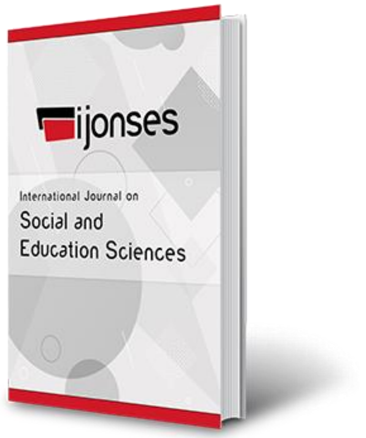

www.ijonses.net

Using Computer Applications in Teaching Play Skills to Children with Autism Spectrum Disorder

Jill Boswell
Southeast Missouri State University, USA

Corrina Carotti-Snigg
Elevate Behavior Solutions, USA

William B. Root
Southeast Missouri State University, USA

Eric J. Billington
Southeast Missouri State University, USA

To cite this article:

Boswell, J., Carotti-Snigg, C., Root, W. B., & Billington, E. J. (2023). Using computer applications in teaching play skills to children with autism spectrum disorder. *International Journal on Social and Education Sciences (IJonSES), 5*(1), 1-18. https://doi.org/10.46328/ijonses.414

International Journal on Social and Education Sciences
2023, Vol. 5, No. 1, 1-18 https://doi.org/10.46328/ijonses.414

Using Computer Applications in Teaching Play Skills to Children with Autism Spectrum Disorder

Jill Boswell, Corrina Carotti-Snigg, William B. Root, Eric J. Billington

Article Info

Article History

Received:
01 June 2022
Accepted:
15 December 2022

Keywords

Play interventions
Autism
Functional play
Apps
Technology

Abstract

Play is an essential skill for children in early intervention settings and contributes to social and emotional development. Children with autism spectrum disorder (ASD) often show significant delays in action-on-object play skills, vocalizations during play, and novel responding. By assessing and targeting play, children with autism can acquire play skills which may increase the likelihood of inclusion in a classroom setting and provide increased opportunities for peer and adult interaction. The current study evaluated the effects of apps as a video model to increase the duration of play, independent and novel action-on-object play, and independent and novel vocalizations during play. Current assessment and intervention strategies, as well as the need for further research making use of current technology and apps to increase play skills for school-age children with autism are discussed.

Introduction

Play is a universal human experience and provides the opportunity for children to practice communication, social interaction, emotional regulation, and process sensory input (Lang et al., 2009). Play develops in stages, beginning with solitary play, parallel play, and cooperative play (Hampshire & Hourcade, 2014). As play skills develop, sequences emerge. Children begin involving peers in their play and begin to assign attributes to toys and imagine uses for objects other than those intended, like using a block to represent a car or a stick as a magic wand. Children with ASD often show delays in the development of play behaviors (Kasari et al., 2013), often engage in less play (Stahmer et al., 2006), and may not naturally develop symbolic and imaginative play without direct training (Kasari et al., 2013). Targeting play skills in early intervention has been shown to increase the likelihood of a child being placed in an inclusive classroom when they begin school (Lifter et al., 2011).

Teaching children to engage with common classroom materials leads to increased independence and increased opportunities for peer interaction and should be included in early intervention programming. Children who do not play or who play differently may be stigmatized. For example, if a child cannot imagine that a banana is anything other than a banana, they may struggle to understand a peer using a banana to represent a telephone (Brown & Murray, 2001). Research has highlighted correlations between play and gains in expressive language, social skills, emotional regulation, reading abilities, sensory processing, and the reduction of stereotypical behavior (Lang et al., 2009; Lifter et al., 2011). As stated in Stanley and Konstantareas (2007), Stahmer (1995) found that teaching pretend play led to an increase in social interaction, even when social interaction was not directly targeted. Research on teaching play to children with ASD has illustrated the importance of targeting this skill, and diagnostic tools for ASD screen for deficits in play skills (Lang et al., 2009).

Measuring and assessing a child's repertoire of play skills proves difficult due to variability in defining play (Lifter et al., 2011). A child can play with a caregiver, alone, or with a peer. Play may be functional (using objects in their intended manner) or involve imagination. Play can be loud and social, with several children chasing one another on a playground, or quiet and solitary, with a single child sitting and rocking a baby doll to sleep. Play may have structure and rules, such as in a board game, or be entirely free form, with children creating a scenario and changing the structure as it evolves (Eberle, 2014). As cited in Terpstra and colleagues (2002), Wolfberg (1995) developed a guide for observing play behaviors that evaluates the symbolic aspects of play across four categories: no interaction with the material, manipulation of materials, functional manipulation of materials, and symbolic use of materials. The social aspect of play behaviors identifies if the child plays alone, plays while oriented towards another child, plays next to another child or engages with other children during play (Terpstra at al., 2002).

Several direct assessments identify gaps in play behaviors. For example, the Symbolic Play Test (SPT) developed by Lowe and Costello (1976), is a measure to assess symbolic functioning in children between 12 and 36 months (as cited in Gould, 1986). Children received four sets of toys and assessors observe interactions with the objects according to a standardized checklist (Stanley & Konstantareas, 2007). Similarly, Mundy and colleagues (1996) developed the Early Social-Communication Scales (ESCS), which is an assessment that evaluates joint attention skills. The child has access to the toys, and bids for joint attention or responses to bids for joint attention from the tester are measured (Kasari et al., 2006). Another assessment, The VB-MAPP Milestones Assessment, includes sections to assess independent play skills, such as object manipulation, variety, generalization, symbolic play, and pretend play. This assessment also identifies gaps in social play behaviors, including observing other children, parallel play, following/imitating peer behavior, initiating physical interaction, manding to and responding to mands from peers, cooperation, and engaging in pretend play. Other commonly used assessments utilize videotaped sessions to evaluate whether a child engages in sensory-motor play, functional play as either emerging or established, or pretend play as either emerging or established (Brown & Murray, 2001). Composite scores from play assessments compared with developmental assessments reveal a correlation between the progression of developmental and play skills. Assessing the child's current level is crucial in selecting attainable therapy goals (Pierucci et al., 2015).

Interventions targeting play typically focus on teaching one particular skill, whether it be increasing joint attention, teaching functional play, or increased engagement in play with pretense. Barton and Wolery (2008) created a taxonomy of terms that described the various target behaviors of play interventions and their definitions. The functional play category addressed object manipulation, and research often targeted feeding and grooming. Several studies that target object substitution included using an object to represent another object, such as a block in place of a car, and imagining absent objects, such as eating invisible food. Studies included in this taxonomy also targeted assigning absent attributes to objects, such as taking on the role of a doctor, mother, or pretending a toy stove is hot. Within this taxonomy, Barton and Wolery (2008) analyzed 29 studies and found all contained modeling or video modeling and prompt hierarchies. For example, Kasari and colleagues (2006) targeted both joint attention and symbolic play using a prompt hierarchy, which consisted of a verbal prompt, then a model, then a physical prompt. Three groups participated in the intervention, with one group targeting joint attention, one group targeting symbolic play, and a control group received no intervention. The intervention consisted of a combination of intensive and milieu teaching. Both experimental groups demonstrated significant gains over the control group and responding generalized from the teaching environment to play with caregivers when given the same assessments post-intervention. Interestingly, participants targeted for joint attention also demonstrated gains in functional play with caregivers.

Similar studies have used therapists as models to increase play skills in children with ASD. For example, Pivotal Response Training involves using preferred toys and allowing the child to choose which item he or she will engage with during play, while the therapist models and positively reinforces appropriate interaction with the toy or adult to increase motivation to play (Stahmer et al., 2006). Stahmer (1995) incorporated pivotal response training and effectively increased symbolic and complex play in six children with ASD. However, in a social validity measure conducted in 2006, naïve judges scored the six children who had received pivotal response training lower than typically developing peers, suggesting that while the quantity of symbolic play increased, the quality still differed. The authors recommended that future research evaluate methods to increase creativity and pleasure in play (Stahmer et al., 2006).

Jahr and Eldevick (2007) conducted a study that examined the effects of an intervention targeting interactive play with peers. Three children, ranging from four to seven years old, received instruction on cooperative play skills using modeling, imitation, and verbal description. Before beginning the study, all three participants engaged in one action on an object but did not combine objects or create sequences with the objects. Two adults modeled a play script and then prompted the child to complete the script. During cooperative play, the child was seated with a peer who initiated play. After targeting cooperative play, researchers conducted independent play probes and compared them to baseline. Though not directly targeted, independent play increased in the number and variety of actions, suggesting elaborated sequences in solitary play may increase following social reinforcement.

Another common intervention to target play skills is the use of video modeling. Hine and Wolery (2006) conducted a study using point-of-view video modeling to teach gardening and cooking play sequences to two children with autism. The angle of the camera filmed toys from the child's point-of-view. Both children showed increased engagement in the modeled behaviors. Both generalized to novel toy materials, but not to novel environments. Paterson and Arco (2007) used video modeling to teach two children with ASD independent toy play and the assessed generalization effects on novel toy play. While video modeling produced an increase in both participant's independent toy play, generalization effects only occurred during conditions with related toys observed in the video model.

MacDonald and Sacramone (2009) used video modeling to teach reciprocal pretend play with peers for two children with ASD. Both children quickly acquired scripted and unscripted vocalizations that maintained during one month follow-up probes. A limitation of this study was the lack of extended novel play in both participants. The authors comment on video-modeling as an explicit prompt that provides the learner to observe a model and then imitate that model, with the imitative response relying on a history of reinforcement for imitation. Boudreau and D'Entremont (2010) conducted a study using video modeling with two four-year-old boys diagnosed with ASD. Participants viewed videos related to two playsets and rapidly acquired scripted verbal prompts and modeled actions that generalized to novel settings and material. However, increases in novel vocalizations or unmodeled actions did not increase. While most studies targeting play involve modeling, there is concern that modeling only teaches imitative behavior, and the child is not engaging in spontaneous behavior, one of the qualifiers for play (Lang et al., 2009).

Today, children are becoming technology-literate at very young ages (More, 2008; Withey, 2017). iPads and other mobile devices are readily available and offer immense versatility (Withey, 2017). Given the prevalence of video games in our society, it would be beneficial for behavior analysts to consider using games in behavior change programming (Morford et al,, 2014). For example, Murdock and colleagues (2013) conducted a study using a play story presented on an iPad to increase play skills in four children with ASD. The format resembled a storybook, where participants viewed six photo slides with a storyline. Every time the participant touched the iPad screen, an accompanying audio clip paired the photos with appropriate scripted verbals. The study aimed to increase play dialogue that would generalize in follow-up, decrease vocal stereotypes (repetitive phrases), and demonstrate an increase in novel and scripted vocalizations. Unlike video modeling, the pictures were static and did not demonstrate the manipulation of the toys. After listening to the story, participants completed the script with a play partner. Three of the four participants showed an increase in utterances of play dialogue, including non-scripted/novel utterances.

Using apps as teaching tools may increase motivation, attention, and cost-effectiveness, requiring fewer staff resources (Murdock et al., 2013). iPads and apps are often interactive, with the game modeling and prompting an action that the player must perform to move on in the sequence of play. Unlike video modeling, where the learner passively observes the video and then demonstrates the skill, apps embedded an active learning component into the model. In other words, the learner touches components in the app and is reinforced by changes in the game, which may aid in programming for generalization to novel play, verbalizations, and environment. Most children already have experience with apps as reinforcers, whereas a video model may be novel. Even if a gaming app is new, the child's history of reinforcement with gameplay may make the app more reinforcing than a video of a therapist manipulating a toy.

In their literature review, Barton and Wolery (2008) asked if children playing interactive computer games containing pretend play themes would be more likely to engage in pretend play with toys. The current study aims to investigate that experimental question further by using apps to increase prompted, independent, and novel action-on-object play and vocalizations. Therefore, the purpose of the current study was to investigate the effectiveness of gaming as a model to increase and generalize action-on-object play and verbal behavior during play, using games which focus on typical preschools play themes such as cooking, doctoring, gardening, and housekeeping, as scripts which will transfer from electronic gameplay to toy sets in the natural environment.

Method

Participants

Two children with autism spectrum disorder (ASD) participated in the current study. Elsa was a four-year-old female, and received 16 hours of Applied Behavior Analysis (ABA) services a week. She completed the 2nd edition of The VB-MAPP (Sundberg, 2014), with a score of 125, placing her in Level Three. Elsa communicated vocally and has an established repertoire of mands, tacts, imitation, and listener skills. She showed deficits in The VB-MAPP Play domain, including engagement in pretend play with peers, playing with items creatively, and engaging in play without adult prompts or reinforcement. Bill was a four-year-old male and received 40 hours of ABA services a week and an hour of speech therapy each week. He completed The VB-MAPP, with a score of 119, placing him in Level Three. Bill communicated vocally and has an established repertoire of mand, tact, and listener skills. He showed play deficits in social play with peers and engaging in pretend/imaginary play.

Setting and Materials

All sessions were each 10 minutes in length and conducted between 12 pm and 3 pm. When multiple sessions were conducted in a single day, they were separated by, at minimum, an hour of work and playtime. All sessions were conducted in a small room, with a small white table, two chairs, and two plastic drawers. The participant engaged with the toy sets on the floor, with only the researchers present and a small window that viewed the breakroom to limit distractions. A total of three apps were used in the current study, which were accessible using Amazon Freetime Unlimited on a Kindle Fire HD (2019). One of the apps was "Doc McStuffins: Baby Nursery," which focused on taking care of a baby doll including bathing, feeding, and putting the baby to bed. Another app was "Daniel Tiger: At Home with Daniel" which involved putting Daniel to bed, brushing his teeth, and playing doctor. The third app "Max & Ruby's Bunny Bake Off" presented cooking scenarios including making lemonade, mud pies, and flan. Play scripts were adapted from each game, and toy sets were assembled to replicate actions presented in games (see Table 1).

Variables, Response Measurement, and Reliability

The primary dependent variable used in the current study was the total duration of play, defined as any instance the participant picked up or manipulated an item in the toy set. A timer started the instant the participant engaged with the item, and the timer stopped when the participant set down the item or had not manipulated it for 20 s. The secondary dependent variable was the frequency of independent action-on-object play, defined as any action that was identical or similar to actions presented in the corresponding app. For example, in the "Doc McStuffins" app, the participant was required to wash the baby's face by selecting a towel and wiping the baby's face back and forth until it was clean. If the participant picked up a towel and wiped the baby's face from the corresponding toy set, this was scored as an occurrence. If the participant picked up a towel from the toy set and began to wipe his or her own face, this would not have been counted as an occurrence. Examples of action-on-objects presented in each of the apps is shown in Table 1. All occurrences of independent action-on-object play were scored only the first time they occurred. For example, if the participant picked up the towel and wiped the baby's face, it would be recorded as one occurrence, regardless of how many times the participant wiped the baby's face.

Table 1
Apps used in the current study, with the corresponding object, action, and vocalization presented in gameplay.

App	Object	Action	Verbalization
Doc McStuffins: Baby Nursery	Cloth Diaper	Change baby's diaper	"Time for a new diaper."
	Outfit	Put baby in outfit	N/A
	Bath Tub	Put baby in bathtub	"Time for a bath."
	Shampoo	Use toy shampoo	N/A
	Towel	Dry off baby doll	That's a lot of water."
	Bear	Tickly the baby	"Play time!"
	Rattle	Shake rattle	N/A
	Bed	Put baby in bed	"Nap time."
	Baby doll	Rock the baby	"Rocking helps baby sleep."
	Light Switch	Turn off the light	"Good night."
	Bib	Put on bib	"Someone is hungry."
	Spoon	Spoon to baby's mouth	"Nom nom nom."
	Wipe	Wipe baby's mouth	"Someone made a mess."
Daniel Tiger: At Home with Daniel	Drums	Bang on the drums	"Music can show I feel"
	Maracas	Shake maracas	N/A
	Blanket	Cover up the tiger doll	"Oh, my blanket"
	Light Switch	Turn off the light	"Goodnight, Tigey"
	Book	Turn pages of book	Pretend to read a story.
	Otoscope	Put otoscope to tiger's ear	"Let's make believe I'm a doctor."
	Stethoscope	Put the stethoscope on the tiger.	
	Stickers		"That tickles"
	Flashlight	Shine light in tiger's eyes	"That sounds good and strong."
	Toy Syringe	Give tiger a shot	"Grrrrific."
			"Follow the light with your eyes."
Max & Ruby's Bunny Bake Off	Measuring cup	Tip cup over bowl	"Let's add some cream"
	Box	Put measuring cup in box	"We need one cup of sugar."
	Toy bottle	Tip bottle over bowl	"Let's add a bit of vegetable oil."
	Spoon	Stir spoon in bowl	"Now let's give it a stir."
	Toy oven	Put bowl in the oven	"Into the oven it goes."
	Pitcher	Tip cup over pitcher	"Let's make some lemonade."
	Spoon	Stir spoon in pitcher	"Give it a quick stir."
	Wooden knife	Cut wood lemon in half	"We need some lemon juice."
	Wooden knife	Cut wood strawberry in half	"Add some freshly cut strawberries."
	Spoon	Stir spoon in pitcher	"Let's give it another stir."
	Spoon	Put spoon in pitcher	"Now scoop it up so it's ready to serve.

The third dependent variable was prompted action-on-object play, defined as any instance the participant picked up or manipulated an item in the toy set following a verbal prompt. For example, if the participant was repeating the same action-on-object play, the researcher would deliver the verbal prompt, "You could try this," and directly state an action-on-object response that corresponded with the those presented in the app. The fourth dependent variable was novel action-on-object play, defined as any action that was contextual to the object and situation, but not presented during the app. For example, if the participant held the baby doll up and simulated walking, which was not a feature of the app, this was scored as an occurrence. If the participant put the baby in time-out, which was not a feature of the app and was not contextual to the object and situation, this would not have been scored as an occurrence. Similar to independent action-on-object play, only the first occurrence was scored. The fifth dependent variable was the frequency of independent vocalizations, defined as any statement that was identical or similar to vocalizations presented in the corresponding app (see Table 1).

Vocalizations that approximated those presented in the app were scored as independent vocalizations. For example, if the participant vocalized, "Night-night," instead of the scripted vocalization "Good night," it was scored as an independent vocalization. Similar to independent action-on-objects, all independent vocalizations were scored only the first time they occurred. If the vocalization was hard to understand or babble, this was not scored as an occurrence.

The sixth dependent variable was the frequency of prompted vocalizations, defined as any participant vocalization that was identical or similar to statements presented in the corresponding app following a verbal prompt. For example, if the participant was repeating the same vocalizations, the researcher would deliver an echoic prompt to state a vocalization that corresponded with those presented in the app. The final dependent variable was the frequency of novel verbalizations, defined as any statement that was contextual to the object and situation, but not presented during the app. For example, if a participant sang a lullaby while putting the baby doll to bed, this was scored as an occurrence. If the participant stated, "She goes to the store," in reference to the baby doll and unrelated to the current context, this was not scored as an occurrence. Similar to independent vocalizations, only the first occurrence was recorded.

An independent observer collected total duration interobserver agreement (IOA) for the duration of play, with 99% agreement. Mean-count-per-interval IOA was calculated for independent action-on-object play and novel action-on-object play, with 86% agreement. Mean-count-per-interval IOA was calculated for independent vocalization and novel vocalizations, with 90% agreement.

Design

A multiple-baseline across participants design was used. The intervention was applied to the second participant when the first had received four intervention sessions, and data demonstrated an increasing trend in action-on-object play and vocalizations in comparison to baseline. Generalization probes were conducted when both participants were consistently performing independent action-on-object play and independent vocalizations at levels significantly higher than baseline.

Procedure

Baseline

Each participant was first instructed to select an app from an array of three apps in the menu function of the tablet. Following participant selection, he or she was provided with five minutes to interact with the gameplay within the app. During this time, dependent on which app the participant selected, the researcher made the corresponding toy set available for the participant to engage in when the five minutes had elapsed, or the participant had stopped engaging in the app. The researcher then provided the verbal prompt, “Time to play.” The researcher interacted minimally with the participant, providing only physical assistance with toy items if requested. No feedback or prompting to manipulate items was provided. If the participant did not engage in an action-on-object play or vocalization for 10 s, the researcher asked, “Are you all done?” If the participant began playing with the toy set, the session continued. If the participant vocalized that he or she was done, the session was terminated.

Teaching

At the onset of each session, participants were instructed to select an app, engage in the gameplay for five minutes, and were provided with the verbal prompt, “Time to play.” Verbal prompts were provided if a child engaged in one action-on-object manipulation but did not initiate others in the sequence. For example, when a participant put the baby doll in the bathtub but did not pick up the toy shampoo bottle or towel, a verbal prompt was given to continue the bath sequence. Verbal prompts were also provided if the participant continued with the same action-on-object or vocalizations. If the participant engaged in an action but did not emit the accompanying vocalization, an echoic prompt was given. For example, if the participant began to bang on the drums, but did not vocalize “Music can show how I feel,” a verbal prompt was given. Verbal praise (e.g., “Cool,” “good job”) and specific praise (e.g., “I like how you fed the baby with the spoon,” “Great job saying time for a new diaper”) was given for performing independent action-on-object play and vocalizations. If the participant did not engage in action-on-object play or vocalization for 10 s, the researcher asked, “Are you all done,” if the participant began playing with the toy set, the session continued. If the participant vocalized that he or she was done, the session was terminated.

Generalization Probes

Neither participant selected “Max & Ruby’s Bunny Bake Off” during baseline sessions, so it was used for the generalization probe following treatment sessions. Participants were given 5 min to play the novel game on the tablet before being presented with the corresponding toy set. No prompts or verbal praise were provided during generalization probes. If the participant began playing with the toy set, the session continued. If the participant vocalized that he or she was done, the session was terminated.

Results

Duration of Play

Figure 1 shows the duration of play (in minutes) across baseline, teaching, and generalization for each participant. Elsa’s baseline demonstrated low variability, low level, and a slight decrease in trend, with an average of 3.55 (range, 3.5 to 4.5) min play. During teaching sessions, there was an immediate increase from 3.5 to 6 min, a high level, low variability, and a slight increasing trend, with an average of 8.15 (range, 6.5 to 9.5) min of play. Elsa’s duration of play decreased from 9.5 to 7.5 min, which then decreased to 8 min by the second generalization probe. Bill’s baseline demonstrated a moderate level, moderate variability, and an increasing trend that decreased by session 6, with an average of 4 (range, 2 to 5.5) min of play. During teaching sessions, there was an immediate increase from 3 to 7.5 min, a high level, low variability, and no trend, with an average of 7 (range, 6.5 to 7.5) min of play. Bill's duration of play decreased from 7.2 to 5.5 min of play during the generalization probe.

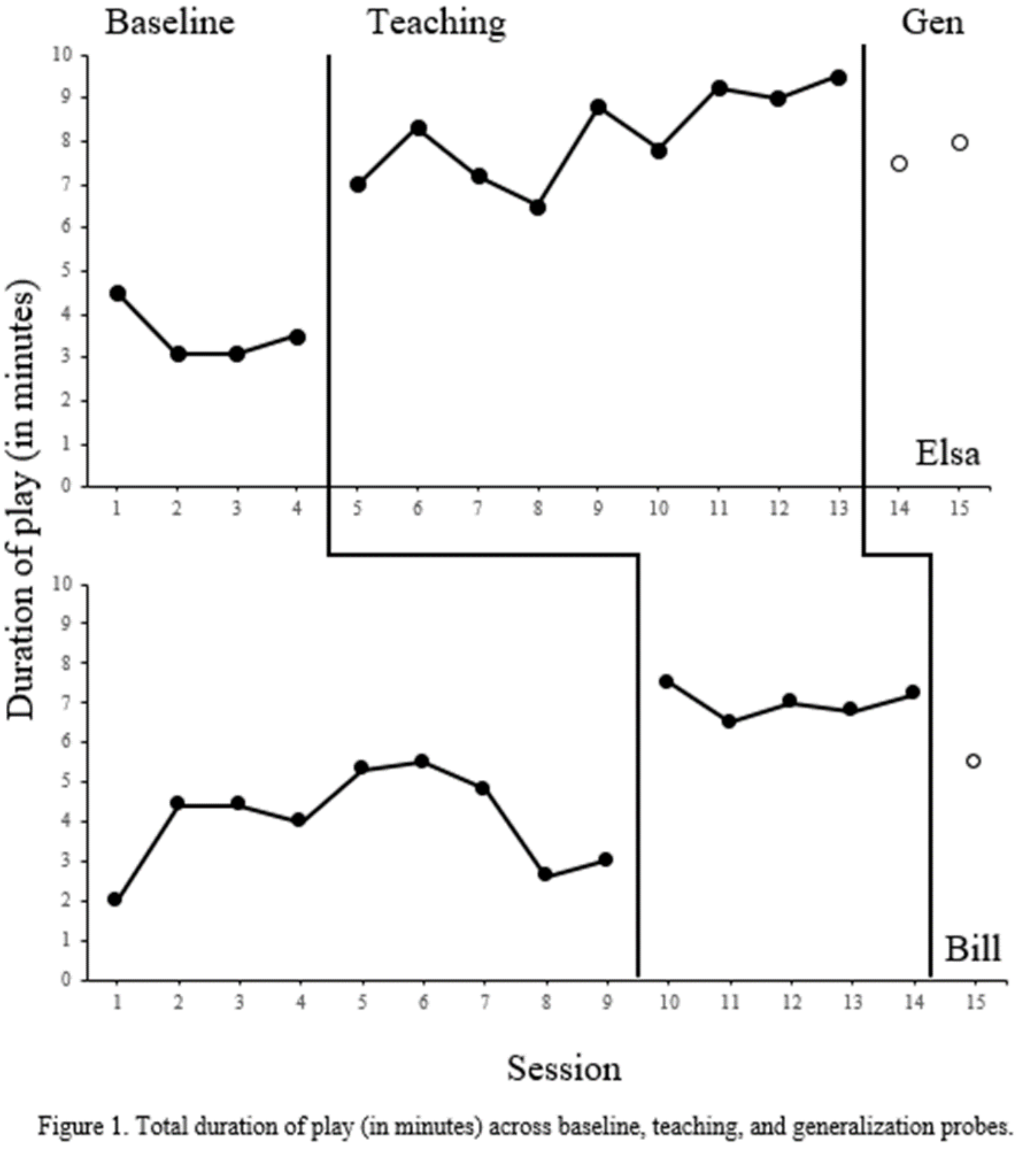

Figure 1. Total duration of play (in minutes) across baseline, teaching, and generalization probes.

Independent Action-on-Object Play

Figure 2 shows the frequency of independent action-on-object play across baseline, teaching, and generalization for each participant. Elsa's baseline demonstrated a moderate level, moderate variability, and a slight decreasing trend, with an average of 5.75 (range, five to seven) instances of independent action-on-object play. During teaching sessions, there was an immediate decrease from five instances to three instances, a moderate level, high variability, and an increasing trend that decreased by session 12, with an average of 8.18 (range, three to 12) instances of independent action-on-object play. Elsa's instances of independent action-on-object decreased from 11 instances to seven instances and decreased to six instances by the second generalization probe. Bill's baseline demonstrated a low level, low variability, and no trend, with an average of 3.44 (range, one to five) instances of independent action-on-object play. During teaching sessions, there was an immediate decrease from three instances to one instance and an increasing trend, with an average of 4.66 (range, one to nine) instances. Bill's instances of independent action-on-object play decreased from nine to six instances during the generalization probe.

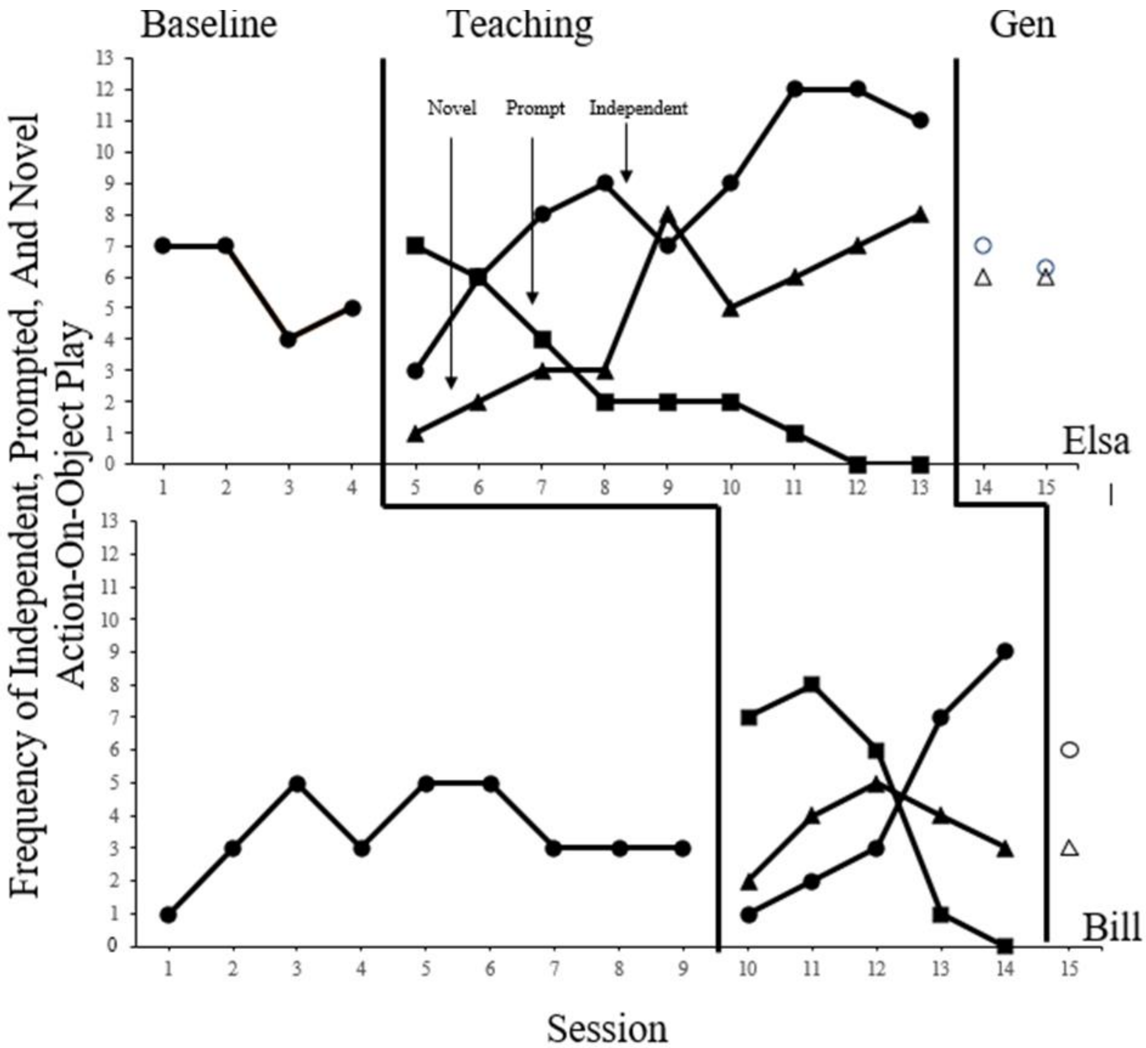

Figure 2. Frequency of independent, prompted, and novel action-on-object play across baseline, teaching, and generalization conditions. The closed circles represent independent responses, and the open circles represent generalization of independent responses. The closed squares represent prompted responses. The closed triangles represent novel responses, and the open triangles represent generalization of novel responses.

Prompted Action-on-Object Play

Figure 2 shows the frequency of prompted action-on-object play across baseline, teaching, and generalization for each participant. Elsa's baseline demonstrated a moderate level, moderate variability, and a slight decreasing trend, with an average of 5.75 (range, five to seven) instances of action-on-object play. During teaching sessions, there was an immediate increase in responding from five instances to seven instances and a decreasing trend, with an average of 2.66 (range, zero to seven) instances. Bill's baseline demonstrated a low level, low variability, and no trend, with an average of 3.44 (range, one to five) instances of action-on-object play. During teaching sessions, there was an immediate increase in responding from three to seven instances, a moderate level, low variability, and a decreasing trend, with an average of 4.4 (range, zero to eight) instances of prompted action-on-object play.

Novel Action-on-Object Play

Figure 2 shows the frequency of novel action-on-object play across baseline, teaching, and generalization for each participant. Elsa's baseline demonstrated a moderate level, low variability, and a slight decreasing trend, with an average of 5.75 (range, five to seven) instances of action-on-object play. During teaching sessions, there was an immediate decrease in responding from five instances and an increasing trend, with an average of five (range, one to eight) instances of novel action-on-object play. Elsa's instances of novel action-on-object play decreased from eight instances to six instances and remained stable at six instances by the second generalization probe. Bill's baseline demonstrated a low level, low variability, and no trend, with an average of 3.44 (range, one to five) instances of action-on-object play. During teaching sessions, there was a slight decrease in responding from three instances to two instances, a low level, low variability, and an increasing trend that decreased by session 12, with an average of 3.6 (range, two to five) instances of novel action-on-object play. Bill's instances of novel action-on-object play remained at six instances during the generalization probe.

Independent Vocalizations

Figure 3 shows the frequency of independent vocalizations across baseline, teaching, and generalization for each participant. Elsa's baseline demonstrated a low level and a steady trend, with an average of 4.5 (range, three to one) instances of vocalizations. During teaching sessions, there was an immediate increase in responding from one instance to three instances and an increasing trend, with an average of 8.55 (range, three to 12) instances of independent vocalizations. Elsa's instances of independent responses decrease from 11 instances to seven instances and decreased to six instances by the second generalization probe. Bill's baseline demonstrated an increasing trend that stabilized at four instances, with an average of 3.66 (range, zero to six) instances of vocalizations. During teaching sessions, there was an immediate decrease in responding from four instances to zero instances and an increasing trend, with an average of 3.33 (range, zero to seven) instances of independent vocalizations. Bill's instances of independent vocalizations decreased from seven instances to three instances during the generalization probe.

Prompted Vocalizations

Figure 3 shows the frequency of prompted vocalizations across baseline, teaching, and generalization for each participant. Elsa's baseline demonstrated a low level and a steady trend, with an average of 4.5 (range, three to one) instances of vocalizations. During teaching sessions, there was an immediate increase in responding from one instance to seven instances and a decreasing trend, with an average of 2.66 (range, zero to seven) instances of prompted vocalizations. Bill's baseline demonstrated an increasing trend that stabilized at four instances, with an average of 3.66 (range, zero to six) instances of vocalizations. During teaching, there was an immediate increase in responding from four instances to eight instances and a decreasing trend, with an average of 4.6 (range, zero to nine) instances of prompted vocalizations.

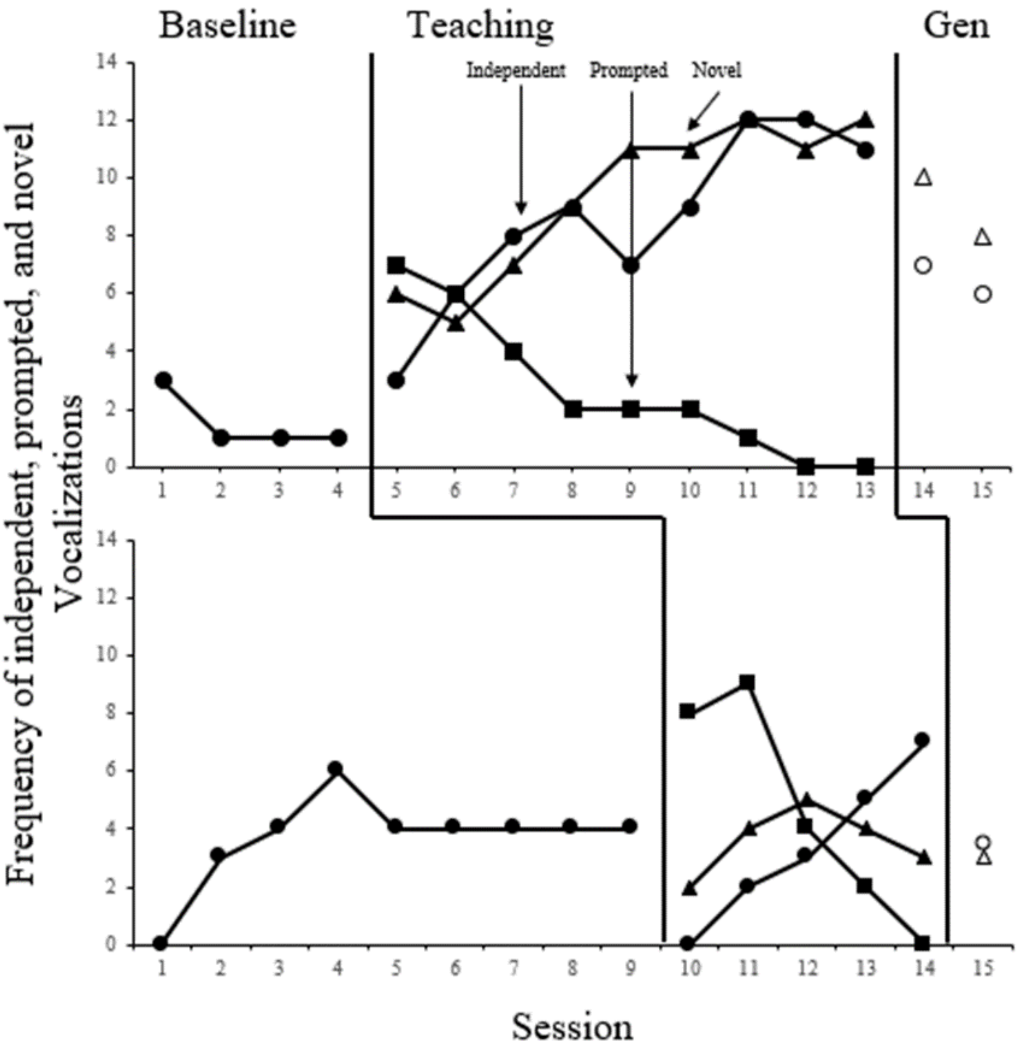

Figure 3. Frequency of independent, prompted, and novel vocalizations across baseline, teaching, and generalization for each participant. Closed circles represent independent vocalizations, and open circles represent generalization of independent vocalizations. Closed squares represent prompted vocalizations. Closed triangles represent novel vocalizations, and open triangles represent generalization of novel vocalizations.

Novel Vocalizations

Figure 3 shows the frequency of novel vocalizations across baseline, teaching, and generalization for each participant. Elsa's baseline demonstrated a low level and a steady trend, with an average of 4.5 (range, three to one) instances of vocalizations. During teaching, there was an immediate increase in responding from one instance to six instances, a moderate level, moderate variability, and an increasing trend that decreases at session 12, with an average of 9.33 (range, five to 12) instances of novel vocalizations. Elsa's instances of novel vocalizations decreased from 12 to ten instances and ten to eight by the second generalization probe. Bill's baseline demonstrated an increasing trend that stabilized at four instances, with an average of 3.66 (range, zero to six) instances of vocalizations. During teaching sessions, there was an immediate decrease in responding from four instances to two instances, a low level, low variability, and no trend, with an average of 3.6 (range, two to five) instances of novel vocalizations. Bill's instances of novel vocalizations remained stable during the generalization probe.

Discussion and Conclusion

The results of the current study further support the use of apps to facilitate play skills (Hourcade, et al., 2013; Fletcher-Watson, et al., 2016). Both participants in the current study increased their independent action-on-object and verbalizations during gameplay. Unlike previous studies, the results included the measurement of novel action-on-object play and vocalizations during play. Both participants demonstrated an increase in novel responding, suggesting the potential for apps to facilitate novel play. Interestingly, for both participants, as independent and novel play increased, prompted play decreased, suggesting that with minimal teaching apps can facilitate play skills (Murdock et al., 2013). As children are using more app-based learning modalities during social experiences, the feasibility of incorporating teaching opportunities into leisure-based devices, such as apps, is promising.

As children move into more inclusive environments in their schools, the longer a child can engage in independent play has practical outcomes for both the therapist and the learner. While the learner is engaged in independent play, this can provide the opportunity for the therapist to prep or take a break. For the learner, increased independent play provides exposure to possible social skill development with increased opportunities for a peer to join or observing peers as they play. For both participants in the current study, duration of play increased immediately following teaching. The characters in the apps used could have functioned as a video model for play skills that were then used with the toy sets. For example, the app would demonstrate how to give the baby a bath, the learner would observe the model, and then perform the skill in the app. The opportunity to practice the skill in the app following the model could have facilitate the increase in duration of play, and contributes to the role of video models in the duration of play (Nikopoulos & Keenan, 2004).

The increase in duration of play could be also be accounted for through the current study's use of designing the environment to resemble the stimuli presented in the app. The toy sets resembled the toys presented in the app, with similar topographies and functions. The teaching opportunities presented in the app and altering the environment with the toy sets could have facilitated the learner generalizing the successful play in the app to the toy sets. This methodology suggests the toy sets supported the transfer from model to actual play. Future studies could investigate this further by modifying certain aspects of the toy sets, incorporating novel toy sets, and future researchers could investigate training on the toy sets to observe generalization effects to the toys presented in the app.

Independent play skills have been shown to decrease less dependence on teacher and aide reinforcement (Morrison et al., 2002), which further mirrors requisites for access to regular education environments. Often, in school or clinical settings, situations present the learner with little opportunities for social reinforcement from either their peers, teachers, or therapist. Furthermore, access to independent leisure skills and self-reinforcement is an important component of overall quality of life. For both participants, independent and novel action-on-object play and vocalizations displayed an increasing trend. The increase in independent action-on-object play skills and verbalizations could be accounted for by the dense schedule of reinforcement embedded throughout the app. The learner is reinforced at a high rate for successful actions of game play. Each correct response was followed by lights and a variety of sound that served as reinforcers following each successful step of game play. The equivalence of stimuli presented in the game and the stimuli presented in the environment, these relations could have provided the opportunity for the transfer of the reinforcing properties of success in the game to the environment.

Both participants in the current study demonstrated deficits in play behavior with peers, and often played in stringent. For example, Elsa plays a birth cake game in the exact same way, every day. This can serve to decrease the motivation for peers to engage in play because the repetitive actions often becoming less reinforcing over time. Of important note, the instances of verbalizations concerning game play increased for both participants. This is important because verbalizing during play may provide the opportunity for social reinforcers and may serve to prompt peers to come over to the play area for group play. Future studies could test this by having the participant play around peers, verbalize during play, and record the number of instances and duration of group play. Previous research has shown that issues with generalization to novel settings following play interventions may be due to a lack of targeting peer play specifically. Children with ASD are more likely to engage in symbolic play when alone than with a peer (Barton & Wolery, 2008). This illustrates the importance of targeting peer play following mastery of a play scenario with a trainer. Examining the use of scripts adapted from gaming apps and introducing peers as agents of play would be an interesting continuation of this research.

Previous research has demonstrated the effectiveness of video modeling to teach play skills, but has also reported minimal novel play (Paterson & Arco, 2000) and generalization to novel settings (MacDonald et al., 2009). Unlike video modeling, the apps used in the current study included an active component to the video model. Furthermore, in video modeling the recording is typically in the same setting, with the same toys, and with a similar model, while the learner passively watches the video and then performs the skills presented. In the app, the animation style of the model, the environment, and the stimuli may have served as further multiple exemplars of the play that set the occasion for novel responding in that environment.

While both participants did not maintain treatment levels of responding when generalization was probed for, responding occurred at higher rates than baseline, demonstrating some experimental control. Both participants demonstrated preference for “Doc McStuffins: Baby Nursery,” with Elsa choosing it in 87% sessions and Bill choosing it in 60% of sessions. In the remaining sessions, both participants chose to play “At Home with Daniel Tiger.” Neither participant chose to play “Max & Ruby’s Bunny Bake Off” in any baseline or training session. The motivation for other games may explain decreased duration, actions and verbalizations in generalization probes. Participants also had greater exposure to the scripted actions and verbalizations from the other two games.

It is possible increased exposure to the sequences of play in the game used for generalization may have led to increased frequency of action-on-objects and verbalizations without training.

Further research could examine the maintenance of this skill over time, if future apps the child encounters serve as scripts for toy play. Pretense behaviors have been shown by past research to be heavily context-dependent, with children more likely to engage in functional play when provided, for example, with a doll and spoon to feed her with. Substitution, a symbolic play behavior, is more likely to occur if a child has a doll and junk toys, like a doll and a stick (Barton & Wolery, 2008). In this research, only toys allowing for functional play were provided. Some pretense was required of participants to pretend there was food in an empty bowl or water in a plastic tub; however, future research could examine generalization to novel play materials including "junk toys" which require substitution behavior. Generalization effects of play skills to novel apps and toy sets is important. Similar to previous findings, only modest gains in generalization was observed (MacDonald et al., 2009). Future research could improve upon generalization effects by programming for less similar toys during teaching, utilize an interrupted chain procedure with one toy missing from the toy set to set the occasion for generalization of toys, liter the environment with more toys, train parents and others to implement the strategies in multiple settings.

While the findings of the current study are promising, there are several limitations worth noting. Other than during the IOA assessments, there were no other people in the environment than the participant and researcher and all sessions were conducted in the same setting. This may greatly impact the generality of these findings to novel environments and people. Future researchers could examine this by incorporating novel researchers during implementation and novel environments to engage in the corresponding toy sets. A second limitation to the current study is the lack of programmed opportunities for the participants to play with peers. Reciprocal play with peers is an important skill for success with social interactions, and future studies could incorporate peers through multi-player apps and toy sets that require multi-players in play. A third limitation is researcher prompting during participant play with the toy sets. While these were recorded as prompted, and independent and novel were discriminated, it is unclear if the app itself would have served as the sole teaching component. Future studies could remove research prompts throughout the study to identify if apps alone could produce similar findings as though observed in the current study. Despite these limitations, the findings of the current study do support the use of video modeling to teach play skills and fill in a much-needed gap on apps and gamification as teaching tool (Morford et al., 2014).

The use of technology in classrooms has increased over the past decade (Ploog et al., 2012; Clark et al., 2015), and technology will likely be a crucial part of interventions designed for children with ASD in the coming years. Early on, Skinner (1984) commented on the success of video games at programming reinforcement contingencies, pointing out that the outcome of a game does not matter, but players continue because of the continuous reinforcement accessed while playing. In a well-designed intervention, reinforcement should be as readily available as in a game (Skinner, 1984). Given the amount of time spent playing games by people of all ages, it would behoove behavior analysts to consider games an integral part of our cultural milieu, which may have a positive impact on how we design and implement contingency management programs (Morford et al., 2014). In Gamification, researchers take the 'building blocks' of games and implement them in real-world situations, often to motivate specific behaviors within the gamified situation. Many authors see gamification as an innovative and promising concept, with application in various contexts (Werbach & Hunter, 2012).

Play is flexible and can be used across many settings. It sets up opportunities for children with autism spectrum disorder to have social and communicative interactions with peers and increases the likelihood that a child will access inclusive settings. When a child engages in play behaviors it creates opportunities to embed interventions for other skills and can lead to increases in social interaction, language and cognitive skills (Barton & Wolery, 2008). Today, preschoolers with ASD spend much of their leisure time engaging with tablets (Withey, 2016). Given the role of technology in the lives of today's young children, it is important that the use of this technology to assist in interventions for children with autism be explored. By training children with autism to use apps they play regularly as scripts to increase play behavior in the natural environment, interventionists can create future opportunities for functional play which may lead to the increased social opportunities play provides.

References

Barton, E. E., & Wolery, M. (2008). Teaching pretend play to children with disabilities: A review of the literature. *Topics in Early Childhood Special Education*, 28(2), 109-125. https://doi.org/10.1177/0271121408318799

Boudreau, E., & D'Entremont, B. (2010). Improving the pretend play skills of preschoolers with autism spectrum disorders: the effects of video modeling. *Journal of Developmental and Physical Disabilities*, 22(4), 415–431. doi: 10.1007/s10882-010-9201-5

Brown, J., & Murray, D. (2001). Strategies for enhancing play skills for children with autism spectrum disorder. *Education and Training in Mental Retardation and Developmental Disabilities*, 312-317. https://www.jstor.org/stable/23879984

Clark, M. L. E., Austin, D. W., & Craike, M. J. (2014). Professional and parental attitudes towards iPad application use in autism spectrum disorder. *Focus on Autism and Other Developmental Disabilities*, 30(3), 174–181. doi: 10.1177/1088357614537353

Eberle, S. G. (2014). The elements of play: Toward a philosophy and a definition of play. *American Journal of Play*, 6(2), 214-233.

Fletcher-Watson, S., Petrou, A., Scott-Barrett, J., Dicks, P., Graham, C., O'Hare, A., ... & McConachie, H. (2016). A trial of an iPad™ intervention targeting social communication skills in children with autism. *Autism*, 20(7), 771-782. https://doi.org/10.1177/1362361315605624

Gould, J. (1986). The Lowe and Costello symbolic play test in socially impaired children. *Journal of autism and Developmental Disorders*, 16(2), 199-213. https://doi.org/10.1007/BF01531730

Hampshire, P. K., & Hourcade, J. J. (2014). Teaching play skills to children with autism using visually structured tasks. *Teaching Exceptional Children*, 46(3), 26-31. https://doi.org/10.1177/004005991404600303

Hine, J. F., & Wolery, M. (2006). Using point-of-view video modeling to teach play to preschoolers with autism. *Topics in Early Childhood Special Education, 26*(2), 83-93. doi:10.1177/02711214060260020301

Hourcade, J. P., Williams, S. R., Miller, E. A., Huebner, K. E., & Liang, L. J. (2013, April). Evaluation of tablet apps to encourage social interaction in children with autism spectrum disorders. *Proceedings of the*

SIGCHI Conference on Human Factors in Computing Systems, 2(2), 3197-3206. https://doi.org/10.1145/2470654.2466438

Jahr, E., & Eldevick, S. (2007). Changes in solitary play following acquisition of cooperative play by children with autism. *The Journal of Speech and Language Pathology – Applied Behavior Analysis*, *2*(2), 182–189. doi: 10.1037/h0100215

Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry*, *47*(6), 611-620. https://doi.org/10.1111/j.1469-7610.2005.01567.x

Kasari, C., Chang, Y. C., & Patterson, S. (2013). Pretending to play or playing to pretend: The case of autism. American Journal of Play, 6(1), 124-135.

Lang, R., O'Reilly, M., Sigafoos, J., Lancioni, G. E., Machalicek, W., Rispoli, M., ... & Zarcone, J. (2009). Enhancing the effectiveness of a play intervention by abolishing the reinforcing value of stereotypy: A pilot study. *Journal of Applied Behavior Analysis*, *42*(4), 889-894. https://doi.org/10.1901/jaba.2009.42-889

Lifter, K., Mason, E. J., & Barton, E. E. (2011). Children's play: Where we have been and where we could go. *Journal of Early Intervention*, 33(4), 281-297. https://doi.org/10.1177/1053815111429465

MacDonald, R., Sacramone, S., Mansfield, R., Wiltz, K., & Ahearn, W. H. (2009). Using video modeling to teach reciprocal pretend play to children with autism. *Journal of Applied Behavior Analysis*, *42*(1), 43-55. https://doi.org/10.1901/jaba.2009.42-43

More, C. (2008). Digital stories targeting social skills for children with disabilities. *Intervention in School and Clinic*, *43*(3), 168–177. doi: 10.1177/1053451207312919

Morford, Z. H., Witts, B. N., Killingsworth, K. J., & Alavosius, M. P. (2014). Gamification: the intersection between behavior analysis and game design technologies. *The Behavior Analyst*, *37*(1), 25–40. doi: 10.1007/s40614-014-0006-1

Morrison, R. S., Sainato, D. M., Benchaaban, D., & Endo, S. (2002). Increasing play skills of children with autism using activity schedules and correspondence training. *Journal of Early Intervention*, *25*(1), 58-72. https://doi.org/10.1177/105381510202500106

Murdock, L.C., Ganz, J., Crittendon, J. (2013). Use of an iPad play story to increase play dialogue of preschoolers with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *43*(9), 2174-2189. doi: 10.1007/s10803-013-1770-6

Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Seibert, J. (2003). Early social communication scales (ESCS). Coral Gables, FL: University of Miami.

Nikopoulos, C. K., & Keenan, M. (2004). Effects of video modeling on social initiations by children with autism. *Journal of Applied Behavior Analysis*, *37*(1), 93-96. https://doi.org/10.1901/jaba.2004.37-93

Paterson, C. R., & Arco, L. (2007). Using video modeling for generalizing toy play in children with autism. *Behavior Modification*, *31*(5), 660-681. https://doi.org/10.1177/0145445507301651

Pierucci, J. M., Barber, A. B., Gilpin, A. T., Crisler, M. E., & Klinger, L. G. (2015). Play assessments and developmental skills in young children with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *30*(1), 35-43. https://doi.org/10.1177/1088357614539837

Ploog, B. O., Scharf, A., Nelson, D., & Brooks, P. J. (2012). Use of computer-assisted technologies (CAT)to enhance social, communicative, and language development in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 43*(2), 301–322. doi: 10.1007/s10803-012-1571-3

Skinner, B. F. (1984). The shame of American education. *American Psychologist, 39*(9), 947–954. doi: 10.1037//0003-066x.39.9.947

Stahmer, A. C. (1995). Teaching symbolic play skills to children with autism using pivotal response training. *Journal of Autism and Developmental Disorders*, *25*(2), 123-141. https://doi.org/10.1007/BF02178500

Stahmer, A. C., Schreibman, L., & Powell, N. P. (2006). Social validation of symbolic play training for children with autism. *Journal of Early and Intensive Behavior Intervention, 3*(2), 196–210. doi: 10.1037/h0100332

Stanley, G. C., & Konstantareas, M. M. (2007). Symbolic play in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 37*(7), 1215-1223. https://doi.org/10.1007/s10803-006-0263-2

Sundberg, M. L. (2014). *The verbal behavior milestones assessment and placement program: The VB-MAPP protocol (2nd ed.).* AVB Press.

Terpstra, J. E., Higgins, K., & Pierce, T. (2002). Can I play? Classroom-based interventions for teaching play skills to children with autism. *Focus on Autism and Other Developmental Disabilities*, *17*(2), 119-127. https://doi.org/10.1177/10883576020170020701

Werbach, K., & Hunter, D. (2012). For the win: How game thinking can revolutionize your business. Wharton Digital Press.

Withey, K. L. (2016). Using apps to develop social skills in children with autism spectrum disorder. *Intervention in School and Clinic*, *52*(4), 250–255. doi: 10.1177/1053451216659475

Author Information

Jill Nelson
https://orcid.org/ 0000-0003-3004-4015
Southeast Missouri State University
One University Plaza, Cape Girardeau, MO 63701
USA

Corri Carotti-Snigg
https://orcid.org/000-0002-0227-3112
Elevate Behavior Solutions, LLC
PO Box 11312, Pensacola, FL 32524
USA

William B. Root
https://orcid.org/ 0000-0002-0291-7141
Southeast Missouri State University
One University Plaza, Cape Girardeau, MO 63701
USA

Eric J. Billington
https://orcid.org/0000-0002-7604-4275
Southeast Missouri State University
One University Plaza, Cape Girardeau, MO 63701
USA
Contact e-mail: *ebillington@semo.edu*