Parent-Child Conversation Quality During Digital Application Use

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Abstract

Language development and play skills impact one another simultaneously and bidirectionally. Because parents and caregivers have the opportunity to guide and supplement play sessions, they have influence over their children's early language and literacy skills. In modern society, more and more play happens digitally. Parents therefore need to be cognizant of what digital media their children engage with. By choosing technology that is evidence-based and educational, and that supports the child as well as guides the parent's involvement, caregivers can use media to supplement play sessions, and therefore supplement language. This study investigated how a digital play-based application that is designed for joint engagement scaffolded parent-child interactions and conversation. After two weeks of playing with the app, parent language decreased. This paper discusses possible explanations for this decrease and suggests future directions for this type of research.

Parent-Child Conversation Quality During Digital Application Use

Language development skyrockets during the initial years of life when the language critical period is open (Ervin & Miller, 2012). To grow into successful speakers, readers, writers, and listeners, children need support and scaffolding during that time in multiple language domains (oral vocabulary and grammar, letter-sound correspondence, sight words, etc.). Parents and caregivers, being the ones who spend the most time with their child, have many opportunities to provide such support and scaffolding, consequentially facilitating language acquisition in their toddlers. To maximize learning benefits, both the quantity and quality of caregivers' utterances matter. Multiple strategies and techniques exist to enhance language and communication, and as technology rapidly advances, children's digital media becomes a frontrunner in this area.

While the long-term benefits and consequences of digital media exposure in terms of supporting language skills remain unknown, one thing is certain – when children and caregivers use media such as television and eBooks together and the media is tailored to joint engagement, all parties involved benefit from the shared experience (Kim & Anderson, 2008; Reiser, Williamson, & Suzuki, 1988; Salomon, 1977; Troseth et al., 2019). For example, when reading an eBook story together, parent-child conversation quantity and quality surrounding the plot of the story increased significantly with the help of an added character who promotes shared reading strategies (Troseth et al., 2019). To fully understand the benefits of educational technology, research must extend beyond building a helpful character into an eBook and look at other forms of digital media as well. The focus of this research is to investigate how incorporating parent tips into an educational play application impacts the quantity, quality, and complexity of parent-child language and conversation.

Importance of Cognitive Demand Language (Quantity, Quality, Complexity)

Parental language input significantly influences child language outcomes in many ways (Beals & Tabors, 1995; Hart & Risley, 1995; Huttenlocher et al.,1991; Weizman & Snow, 2001). The interplay between quantity and quality of parent-child interactions accounts for a large proportion of the variance in children's vocabulary growth (Price et al., 2009). Hart and Risley (1995) discovered that the amount of parent talk was strongly associated with toddler language learning, both within and across socioeconomic status groups. These initially controversial findings were supported by subsequent studies (Fernald et al., 2013; Hurtado et al., 2008). For instance, Hurtado and colleagues (2008) found an association between maternal language input quantity and child vocabulary at 24 months among low-income Latinx families in California. Unlike Hart and Risley (1995), researchers focus on the variability in parent language within low-income families, rather than discrepancies in child-directed language between socioeconomic status (SES) groups (Hurtado et al., 2008). Thus, no matter a family's SES level, parent language input impacts child language growth. Furthermore, child age of acquisition of certain words correlates with the relative frequency of the use of those words in their mothers' speech (Huttenlocher et al., 1991). Approximately 20% of toddlers' language growth can be attributed to parental quantity of spoken words, suggesting the profound impact of something as simple as the number of words a child hears on their language development (Huttenlocher et al.,1991).

Language quality also plays a major role in promoting child language. Specifically, the number of different words a parent uses (measured as unique word count) directly impacts child language outcomes (Weizman & Snow, 2001). Weizman and Snow (2001) claim that roughly a third of variance in vocabulary performance in second graders can be attributed to the number of

rare words used in maternal language. Children's acquisition and use of rare words results in better receptive vocabularies, which support both academic and social success (Beals & Tabors, 1995). These findings suggest that children who hear more unfamiliar, distinctive words go on to develop more extensive vocabularies, therefore exhibiting stronger overall language skills.

The complexity and content of parent language are other aspects of language quality that impact child language outcomes (Hoff & Naigles, 2002). The more complex an utterance or phrase is, the more cognitive effort it requires to understand and remember it. Every word, sentence, thought, and question falls somewhere on a spectrum of cognitive demand, with certain phrases landing on the lower (less demanding) end, and some on the higher end (Price et al., 2009). Utterances of lower cognitive demand include providing or asking for labels, requests for locations, and basic descriptions (Smolkin & Donovan, 2002). Alternatively, talk involving inferences, hypotheses, predictions, judgments, evaluations, and explanations entail higher levels of cognitive demand (Smolkin & Donovan, 2002). They tend to incorporate abstract thoughts, alluding to people, places, or things that are not immediately perceptually available. Parents' use of utterances of high cognitive demand correlates with children's use of utterances of high cognitive demand (Gordon, 1984; Harkins et al., 1994; Peterson & McCabe, 1994). Similarly, Hoff and Naigles (2002) posit that it is not the social aspects of conversation, but rather the lexical variation and complexity of maternal input that has the most profound effect on child vocabulary growth. With more complex language at their disposal, children can both comprehend more and express themselves more eloquently, among other language benefits.

Language Development Through Symbolic Play and Parental Responsiveness

Symbolic play sessions provide parents and caregivers with the perfect opportunity to scaffold language development. Symbolic play refers to the use of objects to represent other

objects during imaginative play (Nourot & Van Hoorn, 1991). Parents have the chance to label new objects and model their uses. For example, a parent could pick up a toy phone, label it as a "phone", and pretend to have a conversation with their child. This links the object with its name and use in the child's mind. It also marks a child's first steps towards mature symbolic representation, an essential component of letter recognition and general literacy, which develops much later in life (Iverson, 2010). Children must be able to recognize letters and words as symbols that carry meaning beyond their immediate perceptual characteristics.

Similarly, symbolic play supports receptive language development. Symbolic play competence highly correlates with oral language comprehension at 14 months, as well as at four and five years (Kirkham et al., 2012; Laakso et al., 2000). One possible explanation for this phenomenon is that performance in both linguistic and non-linguistic symbolic domains develop simultaneously because they are controlled by a domain-general mechanism. Alternatively, it is possible that increases in symbolic play lead to more frequent and accurate word-referent pairings, more interactions with caregivers, and higher levels of exposure to new and unfamiliar words than in general daily activities (Kirkham et al., 2012). The toys and objects available, as well as the abstract concepts used during pretend play, foster the use of more rich and unique language that may not be used frequently in daily life. This hypothesis suggests a more direct and possibly causal relationship between symbolic play, parental language input, and child language development. Play tends to be accompanied by parent language, which promotes child language development. If this is the case, caregiver engagement in symbolic play is an essential component to facilitating language and literacy. However, in order for their engagement to be effective, it cannot be passive. Caregivers must actively listen and respond to their children in

meaningful ways. Specifically, imitations and expansions promote child language development (Tamis-LeMonda & Bornstein, 2002).

Keeping these considerations in mind, parents can use play sessions to scaffold their child's language growth. Historically these play sessions have occurred in-person, face-to-face. However, with modern technology has come opportunities for digital play. Similarly to in-person play, it is possible that digital play sessions including both parents and children provide chances for enhanced parental language input as well.

How Media Plays a Role

The development of digital media for young children offers endless opportunities to support children's practical and artistic capabilities in new and exciting ways, especially when it comes to facilitating language and literacy across the early years. Content designers strive to replicate the advantages of in-person learning through a screen, incorporating evidence-based learning theories into television shows, eBooks, and mobile applications (Bus et al., 2020; Elimelech & Aram, 2019). Digital animations and special features can help grab children's attention, directing them to important information on the screen and mimicking the feedback a parent or caregiver might give. For example, animation and gamification of informational content show promise in promoting language development (Bus et al., 2020). Gamification refers to the use of game-design principles in nongame contexts. Elimelech and Aram (2019) used gamification to design a game that assists preschoolers in developing their early literacy and spelling abilities. The digital game mimics the kinds of tips and advice that parents and teachers would offer during in-person instruction. This gives children the opportunity to practice their literacy skills independently and receive feedback without explicit teacher or caregiver supervision.

Print Awareness and Other Skills

Furthermore, tracking animation in eBooks that points out specific words by changing their color, underlining them, or lighting them up while they're being read aloud directs children's attention to the print itself, promoting word learning and print awareness (Bus et al., 2020). Print awareness includes accepting that letters hold meaning, being able to distinguish letters from other symbols and pictures, knowing that there are spaces between words, and generally understanding the forms and functions of print (Heroman & Jones, 2010). It provides an essential foundation for subsequent language development. Four-year-olds tend to ignore printed words when reading print books, focusing only on the corresponding pictures and scenes (Evans & Saint-Aubin, 2013). Tracking animation therefore can enhance early literacy skills such as print awareness and word learning in preschoolers by highlighting and pointing out letters and words (Bus et al., 2020); this unfortunately may come at the expense of reading comprehension, as children may pay less attention to the story's plot.

Beyond print awareness, other emergent literacy skills such as alphabetic knowledge, phonological awareness, and vocabulary are also better supported by eBooks than print books in a preschool classroom setting (Ihmeideh, 2014). Phonological awareness specifically implies an understanding that words are composed of discrete, separate units of sound blended together. It is a key component of reading, spelling, and writing. Chera and Wood (2003) suggest that eBook exposure in kindergarten classrooms leads to higher phonological awareness post-test scores. The eBook software used in their study incorporated the segmenting and blending of words, as well as interactive features to maintain engagement throughout. Ebooks with these features appeared to better support phonological awareness during reading than did print books.

Digital Features

The literature surrounding the effects of multimedia features and hotspots on children's learning is conflicting. *Multimedia features* include animations, sound effects, and songs. Sarı et al. (2019) concluded that receptive vocabulary suffered with the introduction of music and background sounds. If content designers assign animations to unimportant aspects of the story, this may result in negative learning outcomes because children will pay attention to the animations instead of the intended educational material (Sarı et al., 2019; Takacs et al., 2015). Similarly, *hotspots* are interactive aspects of eBooks that require a user's touch to stimulate multimedia features. These can often be distracting to young readers, taking their attention away from the plot and educational content (Krcmar & Cingel, 2014; Takacs et al., 2015).

However, more recent research suggests that specific, intentionally placed interactive features — such as underlining, multimedia features, and hotspots — can lead to better story retelling and critical thinking (Christ et al., 2019). Animating aspects of the story using motion features such as zooming in or auditory features such as sound effects and music can guide children's visual attention. If these additions further emphasize words or definitions and are congruent with the story's plot and narration, they can significantly support word learning and reading comprehension (Christ et al., 2019; Sarı et al., 2019; Takacs et al., 2015). When eBooks are constructed carefully and in line with developmental theories, they can maximize learning outcomes. The mixed research surrounding the "bells and whistles" of eBooks and digital media point to both the profound potential and the risk of educational technologies. More does not necessarily mean better when it comes to enhancing digital content that aims to promote literacy and language learning.

This conflicting research could also be in part explained by differences in participant characteristics such as age, attentional control, and home environment. For example, children

from disadvantaged families (low SES, immigrant parents, or bilingual families) benefit most from multimedia features (Takacs et al., 2015). We must therefore be cautious about overgeneralizing claims about interactive aspects of digital media, as they may be beneficial for some populations and harmful for others.

Involving Parents

Not all technology is designed to automatically direct children's attention and learning optimally, as is shown by the inconsistent research surrounding the benefits and drawbacks of digital media use among children. However, there is no doubt that parental supervision and engagement can significantly enhance educational gains (Kim & Anderson, 2008; Reiser et al., 1988; Salomon, 1977; Troseth et al., 2019). Parents know their children's strengths, weaknesses, and interests, making them the best candidate for supporting their children's learning in new digital contexts. Yet the harsh reality is that joint engagement with digital media rarely manifests itself in day to day life (St. Peters et al., 1991). Children use technology independently more often than not. When young children watch shows intended for children, they are typically not co-viewing with parents. If parents and caregivers understand the power that joint engagement holds in stimulating learning, they can interact with digital media in more meaningful ways.

Previous Research About Joint Media Engagement

Each form of digital media (television, eBooks, and apps for example) deserves individual scrutiny in order to determine how parents and educators can best use them to facilitate development. Educational television is especially successful in promoting learning under certain viewing conditions. Back in 1977, Salomon first suggested that when parents and children watch shows like Sesame Street together, children learn more. In a post-test about the show's content, children whose parents engaged with them during the viewing session performed

better on questions about letter knowledge and object classification. More specifically, children benefit from shared TV viewing when parents ask questions and give feedback to guide their understanding (Reiser et al., 1988). Brief parental attention and mere physical presence while watching children's television programs are insufficient. When parents actively engage with their children in the form of questions and feedback, children perform better on post-tests about letter and number identification (Reiser et al., 1988).

Similar findings have been seen for eBooks. Shared eBook reading promotes intricate parent-child social interactions, encouraging more diverse language output and more complicated and extensive conversations while reading (Kim & Anderson, 2008; Lurie, 2021; Troseth et al., 2019). More diverse and complicated child language indicates a stronger expressive vocabulary. Correspondingly, more complex parent language helps children to acquire better receptive language skills. Parent-child joint eBook reading therefore aids children in the development of multiple language domains.

Ebooks can be even more educationally beneficial than they already are when enhanced with a character who facilitates joint engagement and enhances dialogic reading (Lurie, 2021; Strouse et al., 2023; Troseth et al., 2019). Dialogic reading refers to when parents ask children open-ended questions relating to or going beyond the content of a story while reading. It includes different prompts that promote recall, expansion, and "distancing", which connects the book to the child's life (Price et al., 2009). Early work by Whitehurst et al. (1998) suggests that this strategy can successfully bolster children's language abilities, specifically their expressive vocabulary. Troseth et al. (2019) extended these results to the realm of digital media, using a narrated eBook. Researchers found that with the help of a character in the eBook who modeled dialogic reading strategies, parents of lower SES used significantly more utterances and unique

words. Even without explicit teaching as to how to implement dialogic reading, parents picked up on the strategies that the character used and built off of the questions to engage in longer conversations with their children. Enhanced eBooks therefore show promise in their ability to close the performance gap between low SES and high SES children. What this research does not include, however, is how similar strategies can be translated to other forms of digital media, such as applications (apps) centered around mathematics, art, or play.

Hypotheses

By exposing parents and children to a digital play app designed for joint engagement, researchers can extend previous work about the linguistic benefits and costs of television and eBooks into the realm of play based apps. In the current study, I hypothesized that two weeks of exposure to a digital play app designed for joint engagement and enhanced with parent tips would increase parent language quality, quantity, and complexity, compared to language use in families who played with a version of the app without parent tips.

However, it was also possible that I would see similar or lower levels of parent language quality, quantity, and complexity across all participants after two weeks of exposure to a digital play app. Initial exposure to and engagement with the games during the pre-test might induce excitement and higher levels of exploration than on subsequent exposures, as parent-child dyads figured out how the app worked and how the games flowed. More extensive app exploration during this first exposure might inspire more language and conversational complexity compared to during the post-test. Similarly, I might see decreases in parent language if parents engaged in scaffolding during the initial play session, providing more explicit supports and then gradually removing those supports as their child became more competent and figured out the game on their own. These results would suggest that the way parent tips were implemented in the experimental

version of the app were insufficient in supporting language and conversation development. Apps designed for play would therefore need more extensive or different parent support measures.

Methods

Participants

Participants included 76 four- to five-year-old children and one of their parents or caregivers. We recruited participants through social media posts, Tennessee state birth records, and the Child Studies Database kept by the Department of Psychology and Human Development at Vanderbilt University. No children had significant developmental delays and all were learning English as their first language. All families had access to an iPhone and/or iPad to use the application OK Play. Children in the study were from a variety of racial backgrounds: 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%). The median family income landed between $105,000 and $150,000, with a range from under $75,000 (18%) to above $150,000 (29%). The majority of parents had obtained a graduate or professional education (53%). 35% of parents were college educated and 10% had less than a four-year degree. Twelve additional parent-child dyads began the initial stages of the study but their data were not included either because they did not complete the study (seven dyads), because their sessions were incomplete (three dyads), or because of experimental error (two dyads).

Materials

Families were asked to download versions of the application OK Play (see Figure 1) that were designed specifically for this study. The commercial OK Play app offers multiple games (drawing, music creation, picture taking) under a “Play” tab that are created for parents and

children to engage with together, although it is also possible for children to play many of the games "solo". The experimental version of the commercial app included *parent nudges* and the control version did not. Generally speaking, parent nudges are small suggestions intended to promote interaction and encourage long-lasting behavioral changes in both parents and children (Doss et al., 2019; Smythe-Leistico & Page, 2018).The nudges were co-written by a developmental psychologist and a preschool teacher. In the experimental version of OK Play, nudges appeared before every activity, offering parents brief ideas about how to improve co-play and conversation during the game (see Figure 2 and Table 1). Nudges were displayed in the form of four slides. The "Get Ready" slide described the activity and reminded parents that it was intended to be played with a partner. The "Play Tip" slide suggested ways to engage with the content. The "Extend the Play" slide described how the content could be incorporated into daily activities beyond playing the app. Finally, the "Parent Insight" slide provided explicit tips on promoting shared interaction throughout the activity. Participants in the experimental group had to scroll through all four slides before beginning the game. No slides appeared for participants in the control group.

Figure 1

OK Play Homescreens

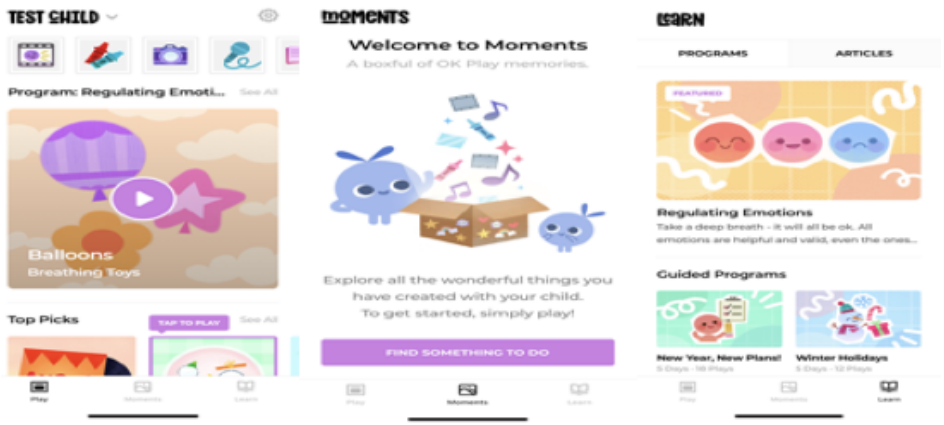

Figure 2

OK Play Parent Nudge Screens

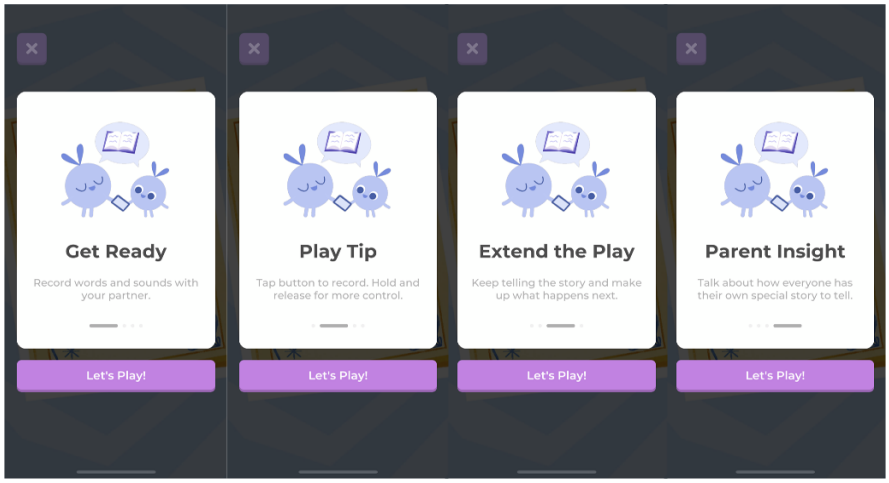

Table 1

Descriptions and Examples of Nudges from Experimental Version of OK Play

Nudge	Purpose	Examples
Get Ready	Gives parents a brief description of the activity; explicitly mentions playing with a partner	Record your words and sounds with your partner Take turns drawing with your partner Take a series of photos with your partner
Play Tip	Specific parent recommendations for ways to interact during the activity	Try making the different faces together Discuss what disappointed means to you Encourage your child to say the commands out loud
Extend the Play	Ways to connect between the activity and the child's own life	Throughout the day, name the shapes of objects you see Make up a story about your drawing Talk with your child about times they have felt angry
Parent Insight	Explains importance of the activity or provides ways for parents to extend the activity	Listening without judgment helps us learn about others Talk about how you created the drawing using teamwork Understanding facial expressions helps in perspective taking

Table from Stuckelman et al. (2023).

Procedures

Parent-child dyads participated in two 20-minute Zoom sessions with the researcher scheduled approximately two weeks apart. During both sessions (the pre-test and the post-test), participants in both conditions played two games on the OK Play app without parent nudges: "Silly Word Club" and "Drawing". In the first game a character directly encouraged specific behaviors ("Spin around when you hear the word 'pineapple'"). The audible prompts from the app and the resulting child behaviors offered parents the chance to jump in and provide encouragement. In the drawing activity, parents and children worked together to create an under-the-sea scene, with fish, a submarine, bubbles, and other ocean objects. After each object was drawn, the app would audibly prompt the parent or child to "pass the drawing to your partner." Once all objects were complete, parents and children could see all of the different parts that they drew combined in a final scene. The passing back and forth directly prompted co-play and conversation. The two games differ in that Silly Word Club does not offer explicit co-play opportunities, whereas Drawing does explicitly elicit co-play through prompts to pass the drawing. By including two games with this one key difference, we could investigate whether parent nudges impact post-test language across different kinds of games. The sessions were recorded on Zoom and the audio was transcribed.

During the two weeks in between Zoom sessions, participants engaged in play with their assigned version of the app (experimental with nudges or control without nudges) a total of at least ten times. Because data collection took place at the height of the COVID-19 pandemic, families were instructed to interact with the app OK Play in whatever way was natural for them, either the parent and child playing together or the child playing alone. They could choose to play

any of dozens of available games from the app (See Table 2). The games prompted varying levels of co-play beyond the parent nudges included in the app used by the experimental group. Most of the games resembled Silly Word Club in that they did not explicitly require co-play, so the encouragement for co-play of those games came solely from the nudges. Parents were taught to make a video screen recording of what was happening on the device screen and also audio-recorded the play session with a separate device. Throughout the two weeks, reminder calls were made to the parents to ensure play sessions were occurring and being recorded and the audio and screen recordings uploaded to a secure Box folder.

Table 2

OK Play Activity Descriptions

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 other activities	Yes. Parents must read the instructions
Stories	Doggy Art Show, Treehouse Club, Haha Haircuts, I ♥ 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 a list	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, 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.	Themed breathing exercises	No

Table from Stuckelman et al. (2023).

Transcription and Coding

Trained research assistants used the CHAT transcription format to transcribe the language used during the pre- and post-test play sessions (Troseth et al., 2019). Each line of transcript included the transcription of one utterance and a three character speaker code (PAR for parent, CHI for child, or TWI for Twiggle, the character whose dialogue is included in games). A break in an utterance was defined as silence for more than two seconds, terminal intonation contour, or syntax that completes a sentence (Ratner & Brundage, 2013). A second trained research assistant reviewed each completed transcript for accuracy prior to coding to increase reliability.

Coding took place using CLAN, a program for analysis of transcripts in CHAT format. The KIDEVAL function within CLAN computed total number of parent words, total number of parent utterances, and total number of unique parent words. These variables allow for analysis of differences in parent language quantity between the two sessions. Unique word count also allows us to measure parent linguistic variation, which has an established positive correlation with children's vocabulary size (Huttenlocher et al., 2010; Pan et al., 2005).

To examine the extent to which parent language quality changed between the two Zoom sessions, parent utterances first were assigned four distinct codes (*social feedback*, *attention-directing*, *cognitive support*, and *uncodable*) (Strouse et al., 2013). Social feedback included any parent utterance responding to the child's utterances or behavior. Attention-directing talk is any command, or comment that a parent uses to attempt to modify the

child's attention or behavior. During a second coding pass, any utterance deemed a cognitive support was further labeled as a certain level of cognitive demand (Level 1, Level 2, Level 3, or Level 4) as defined by Price and colleagues (2009). A low cognitive demand (Level 1 or Level 2) utterance often comes in the form of labeling an object, locating something on the screen, and describing the color, shape, size, or other visually perceptible characteristics of objects or scenes. Level 3 and 4 utterances of higher cognitive demand include making inferences and predictions, recalling information, making comparisons and judgments, providing definitions and explanations, and making connections to the outside world that go beyond the text. For simplicity, the four Price cognitive demand levels were combined into Level 1 (low cognitive demand) and Level 2 (high cognitive demand). Any talk not related to the app was designated "uncodable".

Data Analytic Plan

I conducted a two way analysis of variance with condition (experimental vs. control) and time (pre-test vs. post-test) as the main measures. This test allowed me to determine the main effect of condition, the main effect of time, and the interaction between the two.

The ongoing pandemic and virtual home sessions prevented us from directly enforcing co-play during the two week intervention period. The lack of control led to variation in parental engagement in the experimental group during this time, despite the presence of explicit parent nudges encouraging co-play. Some parent-child dyads played together during this period, while in other cases the child played alone. Therefore, I examined within-group differences in engagement with the nudges and language outcomes in the experimental group.

For this analysis I checked for a correlation between the amount of time the nudges were visible on-screen (measured in fractions of seconds from the screen captures) and language

outcomes (higher unique word count, more complex and variable language, higher number of conversational turns, etc).

To support the use of this measure of engagement, I needed evidence that the time the nudges were visible on-screen was a valid measure of parental participation in app co-play with the child. I assumed that if the parent was involved in a home play session and was reading the nudges, this would be indexed by the nudges being visible in the screen capture for a longer time, whereas if the parent was playing with the child but not reading the nudges or the child was playing alone, the nudge duration would be shorter. This explanation was supported by high correlations between nudge duration and parent involvement in co-play for a sample of parents whose home session audio recordings were coded for amount of co-play (r = 0.65).

Results

Fidelity of Implementation

Families in the control condition recorded an average of 8 play sessions (M=7.66, SD=2.93) and families in the experimental condition recorded an average of 8 play sessions (M=8.43, SD=2.50) during the two weeks between lab Zoom sessions.

During the pre-test, in the experimental group, 57% of parents exhibited co-play behaviors during Silly Word Club and 92% of parents co-played during Drawing. In the control group, 59% of parents co-played during Silly Word Club and 90% of parents co-played during the drawing game. During the post-test, in the experimental group, 46% of parents co-played during Silly Word Club and 84% co-played during Drawing. In the control group, 62% of parents co-played during Silly Word Club and 87% co-played during Drawing (Stuckelman, 2023). There were no significant condition differences in co-play at either time point.

Condition Differences

To assess pre- to post-intervention changes in parent language that resulted from engaging with the experimental version of OK Play enhanced with parent nudges compared to the control version, I used repeated-measures ANOVAs. No significant differences were observed. The closest to significant difference I observed between control and experimental groups was differences in the frequency of Cognitive Support Level 1 utterances; experimental group parents used more of these utterances during pre-test ($F(1,74)=.794$, $p=.376$). Results therefore were not nearing statistical significance at either the .05 or .01 level.

Time Differences

Beyond condition differences, I also assessed general changes in parent language from pre-test to post-test, regardless of which version of the app participants engaged with. I used repeated-measures ANOVAs. Contrary to my hypothesis, parent language decreased significantly in all cases ($p \leq 0.05$), as is reported in Table 1. Most decreases were significant at the .001 level. The exceptions include declines in Social Feedback utterances ($F(1,36)=9.261$, $p = .004$) and Level 2 Cognitive Support Utterances ($F(1,36)=4.434$, $p = .042$), both in the experimental condition.

In all linguistic domains, parents in the control condition displayed a slightly greater decrease in language quality, quantity, and complexity from pre- to post-test, as is shown by higher *F*-values than for parents in the experimental condition . However, these differences were not enough to change their overall significance, as all p-values are less than or equal to .042.

Table 3

Means and Repeated Measures ANOVAs by Condition and Time

	Day 1 M(SD)	Day 2 M(SD)	Repeated Measures ANOVA Testing Time Differences
Control			
Total Utterances	89.923(52.265)	48.487(37.450)	$F(1,38)=27.876$, $p < .001$
Total Word Count	143.103(74.084)	91.385(45.897)	$F(1,38)=22.239$, $p < .001$
Attention Directing	30.308(15.817)	16.000(10.042)	$F(1,38)=56.095$, $p < .001$
Social Feedback	44.539(29.930)	25.846(13.806)	$F(1,38)=21.921$, $p < .001$
Cog Supports L1	27.871(17.599)	14.179(9.973)	$F(1,38)=45.400$, $p < .001$
Cog Supports L2	13.795(13.912)	7.538(5.698)	$F(1,38)=14.506$, $p < .001$
Experimental			
Total Utterances	87.784(54.129)	55.730(41.840)	$F(1,36)=16.241$, $p < .001$
Total Word Count	157.784(120.500)	104.027(72.216)	$F(1,36)=16.024$, $p < .001$
Attention Directing	31.514(14.794)	18.757(11.964)	$F(1,36)=25.220$, $p < .001$
Social Feedback	38.324(25.641)	27.000(20.815)	$F(1,36)=9.261$, $p = .004$
Cog Supports L1	31.514(18.207)	18.649(13.927)	$F(1,36)=23.442$, $p < .001$
Cog Supports L2	12.730(10.186)	8.919(9.275)	$F(1,36)=4.434$, $p = .042$

Correlations With Parent Nudges

A high correlation between duration of nudges and parental involvement was established ($r = .65$) within the sample of home recording sessions that were coded. With nudge duration as a successful measure of parental involvement, I then conducted further correlational analyses to determine if there was a relation between parent nudge duration and parent language outcomes. I looked for correlations between parent language measures and total time spent looking at nudges, as well as average time looking at nudges per home play session. Only Social Feedback

Utterances during post-test were significantly correlated with the total time spent looking at nudges ($r(36)=.337$, $p=.041$). The remainder of correlation coefficients were not statistically significant at the .05 or .01 level.

Discussion

In the current study, I sought to explore whether parent language quantity, quality, and complexity would increase after using a play-based application designed for joint engagement. More specifically, I investigated whether adding parent-directed nudges would impact parent language after two weeks of exposure to the app. Previous research shows that content creators can maximize the educational benefits of children's digital media, such as eBooks, by adding direct parent-facing information that guides parent involvement during the reading session (Lurie, 2021; Strouse et al., 2023; Troseth et al., 2019). I therefore hypothesized that parent-directed nudges displayed immediately preceding the games would support parent language and conversation quality. Alternatively, I speculated that I might see a decrease in parent language between pre-test and post-test, as the novelty of the games wore off and parents' attempt to scaffold their child's behavior became less crucial for children to use the app. Ultimately, I found decreases in parent language between pre-test and post-test regardless of condition, providing support for my alternative hypothesis.

As aforementioned, the intervention was built into an already existing commercial app with tremendous help, generosity, and patience from the app's developers. Since the app was not designed for the sole purpose of this study, the exact adjustments we could ask for as researchers were limited. The following discussion revolves around what did not work in this specific study, and focuses on future directions for digital play apps with similar intentions.

Pre- to Post-Test Changes in Parent Language

Contrary to my hypothesis that experience with the experimental version of OK Play would result in more complex and diverse parent language, parent language in all domains (Total Utterances, Total Word Count, Attention Directing, Social Feedback, Cognitive Supports L1, Cognitive Supports L2) and in both conditions (experimental and control) decreased between pre-test and post-test. While the decreases were slightly less extreme in the experimental group, they were still significant at the .05 or .01 level. There are many possible reasons for this decrease, including the effect of novelty on parental engagement during game play, the exclusion of important digital features from the app that have been shown to increase parental engagement with other media, and the attempts of parents to sensitively scaffold language and behavior.

Effects of Novelty During Game Play

One possible explanation for the decrease in parent language is that the novel experiences during pre-test Zoom sessions inspired more conversation. This interpretation would be consistent with the "novelty effect", which states that positive results can oftentimes be explained by the newness of an educational or medical technology or intervention, rather than the technology itself (Elston, 2021). As the novelty wears off, performance decreases and the true efficacy of the intervention emerges. In the case of OK Play, it is possible that since parents were unfamiliar with the app, initial play sessions were more linguistically rich. The original content that the app displayed during pre-test led to longer and more variable conversations. As the content became familiar over the course of the two weeks, parents may have run out of new material to discuss and bring up during play sessions. This may especially have been the case if parents did not read the nudges (in the experimental group) or were not exposed to them (in the control group), since the nudges did suggest different ways to engage with the app games.

Exclusion of Some Effective Digital Features

It is also possible that the parent nudges used during this study were not specific or consistent enough to inspire noticeable change in parent language. Lurie (2021) and Troseth et al. (2019; also Strouse et al., 2023) added a character in their eBooks that gave parents concrete examples of questions to ask during reading. This character popped up on most pages throughout the story, and provided varying levels of support over the course of the study. Families were unable to turn the page until the character finished offering his suggestion of a conversational prompt. Therefore, the tips were required and parents were automatically exposed to them.

Unlike this character, the parent nudges used in this study were displayed immediately *before* play, were text only (no audio or character) and the parent (or child playing alone) could quickly swipe through them without reading them. Had they been embedded throughout the game, providing parents with particular conversation topics, it is possible I would have seen an increase in parent language instead of a decrease. Future research should use apps that disperse parent nudges throughout games and that provide more concrete conversation topics when looking to integrate educational material and play.

Furthermore, the narrated eBooks used by Lurie (2021), Strouse et al. (2023), and Troseth et al. (2019) required parent involvement one-hundred-percent of the time, as co-reading was part of the instructions. Parents were instructed to be there to help their 3- to 5-year-old child navigate the story and therefore were exposed to the character's model of asking questions relevant to the story. OK Play differs from these eBooks in that the child could play the games on their own. They were even instructed to play on their own, if that was what was most natural for their family. While the experimental group had the nudges directed towards parents, a child could easily tap through the nudges and play the game without the presence of an adult. If we had tightly controlled whether families played the games together, parents in the experimental

group might have had more exposure to the nudges. It is also possible that digital apps designed for play (rather than reading, like eBooks) are simply not conducive to language rich experiences in the same way that eBooks are, because parents view app games as something children can do on their own while parents concentrate on work or other activities. Or, to be effective, a different kind of nudges, or checkpoints that require the presence and active involvement of an adult, must be added to the games..

Future research should investigate whether parents who are explicitly told to pay attention to the parents nudges and stay involved the whole time (rather than being told to play with the app "however is natural for their family") demonstrate increased parent language and conversation quality. Coupled with more concrete tips scattered throughout the game, explicit parental instruction shows promise in its ability to increase language during digital play.

Parental Attempts at Scaffolding

Finally, sensitive scaffolding may account for decreases in parent language between pre-test and post-test. Vygotsky (1978) posited that each child has their individual zone of proximal development, the distance between what they can achieve with an adult's help versus what they can achieve on their own. This is especially important during play, where the adult can follow the child's lead and give the child the chance to show what they are capable of (Bodrova & Leong, 2015). Parents have the important task of providing children with enough support to aid development, but not too much to take away from the child's autonomous growth. This practice is called social scaffolding, which is a *temporary* support that is removed when a child no longer needs it for a task.

It is possible that parents in this study either consciously or unconsciously removed linguistic supports as an attempt to scaffold their child's development. This would make the

decrease in parent utterances between the two Zoom sessions a natural result of strong parenting. More research is needed to confirm if scaffolding accounts for decreases in parent language. The inclusion of a parent survey at the end of the new study which asks questions about a parent's reasons for increasing or decreasing language support could provide insight into this possibility, assuming their decisions surrounding their linguistic output are conscious.

Limitations

There are a few significant limitations to the current study. First, different games on the app inherently promote different levels of conversation and language development. For example, the drawing game was designed for two players, with the hope that parents and children would pass the phone back and forth. Silly Word Club, on the other hand, asked for no effort on the parents' part. During their two weeks between Zoom sessions, some families may have used games that encouraged more interaction (like the drawing game), as parents and children were free to explore any games available to them on the OK Play app. Other families might have accidentally steered clear of such games. Therefore, certain families might have gotten more inspiration for language-intense experiences than others regardless of condition. Future research should exert more control over what digital play experiences parent-child dyads have during unmonitored play sessions. By controlling the exact games parents and children are allowed to play, researchers can better understand what specific aspects of games promote or hinder language and overall play quality.

Secondly, the independent home play sessions may have differed in length, as well as in amount of joint-engagement. The play sessions over the two week period did not take place in a lab with tightly controlled stimuli, meaning some parents were likely more involved than others. With no video of what families were doing while playing the app, there is no foolproof way to

tell whether the parent nudges were being watched, understood, or considered by an adult. We tried to counteract these uncertainties by monitoring a select sample of home play sessions and looking for correlations between nudge duration, parent involvement, and parent language. Future research should directly observe home play sessions to determine what other variables are at play and whether the parent tips are truly being watched and understood. While tighter experimental control may lessen ecological validity, direct observation may be necessary to first establish the potential of parent nudges, before moving on to generalizing parents' co-play abilities to other outside contexts. Furthermore, future research could incorporate the use of parent checkpoints (password entry after reading nudges, text reminders, etc.) that confidently predict parent engagement.

Finally, the sample was not culturally representative, as the majority of participants were of European American descent (75%) and came from high income households with highly educated parents. Cultural norms impact parenting styles and parent-child behaviors, making cultural diversity an important variable to consider in studies such as this that focus on parent-child interaction quality (Bae et al., 2014).

Conclusion

After two weeks of engaging with a digital play app designed for joint engagement, parent language input decreased. Without explicit directions as to how to play with the app and maximize educational benefits while doing so, parents did not increase the quality, quantity, or complexity of their utterances. This suggests that more concrete parent tips during digital play experiences may be necessary to increase parent language. If future innovations mimic the design of successful media interventions (adding characters that offer automatic and consistent parent-directed information and modeling in the form of visual and audio prompts (Lurie, 2021;

Strouse et al., 2023; Troseth et al., 2019)), it is possible we would see more robust, positive results in a play based apps such as this one as well. Or, perhaps digital play experiences are not as useful a context for shared talk as shared book reading or in-person play interactions when it comes to supporting a child's linguistic and social development. This app should serve as an example of an insufficient model of parent informational "nudges" for future educational technology design, encouraging creators to tailor games designed for joint engagement more directly to parents if they hope to increase conversation quality through play.

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