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Case Study: An iPad-Based Intervention on Turn-Taking Behaviors in Preschoolers With Autism

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The purpose of the current observational study was to explore whether a cost- and time-effective intervention using an iPad and an experimenter-created app, adapted from a commercial app called iTake Turns©, can demonstrate an immediate improvement of turn-taking behaviors in preschoolers with autism. Two monozygotic twin boys, ages 4 years and 6 months, with a diagnosis of autism were recruited. A modified multiple baseline design between 2 participants was employed to suggest a functional relationship between the independent and dependent variables. The study took place over an 11-week time span. Two separate PowerPoint slide sets including the experimenter and individual participant's photograph were used. An audio prompt such as "Liz's turn," "Sam's turn," and "Ian's turn" was embedded into these pages. The slide sets were presented via iPad. The percentage of nonoverlapping data indicated that the intervention was fairly effective for 1 child but not reliable for the other child. It is suggested that iPads or tablet devices can be effective tools to support socialization, more particularly, turn-taking behaviors in children with autism. Limitations of the study design were discussed.

Keywords: case study, iPad, monozygotic twins with autism, preschoolers with autism, turn-taking behaviors

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Preschoolers with autism have difficulty utilizing appropriate turn-taking behaviors, or smooth interchanges of verbal and play turns between communicative partners (Kaczmarek, 2002), because of their deficits in socialization (American Psychiatric Association, 2013). Intervention techniques that target turn-taking behaviors of children with autism are a key component of early intervention approaches because (a) the back-and-forth reciprocal structure is a primary framework of early learning and (b) turn-taking behaviors are highly associated with social acceptance in preschoolers (Diamond, Hong, & Baroody, 2007; Guralnick & Neville, 1997; Harrist & Waugh, 2002; Rieth et al., 2014). However, intervention strategies to improve turn-taking behaviors have rarely been investigated empirically and quantitatively including a control of experiment in contrast to interventions to improve communicative, cognitive, and behaviors skills (Brok & Barakova, 2010; Diehl, Schmitt, Villano, & Crowell, 2012; Rao, Beidel, & Murray, 2008: Rieth et al., 2014; Scassellati, Admoni, & Mataric, 2012). The focus of this study was to suggest an innovative intervention technique for children with autism using an iPad and PowerPoint slides to target turn-taking behaviors.

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Children With Autism and Turn-Taking Behavior

Traditionally, (a) adult-facilitated group training, (b) sociodramatic play scripts (i.e., following scripts during play), (c) theme-based activities (e.g., shared-story book reading), developmental, individual-difference, relationship-based model (DIR), and (d) peer-mediated social communication settings (i.e., interacting

with typically developing peers who were previously trained) have been utilized to address deficits in socialization for children with autism (Barry et al., 2003; Craig-Unkefer & Kaiser, 2003; Doctoroff, 1997; Greenspan & Wieder, 1999; Hilton & Seal, 2007; Kamps et al., 1992; Sansosti & Powell-Smith, 2006; Stanton-Chapman & Snell, 2011; Wieder & Greenspan, 2003). Recently, a group of researchers have examined the effectiveness of LEGO© therapy (LeGoff, 2004; LeGoff & Sherman, 2006; Owens, Granader, Humphrey, & Baron-Cohen, 2008). By constructing LEGO© structures in a group or individual setting, participants are expected to use both verbal and visual information to develop social skills. One of the limitations of the existing literature is that researchers have focused on the improvement of social skills among school-age children and adolescents with high functioning autism (HFA) or Asperger's syndrome (AS). Second, little empirical evidence supports the efficacy of intervention on turn-taking behaviors for young children with autism spectrum disorders.

For the past decade, robot therapy has been examined to assist children with autism through social interactions (Aresti-Bartolome & Garcia-Zapirain, 2014; Diehl et al., 2012; Scassellati et al., 2012). A selection of robots applied to autism therapy includes Bandit, bubble blowers, FACE, i-blocks, Infanoid, IROMEC, Kasper, Keepon, Muu, PARO, Roball, Robota, Pleo, and Tito (e.g., Dautenhahn et al., 2009; Duquette, Michaud, & Mercier, 2008; Kim et al., 2013; Kozima, Nakagawa, & Yasuda, 2007; Michaud et al., 2005; Robins, Dautenhahn, Te Boekhorst, & Billard, 2005). Diehl et al. (2012) completed a systematic review of peer-reviewed studies in robot therapy in autism. The researchers concluded that most studies included had similar methodological limitations such as a small sample size, lack of quantitative analyses, and heterogeneity of participants. A major limitation suggested by Diehl et al. (2012) was that the current robot studies are focused on robot development and robot methodology including theories rather than the efficacy, effectiveness, and/or efficiency of robot therapy. To our knowledge, only Kim et al. (2013) conducted a controlled study ($N = 24$) including a statistical analysis to exhibit a social robot's capacity of facilitating social interaction with another adult. In sum, use of robot in socialization, in particular, turn-taking, is promising but preliminary at this time.

One of a few investigations that examined young children's turn-taking behaviors including a strong validity is Reith et al.'s (2014) study, which tested the effect of different types of turn taking on language and play skills for young children with autism. The four types of turn-taking behaviors examined in the study were based on Pivotal Response Training (PRT), a type of evidence-based approach, which is a naturalistic behavioral intervention requiring the therapist to utilize modeling and contingency in a turn (Koegel et al., 1989). The researchers recruited six children, ranging in age from 30 to 39 months, and used an alternating treatments design to test the efficacy of the therapist's turn taking as intervention techniques. It was found that the therapist's turn-taking behaviors positively influenced the responsiveness of children with autism. More specifically, the therapist's controlling materials and requiring a contingent response from the target child were the two key elements that determined the acquisition of play and language skills.

It is noteworthy that Rieth et al. (2014) identified the two key aspects of appropriate turn-taking behaviors of therapists: gaining control of materials and requiring a contingent response from the target child. However, the focus of the authors' study was to define the key elements of the therapist's turn taking which positively affected play and language skills, not to improve the child's turn-taking behaviors per se. Creating an intervention technique which contains the two critical elements warrants further exploration to target deficits in turn taking.

Antecedent-Based Intervention

Antecedents are stimuli that occur before behavior occurs (Zirpoli, 2012). Structural analysis has been created to examine the relationship between antecedent-based contextual variables and subsequent behaviors and systematically evaluate the antecedents under which behavior will occur (Stichter & Conroy, 2005; Stichter, Hudson, & Sasso, 2005). Antecedent-based intervention refers to a treatment technique in which environmental modifications are implemented to alter the conditions in the contexts that lead to an individual with autism to engage

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in a maladaptive behavior (Neitzel, 2009). The goal of antecedent-based intervention is to identify the conditions in the setting that are reinforcing the maladaptive behavior and then to modify the environment or activity so that the environmental conditions no longer elicit the maladaptive behavior (Park & Scott, 2009).

Literature indicates that antecedent-based intervention techniques significantly yield positive behaviors, especially prosocial behaviors, for children with autism. Assessment and intervention procedures are reported to be feasible, acceptable, and effective to implement during a variety of classroom contexts and activities. For example, Stichter, Randolph, Kay, and Gage (2009) used a multiple baseline design across educational contexts for each of three participants. Independent and dependent variables were unique to each participant. Results indicated that teachers successfully presented optimal antecedents to increase the frequency of prosocial adaptive behaviors and decreased maladaptive behaviors. It was also found that the positive outcomes were maintained during follow-up observations across contexts. In sum, significant strengths of antecedent-based intervention have been found in its feasibility, effectiveness, generalizability, acceptability, and accountability. Based on the literature the current case study employed the concept of antecedent-based intervention to increase the participants' turn-taking behaviors.

Use of Tablet Devices and Their Apps in Autism Intervention

The increasing popularity, affordability, accessibility, and availability of hand-held touch-screen electronic devices have influenced research on autism intervention (King, Thomeczek, Voreis, & Scott, 2014). Because of the popularity and versatility of devices, utilizing these devices as therapy tools is not socially stigmatized. Use of diverse applications (hereafter referred to as apps) of tablet devices leads to a variety of possibilities in providing interventions services to children with autism (King et al., 2014). For example, an appropriate use of iPads, one of the leading hand-held touch-screen electronic devices, and their apps can (a) increase play skills (Murdock, Ganz, & Crittendon, 2013), (b) decrease challenging behavior (Neely, Rispoli, Camargo, Davis, & Boles, 2013), (c) provide video models (Cardon, 2012; Kagohara, Sigafoos, Achmadi, O'Reilly, & Lancioni, 2012), and (d) provide a speech-generating Augmentative and Alternative Communication (AAC) device (Light & McNaughton, 2012).

Following the introduction of tablet devices such as iPad and their apps, there has been a paradigm shift, that is, a movement toward more individually targeted intervention away from one-size-fits-all approaches, in the field of autism intervention. For example, commenting on the use of technology in autism intervention, Knight, McKissick, and Saunders (2013) suggest that therapists should (a) make any clinical decisions based on the individual child's characteristics, (b) continually monitor progress, and (c) provide the child with systematic instruction. However, although hand-held electronic devices are claimed to improve play skills, decrease maladaptive behaviors, provide video modeling, and function as a speech-generating AAC device, little empirical research, especially bias-controlled experimental studies, has been conducted to test the efficacy of tablet devices and their apps (Pennington, 2010; Tincani & Boutot, 2005). Because of the limited amount of evidence accumulated, further investigations are needed in which individualized approaches with systematic instruction are created and the individual effects of these interventions are monitored. In an effort to shed light on needed empirical investigations on turn-taking behaviors and on tablet devices' apps, the current case study was designed to demonstrate the functional relationship between a simple experimenter-created iPad app and turn-taking behaviors in preschoolers with autism.

Method

Participants

Participants included two monozygotic twin boys, ages four years and six months, with an autism spectrum diagnosis. Both boys were diagnosed with autism at 12 months of age by a licensed developmental psychiatrist. The twin boys were recruited by the second author, who was the participants' home-based special education teacher at the time of study. The participants had received developmental services by home visit therapists (i.e., occupational therapist, physical therapist, special education

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teacher, and speech-language pathologist) immediately after their diagnoses. Starting from three years of age, both participants attended a half-day ABA-based special preschool for children with autism. Communication-related intervention had consisted of the introduction of manual signs (i.e., "eat," "please," "more," "no," "hi," and "bye"). No spontaneous signing and verbalization have been observed. Neither participant utilized signing and verbalization functionally. Both boys engaged in a high rate of self-stimulatory behaviors (i.e., humming and finger flicking). Aggressive or self-injurious behaviors have not been observed.

Both participants presented with normal hearing in at least one ear as measured by sound field audiometric testing. The participants' vision was reported within normal limits by their pediatrician. The participants ambulated well and presented the fine and gross motor skills necessary for functional object manipulation. Both participants requested and protested by leading others, patting objects, reaching, crying, and using pointing. Both participants' noncry vocalizations were limited to humming and simple repetitive or variable syllable shapes (e.g., "gaga" and "daga") and were not used communicatively. Both boys' primary play skills included (a) banging, pushing, and pulling; (b) moving simple toy pieces from one spot to another; and (c) placing simple puzzle pieces into right spots. They both imitated simple symbolic play skills with physical prompts and models (e.g., putting a baby doll on a bed, and pretending to feed a doll).

To protect the participant identify, pseudonyms are used in the following sections. Sam followed simple one-step verbal commands (e.g., "sit down" and "come here") without physical prompts. Sam discriminated phoneme combinations by responding to auditory stimuli. Ian followed simple one-step verbal commands when physical prompts were presented. Ian was a prelistener who relied on visual cueing to follow simple directions. Home visit therapists used Disney animations' short clips playing on iPad as reinforcement, requested by the twin boys' mother. Both participants were greatly interested in watching movie clips. Sam was the only one who wanted to touch and manipulate the iPad. At the time of study, no iPad apps were used for communication intervention. At the initiation of the study, both participants had severe difficulty in turn-taking skills reported by home visit therapists. The therapists agreed that the lack of turn-taking behaviors greatly hindered both participants' therapeutic and daily activities. Before or while enrolled in the study, neither boy participated in any outside intervention that specifically taught turn-taking skills.

Procedures

All data collection (i.e., baseline and intervention sessions) was completed at the twin boys' therapy room in their home. The room contained a child-size table and two child-size chairs. During the study, none of the home visit therapists utilized the selected toys as their intervention tools or reinforcers. The entire baseline and intervention sessions were videotaped. During intervention sessions, an iPad was used to play the PowerPoint slide sets via Microsoft PowerPoint for iPad. A small table was situated adjacent to the child and experimenter's table where the iPad was placed. The small table was located far away from the child so that the experimenter could physically control the participants' attempts to touch the iPad.

Baseline

During baseline sessions, identical toys to those being utilized in intervention were available for the child and the experimenter to play with for a maximum of 30 minutes. The experimenter presented one toy at a time and covered the rest of toys to minimize the child's distraction. The experimenter and child engaged in play activities by using the toys as described in Table 1. The experimenter changed from one toy to another one when the child lost his interest as indicated by the child's discontinuation of taking turns. The frequency of each participant's appropriate turn-taking behaviors with the experimenter was recorded. Baseline procedures were as follows:

1. The experimenter took her turn as described in Table 1.
2. The child took his turn.
3. If the child completed more than three turns consecutively, the experimenter physically stopped the child and took her turn.

Table 1
Toys' Turns

Toys	Description of turns
Connect Four™	• Picking up a checker • Placing it in a grid
Don't Spill the Beans™	• Picking up beans • Placing them in a bean pot
Puzzle	• Picking up a puzzle piece • Placing in in the puzzle frame
Wood Blocks	• Picking up one block • Placing it on top of other blocks
Alphabet Game	• Picking up an alphabet magnet • Sticking it to a letter board
Timber Tumble™	• Removing a block completely out of the tower • Placing it on the table
Tomy Pop-Up Pirate™	• Picking up a sword from the table • Sliding it into the barrel
Don't' Break the Ice™	• Picking up a hammer • Tapping out ice blocks until at least one falls

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Intervention

During intervention sessions, identical toys to those being utilized in baseline were available for the child and the experimenter to play with for a maximum of 30 minutes. The experimenter presented one toy at a time and covered the others to minimize the child's distraction. The experimenter and child engaged in play activities by using the toys as described in Table 1. The experimenter changed from one toy to another one when the child lost his interest as indicated by the child's discontinuation of taking turns. The frequency of each participant's appropriate turn-taking behaviors with the experimenter was recorded. The PowerPoint program on iPad was utilized. The participants were not allowed to touch the iPad. Intervention procedures were as follows:

1. The experimenter pushed iPad so that the experimenter's page was activated. The experimenter's photograph and audio prompting (i.e., "Liz's turn") were presented.
2. The experimenter took her turn as described in Table 1.
3. The experimenter pushed iPad so that the child's page was activated. The child's photograph and audio prompting (i.e., "Sam's turn" or "Ian's turn") were presented.
4. The child took his turn.
5. If the child completed more than three turns consecutively, the experimenter physically stopped the child and took her turn.

Variables

Discriminative stimulus. The independent variable was two separate PowerPoint slide sets, one for Sam and the other for Ian, including the experimenter and individual participant's photograph. That is, one slide contained one participant's photograph. An audio prompt such as "Liz's turn," "Sam's turn," and "Ian's turn" was embedded onto each page corresponding the photograph. The PowerPoint slides were presented to the individual participants by using Microsoft PowerPoint for iPad. When the experimenter pushed an arrow button on the iPad, either the experimenter or the individual participant's photograph was shown with the corresponding audio prompt. This experimenter-created app was used as a discriminative stimulus. The slides were adapted from iTake Turns by Smarty Ears, a simple turn-taking app with voice output. The limitations of the app include (a) use of pronouns "my" and "your," and (b) use of abstract stick figures. The PowerPoint slide sets were specially designed to accommodate the participants' level of receptive vocabulary and cognitive skills.

Response. The dependent variable was the frequency of appropriate turn-taking behaviors

during play activities. Appropriate turn-taking behaviors were defined as smooth interchanges of play turns between the child and experimenter in the absence of participant's maladaptive behaviors (i.e., screaming, swiping, blocking, and grabbing the target toy) without the experimenter's physical prompts (i.e., blocking and grabbing the participant's hand and/or arm). The used toys' turns are described in Table 1.

Materials

Age-appropriate toys for turn-taking used during baseline and treatment sessions were selected by the boys' mother and home visit therapists based on the participants' interest and level of gross and fine motor skills. Toys included Connect Four™, Do not Spill the Beans™, puzzles (i.e., alphabets, animals, and shapes), wood blocks, alphabet game, Timber Tumble™, Tomy Pop-Up Pirate™, and Don't Break the Ice™.

Design

A modified multiple baseline design across participants ($n = 2$) was utilized to show a functional relation between the treatment and turn-taking behaviors. The study took place over an 11-week time span. Sam and Ian separately participated in baseline sessions twice a week for four and five weeks, respectively. Thereafter, both children separately participated in intervention sessions twice a week for six weeks. Both participants attended baseline and intervention sessions for a maximum of 30 minutes per session. The second investigator, who was a first-year graduate clinician pursuing an M.A. degree in speech-language pathology, served as the experimenter. The experimenter had worked with both participants as a home visit special education teacher for one year before the current study under the supervision of a certified psychologist. The experimenter had a B.A. in special education. The videotapes of baseline and intervention sessions were monitored in their entirety by the first author, who is a certified speech-language pathologist.

Fidelity and Reliability

To ensure that the experimenter implemented baseline and intervention sessions as designed, a checklist was scored from recorded videotapes by three trained independent observers for 100% of all baseline and intervention sessions. During baseline, the protocols required that (a) the experimenter took her turn as described in Table 1, (b) the child took his turn, and (c) if the child completed more than three turns consecutively, the experimenter physically stopped the child and took her turn. During intervention, the protocols required that (a) the experimenter pushed iPad so that the experimenter's page was activated. The experimenter's photo and audio prompting (i.e., "Liz's turn") were presented; (b) the experimenter took her turn as described in Table 1; (c) the experimenter pushed iPad so that the child's page was activated; the child's photo and audio prompting (i.e., "Sam's turn" or "Ian's turn") were presented; (d) the child took his turn; and (e) if the child completed more than three turns consecutively, the experimenter physically stopped the child and took her turn. Summing the scores across the three observers indicated 100% fidelity of baseline sessions and 97.5% fidelity of intervention sessions.

To calculate interrater reliability of the authors' scoring of participants' turn-taking behaviors, two trained graduate assistants observed 100% of the intervention sessions and identified the number of times participants took turns during their sessions through review of the session videotapes. The graduate assistants identified all appropriate turn-taking behaviors which were defined as a participant not attempting to take turn during the experimenter's turn by (a) grabbing or swiping a presented toy, (b) screaming, or (c) requiring the experimenter's physical blocks. Point-by-point comparisons were made, and interrater agreement was calculated for the entire sessions resulting in 96.5% reliability.

Results

Total number of trials and correct turn-taking behaviors are presented in Table 2. Data for each participant are plotted in Figure 1. In the figure, diamond markers represent the percent of appropriate turn-taking behaviors. Intervention sessions are demarcated by vertical lines. First, a visual inspection of the data was conducted as suggested by Kromrey and Foster-Johnson (1996). Both Ian and Sam demonstrated fluctuating and variable performances of

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Table 2
Total Number of Trials and Correct Turn-Tacking Behaviors

Ian: Baseline (8 sessions)								
Date	3/10	3/13	3/17	3/22	3/24	3/29	4/6	4/9
Turn	15	7	10	12	7	4	2	1
Total	60	42	51	48	41	28	30	19
%	25	17	20	25	17	12	7	5

Ian: Intervention (12 sessions)												
Date	4/14	4/17	4/21	4/24	4/28	5/8	5/12	5/15	5/19	5/21	6/2	6/4
Turn	12	10	14	7	9	10	5	14	11	5	8	14
Total	28	20	30	12	21	27	23	20	29	17	41	27
%	43	50	47	58	43	37	22	70	38	30	20	52

Sam: Baseline (10 sessions)										
Date	3/10	3/13	3/17	3/19	3/24	3/27	3/31	4/10	4/14	4/16
Turn	8	4	5	11	4	18	10	10	12	11
Total	37	49	52	51	53	40	50	57	45	42
%	22	8	10	22	8	45	20	18	27	26

Sam: Intervention (11 sessions)											
Date	4/21	4/24	4/28	4/30	5/8	5/12	5/14	5/19	5/21	6/2	6/4
Turn	15	10	8	21	24	22	15	20	8	20	10
Total	43	50	37	28	37	40	47	38	29	48	46
%	35	20	22	75	65	55	32	52	28	42	22

Note. Turn = total number of correct turn-taking behaviors. Total = total number of trials.

turn-taking across baseline and intervention sessions. During baseline sessions, Ian consistently demonstrated difficulty taking his turn appropriately, ranging from 5% to 25% of his turns. During intervention sessions, Ian's general performance in turn-taking was improved, ranging from 20% to 70% of his turns. However, a significant decrease in appropriate turn-taking was observed in intervention Sessions 15 (22%) and 19 (20%). Sam's turn-taking behaviors were less stable and consistent than Ian's performances. During baseline sessions, Sam's appropriate turn-taking behaviors ranged from 8% to 45% of his turns. In baseline Session 6, Sam distinctively demonstrated a high level of appropriate turn-taking behaviors, which greatly contributed to the inconsistent data during baseline sessions. During intervention sessions, Sam's appropriate turn-taking behaviors ranged from 20% to 75%. Sam's intervention sessions are characterized by constant up-and-down performances in appropriate turn-taking behaviors. A significant decrease in turn-taking behaviors was observed in intervention Sessions 12, 13, 17, 19, and 21.

To measure the effect of intervention, the percentage of nonoverlapping data (PND) was calculated by dividing the number of intervention sessions exceeding the highest data point during baseline sessions and dividing by the total number of intervention sessions (Parker, Hagan-Burke, & Vannest, 2007; Manolov & Solanas, 2009; Scruggs & Mastropieri, 2013; Scruggs, Mastropieri, & Casto, 1987). PND statistics higher than 90% are interpreted as highly effective intervention, 70% to 90% as fairly effective treatment, 50% to 70% as questionable effectiveness, and less than 50% as unreliable treatment. Each participant's highest data point during baseline sessions is represented as a horizontal dotted line in Figure 1. Ian's PND statistic is 10/12 = 83.33%, which is fairly effective. Sam's PDN statistics is 5/11 = 45.45%, that is, unreliable treatment. Because the positive outcomes of the intervention were only found for Ian, the results of the case study were inconclusive.

Discussion

The purpose of the current study was to explore whether a cost- and time-effective individualized intervention using an iPad and PowerPoint slide sets could show a functional

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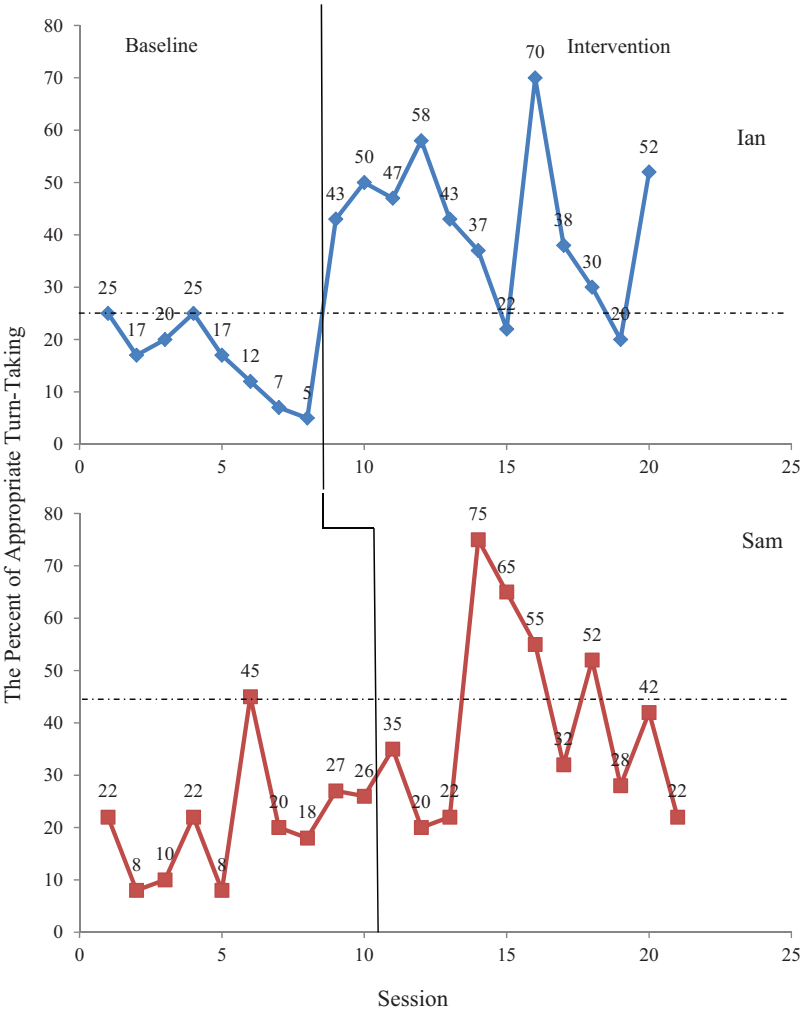

Figure 1. Multiple baseline graphs of intervention sessions.

relationship with turn-taking behaviors in preschoolers with autism via a case study. The study's preliminary findings possibly added to the limited literature on turn-taking behaviors by examining a functional relationship between an experimenter-created simple iPad app which (a) possibly allowed the experimenter to gain control of toys and (b) required contingent responses from the study participants (Rieth et al., 2014). The study also attempted to extend limited research on the effectiveness of tablet devices and their apps by testing a short-term effect of a self-made iPad app which (a) made important clinical decisions based on the participants' characteristics, (b) continuously monitored progress, and (c) provided both boys with systematic instruction (Knight et al., 2013). These findings possibly advanced our understanding of the important role of intervention for turn-taking behaviors in preschoolers with autism.

A major finding from the current study is that the iPad app created by the authors demonstrated an immediate effect on Ian's turn-taking behaviors. The authors attempted to design a turn-taking intervention which allowed a therapist to gain control of toys and required a contingent response from a child, as Rieth et al.

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(2014) indicated. First, the experimenter carefully selected the toys presented following the discussion with the participants' mother and home visit therapists. One toy was presented at a time, and the rest of the toys were covered so that distraction could be minimized. Each toy's turn-taking behaviors were well-described, which led to a great level of control of toys. Also, each participant's contingent response was required throughout the intervention phase. Activation of the experimenter's PowerPoint slide (i.e., audio prompt of "Liz's turn" plus the experimenter's photograph) required each boy's contingent response of discontinuing his turn.

Furthermore, we attempted to design an intervention using a hand-held tablet device and its app, which created an individualized technique, continually monitored the participants' progress, and presented systematic instruction, as Knight et al. (2013) suggested. First, considering the participants' level of receptive language and cognitive skills, PowerPoint slides included the names of experimenter and children, not "your" or "my," and actual photographs, not stick figures or pictures. Next, the participants' progress was continually monitored for the purpose of data collection of the study. Finally, systematic instruction including vivid visual prompts (i.e., photographs) and auditory cueing (i.e., prerecorded auditory messages of "Liz's turn," "Sam's turn," and "Ian's turn") was presented to promote the improvement of turn-taking behaviors. By utilizing an iPad and Microsoft PowerPoint for iPad, individualized visual and auditory stimuli were conveniently presented. Although the focus of the present study was not on the comparison of the created intervention technique with a low-tech solution, use of a family-owned iPad and easily accessible PowerPoint allowed the experimenter to have control over a group of toys, each participant, and discriminative stimulus, possibly easier than use of a series of low-tech stimuli such as multiple photographs and auditory cues.

Limitations of the current study should be addressed. First, the results of the current study are preliminary because of the experimental design, selection of participants, and operational definition of appropriate turn-taking behaviors. Although the participants are twin brothers sharing a variety of homogeneous contexts, only two were recruited in a multiple baseline design. The observed outcomes could have resulted from other environmental variables. A lack of precision in the description of turn-taking behaviors is another factor influencing the study validity. Appropriate turn-taking behavior was defined as smooth interchanges of play turns between the child and experimenter in the absence of participant's maladaptive behaviors (i.e., screaming, swiping, blocking, and grabbing the target toy) without the experimenter's physical prompts (i.e., blocking and grabbing the participant's hand and/or arm). It is possible that the study raters may have counted the presence or absence of experimenter's physical prompts rather than the participants' turn-taking behaviors. Second, the total trials of turn-taking during baseline and intervention phases greatly varied. During Ian's baseline phase, for example, the total trials of turn-taking ranged from 19 to 60. During Ian's intervention phase, the total trials of turn-taking ranged from 17 to 29. Because the experimenter had a limited time slot on each day to complete the experiment, use of an iPad reduced the number of trials per intervention session. This could have led to unstable baseline and intervention data. Finally, a small number of intervention sessions (i.e., 12 times for Ian; 11 times for Sam), compared with a number of baseline sessions (i.e., 8 times for Ian; 10 times for Sam), might have led to compromised improvement of turn-taking behaviors in the participants. Provision of extra intervention sessions for Sam might have demonstrated more significant statistical differences between baseline and intervention phases in turn taking.

The current study demonstrates a possible significance of creating a simple self-made app to facilitate turn-taking behaviors in preschoolers with autism. It is suggested that a therapist can gain control of toys and require a contingent response from a child by using the created intervention to improve turn-taking behaviors (Rieth et al., 2014). Also, the iPad and its app-based intervention used in the current study can allow a therapist to tailor an intervention technique based on an individual child's characteristics, continually monitor progress, and provide a child with systematic instruction (Knight et al., 2013). Finally, iPads or tablet devices can be effective tools to support socialization, more particularly, turn-taking behaviors in children with autism.

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