While behaviors like warmth and cooperation may be desirable in various contexts for families from Western cultures, this may not be the case for all families. Interaction behaviors such as strict limit setting may not lead to as many negative effects for families of Asian and Asian American backgrounds as those of European-American descent (Chao, 1994). Strict limit setting can be commonplace in the realm of screen time mediation (Nathanson, 2001; Schmidt & Vandewater, 2008), and this kind of parent-child interaction may be better tolerated by children who are used to limits in other settings. Similarly, sensitive behaviors towards children of non-European

American heritage do not always have strong positive outcomes, as children from these background may be more tolerant of authoritarian parenting behaviors (i.e., inflexible, high expectations of the child; Dearing, 2004; Dornbusch et al., 1987). While the parenting nudges may have had no effect for the current sample, it is worth noting that there could be variation in whether the latent variable of interaction quality would be made up of the same dimensions for families who hold different parenting beliefs. Future research should consider piloting digital interventions, such as the one used in this study, across different cultures to see whether high-quality parent-child interactions ensue, and the character of those interactions.

Through this dissertation research, I was lucky enough to partner with a company willing to create an experimental version of its commercial application to suit my experimental conditions and I learned much about the ways that academia and industry can interact. One insight: when creating partnerships between academia and any kind of industry, it is important to have in writing the exact specifications that are required of the stimuli that you are creating together, as well as frequent face-to-face meetings to work out any differences. Expectations are then clear from the start, and any kind of miscommunication is avoided. In the case of the current study, I should have pushed for even more frequent planning conversations with the team at OK Play about what I needed for the app layout and discussed features of the two experimental versions of the application, as well as details that could be excluded. This change could have alleviated the stress on both myself and the programming team when the error emerged that reverted families with the nudge version to the no nudge version, as well as when newer content loaded into the application. Unfortunately, due to the fact that I started working with the OK Company in the early stages of their application development, this kind of communication was not realistic to expect of the team that I worked with.

Similarly, it is important to beta test and pilot the experimental stimulus that you and the partner have collaborated on as much as possible before entering the data collection phase of the study. I conducted pilot testing in the beginning of my study that allowed for some minor bugs to be eradicated, and that likely allowed for the study to begin with relative ease. However, given the time constraints of both myself and OK Company, I could not do an entire usability testing process before data collection began. This additional step does not mean that technical issues will never happen during the course of the study, but it can eliminate most of them prior to the first participant.

Finally, ensure that open and consistent communication is established early and throughout the partnership. Academia and industry work at completely different paces with completely different schedules. This can make getting requests fulfilled, errors corrected, and messages responded to even more tricky. Creating a plan early through some kind of face-to-face meeting (live or video chat) is key in forging a partnership that will stand the test of time and changing priorities. Thankfully, I worked with a wonderful team of programmers and content researchers more than willing to meet when issues emerged, as well as take any changes I asked for and apply them in a rapid manner. I believe this final insight to be integral to the success of any future research that will include this kind of partnership.

Despite the null effect of nudges found in the current study, the quality of the joint media engagement (JME) interaction is an area worthy of more study (Vaala & Takeuchi, 2012). The present results demonstrated that the behaviors, conversations, and engagement between parents and children that occurred during a JME activity all indicate a deeper construct that will continue to play an important role in this context. Further, JME is becoming more prominent within the lives of families as young children continue to gain more and more access to digital opportunities

(Ewin et al., 2020; Kabali et al., 2015). In order for young children to get the most out of digital media, parents can use their knowledge of their child's skill level to help them translate and understand content, as well as create healthy usage habits for future engagement (Fidler et al., 2010; Nathanson, 2001; Strouse et al., 2013; Strouse & Troseth, 2014). Yet, parents and children still have strong views and beliefs on the utility of digital media and the kinds of shared opportunities that are possible with it (Cingel & Krcmar, 2013; Common Sense Media, 2013; Strouse et al., 2019). These perceptions may be a hurdle to overcome when trying to convince families to use digital media in a similar way as more traditional shared contexts, such as shared reading or mealtimes (Sosa, 2016; Wood et al., 2016).

Continued research is needed to uncover optimal JME interventions that are accessible for a wide range of families, neither intrusive nor distracting, and strong enough to promote long-lasting, positive behavioral change (Doss et al., 2019; Stuckelman et al., 2021; Troseth et al., 2020). Parents play a critical role for their young children's understanding of what is on screen, due to their knowledge of their child's cognition (Fidler et al., 2010; Strouse et al., 2013). Thoughtful, sensitive, and well researched features can slowly shift negative beliefs towards digital content, and allow for more wide-reaching acceptance of JME interactions as another potential learning tool in a family's toolbox. This worthwhile task is necessary to create the best ways for young children and their families to get the most out of using digital media together.

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