UNPACKING MEANINGFUL PLAY IN THE CLINICAL CONTEXT: MOBILE APP USE BETWEEN CHILDREN WITH DISABILITIES AND THEIR SPEECH LANGUAGE PATHOLOGISTS

Mobile App Use Between Children with Disabilities and Their Speech Language Pathologists

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Abstract

In recent years, children with disabilities who receive speech therapy services are increasingly interacting with iPad-based mobile applications (apps) to work on communication and social skills with their speech language pathologists (SLPs). Yet, limited research has been conducted to explore the collaborative use of mobile technology between them. Through interviewing 23 SLPs and analyzing their iPad use across different work settings, our study reveals that during their clinical practice, SLPs not only use a variety of mobile apps to support academic learning and treatment but also motivate children for therapy by engaging them in collaborative play. Additionally, app design recommendations reported by SLPs also closely align with prior research on usability, mobility, and playability heuristics for mobile games. Ongoing research should continue investigating SLPs' app use and play strategies in the clinical context and translating clinical utility of mobile apps to opportunities and guidelines for design that can support learning and meaningful play for all children with and without disabilities.

Introduction

With the widespread use of mobile devices, recent research indicates that 38% of U.S. children under 2 have used mobile devices for media consumption (Vatavu et al., 2015), and 80% of children between 2 and 4 years old spend at least 20 minutes a day using a tablet or a smartphone (Hiniker et al., 2016). Concerns about excessive "screen time" spent on digital media and games and its potential detrimental effects on children's academic performance, social engagement, and behavioral health, have not only led to public debates but also drawn attention from researchers from both health policymakers as well as researchers in child computer interaction and digital media (Mazurek et al., 2012; Read et al., 2018; Ito, 2017). While American Academy of Pediatrics encourages parents to create "personalized Family Media Use Plans" that attend to each child's age, health, temperament, and developmental stage (Chassiakos et al., 2016), media and game study scholars argue that this perspective on "screen time" is an outdated concept based on a dosage model, and could be decontextualized to reflect quality of learning over quantity of usage (Ito, 2017; Squire & Steinkuehler, 2017).

Unpacking the multifaceted use of technology among modern youth and educating various

stakeholders (e.g., parents, teachers, administrators, healthcare practitioners, and even policy makers) has become a critical issue that warrants additional research. For example, how are youth making meaningful use of technologies like digital games? In what contexts is play meaningful to youth with disabilities? Unfortunately, despite the increased attention in medical and educational research as well as in the field of human computer interaction (HCI), children with communication-related disabilities has not been positioned at the center of the discussion.

Children with communication-related disabilities

It is estimated that one in 12 U.S. children between ages three and 17 may have speech, language, swallowing, and voice related disorders (Black et al., 2015). Specifically, 5 to 12% of children between 2 to 5 years old are estimated to have speech and language delays and disorders (Prelock et al., 2008), which are considered the "most common and least diagnosed disability of childhood" by primary care pediatricians (Wallace et al., 2015). Communication-related impairments can present as a co-morbid condition along with many different types of disabilities that are neurodevelopmental (e.g., autism spectrum disorder, attention-deficit disorder, intellectual disabilities), genetic (e.g., Down syndrome), congenital (e.g., cerebral palsy), and orofacial (e.g., cleft palate). Failure to provide therapy services to young children in a timely way may significantly hinder them from receiving early intervention and making effective progress, leading to challenges in acquiring functional communication and literacy skills for school readiness (Wallace et al., 2015; Morgan et al., 2015).

Children with communication impairments constitute a marginalized group of research subjects that are known to be challenging for research. For instance, they may have reduced cognitive and linguistic abilities to offer consistent and accurate user feedback to participate in traditional methods of inquiry (e.g., survey, interview, focus groups), and they may exhibit behavioral disturbances during user testing due to issues such as sensory and lack of interests in social communication (Hourcade, 2017). Ethnographic work by Alper (2017) with parents and children with autism suggests that researchers are limited in their knowledge about "the experiences that disabled youth, their siblings, and their parents have with media and technology at home and as part of domestic activities" (p. 23). For example, nonverbal children with autism who rely on using iPads as alternative augmentative communication (AAC) systems are "drawing on a larger ecology of speech tools, including interactive games and apps" to develop "creative expressions of voice through other media" (p. 63). To our knowledge, no research has systematically investigated questions such as: Who provided these "speech tools" and what tools have they implemented? How were these tools used across different settings (e.g., home, school, clinics) and what are the benefits and challenges when using these apps? Are these tools being used as a medium for instructional work, behavioral reinforcement, and/or leisure play? These questions remain unaddressed and require researchers to investigate key stakeholders who participate in the design and use of these digital tools with children with disabilities. Additionally, prior work primarily focused on how researchers approach design and/or service delivery with children (and their parents) in settings such as home and schools. How children with disabilities interact with their clinical service providers, such as their SLPs, remains a gap in research.

Speech language pathologists and Their Work

Governed under American Speech-Language-Hearing Association (ASHA), pediatric speech language pathologists (SLPs) are clinical professionals who provide speech therapy services to these children

with communication impairments from birth to adulthood (ASHA, 2016). Speech therapy services can be provided at home and in both educational and medical settings such as a private clinic, or at care facilities (e.g., hospitals or daycare center). A report from ASHA (2017) indicates that more than 50% of SLPs – approximately 71,000 clinicians – were employed in educational settings in 2016, working with individuals from preschoolers to young adults. In the school setting, an SLP can work with students inside the classroom (referred to as "push-in") in an inclusive manner or outside the classroom in a speech therapy office (referred to as "pull-out"). An SLP may conduct speech therapy with an individual student or a group of students that can benefit from peer support and social communication with each other. This kind of service delivery provides opportunities to design for not only 1:1 interaction but also interaction across one clinician and multiple children with different impairments and therapy goals.

In recent years, there has been a rapid increase in SLPs' use of digital media (e.g., Youtube videos) and mobile technology (e.g., iPads) for therapy (Fernandes, 2011). It is estimated that more than 60% of SLPs in a U.S. state level survey reported using iPads in clinical practice (Edwards & Dukhovny, 2017), and during a therapy session, iPad-based therapy can occur up to 25% of the time along with a combination of physical and digital therapy materials (Cohen et al., 2017). Despite the increased use of digital technology at work, in literature across HCI, communication science and disorders (CSD), and media and disability studies, few researchers have examined how SLPs use these digital tools across different settings with their clients, and how children with disabilities interact with their clinician using digital media and technology during speech therapy.

Therapeutic Play and Meaningful Play

Prior to the age of mobile and video games, play-based assessment and intervention using toys and non-digital games (e.g., card games, board games) has been widely used during speech therapy (Linder, 1993; Bratton et al., 2005). Due to the nature of their disabilities, children with communication impairments often experience difficulties during symbolic, interactive, and social play with peers and adults very early in life and throughout their critical periods of speech and language development (Danger & Landreth, 2005). Many children with disabilities who are chronologically older may also demonstrate play skills at a younger developmental age. As a result, designing play in the clinical context also involves additional therapeutic planning to improve children's areas of deficits as a major outcome, rather than merely facilitating ludic activities of "playing" (Deterding et al., 2011). Although language and play are interconnected, SLPs pay more attention to the functionality of child-centered play as an effective strategy rather than critically analyzing whether the play leads to a meaningful interaction. To many clinicians, a higher-order goal may emphasize on "meaningful use of language" over "meaningful play experience". This notion of therapeutic play differs from perspectives on play from game designers, who seek to design play to first create meaningful experiences and then help players communicate an attitude towards their own course of actions (Salen & Zimmerman, 2004).

In the past few years, SLPs and clinical researchers have begun to explore opportunities to integrate playful activities such as games for speech therapy. Many have published case studies on how to use video game design principles and mobile games (e.g., casual games like *Angry Birds*) to improve therapy engagement while targeting both assessment and treatment goals (Folkins et al., 2016; Sweeney, 2017; Sweeney, 2014; Roehl, 2015). Constantinescu et al. (2017) suggest that by targeting the experience of game flow to "make deliberate practice more enjoyable and a habit," gamified health apps can

be designed to facilitate patient adherence to swallowing exercises. Barbour (2015) and Tye-Murray (2016) anticipate that the future of aural rehabilitation could be delivered via automated and customized hearing exercise games beyond audiology clinic visits. Yet, how to apply game design principles and game play strategies to improve clinical success for specific impairments remains largely incomprehensible to clinicians, researchers, and designers.

Research Rationale and Questions

The motivation for this study originated from the author's own experience using mobile apps on the iPad for therapy as a pediatric SLP, who found limited to no research evidence and resources to evaluate and commercialized apps. This paper describes the preliminary results from an initial interview study of a research project, which includes interviews and surveys with three key stakeholders: (1) SLPs who use iPad apps for therapy, (2) SLPs who have used and designed their own apps, and (3) app designers and developers who have no background in speech therapy. The goal of the initial interview is to explore diverse practices of mobile app design and use by SLPs and app designers and developers. For the purpose of this paper, we only describe interviews with SLPs who are either app users or app designers and users, since interviews with app designers and developers are still being conducted at this time. This paper addresses the following research questions:

- (1) What types of mobile apps do SLPs use with children during speech therapy, where do they find these apps, and why do they use these apps?
- (2) What are some needs and challenges that SLPs encounter when using apps with children with communication impairments?
- (3) What heuristics best support the user experience of these apps for SLPs and children with communication impairments?

Research Methods

Participants

Using a snowball sampling technique from the lead researcher's professional network, initial recruitment emails were sent to SLPs between December 2017 and June 2018. Each individual received a copy of the study information sheet and a UCI-approved IRB protocol. To date, a total of 37 SLPs participated in semi-structured interviews, including 23 SLPs who have only used apps for therapy and 14 SLPs who have used apps and also designed their own apps. Participating SLPs come from 18 states in the U.S. (except three SLPs from China, Malaysia, and Sweden), have between two and 36 years of clinical experience, and provide therapy in-person and via telepractice for diverse settings (e.g., private practice, public school, children's hospital, university clinic, home health) to children across different ages in school (e.g., preschool, elementary school, middle and high school, and young adults).

Interview Protocol & Data Analysis Procedures

Interview questions were constructed using two domains ("intervention characteristics" and "characteristics of individuals") from the consolidated framework for implementation science (CFIR), a theoretical framework used by researchers across a wide variety of study objectives and settings to evaluate the implementation of an intervention (Olswang & Prelock, 2015). This framework offers

opportunities to examine both characteristics of SLPs in terms of "personal attributes" and "individual stages of change" before and after iPad use, and the characteristics of iPad as an "intervention" method using these five specific domains for analysis: "sources, relative advantage, design quality and packaging, cost, and adaptability." All interviews were conducted via audio/video conference calls, and interview lasted one hour on average. The lead researcher audio-recorded, transcribed, and conducted preliminary data analysis of each interview and developed recurring themes within each individual interview and across interviewers based on specific stakeholder groups they belong to. Since data analysis is still in progress, for the purpose of this paper, we will discuss interviews from 23 SLPs (15 app users and 8 app designers).

Results & Interpretations

RQ1: What types of mobile apps do SLPs use with children during speech therapy, where do they find these apps, why and how do they use them?

To meet the learning needs of children with disabilities who have different levels of physical, cognitive, and linguistic abilities, all SLPs report they use a combination of traditional non-digital materials (e.g., worksheets, books, toys, board games) in conjunction with iPad apps. SLPs implement not only native apps (e.g., camera, voice memo, photos) but also a combination of children's educational apps, health and medical apps, apps for speech therapy, and casual games to capture and manage data, provide interactive instruction with multimodal and real time feedback, increase motivation and engagement, and facilitate carryover therapy exercises at home. When searching in the iOS store, besides using keywords that are related to target impairments or instructional content, SLPs also utilize parents and teacher referrals, in-person training and workshops, online search and educational blogs, and a variety of social media platforms (e.g., Facebook, Twitter, Instagram, Pinterest) to find apps.

Having the iPad as a clinical tool brings SLPs various affordances such as portability, social interactivity, context sensitivity, connectivity, and individuality (Klopfer & Squire, 2008), and also creates additional collaborative (Bardram & Houben, 2018) and motivational benefits (Zhang, 2008; Deterding, 2011). To some SLPs, the rich variety of mobile apps on the iOS store makes the iPad not only an instructional tool and a reinforcement tool for therapy, but also a medium to "create a culture of fun". For example, SLPs such as P19 love the ability to use a book creation app to work on social cognition and storytelling by making a book or journal with different ages of students. SLPs P4 & P30 shared ways of leveraging both the content and the context of the popular game *Angry Birds* for teaching articulation of speech sounds and functional language:

> I can infuse this Angry Birds game with one of these kiddos…on his articulation, the /r/ sound. I remember there was a RED bird and the RED bird was 'REALLY fast', and I would emphasize these sentences to this particular student. He would attempt to say these sentences back to me, while thinking about strategies of the /r/ sound that we did. And I was keeping data. And then once he was able to give me a certain amount of correct responses, I would say: 'Now let's play this app for like 2-minutes!' And while we play that app together…he was again verbalizing those same sentences that directly related to the articulation. So as he was swiping his finger, he was saying: 'Oh here I am. This is the RED bird.' And he would take his turn. So he was playing the game but he was still giving me

> data that I was collecting with regards to his articulation. And that was really a cool thing for me to see, how this tablet-based experience could exist in our therapy world in some capacity." (P4)

> I always recommend Angry Birds for language, but with support, with control, with guided access…So I always say 'pull, go, fly, pigs, oh my gosh' just to get verbalizations not letting them touch it until they say something…If you have Angry Birds on one device, and you have their AAC app opened, then you can do 'cool, fun, oh-no' and teach them how to do functional communication. So lots of great things. (P30)

Interestingly, although games can become a motivating tool for therapy, SLPs still create their own tangible materials (e.g., visuals aids based on games like *Angry Birds*). Students with disabilities often demand extra multimodal supports, therefore, it is common for SLPs to redesign and improvise materials as part of their daily practice, especially for students who are chronologically older but functioning at a younger age.

> People have designed really good self-regulation visuals that relate to Angry Birds…or just having them play hands-on games that are Angry Birds, like the ones with the real, physical catapults and stuff like that. Have a lot of self-regulation and executive function components to them, like they're supposed to look at this card and build that structure. (P19)

SLPs are also very skeptical about the utility of the applications and stress the value of implementing fundamental teaching techniques (e.g., modeling, prompting, scaffolding) when using apps and games. As P21 states: "the meaning comes from you (SLPs) showing your child the value of the tool…A lot of the value comes from guiding that whole experience." P28 also highlights the importance of determining the purpose of using these games: "how can we incorporate that game, make it fun for them (students), make it fun for us, and also work on their goals at the same time." These responses demonstrate that determining the meaning and values of technology use are intertwined with complex clinical decision making and consideration of how to create a meaningful therapy experience for their clients through using functional instructional and therapeutic tools.

RQ2: What are some needs and challenges that SLPs encounter when using these apps with children with communication impairments?

Due to limitations in resources in time and money and restrictions in clinical environments (e.g., privacy and security issues), most SLPs expect apps to be cost-effective, easy-to-use, and versatile, which lead them to use a range of free, commercially available game apps. Since children with communication impairments may have diverse abilities and user preferences, SLPs also found tensions between the interaction they provide as clinicians and the interactivity offered by apps. For example, there are many free games on the iOS app store, but most of them have distracting advertisements or background music. The visually appealing advertising leads to a particularly distractive gameplay experience for children with autism who seek visual stimulation, and the background music overwrites natural speech and language communication that can potentially occur between the child and the therapist. Several SLPs have voiced the need to minimize these types of distractions in order to offer more offline communication opportunities and better interaction, so

children can focus on the therapy activities with the clinician rather than becoming overly engaged using apps. As P28 described:

> Sometimes you might want to look at a fun game like Angry Birds or something to use in speech therapy. Because I know with that one, during the game there's music, the birds are making a sound…as a speech therapist…I'm going to totally turn the volume off on it so I'll show them like: 'hey, we're gonna work on our sounds today and every time you say your sound you get to shoot a bird into the house'…we can minimize that distraction. I'll show them what we're gonna do and then I'll put it face down and I'll say, okay let's practice our sound; say this word, say this sentence. And when they do I'll flip it up and then they can shoot a bird across and then we're putting it back down but again we also turn the sound off…I think there's definitely ways we can utilize a lot of the apps we're not using.

Besides reducing distractions, some SLPs want apps to be "open-ended" without "language built into them" (P21) so that they can model diverse language use during therapy practice. They also need games that are "slow enough to foster communication" but "fast-paced" to play through using "short turns with a very definite beginning and end" (P19) due to the fast-paced clinical environment. These conflicting design requirements suggest that when creating apps for speech therapy, design features that stimulate children for immersive and engaging interactions may need to be controlled to account for communication that happens offline, as well as "the nature of the relationship between play and real life" (Schüll, 2012, p. 190), which in this case, between playing the games and engaging in therapy exercises.

While creative in their use of apps and games, many SLPs struggle to find apps that are specially designed for specific functions (e.g., apps for speech and language assessment, apps for behavioral tracking), specific skill domains (e.g., voice, fluency, and social skills), and specific patterns of play (e.g., creative play and collaborative play, rather than cause-effect play). In our interview, P28 observed that when given the chance to choose either games on the digital iPad or traditional board games, students may also select non-digital play with other peers because "they are getting that social interaction, they're getting that feedback and engagement with a peer and they're just happy and excited." Contrary to how Schüll (2012) illustrated in her ethnography work with gambling addicts who "seek a zone of reliability, safety, and affective calm that removes them from the volatility they experience in their social, financial, and personal lives" (p. 208), when provided with alternative choices from their adult clinicians to play with their student peers, many children actively seek for play that involves social interaction and competition.

In addition to play, there is also an emerging need to tie speech therapy apps to academic curriculum (e.g., science and social studies). Previous research has shown that play activities in virtual worlds foster scientific habits of mind in massively multiplayer online games (Steinkuehler & Duncan, 2008), but research on technology-integrated science curriculums is lacking in the field of special education. For instance, during clinical practice, P19 frequently uses a game app that invites children to combine elements such as fire, air, earth, and water to create new things (e.g., mud and steam). P19 argues that this chemistry game not only allows children to learn about scientific process but also help clinicians to target multiple speech therapy goals, including complex sentence formulation and using language to make predictions and inferences.

> STEM is a big push, but SLPs see that as not related to that. And particularly with the systematic minds we serve in the autism spectrum disorder population who will probably go into science, I think it would be really great if we leveraged that more strongly. That seems like a gap that hasn't really been served of apps that strongly explore the language of these content areas. (P19)
>
> P23 also reported a client with autism who started as nonverbal at age three, learned to use verbal language through speech generating apps on the iPad, and later experienced a burst of language development. Although this client still receives speech therapy to learn about social skills (e.g., initiating a conversation), he has grown to become a high-functioning boy with autism who has mastered organic chemistry as a first grader. His favorite app is a chemistry app, which is being used to destress for social demands at school. His therapist is unable to classify whether this atypical behavior should be classified as play or a form of learning, as his age-equivalent peers would rather relax after school with entertainment apps, such as Youtube Kids. Nevertheless, these empirical accounts suggest that given the diversity in children with disabilities, integrating STEM-curriculum when designing speech therapy apps may not only foster better digital play and language stimulating environments, but also bring long-term impact in academics and career development for young children with communication impairments.

Additionally, interviews with clinicians also reveal that large quantities of data are being produced when SLPs are interacting with children using the digital technology, which provides both opportunities for research and concerns about privacy. When dealing with children's data, depending on the functionality of individual apps, privacy and security regulations (e.g., the Children's Online Privacy Protection Rule, the Health Insurance Portability and Accountability Privacy Rule) may bring multiple levels of constraints that SLPs and app developers should both be aware of. Although SLPs reported using a mixture of both traditional paper-based data collection and digital data collection in the app, multiple forms of digital media data have been generated. In addition to artifacts co-created by clinicians and their clients (e.g., using books to create a story together), many audios and videos can be captured for both educational and therapeutic purposes, but this valuable and child-sensitive information is often deleted or shared through workarounds.

RQ3: What heuristics best support the user experience of these apps for SLPs and children with communication impairments?

Although individual preferences and needs may differ, all SLPs also use specific app selection criteria such as educational relevance, cost, usability, aesthetics, accessibility, and functionality (e.g., customization, relevance to therapy, multilingual features, and data collection capacity). Interestingly, although the lead researcher did not probe questions for specific mobile use heuristics, participating SLPs provided use scenarios that closely overlapped with previous research on mobile games heuristics. In the next section, we illustrate how quotes from SLPs relate to the playability heuristics for mobile games by Korhonen & Koivisto (2006). Although these heuristics are initially proposed to target pre-production and production phases of games, SLPs' post-production evaluation of their apps indicates that these heuristics can be applied beyond the production phase, leading to future feature designs. The three heuristics are: usability heuristics, mobility heuristics, and gameplay heuristics.

Game Usability Heuristics

According to Korhonen & Koivisto (2006), mobile games are considered software products, therefore, the user interface should be "convenient, reliable, and usable" for players, while also creating an enjoyable and fun gaming experience. The game usability heuristics (Table 1) also resonate with SLPs' clinical needs and their client's cognitive and linguistic abilities. Children with disabilities not only enjoy the audio-visual representations (GU1) and visually pleasing interface designs (GU2), they also need consistency of navigation and controls (GU6, GU7, GU8), as well as feedback and scaffolding (GU9, GU12) to support their app use.

No.	Game Usability Heuristics	Participant Quotes
GU1	Audio-visual representation supports the game	"I just like that it's fully usable, the graphics are good, the sounds are not too annoying. Background music is bad, plus it interferes with language if we work on expressive language. It's okay to have sound but background music is annoying." (P33)
GU2	Screen layout is efficient and visually pleasing	"Proloquo had a lot of fringe stuff that makes it more appealing, if the layout is more appropriate for them." (P1) "I love the different variations of colors and the fact how colors can truly elicit different types of feelings in a person." (P4)
GU3	Device UI and game UI are used for their own purposes	"Still one of the top paid apps in sports is this one called Coaches' Eye." It's basically a video modeling app for sports, but it allows you to visually annotate what's going on in the screen...annotating on screen could be a way to give someone feedback on what they did and what their communication looked like." (P19) "It's really easy to see when their little fingers are going to the exit button. I forget what it's called. There's a way they lock a certain app so they can't get out it." (P21)
GU4	Indicators are visible	"Identify the picture that demonstrates this preposition, identify the preposition in the sentence. Drag and drop the item to the correct location, identify the preposition, if the preposition indicates location time or movement, it's just given us four different activities to start that goal with that student, which is really awesome." (P28)
GU5	The player understands the terminology	"I download them and just mess with them a lot and I'll play with them to see if its user friendly, if there's any glitches." (P28)

GU6	Navigation is consistent, logical, and minimalist	"I try apps that I downloaded and if I can't figure out within about three minutes, I delete it." (P3)
GU7	Control keys are consistent and follow standard conventions	"LAMP, it works on motor planning principles, where the same word is in the same spot, and you can't and you really shouldn't modify anything." (P1)
GU8	Game controls convenient/flexible	"The games, I'd say, are more flexible in their use." (P1)
GU9	The game gives feedback on the player's actions	"And the iPad is helpful because apps are useful with cause and effect for everything, and visuals assist with everything." (P2)
GU10	The player cannot make irreversible errors	"We like things to be relatively errorless." (P19)
GU11	The player does not have to memorize things unnecessarily	"I like apps that allow some kind of structuring, like organizational language. So, not necessarily games, but apps that can foster oral language and writing...within spaces that help students see the connection between ideas. Lots of if-then sort of thinking." (P19)
GU12	The game contains help	"It's Restaurant Asia, and they can look at the cues and make the food, and then they can decide whether they would use it or not." (P2) "I think if people have more of a stronger rationale in how the app is helping them go through the steps of something that the children are internalizing, it's been more successful and more of an interest." (P19)

Table 1: Heuristics for Evaluating Game Usability

Mobility Heuristics

Mobility heuristics (Table 2) offers multiple contributions to the fast-paced and dynamic nature of speech therapy work. As we described in the background section, during group therapy, there are multiple students in a therapy session requiring individualistic attention and instructional support from a single SLP. This requires the SLP to be able to not only shift between students but also work around interruptions. Mobile devices such as the iPad offer portability, and apps on the iPad further accommodate the complex temporal (MO1), environmental (MO2), and contextual (MO3) needs during a therapy session.

No.	Mobility Heuristics	Participant Quotes
MO1	The game and play sessions can be started quickly	"That's me really evaluating: can this person do the thing that I want them to do in a quick manner. Because the quicker they can do it, the faster they can do the speech therapy and involve that app in the therapy." (P4)
MO2	The game accommodates with the surroundings	"I wanna create apps where my students can physically see their own backyard in the app. I wanna create apps that allow them to be able to take videos of themselves and in the process of them taking a video or taking a photo of themselves, we turn that into the digital therapy material." (P4)
MO3	Interruptions are handled reasonably	"That's a good thing about Subway Surfer and other games like that...you can pause it and when the student hit 'unpause', it gives them a 3-second countdown so it's not immediate…gives them a chance to get back into it." (P28) "You also have two or three students so it could be something as simple as you're giving them ten seconds like – how many coins can you get right now? And then you pause it and you're asking the group another question and that kid answers and you're like okay, ten seconds. How many coins can you get?" (P28)

Table 2: Heuristics for Evaluating Mobility

Gameplay Heuristics

Another unique affordance of game-specific apps is that SLPs also found that when giving children control of play (GP4) to work towards their own game play goals (GP1), it creates a better therapy environment where children are also intrinsically motivated to learn and work towards clinicians' therapy goals. It is worthy to note that clinicians are trained to provide engaging therapy experiences (GP6), but many clinical activities they implement may not have the sophisticated storyline or narrative grounding that games can offer (GP7). Due to the needs to balance gameplay and therapy experience, many clinicians not only want games to offer a reasonable amount of choices but also offer a slower pace so that they can also communicate with their clients during play (GP5). Furthermore, after extended therapy, traditional therapy materials and activities may lose novelty (GP8) for children with diverse play preferences and interests (GP10). However, with games, SLPs can leverage the game flow (GP11) to maintain continuity of activities, the visualized progress (GP2) for additional instructional support, and meaningful rewards (3) for motivation. Built-in creative play in some high-quality children's apps can further foster creative expressions (GP9) among these children.

No.	Gameplay Heuristics	Participant Quotes
GP1	The game provides clear goals or supports player-created goals	"But that definitely sells an app if the kid really loves it and it works towards their goals." (P1) "You can use them in other areas for language, so it has more purposes than just articulation, so it has more than one purpose." (P2)
GP2	The player sees the progress in the game and can compare the results	"But the other aspect of technology, speech and language pathology, and visual support, is just that we can make abstract things visual through technology for the kids. Whether that can be an engagingly typed agenda for the session, or a concept map, or vocabulary pictures in an app that lets us quickly bring up those types of visual supports.A place you can display ideas to scaffold understanding and scaffold kids talking about the idea." (P19) "When I'm looking at applications I'm trying to find one, which ones that are gonna help us target their goal, target students' progress." (P28)
GP3	The players are rewarded and rewards are meaningful	"I can just press it on that tablet...the kids I work with are just so excited about that routine that goes with it, and then they get to trace that letter on the tablet as they practice the sound." (P1)
GP4	The player is in control	"I'm letting you hold this to give you some control right now, but we're actually doing the task that I want to do." (P1) "Here again, touching musical instruments, it makes sounds, which I know that I determine the sounds…It just gives the students control." (P18)
GP5	Challenge, strategy, and pace are in balance	"Having too many choices on the screen would really distract the students...The lower the amount of options on there, the simpler it is for them to use it." (P18) "I think it's important for games to have a pace that allows for communication to take place outside the screen... I don't necessarily think that everything we do has to be errorless, but if it's a game, just pace is important and it being slow enough to foster communication." (P19)
GP6	The first-time experience is encouraging	"Stop, Breathe, & Think Kids, there's a kid version, and it frames it in terms of missions. So it gamifies it a little bit for kids and then it shows a video there, so they are mindfulness-based video resources that encourage practice of a particular skill." (P19)
GP7	The game story supports the gameplay and is meaningful	"Peekaboo barn, which once again can be more like I want you to maybe imitate the sound that the animal's making. Can you guess what animal it is?" (P1) "I feel like it's more of a productive type of problem solving. Something that could happen in real life. Like, don't eat raw chicken; you'll probably get food poisoning. That's why the character in the game didn't want to eat it because he was probably gonna get sick. It just lets us talk about more real-life scenarios, versus these other games about throwing birds at a house." (P28)
GP8	There are no repetitive or boring tasks	"Because I hate when I have sessions where in the middle of it, a student's like: 'Are we done yet? Are we almost done?' That just gives me a note like, OK, this one was a little sluggish. This one just didn't catch their attention. What can I do next time? Maybe I can incorporate an iPad game to make it more fun." (P28) "I have children that get tired of the toys that I have in my room, or maybe I want to find a new way to use it. With the iPad I can just download a new app." (P21)
GP9	The players can express themselves	"You hear the /r/ sound in that sentence, the app asks you to do that, so it's the clinician's role to maybe ask the child to say that sentence. And then, you would allow that child to act out that sentence." (P4) "They get really imaginative with it, and like 'oh I need this for dinner tonight, I need the chicken, and oh I'm gonna make fish sticks,' and they're just creating this dialogue and it's really cool to see. It's really interesting." (P28)
GP10	The game supports different playing styles	"I love when an app is designed to be used together with multiple people and allows for that so that it can easily be passed from person to person, and they could collaborate and work together on it." (P19) "Kids pick the items they're gonna sell and then someone is the cashier and then someone is buying stuff." (P28)
GP11	The game does not stagnate	"Sometimes the students can't do something until they do something else so it kind of pushes them to problem solve...There's one called Toca-Boo where the kid puts on a sheet and he scares his family. The kids love it when he scares them and they run away, but the only way they'll run away is if he hides somewhere in the room first." (P28)
GP12	The game is consistent	"So if it's working, I feel like…I consistently do that app with the child, if I see steady progress, even if it's just two, three, five percentage points from week to week or month to month." (P3)
GP 13	The game uses orthogonal unit differentiation	"I often am drawing more from content areas, and seeing what kids are doing in science and social studies, and what are the linguistic elements and underpinnings of those units that they seem to not get or not really be able to use. I think there is a big tie-in with the disciplinary literacy...correlates between language and disciplinary literacy, like the fact that science has lots of procedures, has lots of nominalization of turning verbs into nouns." (P19)
GP 14	The player does not lose any hard-won possessions	"For the little ones it has to be a more open-ended game. No competition." (P21)

Table 3: Heuristics for Evaluating Gameplay

Discussion

The increased adoption of iPad-based games and apps during speech therapy suggest that speech

language pathology, as a profession, has begun to leverage the multifaceted affordance of mobile technology, and designers and researchers should recognize the needs for both of SLPs and children with disabilities. When children with disabilities receive speech therapy services, they engage in therapeutic learning of various communication-related skills using a range of applications under the guidance of their therapists. Although this collaboration is initially manifested through the form of therapy work that involves instructional strategies and interaction – teaching and learning, unpacking the play activities during this process can further help game designers and researchers to understand the discourse of meaningful play between clinicians and their clients. These can be achieved through building a shared understanding of play and collaborative research agenda. First, because of the complex interplay between language and play that happens offline, both clinicians and mobile game designers need to first recognize how functional communication and interaction may blossom during various forms of play. Since "the goal of successful game design is the creation of meaningful play" (Salen & Zimmerman, 2004), reconceptualizing the definition of meaningful play with a focus on evaluating different types of play in the context of speech therapy may shed light on future research in game design for children with disabilities. Second, researchers need to realize that SLPs may be experts in creating non-digital play experiences during an era where play-based therapy was delivered via toys or card and board games; app designers and developers may be skilled at creating innovative interfaces and interaction. Both groups need to establish a shared epistemology using design principles from multiple disciplines including instructional design, game design, and mobile interaction design. Third, there is a high value in involving SLPs in the early phases of design and research, as SLPs engage with children with special needs on a daily basis and can become resourceful informants as care professionals who support children's learning. When collaborating with SLPs, game designers should also find a fine balance between protecting children's right to play knowing that SLPs may have different values when integrating play during instruction and therapy.

One of the biggest challenges in creating mobile games and apps for speech therapy is designing for two users, the therapist and the child, who have different goals. By positioning children at the center of design with additional considerations to integrate SLPs' goal and workflow, mobile apps have the possibility to become a powerful educational and therapeutic tool that meet multiple purposes for instruction, reinforcement, and leisure play. Interviews with SLPs indicate a gap in the current market that lacks not only educational and therapeutic apps for children with communication impairments but also a shared knowledge of how to design for collaborative play-based therapy between SLPs and their clients. Additionally, during this interaction between clinicians and children, they create rich data that allows opportunities for in-depth qualitative and quantitative analysis (Chi, 1997) to monitor learning and therapy progress. Gameplay data also offers a context for future researchers to apply existing advancement in game analytics and building frameworks for recommending educational content. Leveraging potential advances in game research, it is possible that in the future, therapists can offer "objective measurement of user experience" based on their clients' demographics, personality, and preferences of play during therapy (Yee et al., 2011; Yee at al., 2012).

Additionally, interview results indicate additional opportunities to support advanced pedagogy skills among SLPs by teaching them principles of instructional and game design to create a student-centered experience using technology. Many existing educational apps in science and social studies can also foster more opportunities to connect communication to academic learning. Both SLPs and app designers and developers may have neglected the fact that language is closely connected to

literacy skills and scientific knowledge. Utilizing SLPs clinical background, designers and researchers in educational technology may consider building additional support for functional communication and language learning to take place in games for science and social studies. Although individual SLPs have their own knowledge, beliefs, and practices using apps for speech therapy, they do not receive any professional training to systematically evaluate or critique iPad apps for therapy. SLPs were able to report observations of factors that link to increased engagement and motivation during app use, but many of them could not articulate what objective measures they used for engagement and motivation, nor to elaborate on research efficacy of app use in meeting speech therapy goals. This is consistent with ethnographic work from Alper (2014), who reported that "professionals who work in educational and therapeutic contexts with youth with disabilities rarely have a background in children's media use, are frequently ignorant about new media, and are in need of professional development…to support their own understanding of digital media and integrating technology into curriculum" (p. 14). This finding indicates another gap in knowledge and training for new media and technology among SLPs who use mobile technology to work with children with disabilities. With ongoing training and education from game designers and researchers on how to design meaningful play experience, SLPs can further educate and support meaningful technology use for other stakeholders (e.g., parents and teachers) for home and school environments.

Conclusion

This is the first known interview study to investigate pediatric SLPs who use and design commercial iPad-based apps for children with disabilities. By interviewing SLPs about mobile app use, evaluation, and design recommendations from their collective clinical experiences with children with disabilities, this paper investigate the deeper value of how and why mobile apps are integrated in the modern clinical practice a variety of apps for different purposes, including but not limited to instructional, assistive, and recreational. Based on descriptions of SLPs' current needs and challenges designing and using iPad-based apps, this paper brings multiple contributions: (1) helping researchers understand how SLPs' app use can foster meaningful play and communication among children who have impairments in these areas, (2) utilizing existing mobile game heuristics as guidelines to create mobile apps for children and clinicians in the context of speech therapy, (3) offering implications to design effective apps to facilitate these children's communication and interaction, and (4) providing direction for future research to educate the general public about the value of play and meaningful use of games, especially for children with disabilities.

Due to socioeconomic, technical, cultural-linguistic, and ethical constraints, there is a gap of knowledge across clinical and technical communities about best practices to design mobile games and apps that offer not only educational and therapeutic curriculum-based learning content but also intrinsic motivation for children to stay engaged for therapy. Interviews from SLPs demonstrate that mobile game heuristics may offer guidelines for designing mobile apps for speech therapy, however, these apps should be co-designed with domain experts such as SLPs to ensure educational and therapeutic values. Furthermore, mobile games, as a form of interactive medium, have gained appeal among children with communication impairments as well as SLPs who work with them, due to its multimodal presentation of instructional and learning content, and stimulation for complex situations that foster communicative opportunities to use oral communication in this particular clinical environment. Ongoing research should continue to investigate implications of using these mobile game heuristics to support the collaborative work between SLPs and children. This design

approach not only can help designers and researchers reveal additional affordances for mobile technology, but also educate parents and teachers to understand the benefits of mobile technology and offer design knowledge that can shape the future human-technology frontier for special education and health. Our study also calls for attention to this marginalized group of children and clinicians who lack of high quality apps at a global scale, and additional research is crucial to support the design, development, and deployment of accessible mobile applications for an international audience who lack robust speech therapy resources.

Ethical issues

Although all participating SLPs report using iPad for clinical practice, individual SLPs may have different years of clinical experience and levels of technology implementation. It is important to acknowledge that the author intends to report research outcomes to reflect the needs of these individuals, rather than to critique their clinical practices. Due to the clinical and technical challenges of directly including children as part of the interview study, this study only reflected interviews with SLPs, but it is also important to note the lack of values and voices from children. Researchers should also consider including children who have received speech therapy services, as many students may still receive speech therapy services and are capable of becoming informants for future research. Future research also may consider including multiple stakeholders such as parents and teachers to across multiple communities.

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