Improving Behavior of Students with Intellectual and Developmental Disabilities with Computer-Assisted Literacy Instruction: An Experimental Comparison

By

Lauren M. LeJeune

Dissertation

Submitted to the Faculty of the
Graduate School of Vanderbilt University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY
in
Special Education

August 9, 2019
Nashville, Tennessee

Approved:
Christopher J. Lemons, Ph.D.
Allison L. Bruhn, Ph.D.
Blair L. Lloyd, Ph.D.
Joseph H. Wehby, Ph.D.

ACKNOWLEDGEMENTS

This research was funded in part by Grant H325D140073 from the Office of Special Education Programs within the U.S. Department of Education, a Vanderbilt University Discovery Grant, and a Peabody College Professional Development Grant. Nothing in the article necessarily reflects the positions or policies of the funding agencies and no official endorsement by them should be inferred.

There are many who contributed to this work and to whom I am forever grateful. For his outstanding mentorship throughout the past four years, I foremost thank Dr. Chris Lemons. His thoughtful advice has always been shared with the utmost patience and kindness, and I believe I will be a better faculty member due to his example. For their trust and dedication, I thank the teachers and students who participated in this study. For their contributions to the quality and clarity of my work, I thank my doctoral committee members. Finally, I thank the Team Lemons lab members, research assistants, friends, and family members were invaluable in their contributions of time, knowledge, and emotional support.

TABLE OF CONTENTS

Page

Appendix

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER 1

INTRODUCTION

Students with intellectual and developmental disabilities (IDD) are characterized by challenges related to physical, intellectual, and/or emotional development (National Institutes of Health [NIH], 2010). Based on the U.S. Department of Education's (2018) report, students with IDD comprise approximately 20% of all students with disabilities; this includes the categories of intellectual disability (ID), autism spectrum disorder (ASD), developmental delay, and multiple disabilities. Parents and society expect that these students will learn to read in order to improve their long-term quality of life (e.g., inclusion, self-determination, employment; Browder et al., 2009; Lemons, Allor, Al Otaiba, & LeJeune, 2016). However, there remains a need to identify evidence-based practices to support comprehensive reading growth for students in this population (Spooner, Knight, Browder, & Smith, 2012).

Despite increasing evidence that students with IDD can acquire the skills necessary for reading (see Allor, Mathes, Roberts, Cheatham, & Al Otaiba, 2014), their literacy achievement lags behind peers with other disabilities (Allor et al. 2018; Wei, Blackorby, & Schiller, 2011). For example, data from the Special Education Elementary Longitudinal Study (SEELS) indicated that 92% of students with ID and 74% of students with ASD scored below the 25th percentile on the Woodcock Johnson III Passage Comprehension (WJ III; Woodcock, McGrew, & Mather, 2001) compared to 63% of all students with disabilities (Blackorby, Chorost, Garza, & Guzman, 2004). Furthermore, SEELS results for teacher-reported grade level equivalence in reading indicated that students with ID and ASD (3.1 and 1.6 grade levels behind, respectively) fair

worse than students from all disability categories (who were 1.3 grade levels behind). These results highlight the need to provide intensive, early literacy intervention for students with IDD.

Impact of Challenging Behavior on Literacy Instruction

In addition to learning struggles, students with IDD commonly engage in challenging behaviors and display low levels of motivation during instruction (Allor et al., 2018). For example, researchers have observed that children with Down syndrome (DS; the most common genetic cause of ID) often display low task persistence, including abandoning tasks sooner than other children at similar developmental levels, requesting help more frequently, and diverting instructor's attention away from tasks (Feeley & Jones, 2008; Fidler & Nadel, 2007; Kasari & Freeman, 2001; Pitcairn & Wishart, 1994). Students may escalate from low-intensity behaviors (e.g., noncompliance) to more challenging topographies when educators persist with delivering instruction (e.g., aggression; see LeJeune, Gesel, & Lemons, 2018). Indeed, researchers have reported that behavior management systems and strategies are often necessary to support students with IDD's participation in literacy instruction (Allor, Champlin, Gifford, & Mathes, 2010; Goodman & Williams, 2007).

One well-developed theory for why students may engage in challenging behaviors during instruction is that specific instructional features (e.g., difficulty or interest level) are aversive, and student behavior is reinforced by avoidance and escape from that instruction (Geiger, Carr, & LeBlanc, 2010; Gunter, Shores, Jack, Denny, & DePaepe, 1994; Rispoli et al., 2013). Challenging behaviors often terminate when educators remove or reduce the instruction; this termination of behavior may, in turn, reinforce the educator's behavior (Carr, Taylor, & Robinson, 1991). As students repeatedly contact an escape contingency, they become more

likely to engage in challenging behavior in the future. This perpetuates a negative reinforcement cycle in which teachers continue removing instruction and academic tasks become increasingly difficult and aversive (McIntosh, Horner, Chard, Dickey, & Braun, 2008; Patterson, 1976; Wehby, Lane, & Falk, 2003). The negative results of this cycle can be far-reaching for both the students (e.g., reduced access to instruction, Wehby et al., 2003) and educators themselves (e.g., reduced job satisfaction, Ozdemir, 2007). Thus, it is important to develop strategies that facilitate implementation of literacy instruction for students who engage in challenging behaviors.

Incorporating Student Preference with Computer-Assisted Instruction

Across the past several decades, research has accumulated that supports the use of various technologies to enhance the education of students with IDD (Knight, McKissick, & Saunders, 2013; Wehmeyer, Smith, Palmer, Davies, 2004). Earlier applications focused on using assistive technology (AT) for augmentative and alternative communication (e.g., speech generating devices; Knight et al., 2013). More recently, computer-assisted instruction (CAI; i.e., using computer programs to teach concepts or skills) has gained attention for its use with both academic and language/communication skills (Wehmeyer et al., 2004). Researchers have found that CAI results in improved literacy outcomes for students with IDD when using devices such as laptops, tablets, and audio players (Kagohara et al., 2013; Root, Stevenson, Davis, Geddes-Hall, & Test, 2017). However, there remains a need to investigate varied uses of CAI (e.g., multiple academic content areas, behavioral support; Kagohara et al., 2013; Knight et al., 2013; Root et al., 2017). Research on relatively affordable, widely available technology (e.g., iPads®, Chromebooks®) may be especially beneficial.

One potential use of CAI is to improve student behavior during academic instruction. Researchers have reported that students with IDD may prefer using devices such as iPads® over more traditional, paper-based instruction (Kagohara et al., 2013). This suggests that using CAI could incorporate student preference, which is a strategy with emerging research support for its use in reducing challenging behaviors (LeJeune, Sinclair, Gesel, & Lemons, 2018). However, there are currently few examples of implementing CAI to improve student behavior. This research is warranted, given that CAI may help educators decrease aversive aspects of instruction. By planning less aversive instruction, teachers may maintain low levels of challenging behaviors and high levels of engagement and, consequently, interrupt or prevent a negative reinforcement cycle (Geiger et al., 2010; Gunter et al., 1994; Rispoli et al., 2013).

Various aspects of CAI may contribute to students preferring its use over more traditional (i.e., paper-based) instruction. CAI often includes appealing instructional features such as: (a) immediacy of reinforcement for correct responding (Wehmeyer et al., 2004), (b) embedded scaffolds for navigating content (e.g., visual prompts, text-to-speech), (c) use of interactive, game-like formats (Knight et al., 2013), (d) predictable and sequential activities (Knight et al., 2013), and (e) a multitude of materials/stimuli contained within one device (Clinton, 2019). Touch-screen tablet computers (e.g., iPads®) may be especially appealing due to their portability and ease of use for students who experience fine motor difficulties. For example, swiping a screen to turn the page of an electronic book may be considerably easier than turning the page of a paper book. In addition to these instructional features, students who enjoy tech-based leisure activities (e.g., videos, games) may choose to engage with CAI if those preferred leisure tasks are available when instruction is complete.

Previous Research on Reducing Challenging Behavior with CAI

Although some researchers have anecdotally noted that participants' behavior improved during technology-based portions of intervention (LeJeune et al., 2018; Quillen, 2011), there are few direct comparisons between paper-based instruction and CAI (Knight et al., 2013). To date, I have identified three peer-reviewed experimental studies in which researchers compared traditional (e.g., paper-based) instruction to CAI and measured effects on challenging behavior or academic engagement of students with disabilities. For example, Kern, Delaney, Clarke, Dunlap, & Childs (2001) conducted a study that included two 11-year-old boys with emotional or behavioral disorders (EBD). Prior to intervention, researchers conducted observations and interviews and collected information on student preferences. Assessment results indicated that both students engaged in noncompliance when presented with paper-and-pencil writing tasks and both preferred computer-based tasks. Kern and colleagues then compared two conditions—one in which the students completed independent writing assignments with paper and pencil (Traditional Medium) and one in which they completed similar assignments on the computer (Preferred Medium). In both conditions, students received points after completing the assignment and could exchange the points for tangibles at the end of the school day. The authors compared the conditions with single case A-B-A-B designs and found that the computer-based condition resulted in increased engagement and reduced disruptive behavior for both participants. These results indicated that a teacher could incorporate CAI with positive effects, even while continuing typical classroom procedures.

Neely, Rispoli, Camargo, Davis, and Boles (2013) also conducted a single case A-B-A-B design study to compare levels of challenging behavior and academic engagement with traditional (i.e., paper and pencil) materials and iPad®-based materials. Participants were two

students with autism (ages 7 and 3 years old) who were reported to engage in challenging behaviors during academic tasks (double-digit subtraction with regrouping and matching color cards) and to prefer technology (iPad® and computer) as reinforcers. Researchers conducted a behavioral function questionnaire with caregivers and hypothesized that both students' behaviors were maintained by escape, and then they confirmed this hypothesis through a single-function functional analysis (FA). Next, Neely et al. compared student behavior during traditional and iPad® conditions in which interventionists presented the same demands (subtraction and matching) and continued to provide negative reinforcement (i.e., escape) for challenging behaviors. Visual analysis of graphed results indicated there was a functional relation between presentation mode and student behavior—the iPad® was associated with reductions in challenging behavior and increases in engagement for both students. These results indicated that CAI may improve escape-maintained behavior, even in the absence of escape extinction.

Most recently, Zein et al. (2016) compared two modes of reading comprehension instruction—teacher-directed instruction (TDI) and iPad®-assisted instruction (IAI)—with three male students with ASD who were 9 to 10 years old. In the TDI condition, students wrote responses on a paper-based main idea graphic organizer while reading a passage. In the IAI condition, students read a passage and used the *Space Voyage* iPad® application to select the best main idea statement from three options. Teachers used a token economy to reward student behavior with access to tangibles (e.g., games, snacks) in both conditions. Zein and colleagues used a single case alternating treatments design to compare effects of TDI and IAI on task refusal and curriculum-based measurement (CBM) probes of reading comprehension. The data indicated that the IAI condition resulted in fewer task refusals for two of the three participants; in contrast, CBM probes administered after TDI sessions had higher percentages of correct responses for all

three students. These authors concluded that IAI improved student behavior; however, it should be noted that differences between IAI tasks (i.e., selecting a response) and TDI tasks (i.e., generating multiple responses) may partially account for these findings.

These studies provided evidence that implementing CAI can have positive effects on student behavior; nonetheless, this research base has limitations that warrant further investigation. First, these three studies included only five total students with ASD (and two with EBD); thus, replication with additional students with IDD and those with different etiologies (e.g., DS) is necessary. Second, there is currently limited information on using assessments to determine whether using CAI will improve a specific student's behavior. Both Kern et al. (2001) and Zein et al. (2016) conducted caregiver interviews and student assessments; whereas, Neely et al. (2013) conducted an experimental analysis. Although using CAI can be characterized as incorporating student preferences, none of these authors conducted a direct preference assessment. Preference assessment may be a feasible and effective method to inform the use of CAI; however, this must be empirically investigated. Third, none of these studies presented evidence supporting the social validity of using CAI to improve behavior. Although improving student behavior is an important outcome, it is also necessary to determine whether educators and students consider CAI acceptable and the effects desirable.

Finally, there is a need to investigate whether CAI can support the implementation of research-based, intensive literacy intervention for students with IDD. Research indicates that students with IDD require extended intervention implementation (i.e., daily instruction for multiple years) to make measurable reading progress (Allor et al., 2014). However, there is no current evidence to support whether the effects of CAI on behavior maintain across time. Sessions in these three studies ranged from 5 to 20 min, and authors noted that increased demand

time may alter the effectiveness of CAI (Neely et al., 2013). Thus, studies that include longer sessions and extended implementation are needed. Relatedly, these previous studies focused on isolated components of instruction, such as independent writing tasks (Kern et al., 2001), subtraction or matching demands (Neely et al., 2013), and main idea instruction (Zein et al., 2016). This suggests there is a need to investigate whether CAI sessions that include more comprehensive instruction on multiple literacy subskills (e.g., phonological awareness, phonics) result in similar effects on student behavior.

The Present Study

The purpose of this study was to extend previous research on using CAI to improve student behavior through replicating with students with IDD, incorporating a pre-intervention preference assessment, including a comprehensive literacy intervention, and collecting social validity data. This study included participants who had a history of engaging in challenging behaviors during instruction and who were interested in technology (based on teacher report). Teachers implemented a paper-based version and an equivalent iPad®-based version of *Friends on the Block* (FOTB; Allor et al., 2018)—a comprehensive, text-based literacy intervention with evidence supporting its effectiveness for students with IDD. I used a single case experimental design to assess effects on challenging behavior, academic engagement, and mastery of targeted letter sounds and sight words.

My primary research question was "Compared to paper-based literacy instruction, does CAI result in lower levels of challenging behavior and higher levels of engagement for students with IDD?" My secondary aims were to describe (a) differences in mastery of taught items from paper-based and CAI sessions, (b) correspondence between results from pre-intervention

preference assessments and intervention comparisons, (c) maintenance of results during a "superior alone" condition, and (d) social validity using information from teacher interviews and a student choice assessment.

CHAPTER 2

METHOD

Participant Recruitment and Screening

I received approval from Vanderbilt University's Institutional Review Board and from a school district in Nashville, TN prior to beginning recruitment for this study. Two university-based research coordinators provided names and contact information for 14 teachers whom they indicated taught potentially eligible students. I e-mailed a recruitment flyer to each teacher and scheduled 15-min phone calls with those who responded, and then I provided copies of consent forms to interested teachers. I received signed consent from parents, teachers, and school administrators for five students. Three of those students met inclusion criteria (described below) and provided their verbal assent to participant. I enrolled participants in a staggered schedule—the first began assessments in December 2018 and the third completed intervention in May 2019.

Eligible students (a) were identified as having an intellectual or developmental disability (e.g., ID, ASD, developmental delay [DD]) by their school district, (b) were in elementary school, (c) used spoken English as their primary form of communication, (d) could hear and see well enough to benefit from typical classroom instruction, (e) were available for up to 5 months of instruction with the same educator for 30 min per day, four times per week, (f) engaged in high-frequency, low-intensity challenging behaviors during academic instruction, and (g) were interested in technology as reported by their teacher.

I identified eligible participants through a multiple-gating procedure adapted from the Systematic Screening for Behavior Disorders (SSBD; Walker, Severson, & Feil, 2014). First, I conducted a 10-min interview in which I asked teachers to nominate, in rank order, up to three of

their students who met inclusion criteria and to identify the behaviors of concern (see Appendix A). Second, after receiving administrator and parent consents, I conducted up to three 15- to 20-min observations during one-on-one reading instruction. I estimated duration of challenging behavior with 10-s partial interval recording (Appendix B) and proceeded to the third step if the student engaged in challenging behavior for at least 10% of one or more observations.

Third, I administered an intervention-aligned screening assessment which included each of the six letter sounds (/c/, /f/, /p/, /m/, /s/, /t/) and six sight words (I, a, like, not, want, do) targeted in FOTB Level 1 (adapted from Allor et al., 2018). To conduct the assessment, I shuffled a stack of flashcards on which each of the 12 items were printed. Then, I presented each item while asking "What sound?" or "What word?" I scored '1' if students responded correctly within 5 s and '0' if students responded incorrectly or did not respond within 5 s. Students who received a total score of 10 or fewer were included in the study.

Participant Characteristics

Participants were three male students (Jalen, Koby, and Berto) who were between the ages of 7 and 9 years old and were receiving special education services under the categories of ID or ASD. See Table 1 for each participant's demographics and assessment performance. Participant intelligence quotient (IQ) scores ranged from 40 to 78 on a researcher-administered assessment (Kaufman Brief Intelligence Test-2nd Edition [KBIT-2; Kaufman & Kaufman, 2004]). Note, although Jalen's IQ score was higher than the typical two standard deviation cut-point for ID, his psychological assessment report indicated he had met state standards for ID based on school-administered assessments. Participants' raw scores on the researcher-administered Test of Preschool Early Literacy (TOPEL; Lonigan, Wagner, Torgeson, &

Rashotte, 2007) subtests ranged from 3 to 24 on Print Knowledge (PF), 1 to 52 on Definitional Vocabulary (DV), and 3 to 13 on Phonological Awareness (PA). These were all lower than the 50th percentile raw scores (PF=25; DV=61; PA=22) of the oldest age included in the TOPEL normative sample (5 years, 11 months old).

Table 1

Student Demographics and Assessment Performance

					TOPEL[b] Scores		
Student	Disability	Age	Race/Ethnicity	IQ[a] (90% CI)	PK	DV	PA
Jalen	ID	7:4	Black; Not Hispanic	78 (73-84)	24	52	13
Koby	ASD	7:4	Black; Not Hispanic	54 (50-60)	17	1	4
Berto	ID; DS	9:2	White; Hispanic	40 (36-49)	3	6	3

Note. ID=Intellectual disability; ASD=Autism spectrum disorder; DS=Down syndrome; PK=Print Knowledge; DV=Definitional Vocabulary; PA=Phonological Awareness
[a] Kaufman Brief Intelligence Test-2nd Edition (Kaufman & Kaufman, 2004)
[b]Test of Preschool Early Literacy (Lonigan et al., 2007

Teacher-reported information on topography of challenging behaviors, access to technology, and each participant's reading goals from his Individualized Education Program (IEP) are displayed in Table 2. Participants engaged in a variety of challenging behaviors, such as aggression, verbal protests, and getting out of seat (i.e., elopement) during instruction. None of the participants had a behavior intervention plan. All participants had daily access to multiple types of technology (e.g., computer, tablet) for both academic and leisure activities (range=6-60 min/day). Reading IEP goals most commonly focused on identifying letter names or sounds and reading sight words.

Table 2

Topography of Challenging Behaviors, Access to Technology, IEP goals

Student	Challenging Behaviors	Access to Technology			Reading IEP Goals
		Type	Use	Min/Day	
Jalen	Aggression; Verbal protests; Shouting/crying/making noises; Head down; Non-compliance; Out of seat; Property damage	Smart Board	A; L	60	Identify upper and lower case letters
		Computer/Laptop	A; L	30	
		Tablet (e.g., iPad®)	A; L	30	
Koby	Aggression; Verbal protests; Shouting/crying/making noises; Non-compliance; Out of seat; Property damage	Computer/Laptop	A; L	60	Identify letter sounds; Identify sight words; Read phrases with sight words & pictures
		Audio Player (e.g., iPod)	L	15	
		Projector	A; L	5	
Berto	Verbal protests; Shouting/crying/making noises; Non-compliance; Out of seat; Property damage; Removing clothing	Tablet (e.g, iPad)	L	20	Identify sight words; Identify functional/ safety words
		Projector	A; L	15	
		Computer/Laptop	A	5	

Note. A=Academic; L=Leisure

Interventionists and Settings

Special education teachers implemented FOTB with all student participants. All teachers were White, non-Hispanic females between the ages of 30 and 54 years old and had master's degrees in special education. Their special education teaching experience ranged from 1 to 9 years, and each teacher had taught the participating student for 1 to 3 years. In the week after completing screening and assessments, Berto was assigned to a new teacher in his building who consented to participate in the intervention portion of the study. See the intervention section for a description of teacher training procedures.

Sessions took place in three public schools in Nashville, TN. Teachers implemented one-on-one FOTB sessions in their special education classrooms. A research team member was present during all sessions to video record and provide procedural coaching as needed. One or two other adults and students were often present in the classrooms; however, I requested that they refrain from interacting with participants during sessions.

Pre-Intervention Assessment Procedures

Following participant screening, I conducted a multiple stimulus without replacement (MSWO; DeLeon & Iwata, 1996) preference assessment and a concurrent operants analysis (COA; Harding et al., 1999) with each participant. The purpose of these assessments was to provide information on whether participants preferred to interact with technology during leisure and academic activities. I will describe procedures for each assessment in the next sections.

MSWO. First, I conducted an MSWO preference assessment to determine a hierarchy of participants' preferred tangible items. I asked each teacher to nominate five to seven items with

which the student typically interacted during leisure times, including some that were technology-based and some that were not. Prior to each trial, I provided the student at least 30 s exposure to each item and then placed the items in a line. At the start of each trial, I instructed the student to "pick one" and allowed the student to interact with the chosen item for 15 to 30 s. Then I removed the item, rearranged item order, and instructed the student to choose a new item. I repeated this procedure until all items were chosen or the student no longer chose. I completed three MSWO trials with each participant and calculated the percentage of trials in which each item was selected by dividing the number of times the item was chosen (range=0-3) by the total number of times it was presented (range=3-21; see sample form in Appendix C). I concluded that students "highly preferred" the two items with the highest percentages.

Research assistants collected interobserver agreement (IOA) and procedural fidelity (PF) data for one trial per participant (33.33%). I calculated IOA by recording whether data collectors agreed on each item's ranking, dividing the number of agreements by the sum of agreements plus disagreements, and multiplying by 100. We used a direct observation method for PF; data collectors tallied whether I engaged in each required behavior (e.g., rotating materials, giving the student access for at least 15 s) correctly or incorrectly. I then calculated PF percentage by dividing the number correct by the sum of correct plus incorrect and dividing by 100. IOA and PF were 100% for Jalen and Berto's sessions. For Koby's sessions, IOA was 100% and PF was 90% due to one opportunity in which he was not given access to the chosen item for at least 15 s.

COA. Next, I conducted a COA with each participant to determine how they allocated their time if provided a choice between paper-based and iPad®-based activities. A research assistant was present during all sessions as a facilitator. She used a smart phone application

(counteeapp.com) to record data for decision-making immediately following the session. Research assistants then collected data from video for the final analysis. COAs for Jalen and Berto were conducted without the teacher present; Koby's teacher observed during his COA.

Sessions occurred for 3 min in a quiet area of the participant's classroom and proceeded through three choice conditions (see Table 3). Prior to beginning each session, I used colored tape to designate two spaces and arranged relevant session materials within each space. The facilitator then described each choice and we provided the participant with the opportunity to interact with materials. Next the facilitator directed the participant to stand away from the table and instructed him to "make a choice." Throughout the session, participants could freely move between options (i.e., sides of the table). When a participant entered a designated area, I immediately responded with the prescribed behaviors and continued until the participant moved to a different area. Following each session, we immediately re-presented the same options on opposite sides of the table in order to detect preference stability and rule out side-bias. I concluded that a participant preferred an option if he allocated at least 2 of 3 min (66.6% of session) to the same option for two consecutive sessions.

A research assistant collected IOA and PF from randomly selected video recordings of 33.33% of sessions for Jalen and Koby and 37.5% of sessions for Berto. IOA results represent the percentage of proportional agreement between data collectors; we used the calculator on counteeapp.com set to 10-s intervals. We calculated PF with a direct observation method; data collectors recorded whether set-up procedures (e.g., explaining rules) were correct at the beginning of the session and then recorded whether condition procedures (e.g. placing demands, rule reminders) were correct with 30-s interval recording. We calculated PF percentage by counting the number of correct procedures and then diving the sum of correct plus incorrect and

Table 3

Concurrent Operants Analysis (COA) Conditions

Choice Conditions	Options	Materials	Therapist behaviors
Condition 1	A: Work on paper alone	Writing worksheet	None
	B: Play on iPad® with attention	iPad® with games	Comment about game every 30 s
Condition 2	C: Teacher reads iPad® story (no demands)	Book displayed on iPad®	*Both conditions:* Read book
	D: Teacher reads paper story (no demands)	Book on paper	
Condition 3	E: Teacher reads iPad® story (with demands)	Book displayed on iPad®	*Both conditions:* Read book Place demand to touch picture on each page Use verbal-model prompt sequence Praise compliance
	F: Teacher reads paper story (with demands)	Book on paper	

Note. Books were selected from Reading A-Z Level G (readinga-z.com) and focused on high-interest topics (e.g., bugs). In Conditions 2 and 3, each option contained the same books. For Jalen, the same books were available throughout a given condition. For Koby and Berto, the therapist rotated books each session.

multiplying by 100. Mean IOA was 99.38% for Jalen (range=98.15-100%), 99.03% for Koby (range=97.22-100%), and 93.98% for Berto (range=83.33-100%). Mean PF was 93.63% for Jalen (range=90-100%) and 100% for both Koby and Berto.

Intervention

Overview. Teachers implemented an adapted version of FOTB (Allor et al., 2018), a text-based intervention that includes explicit instruction in phonics, sight words, vocabulary, fluency, and basic comprehension. I adapted activities from the commercially available version of FOTB to decrease session-based variation because I hypothesized those variations could affect student behavior and potentially confound results. My adaptations included modifying or substituting some activities and omitting the fifth weekly intervention day that focused on reinforcement. I will further describe adaptations within each of the intervention steps.

During the intervention comparison phase, teachers alternated paper-based and iPad®-based implementation daily in a block-randomized order. Intervention focused on one story per week, the order of which was randomly selected for each participant. If a participant completed four weeks without mastering the target content, teachers re-presented the stories in the same sequence. Sessions occurred for 25 min, four to five times per week.

Teachers implemented Level 1 during the intervention comparison phase and could implement Level 2 during the "superior alone" phase if the participant mastered Level 1 content. Level 1 includes four stories (*A Healthy Breakfast*, *How to Make a Pizza*, *Let's Make Lunch*, *Sam's Lunch)*, six letter sounds (/c/, /f/, /p/, /m/, /s/, /t/), and six sight words (I, a, like, not, want, do). Level 2 introduces four new stories (*Dad and Sam Bake a Cake, Families, Hide and Seek, I*

Like the Zoo), three additional letter sounds (/d/, /j/, /n/) and eight sight words (dad, is, Mom, the, here, look, see, where).

Behavior management. During intervention sessions, I instructed teachers to respond to challenging behaviors by reminding the student of the rules (which were introduced at the beginning of each session) and then continuing with instruction. If a student eloped, the teacher requested that he return and provided physical guidance if necessary. During all sessions, Jalen and Koby's teachers implemented token economy interventions. Jalen earned tickets to exchange in the school-wide behavior reward system, and Koby earned edible rewards (e.g., juice). Jalen and Koby's teachers also provided access to preferred activities on the iPad® following both paper-based and iPad®-based sessions. Berto's teacher did not use a behavior system during any sessions; he was typically able to use the classroom swing after sessions.

Materials. During sessions, teachers used lesson scripts that included instructions, sample language, and corrective feedback for implementing each activity. Lesson rules and visual schedules were on laminated cardstock. The rules were: (1) have a safe body, (2) stay in our area, and (3) be kind to others. The visual schedule included symbols to indicate whether the session was paper-based or iPad®-based and each of the four lesson steps.

There were both paper- and iPad®-based versions of warm-up sheets, stories, text building games, and assessment materials. All iPad®-based materials were displayed on 9.7" iPads®. Assessment materials were located in the Chegg® Flashcards application and warm up sheets and stories were stored in the iBooks application. Paper-based materials were printed to a similar size. Each warm-up sheet included five letters and five sight words. Each story included a

title page, an introduction page (including sight words, picture words, and a one-sentence story starter), and six content pages (including teacher text and student text with picture support). Each assessment included the six letter sounds and six sight words presented in a shuffled order. I videotaped all sessions by placing recorders in an unobtrusive area and positioning them in a direction so that the teacher, student, and all materials were visible; these videos allowed for post-session data collection.

Teacher training. I used a three-step behavioral skills training (BST; Parsons, Rollyson, & Reid, 2012) procedure to train teachers. First, I delivered intervention materials and requested that teachers watch a 13-min video that described the study and included models of the research team implementing both paper-based and iPad®-based activities. Second, I scheduled a 30-min meeting to discuss the procedures and answer any questions. Third, the teacher role-played the procedures without the participant present during a 30-min meeting and I provided feedback until she achieved at least 90% fidelity on a training checklist (see Appendix D). All teachers met this criterion within one practice session. Following training, I provided in-vivo coaching daily during the first week of intervention and then provided feedback on procedural fidelity immediately following one randomly selected session per week.

Intervention steps. Each intervention session included four steps: (1) mastery test, (2) warm-up, (3) story reading, and (4) text building games.

Step 1: Mastery test (5 min). Teachers began each session by reading the lesson rules, stating whether they would use paper materials or the iPad® during the session, and naming each lesson step while pointing to it on the visual schedule. Then they administered a mastery test in

which they presented each letter sound and sight word in a shuffled order (adapted from Allor et al. [2018), which only included sight words). The teacher held up each item while asking "What sound?" or "What word?" She scored '1' if the student responded correctly within 5 s and '0' if the student responded incorrectly or did not respond within 5 s. During Level 2 sessions, teachers shuffled the decks of letters/words and assessed the first six items from each deck.

Step 2: Warm-up (5 min). Second, the teacher used an "I do-We do-You do" procedure to guide the student through orally blending the onset-rime and identifying the first sound (i.e., phonological awareness) of four words from the story. For example, the teacher modeled blending by saying "I will say the sounds in a word, then I will say the word. I'll do the first one. Listen /nnn/ /ot/. That word is *not.* Say *not."* During the second example, the teacher prompted the student to blend the word with her. Then the instructor prompted the student to independently blend a word. Finally, the instructor used the warm-up sheet and the same procedure to guide the student through identifying five letter sounds and five sight words. These procedures were identical to those described in the FOTB teacher guide.

Step 3: Story reading (10 min). Next, teachers read the story to the student while asking dialogic-style reading questions. Teachers read complex "helper" text printed at the top of the page, and then students read instructional-level text that was displayed within a caption/bubble and accompanied with picture support (e.g., *I like pizza* with a picture of a pizza underneath the word *pizza*). Teachers then used the accompanying lesson script to ask one simple recall question per page (adapted from FOTB teacher guide, which includes options for higher-order questions). For example, questions for *A Healthy Breakfast* included "What color are the eggs?" and "What is this?" while pointing to pictures (e.g., oatmeal, milk). Teachers corrected errors with an "I do-We do-You do" procedure. For example, the teacher would say "Eggs are white. Say white with

me. Good. You try again. What color are the eggs?" These procedures were the same during each session for a given story (note that FOTB typically includes prediction questions on Day 1 and review questions on Day 4).

Step 4: Text building (5 min). Third, teachers led students through two text-building games. In Build-A-Word, students arranged individual letters to build each of the six target sight words with a model of the word present. In Build-A-Sentence, students arranged individual words to build five to seven total sentences. In the iPad®-based condition, the application demonstrated how to build one word or sentence. Following each opportunity, an animation with sounds effects played, along with praise statements (e.g., "Great job. Let's build another one."). In the paper-based condition, the teacher provided one model and praised after each opportunity. These text-building games replaced the multiple FOTB learning games (e.g., sorting, reading fluency). Although the FOTB research team developed these text-building games and shared them with our research team, they were not included in previous research (Allor et al., 2018).

Data Collection and Dependent Variables

The percentage of intervals with challenging behavior and academic engagement were the primary and secondary dependent variables, respectively. We collected these data from video recordings with ProCoderDV™ software (Tapp, 2003). Using the software, data collectors divided the video recording of each session into 10-s intervals. They could then play and replay selected intervals and pause at the end of each interval. Data collectors coded all intervals and then estimated duration by calculating the percentage of intervals with each behavior (i.e., dividing the number of occurrences by the total number of intervals and multiplying by 100).

Behavior definitions. I defined challenging behavior as "behavior that interferes with or interrupts a teacher's presentation of a lesson." Examples of challenging behavior included those that teachers identified during screening interviews (e.g., verbal protests, leaving the area [i.e., elopement], property damage, shouting). Non-examples included behaviors such as talking or making noises at a conversational level, touching materials, or standing up during the lesson. I estimated the duration of challenging behavior with partial interval recording because the behaviors could occur for extended time periods (e.g., elopement) and had varied topographies which did not all have clear onsets and offsets (e.g., verbal protests).

I defined academic engagement as interacting with the teacher and/or study materials as directed (definition adapted from Bruhn, Woods-Groves, Fernando, Choi, & Troughton, 2017). Examples included looking at the teacher while she was speaking, attending to and using materials in a contextually appropriate way, waiting for the teacher (if instructions were not provided), asking for assistance, and talking to the teacher about lesson content. Non-examples included looking away from the teacher or materials during times when instruction was being presented and engaging in behaviors that did not meet the definition of challenging behavior but were unrelated to instruction (e.g., talking about an off-topic subject). Data collectors recorded whether the student was academically engaged when the video recording paused at the end of each 10-s interval (i.e., momentary time sampling).

Mastery test items correct. I collected data on students' mastery of taught content (i.e., sight words and letter sounds) by recording the number of items correct on the daily mastery test (described in previous intervention section). Scores could range from 0 to 12. Students could

begin FOTB Level 2 in the "superior alone" phase after scoring 10 items or greater correct (83.33%) on Level 1 for two consecutive sessions.

Data Collection Training

Prior to the baseline phase, I conducted a 2-hr initial training with data collectors (both were graduate students enrolled in a speech-language pathology program). I provided a task analysis for using ProCoderDV™ and definitions of each dependent variable with examples and non-examples. I then modeled using the software and coding behavior. Following the training, data collectors independently coded 20-min videos from a previous, similar project and I compared their codes to my "gold standard." We discussed discrepancies after each coding session and they continued until they reached at least 90% agreement for both dependent variables across two videos. Both data collectors met this standard after coding five videos.

Interobserver Agreement and Procedural Fidelity

I collected IOA and PF data on 30% of each participant's sessions, distributed across phases (see Table 4 for results). I calculated IOA by counting the number of intervals with data collector agreement, dividing the number of agreements by the sum of agreements plus disagreements, and multiplying by 100 (i.e., interval-by-interval method [Ayres & Ledford, 2014]). Mean challenging behavior IOA was 95.30% or greater and mean academic engagement IOA was 87.80% or greater for all participants. Although IOA results for paper and CAI sessions were comparable, agreement was generally lower for academic engagement than challenging behavior. When IOA for any session was below 90% agreement, I met with data collectors to view video segments in which there were disagreements and discuss the correct code.

I used a direct observation method to collect in vivo PF data and then referred to videos if clarification was necessary. The fidelity form listed necessary procedures for each intervention step (e.g., reviewing rules, reading text in story [see Appendix E]). I recorded that a procedure was 'correct' each time a teacher engaged in a required procedure correctly. I recorded that a procedure was 'incorrect' each time teacher engaged in a required procedure incorrectly or did not engage in a required procedure. I then calculated a PF percentage by dividing the number correct by the sum of correct plus incorrect and multiplying by 100. Mean PF for all teachers was 89.86% or greater. Results for paper and CAI sessions were comparable for Jalen and Koby, and Berto's teacher demonstrated higher PF in CAI sessions.

At the conclusion of the PF session, I used a 5-point, Likert-type scale to rate the overall quality of teacher tone and interactions. For example, I rated '1' if the teacher was highly negative/punitive, '3' if she was neutral, and '5' if she was highly supportive and encouraging. See Appendix F for definitions for each rating. The purpose of this rating was to detect whether there were differences in teacher tone and interactions between paper-based and iPad®-based sessions that could explain differences in student behavior. Mean quality ratings ranged from 3.40 to 5 and were comparable for paper-based and CAI sessions. This comparability suggests that it was unlikely differences in student were due to differences in quality of teachers' tone and interactions.

Experimental Design and Data Analysis

I used an alternating treatments single case experimental design (ATD; Barlow & Hayes, 1979) to evaluate the effects of paper-based instruction versus CAI (i.e., iPad®-based instruction) on student behavior. This included an intervention comparison phase and a superior

condition alone phase. During the intervention comparison phase, teachers conducted each pair of sessions (i.e., one paper-based and one iPad®-based) in a block-randomized order. I used visual analysis of graphed data to determine whether there was differentiation (i.e., vertical separation) between data paths. Teachers implemented the comparison phase until three consecutive series of challenging behavior data demonstrated differentiation or if differentiation did not occur within 10 series (i.e., 20 sessions). I then conducted the "superior alone" phase (Barlow & Hayes, 1979) for 10 sessions with the condition that resulted in the lowest percentage of challenging behavior. The purpose of this phase was to describe whether results maintained over time. I omitted this phase if neither condition was superior.

Table 4

Mean IOA and PF Results by Phase and Condition

Student	DV	IOA[a]		PF - Implementation[a]		PF - Quality[b]	
		Paper	CAI	Paper	CAI	Paper	CAI
Jalen	Challenging behaviors	96.67% (93.42-99%)	95.30% (90.60-100%)				
	Academic engagement	91.59% (88.30-97%)	88.94% (77.85-95.52%)	94.24% (91.30-97.18%)	94.29% (77.85-95.52%)	3.50 (3-4)	3.40 (3-4)
	Mastery test score	100%	95.83% (83.33-100%)				
Koby	Challenging behaviors	96.61% (95.83-97.83%)	97.11% (93.71-99.23%)				
	Academic engagement	89.01% (86.71-91.30%)	87.80% (77.17-98.25%)	93.70% (91.43-95.71%)	92.30% (80.56-98.51%)	3.80 (2-5)	3.75 (2-5)
	Mastery test	96.67% (91.67-100%)	100%				
Berto	Challenging behaviors	99.47% (99.20-100%)	97.89% (95.90-98.54%)				
	Academic engagement	94.68% (92.06-96.80%)	91.31% (89.05-93.89%)	89.86% (81.16-98.55%)	96.03% (91.30-98.59%)	5	4.50 (4-5)
	Mastery test	100%	100%				

Note. DV=dependent variable; IOA=interobserver agreement; PF=procedural fidelity

[a]Mean results; range in parentheses

[b]Quality measured on 1-5 scale (1=highly negative/punitive; 5=highly supportive/encouraging)

Correspondence of assessment and intervention results. Following the intervention comparison phase, I compared data from each student's pre-intervention assessments with intervention data to evaluate whether there was correspondence. If data indicated the iPad®-based condition resulted in reduced challenging behaviors, I concluded there was (a) high correspondence if all preference assessment data indicated technology was preferred, (b) moderate correspondence if a portion of preference assessment data indicated technology was preferred (e.g., MSWO but not COA; a portion of COA), and (c) low correspondence if preference assessments indicated technology was *not* preferred.

If the treatment comparison indicated the iPad®-based condition *did not* result in reduced challenging behaviors, I determined there was (a) high correspondence if all preference assessment results indicated technology was *not* preferred, (b) moderate correspondence if a portion of preference assessment results indicated technology was *not* preferred, and (c) low correspondence if preference assessments indicated technology was preferred.

Social Validity

I collected social validity data from both students and teachers. Immediately following the intervention comparison phase, I used a concurrent chains procedure (Hanley, 2010) to collect direct social validity data on students' preference for paper-based versus iPad®-based conditions. During this assessment, teachers provided students with a choice to complete FOTB on paper or iPad® by presenting the symbols from the visual schedule and stating "choose one." Next, the teacher implemented a brief session of the chosen condition with the mastery test omitted. Teachers conducted the procedure once or twice each day until data representing

cumulative number of choices indicated the participant chose the same condition on three consecutive occasions or they completed 10 sessions.

At the conclusion of the study, teachers completed a 12-item survey that included statements pertaining to the goals, procedures, and results of both paper-based and iPad®-based instruction (see Appendix G). Teachers rated each statement on a Likert-type scale (1=strongly disagree; 5=strongly agree) to provide indirect data on their experience. Although I had occasionally shown teachers data to provide rationales for study procedures (e.g., implementing additional intervention sessions), they did not view student graphs while completing the surveys. I will describe student and teacher social validity results within the next section.

CHAPTER 3

RESULTS

In this section, I will first describe preference assessment and intervention results for each student. Second, I will describe overall correspondence between those results. Third, I will describe social validity results from the concurrent chains assessment and teacher interviews.

Jalen

Preference assessments. The first pane in Figure 1 depicts results from Jalen's MSWO. MSWO results for percentage of trials selected indicated that Jalen highly preferred magnetic tiles (60%) and drawing materials (37.50%). His lower-preferred items included iPad® games (33.33%), Play-Doh (30%), and a paper book (23.08%).

Results from Jalen's COA are depicted in the second pane of Figure 1. During Condition 1 (see Table 3), Jalen consistently chose to play on the iPad® with attention (85% and 88.89% of time allocated) compared to completing academic work on paper without attention (0% and 8.33% of time allocated). Across Condition 2, data indicate that Jalen preferred listening to a story on iPad® (range of time allocated=33.88-96.11%) compared to the paper (range of time allocated=0-62.2%). In Condition 3, data from three of four sessions indicate that Jalen allocated more time to listening to a story on iPad® (range of time allocated=0-91.11%) compared to the paper (range of time allocated=0-83.33%). Jalen began engaging in challenging behaviors (e.g., attempting to leave the room); therefore, we discontinued the COA after four sessions in Condition 3 and did not meet a priori criteria for determining a preference (66.67% of two consecutive sessions).

Intervention comparison phase. Figure 2 depicts Jalen's data for challenging behavior, academic engagement, and mastery test scores. Jalen completed 10 sessions of the intervention comparison phase. Challenging behavior data in the paper condition were variable and ranged from 4 to 32.04% of intervals. In the iPad® condition, challenging behavior data were relatively low and stable, ranging from 4.9 to 11.41% of intervals. Data from sessions 6 to 10 indicate that there was a functional relation in which the level of challenging behavior was consistently lower in the iPad® condition.

Academic engagement data in the paper condition were variable (range=47.57-85%) with an increasing trend across the final three sessions. In the iPad® condition, academic engagement data were relatively stable, ranging from 83.22 to 90.85% of intervals. Data from sessions 6 to 10 indicate that there was a functional relation in which the level of academic engagement was consistently higher in the iPad® condition.

Mastery test scores in the iPad® condition were low and stable (range=3-4 items correct); whereas data in the paper condition were low and variable (range=1-4 items correct). Data from sessions 1 through 6 indicate there was a functional relation with mastery test data in the iPad® condition consistently higher compared to the paper condition. However, this conclusion was weakened by data from sessions 7 through 10 in which the pattern of differentiation did not continue.

Superior alone phase. Jalen completed 10 iPad®-based (i.e., CAI) sessions in the superior alone phase. Across the first 6 sessions, challenging behavior data displayed an increasing trend (range=3.88-32.09%) and academic engagement data displayed a decreasing trend (range=83.74-58.1%). I hypothesized that these patterns were related to reduced novelty

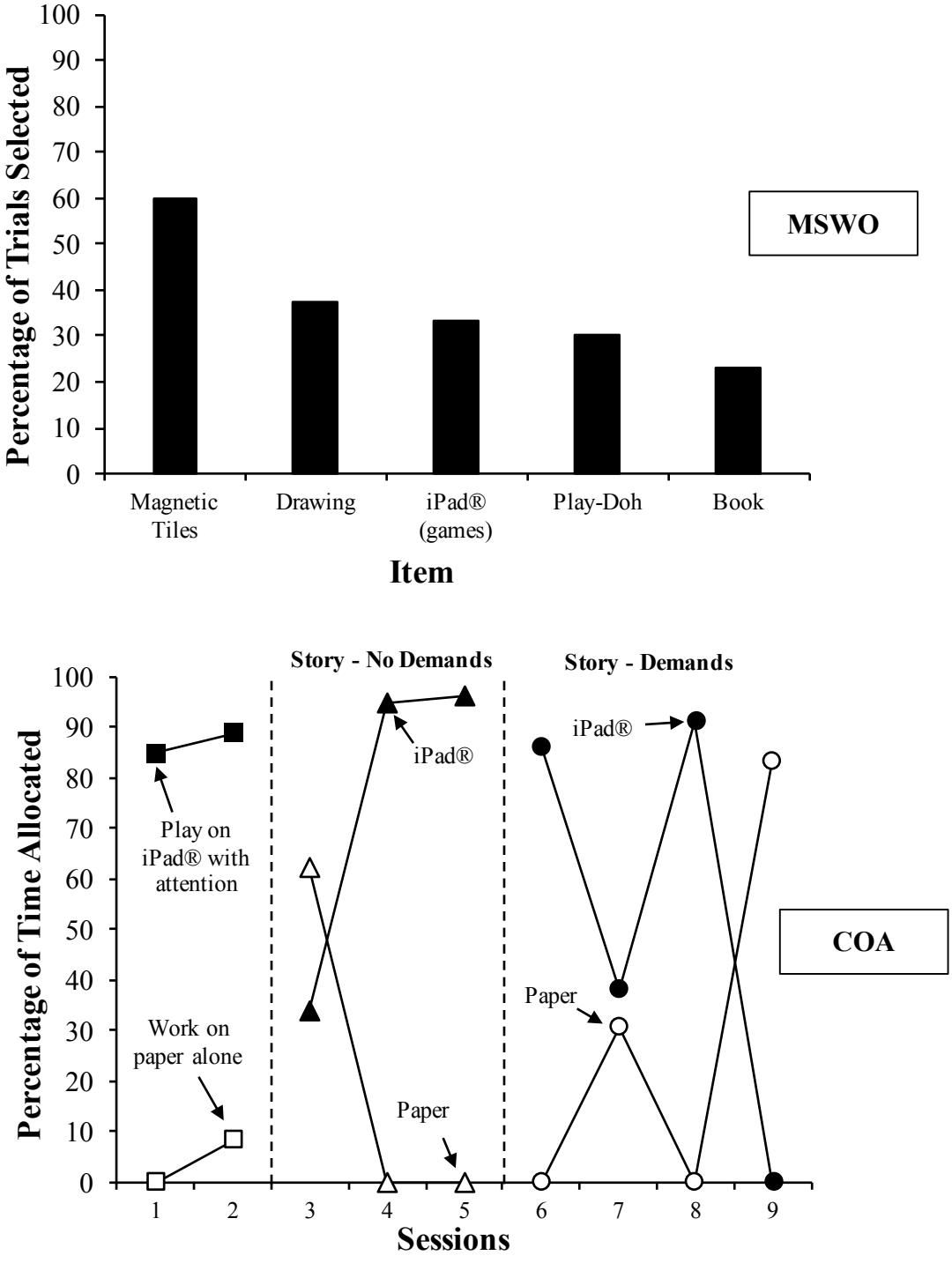

Figure 1. Jalen's MSWO and COA Results

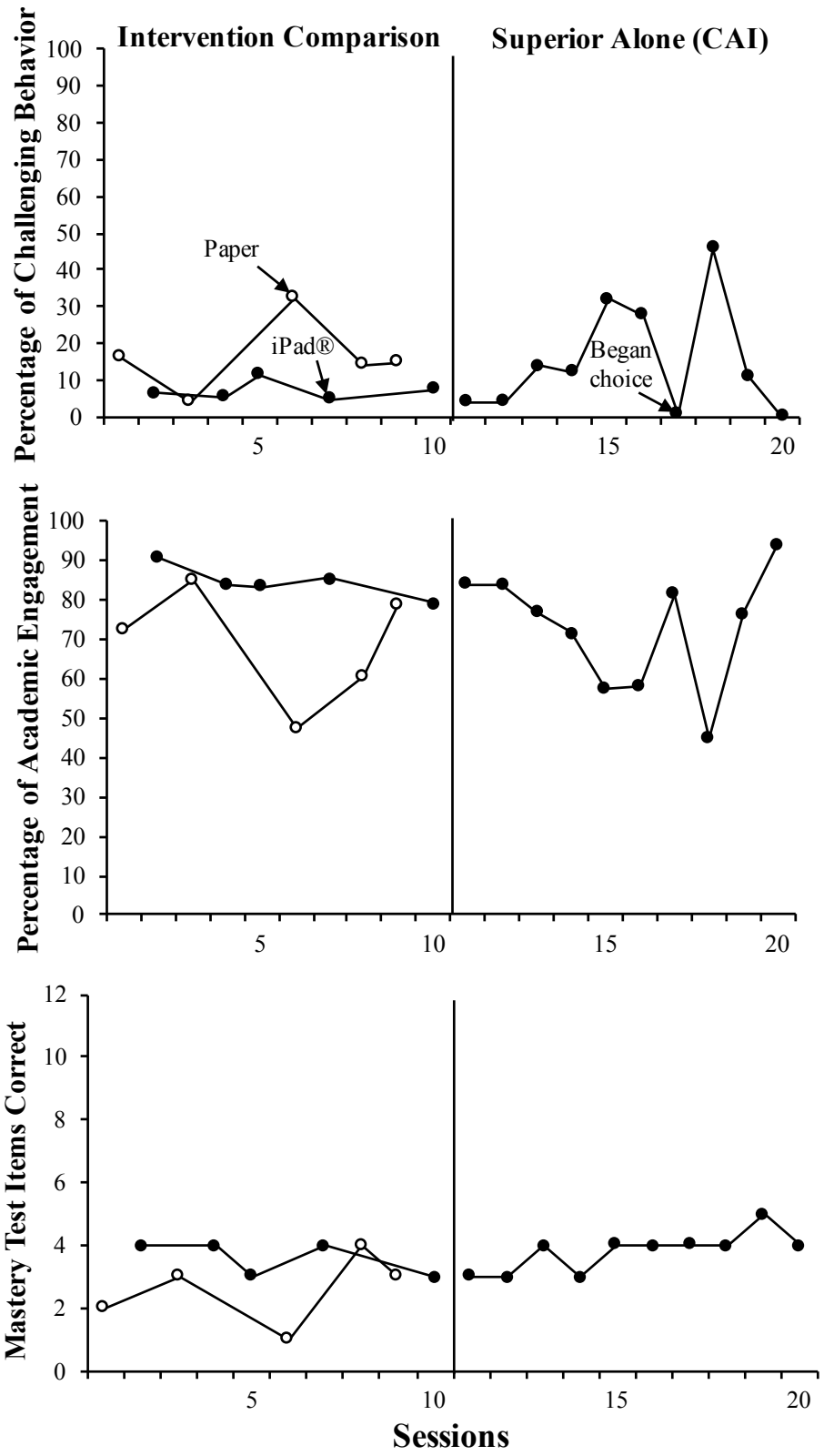

Figure 2. Jalen's Intervention Results

because Jalen had completed the four FOTB Level 1 stories and his teacher was repeating the sequence. Therefore, starting with the seventh session, we adapted procedures and began each session by giving Jalen a choice of which Level 1 story to complete. Data across the final three sessions display a decreasing trend for challenging behavior (45.75 to 0%) and an increasing trend for academic engagement (44.96 to 94.29%). Mastery test data during the superior alone phase were stable and remained at a level similar to data from the iPad® condition in the comparison phase (range=3-5 items correct).

Koby

Preference assessments. Koby's MSWO results are depicted in the first pane of Figure 3. His highly preferred items included videos on a computer (75% of trials) and a stuffed animal toy (50% of trials). The data indicated that Koby had a lower preference for iPad® games (33.33% of trials), kinetic sand (25% of trials), toy figurines (22.22% of trials), drawing materials (20% of trials), and a paper book (14.29% of trials).

Koby's COA results are depicted in the second pane of Figure 3. Across all comparisons, Koby's data indicate that he consistently preferred iPad® conditions. In Condition 1, his time allocated to playing on the iPad® with attention ranged from 90 to 95%. In Condition 2, Koby allocated 96.67% of both sessions to listening to a story on the iPad®. In Condition 3, Koby allocated 96.11% of the first session and 94.44% of the second session to completing demands while listening to a story on the iPad®. Across the three conditions, Koby did not allocate any time to working on paper without attention, listening to a story on paper, or completing demands while listening to a story on paper.

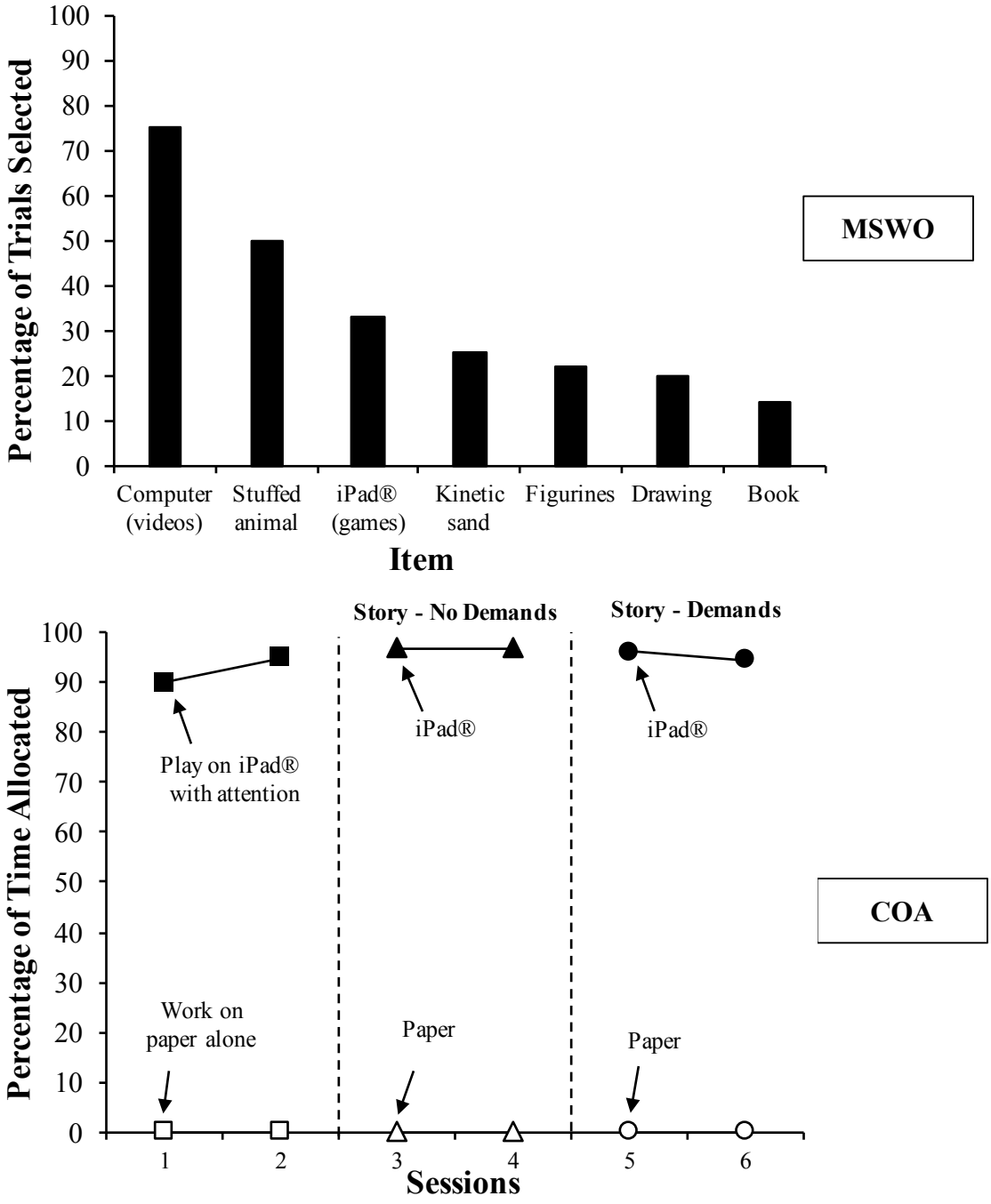

Figure 3. Koby's MSWO and COA Results

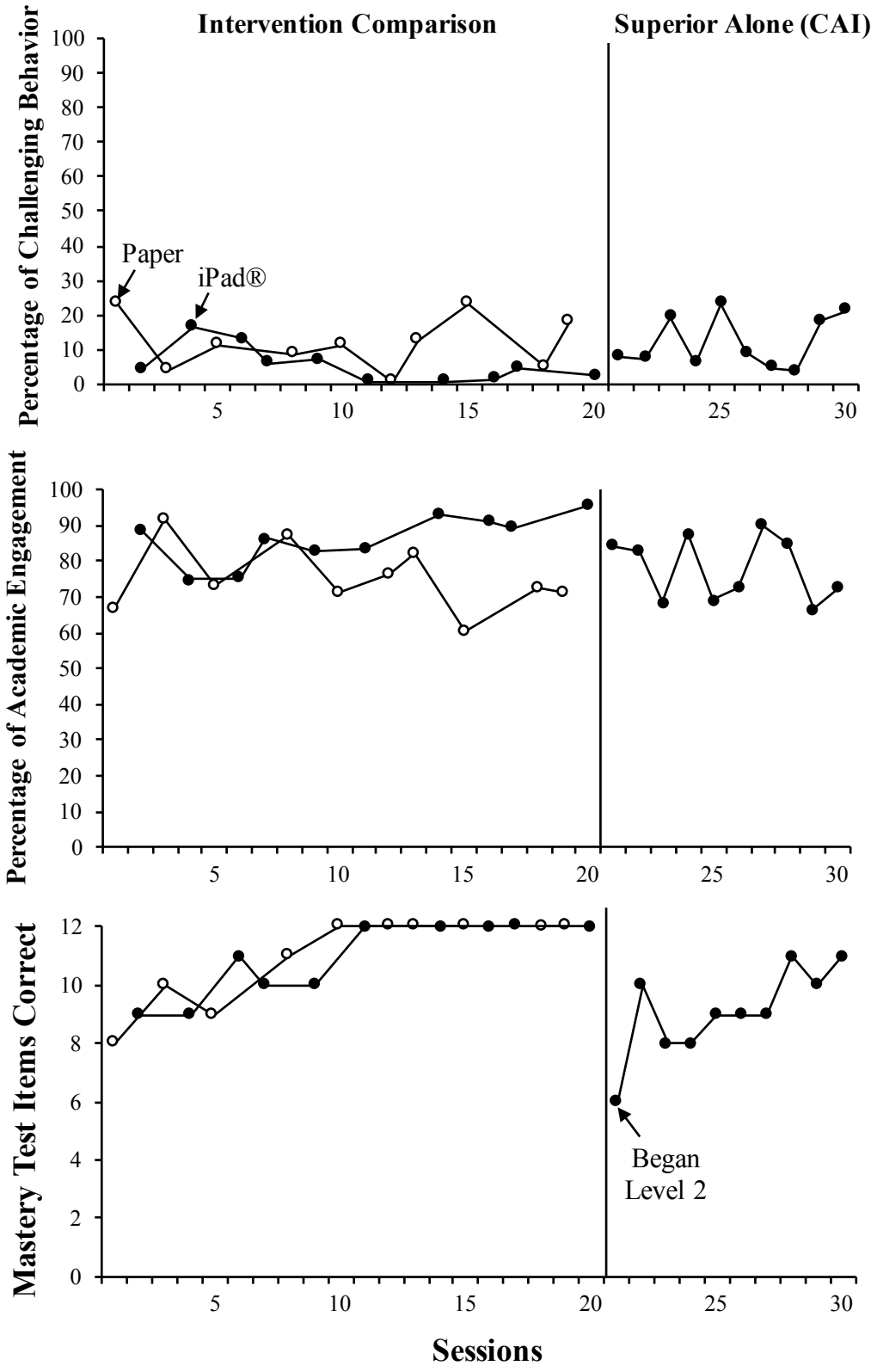

Figure 4. Koby's Intervention Results

Intervention comparison phase. Koby completed 20 sessions of the intervention comparison (see Figure 4). Challenging behavior in the CAI condition demonstrated a decreasing trend through Session 11 (range=0.72-16.25%) and then remained low and stable through Session 20 (range=0.87-4.86%). Data from paper-based sessions were variable throughout the phase, ranging from 0.76 to 23.13%. In the final six sessions, data were consistently lower in the iPad® condition, which indicated there was a functional relation between CAI and reduced challenging behavior.

Academic engagement data overlapped in Sessions 1 through 8, ranging from 66.67 to 87.31% in paper sessions and 74.85 to 89.09% in iPad® sessions. Across Sessions 9 to 20, vertical separation between conditions emerged in that iPad®-based data remained high and stable (range=82.76-95.73%) and paper-based data demonstrated a decreasing trend (range=60.45-81.97%). These data indicate that there was a functional relation between CAI sessions and higher levels of academic engagement.

Mastery test data are depicted in the third pane of Figure 4. Data in both conditions displayed an increasing trend in Sessions 1 to 10, ranging from 8 to 11 items correct. From Sessions 10 to 12, Koby scored 12 on all mastery tests. Thus, there was not a functional relation between mastery test items correct and either intervention condition (both conditions supported high mastery test scores).

Superior alone phase. Koby completed 10 sessions in the superior alone (CAI) condition and began Level 2 at the beginning of the phase (i.e., Session 21). Both behavior data paths were variable across this phase—challenging behavior ranged from 3.77 to 23.39% and academic engagement ranged from 66.48 to 89.72%. Mastery test items correct initially

decreased to lower than the comparison phase; though an increasing trend from 6 to 11 items correct was evident across the phase.

Berto

Preference assessments. The top pane of Figure 5 depicts results from Berto's MSWO. The data indicate that his highest preferred choices were music on an iPad® (100% of trials) and drawing materials (37.5% of trials). Berto's lower-preferred choices included Play-Doh (30% of trials), puzzle (24% of trials), adding machine (21.42% trials), and a paper book (18.75% of trials).

The bottom pane of Figure 5 depicts results from Berto's COA. During Condition 1, data indicate that Berto preferred playing on the iPad® with attention (range of time allocated=80%-93.33%) compared to working on paper without attention (range of time allocated=3.33%-9.44%). Data from Condition 2 indicate that Berto preferred listening to a story on the iPad® (range of time allocated=95%-95.56%) compared to paper (0% of time allocated). Data from Condition 3 are highly variable and indicate that Berto did not prefer either completing demands while listening to a story on the iPad® (range of time allocated=0%-96.67%) or paper (range of time allocated=0%-96.67%). Berto began engaging in challenging behaviors during Condition 3 (e.g., low-intensity aggression); therefore; I discontinued the COA after four sessions.

Intervention comparison phase. Berto completed 20 sessions of the intervention comparison (see Figure 6). Across the phase, challenging behavior data in both conditions were low or at zero levels (paper range=0-1.65%; iPad range=0-3.31%). Academic engagement data were high across both conditions and data paths frequently overlapped (paper range=84.30-

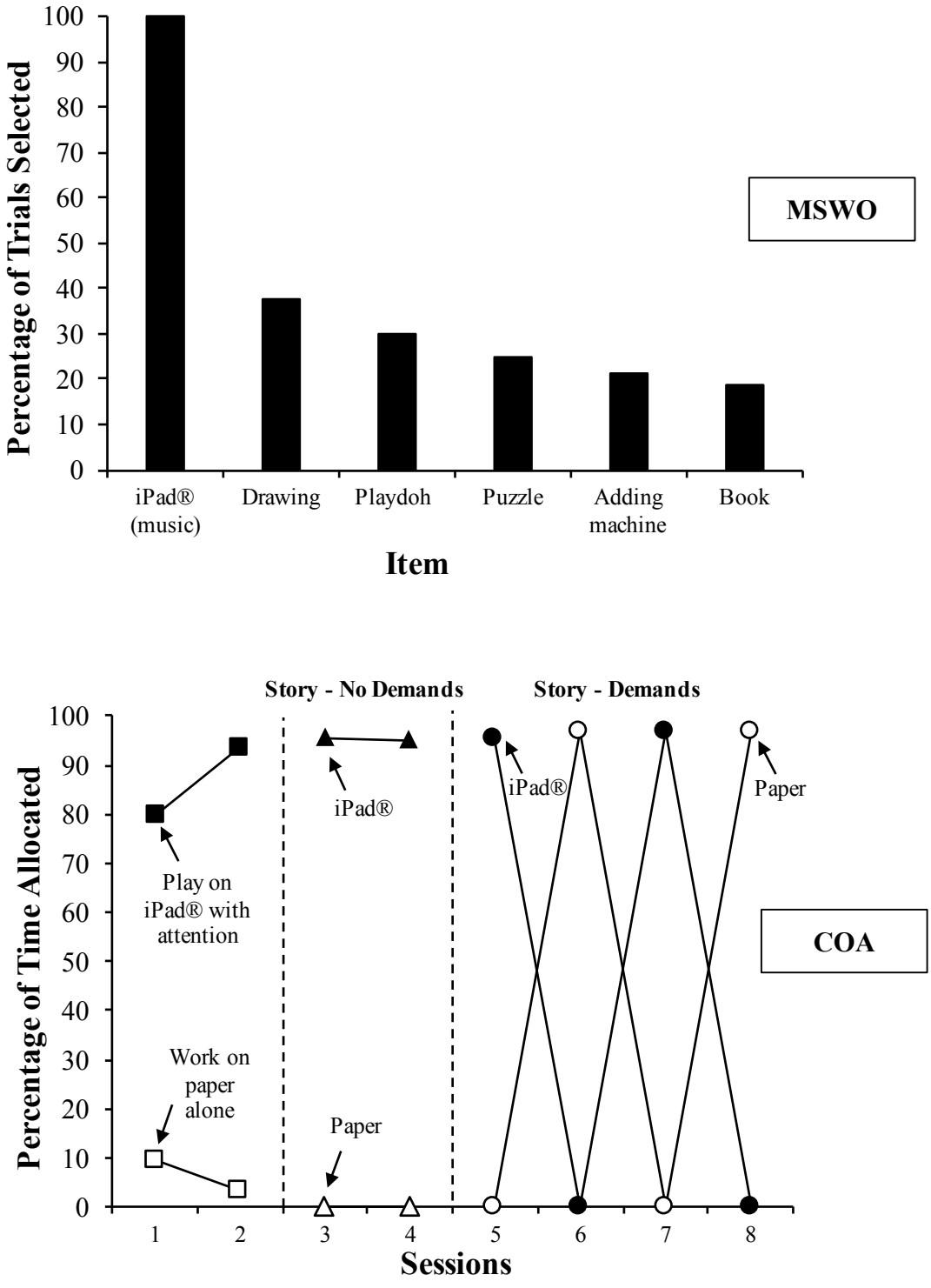

Figure 5. *Berto's MSWO and COA Results*

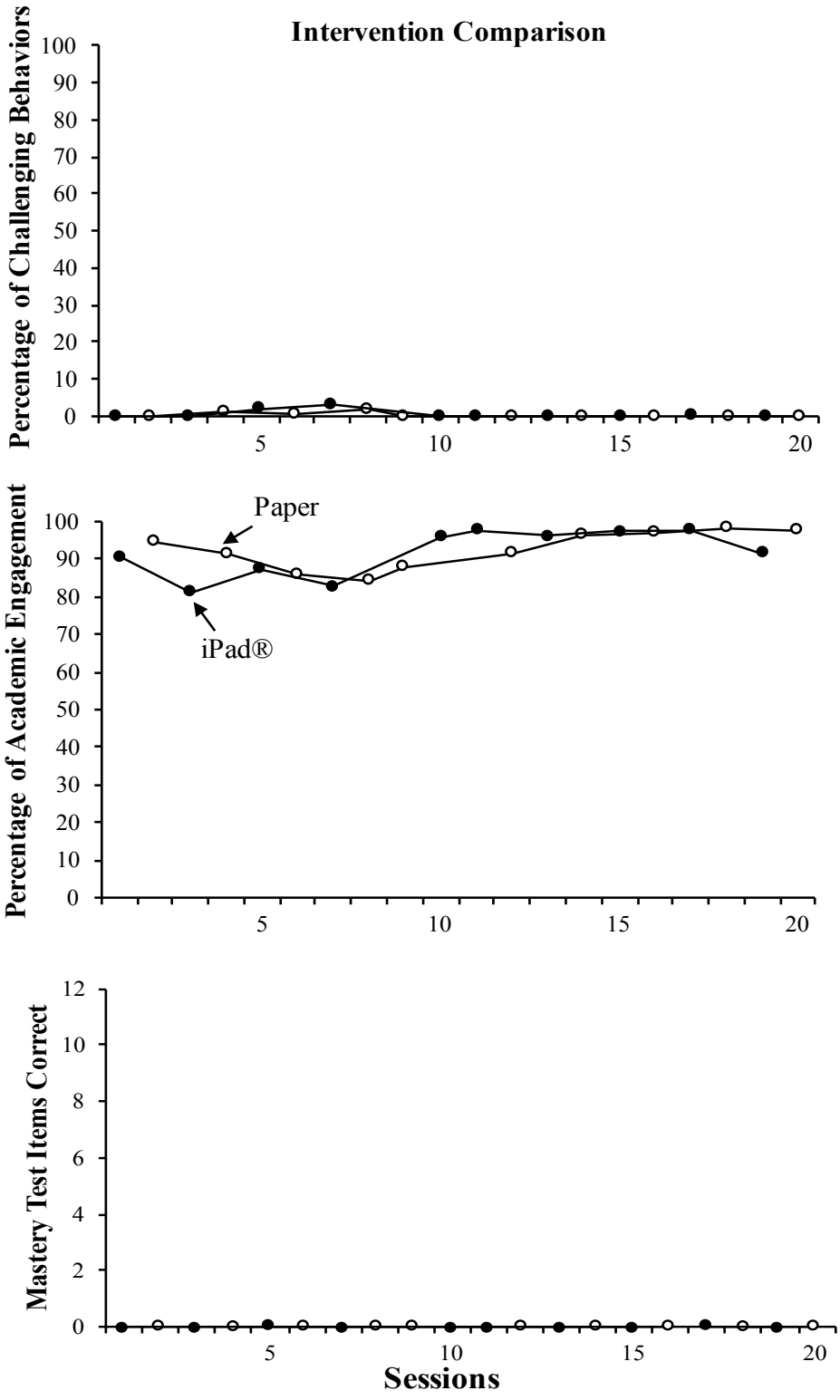

Figure 6. Berto's Intervention Results

97.96%; iPad range=81.06-97.71%). Mastery test scores during all sessions were 0. These data indicate that there was not a functional relation between either condition and Berto's challenging behavior, academic engagement, or mastery test items. Thus, Berto did not complete a superior alone condition.

Correspondence of Assessment and Intervention Results

The correspondence between the three students' assessment and intervention results ranged from moderate to high. Koby's results provided the sole example of high correspondence.

Data from Koby's MSWO indicated that the computer was his highest preferred item, and he allocated all time to iPad® conditions in the COA. Subsequently, his intervention comparison results indicated that challenging behavior was lowest in CAI sessions.

Jalen and Berto's assessment results demonstrated moderate correspondence with their intervention comparison results. Jalen's data indicated that his challenging behavior reduced in the CAI condition; however, the MSWO did not indicate the iPad® was preferred and only a portion of the CAI indicated the iPad® was preferred. Berto's MSWO data indicated listening to music on an iPad® was the highest preferred activity and a portion of COA results indicated Berto preferred iPad®-based activities. However, Berto's data in COA Condition 3 were variable and did not indicate a clear preference, which aligns with the lack of differentiation in the intervention comparison.

Social Validity

Concurrent chains assessments. Results from the concurrent chains assessments are depicted in Figure 7. All three students completed three consecutive sessions in which they chose CAI. This indicates that students preferred CAI sessions and suggests that CAI was a socially valid method of instruction from their perspectives.

Teacher interviews. Results from teacher interviews are displayed in Table 5. Jalen and Koby's teachers strongly agreed (rating=5) with all intervention goals. Berto's teacher agreed (rating=4) it was important to reduce his challenging behavior during literacy intervention and strongly agreed with the remaining goal statements. Similarly, two teachers (Koby's and Berto's) strongly agreed with all statements pertaining to intervention procedures. Jalen's teacher strongly agreed that it was feasible to present FOTB in both formats. Regarding her willingness and ability to continue implementing FOTB, Jalen's teacher agreed with the iPad®-based option and was neutral (rating=3) toward paper-based instruction. These results indicate that all teachers perceived both the goals of this study were socially valid and that, overall, both paper-based and iPad®-based procedures were feasible and acceptable.

Teacher ratings for statements pertaining to results were the most variable. Jalen's teacher did not agree (rating=2) that she noticed reductions in challenging behavior and increases in engagement during paper-based sessions and Koby's teacher agreed with this statement. When rating results for iPad®-based sessions, Jalen's teacher agreed and Koby's teacher strongly agreed that they noticed reductions in challenging behavior and increases in engagement. Berto's teacher responded neutrally regarding challenging behavior and strongly agreed with statements

pertaining to his engagement during both paper-based and iPad®-based sessions. These results suggest that Jalen and Koby's teachers perceived that iPad®-based sessions resulted in lower challenging behavior and higher academic engagement; whereas, Berto's teacher perceived that his academic engagement was high during both paper-based and iPad®-based sessions.

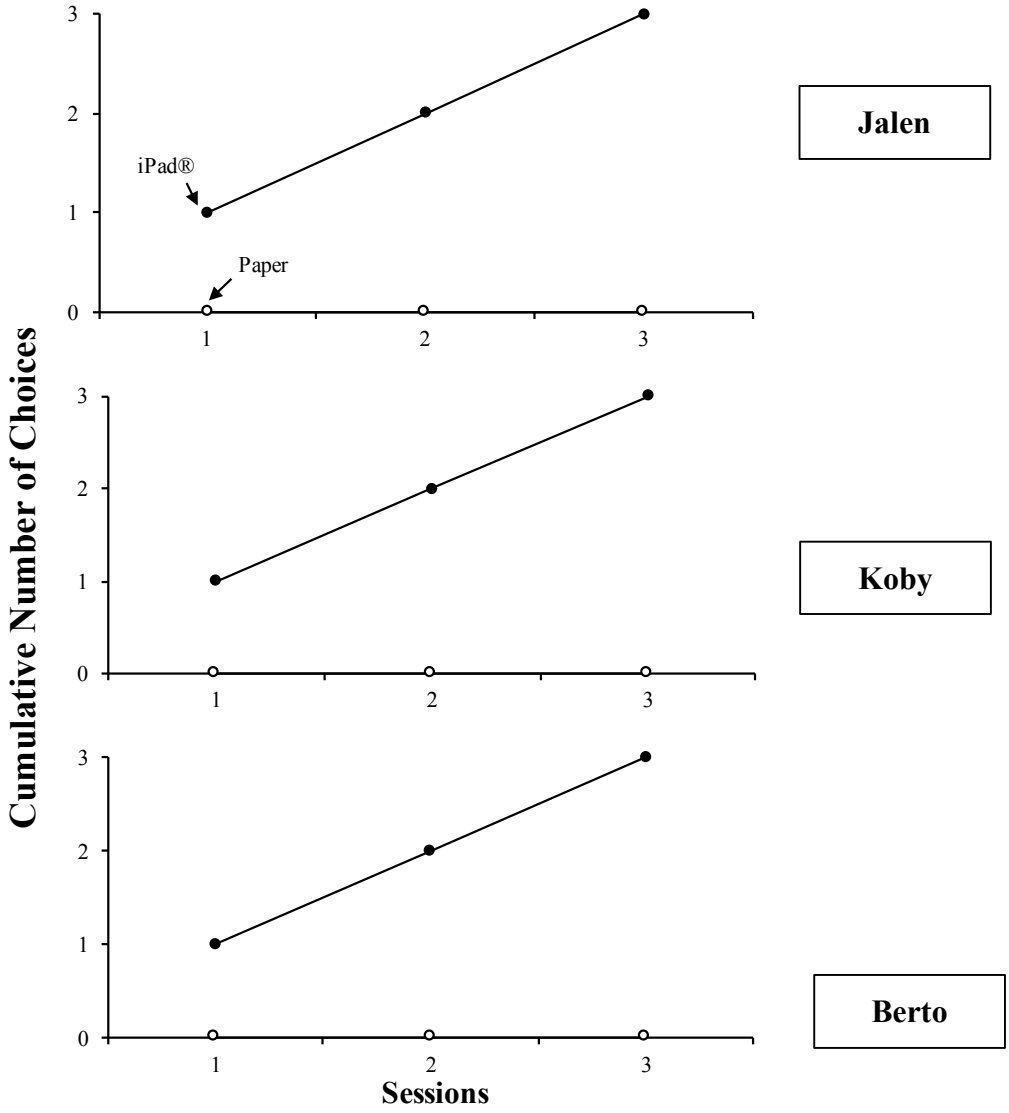

Figure 7. Concurrent Chains Results by Participant

Table 5

Teacher Social Validity Interview Results

Statements by Category	Teacher Responses by Student		
Goals	Jalen	Koby	Berto
1. It is important to identify ways to reduce my student's challenging behavior during literacy instruction.	5	5	4
2. It is important to identify ways to increase my student's engagement during literacy instruction.	5	5	5
3. It is important to identify assessments that I can use to choose potentially effective methods of literacy instruction for this student.	5	5	5
4. It is important to consider this student's preferences and interests within instruction.	5	5	5
Procedures			
5. It was feasible for me to present *Friends on the Block* (FOTB) in a paper-based format.	5	5	5
6. I would be willing and able to continue implementing FOTB in a paper-based format.	3	5	5
7. It was feasible for me to present FOTB in an iPad-based format.	5	5	5
8. I would be willing and able to continue implementing FOTB in an iPad-based format.	4	5	5
Results			
9. I noticed reductions in the duration of my student's challenging behaviors during paper-based sessions.	2	4	3
10. I noticed increases in the duration of my student's engagement during paper-based sessions.	2	4	5
11. I noticed reductions in the duration of my student's challenging behaviors during iPad-based sessions.	4	5	3
12. I noticed increases in the duration of my student's engagement during iPad-based sessions.	4	5	5

CHAPTER 4

DISCUSSION

I conducted this study to extend previous research on implementing CAI to improve the behavior of students with IDD. More specifically, I focused on using iPad®-based activities to support early literacy intervention as this is an area of intensive need for this population (Allor et al., 2018; Spooner et al., 2012; Wei et al., 2011). My primary research question was "Compared to paper-based literacy instruction, does CAI result in lower levels of challenging behavior and higher levels of academic engagement?" Study participants were three elementary-aged students with IDD. Their special education teachers implemented paper-based and iPad®-based versions of FOTB, an early literacy intervention that includes instruction in letter sounds, sight words, and basic comprehension. Prior to intervention, I conducted preference assessments to determine whether students chose to interact with iPad®-based leisure and academic activities. Teachers then implemented FOTB within an alternating treatments single case design. In addition to the primary research question, I aimed to describe differences in (a) mastery test scores between conditions, (b) maintenance of results following the intervention comparison, (c) correspondence between assessment and intervention results, and (d) social validity of CAI from the perspectives of student and teacher participants. In the following sections, I will discuss results, connections to previous research, directions for future research, and implications for practitioners.

Primary Research Question

Two of the three participants' data indicated that a functional relation was present—CAI sessions were consistently associated with lower levels of challenging behavior and higher levels

of engagement compared to paper-based instruction. The functional relation emerged within 10 sessions for Jalen and 20 sessions for Koby. It is interesting to note that, for both of these participants, the degree of differentiation was greater for academic engagement than challenging behavior. This is likely due to a floor effect in that the highest levels of challenging behavior in either condition were relatively low for both students (32.04% for Jalen and 23.13% for Koby). A functional relation was not evident for the third participant, Berto. His data indicated that both CAI and paper-based instruction were associated with zero or near-zero levels of challenging behavior and consistently high levels of academic engagement.

Multiple components of iPad®-based FOTB may have reduced aversive features of instruction and influenced two of the three students' behavior. One explanation may be that iPad® stimuli were more responsive and interactive than paper stimuli (i.e., reinforcement was immediate [Wehmeyer et al., 2004]). For example, iPad®-based text building games included sound effects and immediate, enthusiastic praise when a student matched a letter correctly. In contrast, teacher praise during paper-based games frequently varied in immediacy and tone. A second hypothesis is that these participants had positive associations with technology due to often using technology for leisure activities. Notably, pre-intervention survey results indicated that Jalen and Koby had more frequent leisure access to technology (up 120 min/day and 80 min/day, respectively) than Berto (up to 35 min/day). Third, it is plausible that instructional features of FOTB that were present in both conditions (e.g., repetition, structure, scaffolding) could have positively impacted behavior. This may explain why challenging behavior was relatively low across both conditions for all students and undifferentiated for Berto.

Findings for Jalen and Koby aligned with previous research indicating that CAI is associated with improved behavior (Kern et al., 2001; Neely et al., 2013; Zein et al., 2016). To

my knowledge, this study provides the third example of using tablet computers (i.e., iPads®) for this purpose, extending the work of Neely et al. and Zein et al. An additional contribution of this study is the use of a multi-component intervention within relatively long (25 min) sessions compared to previous research (5-20 min sessions; single component instruction). Based on the present findings, it seems that CAI may improve some students' behavior for extended sessions and across varied demands. Although CAI did not improve Berto's behavior, his data demonstrated that, within this context, both conditions led to similarly positive outcomes. A third contribution of this study is that it provides two replications of reducing challenging behavior with CAI for students with IDD. This replication was necessary in that previous research on this topic included only 5 participants from this population.

Secondary Aims

There were four secondary aims in this study. First, I aimed to compare scores on mastery tests that teachers conducted during each session. The results did not clearly demonstrate that either method (CAI or paper) was more effective. For one student (Jalen), data were consistently higher in the CAI condition (i.e., there was a functional relation). However, Koby's scores were consistently high across both conditions and Berto's scores remained at zero. This lack of differentiation may be because academic content was identical across conditions. Also, Jalen and Berto's overall lack of progress aligns with previous literacy research including students with IDD. These two participants received only 20 total days of intervention and previous research has demonstrated that students with IDD often require substantially higher dosage to make measurable growth (Allor et al., 2014). Further, it is important to note that mastery test data are descriptive as they were not used for experimental decisions. Future

researchers may consider comparing the efficiency of paper-based instruction and CAI through an adapted alternating treatments design in which unique content is assigned to each condition.

Second, I investigated whether pre-intervention assessment data aligned with behavior data during intervention comparisons. This study was the first example, to my knowledge, of a researcher using direct preference assessments for this purpose. Based on *a priori* criteria, one participant's data demonstrated high correspondence and two participants' data demonstrated moderate correspondence. Koby's assessment data appear to have been a strong indicator that CAI would be beneficial. In contrast, Jalen and Berto's results are less clear. Their assessment data indicated that neither student clearly preferred technology; subsequently, CAI resulted in improved behavior for Jalen but not for Berto. In other words, similar assessment data were followed by dissimilar intervention data. The variation within these participants' results indicates that future research is needed to determine whether preference assessments such as COAs can help practitioners determine whether to use CAI.

Third, I aimed to describe whether results from intervention comparison phases maintained during superior alone conditions. This was a necessary extension of previous research in that prior work did not include maintenance data. Jalen and Koby both completed 10 CAI sessions in the superior alone condition, and both participants' data demonstrated counter-therapeutic changes in level and variability within that brief time period. Although these results were somewhat disappointing, it is important to understand whether CAI could be a long-term solution for improving student behavior. These data suggest that CAI alone is not. The first possible explanation may be that CAI was initially a novel method of instruction that became less novel over time (i.e., satiation occurred). Jalen's data support this hypothesis because the repetition of Level 1 content was associated with increases in challenging behavior and decreases

in academic engagement. These patterns subsequently reversed when we re-introduced novelty (i.e., choice of story). An alternative explanation is that increased difficulty of instruction could worsen behavior of some students. This hypothesis is supported by Koby's data pattern which became counter-therapeutic when we implemented FOTB Level 2. Considering that these patterns were different for each student, the interactions between student, curriculum, and technology appear to be complex. This suggests that technology is not a comprehensive solution for improving behavior—teachers must consider individual student need. Educators who choose to implement CAI to improve student behavior should collect maintenance data and be prepared to respond to potential decreases in effects over time.

Fourth, I collected social validity data from teachers and students. Interview results indicated that all teachers thought the goals were important, the procedures were feasible and acceptable (i.e., they were willing and able to continue implementation), and that the results were positive. Furthermore, direct student choice data indicated that CAI was socially valid to students. That is, students consistently chose to complete iPad®-based instead of paper-based sessions. It is important to note that a research team member provided iPads® with all materials downloaded and organized and was always present to assist with implementation issues (e.g., Wi-Fi connection, locating materials). Teachers' perceptions of CAI social validity may differ based on the support available. For example, a teacher may find it too time-consuming to locate, purchase, and download all materials herself. Also, even though I collected social validity data after the superior alone condition, readers should consider these results with the knowledge that behavior improvements did not maintain.

Limitations

This study has limitations to consider related to participant inclusion, assessment procedures, intervention components, and data collection procedures. First, readers may note that Berto's percentage of challenging behavior was zero during his first three sessions. These data indicated that he no longer met original inclusion criteria when his teacher was switched to a different person. I started intervention without a second screening because the teacher reported that he engaged in challenging behaviors and there was limited time available before the school year ended. Nonetheless, this study's conclusions may have been different if I had sought a new participant who better met inclusion criteria.

Second, decisions that I made during COA sessions likely affected those results. More specifically, I discontinued Jalen and Berto's COAs after four sessions in the third condition and prior to obtaining data that supported a conclusive result. I chose to discontinue because these two participants began to demonstrate fatigue and challenging behaviors (e.g., attempts to leave the room). These behaviors were potentially related to satiation due to the repetition of materials. Conducting the full assessment within one appointment (which lasted 45 min to 1 hr) may have also resulted in participant frustration. Clear preferences may have emerged if I had included a larger selection of materials (i.e., stories), conducted additional sessions, or completed the assessment across multiple appointments. Future researchers should consider these variables when designing COAs.

Third, conclusions about Jalen and Koby's positive results may be limited to the literacy intervention we used (an adapted version of FOTB). Intervention sessions were highly structured and repetitive—results may not replicate with less-structured interventions or ones that change in format from session to session. As noted previously, these features may have contributed to

improved behavior in both conditions; however, I cannot confirm this hypothesis because I did not include a baseline of typical instruction. Also, the commercially available version of FOTB includes more variation and not all activities are available on technology; thus, it is unknown whether implementing the intervention as developed would produce similar results. On the other hand, interventions that more frequently introduce novelty may better support long-term reductions in challenging behavior. Both of these points are areas for future investigation.

Fourth, despite evidence of a functional relation for Jalen and Koby, these two students engaged in overall low levels of challenging behavior. This may be the result of teachers using multiple effective strategies during sessions (e.g., rule reminders, visual schedules, minimizing attention to challenging behavior, token economies). An additional explanation is that my definition of challenging behavior was more conservative than previous researchers. For example, Neely et al. (2013) coded task refusal when a participant closed his eyes for more than 1 s or laid his head down. I defined these same behaviors as non-examples of academic engagement. This variation in operational definitions may explain why data differentiation in this study is less than what has been demonstrated in previous studies (e.g., Neely et al.). Nonetheless, Jalen and Koby's data represent behaviors that were most likely to disrupt instruction (e.g., screaming, elopement). Therefore, I believe the reduction in these behaviors during CAI sessions is indicative of meaningful change.

Directions for Future Research

The results of this study, in conjunction with previous research, indicate that CAI may be a promising method for improving behavior of some students. These results may only replicate with students with similar characteristics to participants in this study (e.g., history of using

technology). Additionally, our maintenance (i.e., superior alone condition) data suggest that CAI may improve behavior only for a limited time. Thus, one suggestion for future research is for investigators to build flexibility and choice into reading interventions for students with IDD. FOTB provides one example of this in that some materials (e.g., stories) are available in both paper-based and technology-based (i.e., eBook) formats. By incorporating multiple material types in one intervention, researchers can facilitate opportunities for student or teacher choice and thus maintain novelty. In addition, options such as these would likely benefit teachers who have multiple students with different preferences.

There also remains a need to investigate other parameters of implementing CAI to improve student behavior. Effects may differ for fully technology-based sessions compared to partially technology-based sessions. Using CAI for only a portion of sessions might be beneficial because it could increase variation (i.e., novelty), especially if teachers alternate which activities are technology-based. On the other hand, if only a portion of intervention is CAI, dosage may not be high enough to effect student behavior. This should be empirically evaluated. Relatedly, current research on improving student behavior with CAI is limited to one-on-one instructional groups and should be extended to other grouping arrangements. Small group sessions have multiple benefits that include increased social interaction with peers and increased instructional time across the school day (Croner, Smith, Woods, Weiss, & Maguire, 2018). Researchers who investigate CAI during small group instruction may utilize different technology (e.g., interactive white boards) that allows multiple students to view and interact with materials.

A third area of future research pertains to using COAs to inform academic instruction. In this study, I conducted all COAs during single appointments. This may have caused participant frustration with the extended length (e.g., 45 min) and also satiation related to the materials (i.e.,

books). Features of materials such as length, interest level, and novelty may impact student choice, and thus, a practitioner's ability to apply results to intervention decisions. For these reasons, future researchers may investigate (a) whether results from COAs conducted within a single appointment differ from results of COAs distributed across multiple appointments and (b) the effects of varying materials on COA results.

Implications for Practitioners

In this study, special education teachers implemented an iPad®-based literacy intervention with high fidelity following relatively brief training (i.e., just over 1 hr) and ongoing feedback (e.g., 0-5 min per session). CAI was associated with improved behavior for two participants and low challenging behavior for the third. When these results are combined with evidence that CAI was considered socially valid by both teachers and students, I encourage special educators to incorporate technology into their instruction. The FOTB intervention may be an excellent choice because materials are commercially available and span 11 levels. However, teachers who do not have access to this curriculum may choose to locate and adapt materials themselves. The iPad® appears to be a useful tool because an abundance of fully developed and customizable applications (e.g., the flashcards application we used for mastery tests) are available; in addition, the iPad®'s can display web pages and documents (e.g., PDFs). Teachers may also choose to explore types of technology available within their classrooms that have similar functions, such as laptops or interactive white boards.

Barriers to using technology may include discomfort related to unfamiliarity or lack of time and resources for learning new technology and interventions. One way to address these barriers is for teachers to use group planning times or Professional Learning Communities

(PLCs; Vescio, Ross, & Adams, 2008) to train each other on new ways to use technology. For example, during 30-min meetings, a more expert teacher could train peers with a BST model (Parsons et al., 2012) like the following: (1) briefly describe how to implement the new skill (i.e., implementing a tech-based intervention), (2) model implementation via live demonstration or a pre-recorded video, and (3) provide an opportunity for learners to receive feedback while role-playing, and (4) schedule brief (e.g., 5 min) post-training observations to provide feedback on implementation with students. If using pre-made resources (e.g., videos), the first two steps could be completed during individual planning times. In addition to peer training and coaching, teachers could utilize the expertise of related service providers (e.g., Speech-Language Pathologists) and also include paraprofessionals within training sessions.

Finally, educators may wonder how to determine whether CAI will improve a specific student's behavior and whether results will maintain. While correspondence results in this study were mixed, Koby's data suggest that preference assessments can be informative for some students. MSWOs and COAs may be acceptable to educators because they are relatively brief, only require typical classroom materials, and do not involve purposefully evoking challenging behavior. Based on the results of this study, I believe educators can be most confident that CAI may improve student behavior if results of both assessments clearly indicate that a student prefers technology. In addition to considering preference, previous research (Neely et al., 2013) suggests that CAI may decrease challenging behavior of students with escape-maintained behavior. Teachers whose districts implement functional behavior assessment (FBA) may use behavior function in conjunction with preference data to inform the use of CAI.

If practitioners choose to compare their typical instruction with CAI, I recommend that they use direct measures of student behavior to monitor response. For example, teachers could

use a time-sampling procedure with relatively large intervals (e.g., 1 min) to estimate duration of challenging behavior, or they could record a tally of discrete behaviors. These data would allow teachers to determine whether one mode better supports behavior or whether they are equally effective. In cases where traditional instruction and CAI are equally effective, I recommend that teachers use the method best aligned with their own and their student's ongoing preferences. Finally, I recommend that teachers who adopt long-term use of CAI schedule occasional (e.g., weekly) measurement of student behavior to determine whether results maintain. Should improvements fade over time, teachers can consider ways to re-introduce novelty by providing student choice or incorporating new activities within CAI.

Conclusion

This study extended research on improving student behavior with CAI through the inclusion of students with IDD, implementation of a comprehensive literacy intervention, analysis of pre-intervention preference assessments, and collection of social validity data. Study results suggest that implementing literacy intervention via CAI is a socially valid method that can indeed improve challenging behaviors and academic engagement for some students from this population. Despite these promising results, there remains the need for continued research focused on the use of assessment for this purpose, along with variables that contribute to both initial results and maintenance of effects.

REFERENCES

Allor, J. H., Champlin, T. M., Gifford, D. B., & Mathes, P. G. (2010). Methods for increasing the intensity of reading instruction for students with intellectual disabilities. *Education and Training in Autism and Developmental Disabilities, 45,* 500-511.

Allor, J. H., Gifford, D., Jones, F. G., Al Otaiba S., Yovanoff, P., Ortiz, M. B., & Cheatham, J. P. (2018). The effects of a text-centered literacy curriculum for students with intellectual disability. *American Journal of Intellectual and Developmental Disabilities, 123,* 474-494. doi: 10.1352/1944-7558-123.5.474

Allor, J. H., Mathes, P. G., Roberts, J. K., Cheatham, J. P., & Al Otaiba, S. (2014). Is scientifically based reading instruction effective for students with below average IQs? *Exceptional Children, 80,* 287-306.

Ayres, K., & Ledford, J. R. (2014). Dependent measures and measurement systems. In D. L. Gast & J. R. Ledford (Eds.), *Single case research methodology: Applications in special education and behavioral sciences* (124-155). New York, NY: Routledge.

Barlow, D. H., & Hayes, S. C. (1979). Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. *Journal of Applied Behavior Analysis, 12,* 199-210. doi: 10.1901/jaba.1979.12-199

Blackorby, J., Chorost, M., Garza, N., & Guzman, A. (2004). *The academic performance of elementary and middle school students with disabilities.* Retrieved from Special Education Elementary Longitudinal Study website: https://seels.sri.com/designdocs/engagement/04_SEELS_outcomes_C4_8-19-04.pdf

Browder, D., Gibbs, S., Ahlgrim-Delzell, L., Courtade, G. R., Mraz, M., & Flowers, C. (2009). Literacy for students with severe developmental disabilities: What should we teach and

what should we hope to achieve? *Remedial and Special Education, 30,* 269-282. doi: 10.1177/0741932508315054

Bruhn, A. L., Woods-Groves, S., Fernando, J., Choi, T., & Troughton, L. (2017). Evaluating technology-based self-monitoring as a tier 2 intervention across middle school settings. *Behavioral Disorders, 42,* 119-131. doi: 10.1177/0198742917691534

Carr, E. G., Taylor, J. C., & Robinson, S. (1991). The effects of severe behavior problems in children on the teaching behavior of adults. *Journal of Applied Behavior Analysis, 24,* 523-535. doi: 10.1901/jaba.1991.24-523

Clinton, V. (2019). Reading from paper compared to screens: A systematic review and meta-analysis. *Journal of Research in Reading.* Advance online publication. doi: 10.1111/1467-9817.1226

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis*, *29*, 519-533. doi: 10.1901/jaba.1996.29-519

Feeley, K., & Jones, E. (2008). Strategies to address challenging behavior in young children with Down syndrome. *Down Syndrome Research and Practice, 12,* 153-163. doi:10.3104/case-studies.2008

Fidler, D. J., & Nadel, L. (2007). Education and children with Down syndrome: Neuroscience, development, and intervention. *Mental Retardation and Developmental Disabilities Research Reviews, 13,* 262-271. doi: 10.1002/mrdd.20166

Geiger, K. B., Carr, J. E., & LeBlanc, L. A. (2010). Function-based treatments for escape-maintained problem behavior: A treatment-selection model for practicing behavior analysts. *Behavior Analysis in Practice, 3,* 22-32. doi: 10.1007/BF03391755

Goodman, G., & Williams, C. M. (2007). Interventions for increasing the academic engagement of students with autism spectrum disorders in inclusive classrooms. *TEACHING Exceptional Children, 39,* 53-61. doi: 10.1177/004005990703900608

Gunter, P. L., Shores, R. E., Jack, S. L., Denny, R. K., & DePaepe, P. A. (1994). A case study of the effects of altering instructional interactions on the disruptive behavior of a child identified with severe behavior disorders. *Education and Treatment of Children, 17,* 435-444.

Hanley, G. P. (2010). Toward effective and preferred programming: A case for the objective measurement of social validity with recipients of behavior-change programs. *Behavior Analysis in Practice, 3,* 13-21. doi: 10.1007/BF03391754

Harding, J. W., Wacker, D. P., Berg, W. K., Cooper, L. J., Asmus, J., Mlela, K., & Muller, J. (1999). An analysis of choice making in the assessment of young children with severe behavior problems. *Journal of Applied Behavior Analysis, 32,* 63-82. doi: 10.1901/jaba.1999.32-63

Kagohara, D. M., van der Meer, L., Ramdoss, S., Lancioni, G. E., Davis, T.N., Rispoli, M.,…Sigafoos, J. (2013). Using iPods® and iPads® in teaching programs for individuals with developmental disabilities: A systematic review. *Research in Developmental Disabilities, 34,* 147-156. doi: 10.1016/j.ridd.2012.07.027

Kasari, C., & Freeman, S. (2001). Task-related social behavior in children with Down syndrome. *American Journal on Mental Retardation, 106,* 253-264. doi: 10.1352/0895-8017(2001)106<0253:TRSBIC>2.0.CO;2

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Brief Intelligence Test—Second Edition* (KBIT-2). Bloomington, MN: Pearson.

Kern, L., Delaney, B., Clarke, S., Dunlap, G., & Childs, K. (2001). Improving the classroom behavior of students with emotional and behavioral disorders using individualized curricular modifications. *Journal of Emotional and Behavioral Disorders, 9,* 239-247. doi: 10.1177/106342660100900404

Knight, V., McKissack, B. R., & Saunders, A. (2013). A review of technology-based interventions to teach academic skills to students with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 43,* 2628-2648. doi: 10.1007/s10803-013-1814-y

LeJeune, L. M., Gesel, S. A., & Lemons, C. J. (2018). Explicit phonological awareness instruction for preschoolers with Down syndrome. *Inclusion, 6,* 239-257. doi: 10.1352/2326-6988-6.4.239

LeJeune, L. M. Sinclair, A. C., Gesel, S. A., & Lemons, C. J. (2018). *Adapting instruction to reduce challenging behavior: A systematic review*. Manuscript in preparation.

Lemons, C. J., Allor, J. H., Al Otaiba, S., & LeJeune, L. M. (2016). 10 research-based tips for enhancing literacy instruction for students with intellectual disability. *TEACHING Exceptional Children, 49,* 18-30. doi:10.1177/0040059916662202

Lonigan, C. J., Wagner, R. K., Torgeson, J. K., & Rashotte, C. A. (2007). *Test of Preschool Early Literacy* (TOPEL). Austin, TX: Pro-Ed.

McIntosh, K., Horner, R. H., Chard, D. J., Dickey, C. R., & Braun, D. H. (2008). Reading skills and function of problem behavior in typical school settings. *The Journal of Special Education, 42,* 131-147. doi: 10.1177/0022466907313253

National Institutes of Health. (2010). *Intellectual and developmental disabilities* [Fact sheet]. Retrieved from

https://report.nih.gov/nihfactsheets/Pdfs/IntellectualandDevelopmentalDisabilities(NICHD).pdf

Neely, L., Rispoli, M., Camargo, S., Davis, H., & Boles, M. (2013). The effect of instructional use of an iPad® on challenging behavior and academic engagement for two students with autism. *Research in Autism Spectrum Disorders, 7,* 509-516. doi: 10.1016/j.rasd.2012.12.004

Ozdemir, Y. (2007). The role of classroom management efficacy in predicting teacher burnout. *International Journal of Social Sciences, 2,* 751-757.

Parsons, M. B., Rollyson, J. H., & Reid, D. H. (2012). Evidence-based staff training: A guide for practitioners. *Behavior Analysis in Practice, 5,* 2-11. doi: 10.1007/BF03391819

Patterson, G.R. (1976). The aggressive child: Victim and architect of a coercive system. In E.J. Mash, L.A. Hamerlynck, & L.C. Handy (Eds.), *Behavior modification and families* (pp. 267-316). New York: Brunner/Mazel.

Pitcairn, T. K., & Wishart, J. G. (1994). Reactions of young children with Down's syndrome to an impossible task. *British Journal of Developmental Psychology, 12,* 485-489. doi: 10.1111/j.2044-835X.1994.tb00649.x

Quillen, I. (2011). Educators evaluate learning benefits of iPad. *Education Week: Digital Directions.* Retrieved from http://www.edweek.org/dd/articles/2011/06/15/03mobile.h04.html.

Rispoli, M., Lang, R., Neely, L., Camargo, S., Hutchins, N., Davenport, K., & Goodwyn, F. (2013). A comparison of within- and across-activity choices for reducing challenging behavior in children with autism spectrum disorders. *Journal of Behavioral Education, 22,* 66-83. doi:10.1007/s10864-012-9164-y

Root, J. R., Stevenson, B. S., Davis, L. L., Geddes-Hall, J., & Test, D. W. (2017). Establishing computer-assisted instruction to teach academics to students with autism as an evidence-based practice. *Journal of Autism and Developmental Disorders, 47,* 275-284. doi: 10.1007/s10803-016-2947-6

Spooner F., Knight V. F., Browder, D. M., & Smith, B. R. (2012). Evidence-based practice for teaching academics to students with severe developmental disabilities. *Remedial and Special Education, 33,* 374-387. doi: 10.1177/0741932511421634

Tapp, J. (2003). Procoder for Digital Video. [Computer software]. Nashville, TN: Vanderbilt Kennedy Center.

U.S. Department of Education, Office of Special Education and Rehabilitative Services. (2018). *40th Annual Report to Congress on the implementation of the Individuals with Disabilities Education Act.* Washington, D.C.: U.S. Department of Education, Office of Special Education and Rehabilitative Services.

Walker, H. M., Severson, H. H., & Feil, E. G. (2014). *Systematic Screening for Behavior Disorders (SSBD): Administrator's Guide.* Eugene, OR: Pacific Northwest Publishing.

Wehby, J. H., Lane, K. L., Falk, K. B. (2003). Academic instruction for students with emotional and behavioral disorders. *Journal of Emotional and Behavioral Disorders, 11,* 194-197. doi: 10.1177/10634266030110040101

Wehmeyer, M. L., Smith, S. J., Palmer, S. B., & Davies, D. K. (2004). Technology use by students with intellectual disabilities: An overview. *Journal of Special Education Technology, 19,* 7-21. doi: 10.1177/016264340401900402

Wei, X., Blackorby, J., & Schiller, (2011). Growth in reading achievement of students with disabilities, Ages 7 to 17. *Exceptional Children, 78,* 89-106. doi: 10.1177/001440291107800106

Woodcock, R., McGrew, N., & Mather, K. (2001). *Woodcock Johnson III–Tests of Achievement* (WJ III). Rolling Meadows, IL: Riverside Publishing.

Zein, F. E., Gevarter, C., Bryant, B., Son, S., Bryant, D., Kim, M., & Solis, M. (2016). A comparison between iPad-assisted and teacher-directed reading instruction for students with autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 28,* 195-215. doi: 10.1007/s10882-015-9458-9

Appendix A

Student Behavior Screening

Teacher: _____ Date: _____
Interviewer: _____

Step 1. Identify up to three students who are in elementary school, have an intellectual or developmental disability, and engage in challenging behaviors during academic instruction. Rank order students, with #1 being the most challenging. Check the behaviors of concern.

1. _____

☐ Aggression towards people
☐ Arguing/verbally protesting
☐ Shouting/Crying/Making noises
☐ Head down during instruction
☐ Noncompliance with teacher instructions
☐ Out of seat without permission
☐ Damaging property (throwing/hitting/ripping)
☐ _____

2. _____

☐ Aggression towards people
☐ Arguing/verbally protesting
☐ Shouting/Crying/Making noises
☐ Head down during instruction
☐ Noncompliance with teacher instructions
☐ Out of seat without permission
☐ Damaging property (throwing/hitting/ripping)
☐ _____

3. _____

☐ Aggression towards people
☐ Arguing/verbally protesting
☐ Shouting/Crying/Making noises
☐ Head down during instruction
☐ Noncompliance with teacher instructions
☐ Out of seat without permission
☐ Damaging property (throwing/hitting/ripping)
☐ _____

Step 2. Seek parent consent for students ranked #1 and #2 if they are available for 1-on-1 instruction for 30 minutes per day, 4 days per week.

Step 3. For consented students, complete up to three 15- to 20-min observations of 1-on-1 literacy instruction. Code challenging behavior with 10-s partial interval time sampling.

Step 4. Include students who engage in challenging behavior during at least one observation.

Appendix B

Student Screening Observation

Student: _____ Observer: _____
Start time: _____ End time: _____

Directions: Use partial interval recording with 10-s intervals. Record + for intervals with challenging behavior and – for intervals without challenging behavior.

Minute	Interval						Total
	1	2	3	4	5	6	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Appendix C

Sample Multiple Stimulus Without Replacement (MSWO) Data Sheet

MSWO Preference-Assessment Data Sheet

Participant: 01
Target Behavior:
Date:
Time:
☒ Primary Data Collector:
☐ Reliability Data Collector:

Materials:

1. Playdoh	Selected 3 / 10 = .33 *100= 30 %
2. Bubbles	Selected 3 / 12 = .25 *100= 25 %
3. iPad	Selected 3 / 4 = .75 *100= 75 %
4. Book	Selected 3 / 19 = .16 *100= 16 %
5. Legos	Selected 3 / 6 = .5 *100= 50 %
6. Stuffed animal	Selected 3 / 20 = .15 *100= 15 %
7. Ball	Selected 3 / 13 = .23 *100= 23 %

List the items in the first column. Under each trial number, denote in what order the item was chosen. (e.g. iPod – 1th; toothbrush, 4th)

Trials ⇒ Items (list) ⇓	1 (chosen nth)	2 (chosen nth)	3 (chosen nth)
1. Playdoh	3	5	2
2. Bubbles	4	3	5
3. iPad	1	2	1
4. Book	7	6	6
5 Legos	2	1	3
6. Stuffed animal	6	7	7
7. Ball	5	4	4

Use the 2 materials with the highest percentages in the tangible trials (if used):

_____ _____

Use 2 materials with moderate percentages in the attention trials.

_____ _____

Appendix D

Teacher Training Procedural Fidelity Form

Set-up and Mastery Test	Yes	No
1. Correct materials present (e.g., paper vs. iPad)		
2. Demonstrate assessing 1 letter sound		
3. Demonstrate assessing 1 sight word		
Warm-up	**Yes**	**No**
1. State whether session will occur on iPad or paper.		
2. Review three rules		
3. Describe steps with visual schedule		
4. Demonstrate provide 1 opportunity to orally blend onset-rime		
5. Demonstrate providing 1 opportunity to orally identify first sound		
6. Demonstrate providing 1 opportunity to identify letter sounds		
7. Demonstrate providing 1 opportunity to identify sight words		
8. Demonstrate 1 instance of error correction		
Story Reading	**Yes**	**No**
1. Follow script for introduction page.		
2. Read helper text on 1 page.		
3. Demonstrate guiding student through reading instructional text on each page.		
4. Demonstrate asking 1 comprehension question		
5. Demonstrate 1 instance of error correction		
Text Building	**Yes**	**No**
1. Model sentence building (teacher or iPad)		
2. Demonstrate providing 1 opportunity to build a sentence		
3. Model word building (teacher or iPad)		
4. Demonstrate providing 1 opportunity to build a word		
5. Demonstrate 1 instance of error correction		

Appendix E

Intervention Procedural Fidelity Form

Tech-Based Literacy Procedural Fidelity

Student ID: _____ Observer: _____ Date: _____ Start Time: _____ End Time: _____

Directions: *Record tally mark in correct column when interventionist correctly implements component. Record tally mark in incorrect column when interventionist incorrectly or does not implement component. Calculate total score and overall quality of tone and interactions.*

Set-up and Mastery Test	**C**	**I**	**Totals**
1. Correct materials present (e.g., paper vs. iPad)			C: ____
2. Assess 6 letter sounds			
3. Assess 6 sight words			I: ____
Warm-up	**C**	**I**	
1. State whether session will occur on iPad or paper.			
2. Review three rules			
3. Describe steps with visual schedule			C: ____
4. Provide 4 opportunities to orally blend onset-rime			
5. Provide 4 opportunities to orally identify first sound			I: ____
6. Provide 5 opportunities to identify letter sounds			
7. Provide 5 opportunities to identify sight words			
Story Reading	**C**	**I**	
1. Follow script for introduction page.			C: ____
2. Read helper text on each page (6 total)			
3. Guide student through reading instructional text on each page. (6 total)			I: ____
4. Ask 1 comprehension question on each page (6 total)			
Text Building	**C**	**I**	
1. Model sentence building (teacher or iPad; 1 total)			C: ____
2. Provide opportunities to build a sentence (5-7 total)			
3. Model word building (teacher or iPad; 1 total)			I: ____
4. Provide opportunities to build a word (6 total)			
Overall Session			
1. Session length correct (25-35 min)			C: ____
2. Praise distributed across session			
3. As needed, error correction distributed across session (can be N/A)			I: ____

Implementation Totals	Correct:_____ Incorrect: _____
Quality of teacher tone and interactions *(circle one; see definitions)*	1 2 3 4 5

Appendix F

Quality of Tone and Interactions Definitions

Quality of Teacher Tone and Interactions	
Rating	**Definition**
1-Highly negative/Punitive	• Teacher makes negative remarks or uses sarcasm throughout session ("You would have gotten that right if you were paying attention"). • Threatens student with negative consequences (loss of recess) • Teacher does not provide positive statements • Teacher scowls, does not smile, and/or does not make eye contact with student throughout session
2	• Overall interaction is mostly negative, but may include brief praise or positive interactions
3- Neutral, not overly positive or negative	• Teacher provides factual information following student responses ("that was correct") • Nature of interaction is not overly positive or overly negative.
4	• Interaction is mostly positive. • Teacher uses many elements that are highly supportive and encouraging, but may also use some elements that are neutral or negative
5- Highly supportive and encouraging	• Entire session is positive, supportive, and encouraging. • Teacher praises student in a genuine tone ("Awesome work!"). • If corrective feedback is provided, it is done in a supportive manner ("Let's try this one again. I bet you will get it right."). • Teacher smiles and makes eye contact throughout session.

Appendix G

Social Validity Interview

Tech-Based Literacy Study
Interventionist Social Validity Survey

Interviewer: _____ Interventionist: _____ Date: _____

Consider each statement as it applies to the student who participated in this research study. Use the following scale to indicate your level of agreement with each statement.

1=strongly disagree 2=disagree 3=neutral 4=agree 5=strongly agree

Part 1. Goals

____ 1. It is important to identify ways to reduce my student's challenging behavior during literacy instruction.
____ 2. It is important to identify ways to increase my student's engagement during literacy instruction.
____ 3. It is important to identify assessments that I can use to choose potentially effective methods of literacy instruction for this student.
____ 4. It is important to consider this student's preferences and interests within instruction.

Part 2. Procedures

____ 5. It was feasible for me to present *Friends on the Block* (FOTB) in a paper-based format.
____ 6. I would be willing and able to continue implementing FOTB in a paper-based format.
____ 7. It was feasible for me to present FOTB in an iPad-based format.
____ 8. I would be willing and able to continue implementing FOTB in an iPad-based format.

Part 3. Results

____ 9. I noticed reductions in the duration of my student's challenging behaviors during paper-based sessions.
____ 10. I noticed increases in the duration of my student's engagement during paper-based sessions.
____ 11. I noticed reductions in the duration of my student's challenging behaviors during iPad-based sessions.
____ 12. I noticed increases in the duration of my student's engagement during iPad-based sessions.