LSHSS

Research Note

The Effects of Shared e-Book Reading With Dynamic Text and Speech Output on the Single-Word Reading Skills of Young Children With Developmental Disabilities

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Purpose: This study investigated the use of a new software feature, namely, dynamic text with speech output, on the acquisition of single-word reading skills by six children with developmental disabilities during shared e-book reading experiences with six typically developing peers.
Method: A single-subject, multiple-probe design across participants was used to evaluate the effects of the software intervention. Six children with developmental delays were the primary focus for intervention, while six children with typical development participated as peer partners in intervention activities. e-Books were created with the new software feature, in which a child selects a picture from the e-book and the written word is presented dynamically and then spoken out. These e-books were then used in shared reading activities with dyads including a child with a disability and a peer with typical development. Participants engaged in the shared reading activity for an average of 13 sessions over a 6-week time period, an average of 65 min of intervention for each dyad.
Results: Participants with disabilities acquired an average of 73% of the words to which they were exposed, a gain of 4.3 words above the baseline average of 1.7 correct responses. The average effect size (Tau-U) was .94, evidence of a very large effect.
Conclusion: The results provide evidence that the use of e-books with the dynamic text and speech output feature during inclusive shared reading activities can be an effective and socially valid method to develop the single-word reading skills of young children with developmental disabilities.

Fluent reading is a skill acquired over time. As a first step, many children learn to recognize single words; later, as a result of literacy experiences and instructional activities, they develop the skills to derive meaning from connected text (Adams, 1994). Beginning readers may use a variety of skills in reading single words: They might recognize a word as a whole or sight word, apply knowledge of letter–sound correspondences to decode the word, or use a combination of approaches (Ehri, 2014, 2017).

To support the wide range of knowledge and skills needed for successful reading, all children should have access to a comprehensive literacy program, including supports for developing vocabulary knowledge, phonological and phonemic awareness, and other reading skills (National Early Literacy Panel, 2008; National Reading Panel, 2000). Instructional activities focused on single-word recognition, however, can have benefits for young children with and without disabilities (Lane et al., 2015). The development of a single-word reading vocabulary can both support participation in early reading activities (e.g., recognizing words during shared reading activities) and provide a foundation for the development of phonemic awareness and phonics skills such as knowledge of letter–sound correspondences

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(Ehri, 2014, 2017; Mandak et al., 2019; Price-Mohr & Price, 2018).

The acquisition of a single-word reading vocabulary is often a challenge, however, for children with disabilities, including children with autism spectrum disorder (Huemer & Mann, 2009; Lanter & Watson, 2008), Down syndrome (Martin et al., 2009), and other developmental delays. While acknowledging that it should only be one component of a comprehensive literacy intervention (Terrell & Watson, 2018), this research note thus focuses on single-word reading instruction for children with developmental disabilities.

When providing literacy intervention for young children with developmental disabilities, instructional activities must not only address an area of need but also make use of developmentally appropriate practice (American Speech-Language-Hearing Association [ASHA], 2008; National Association for the Education of Young Children [NAEYC], 2009). For example, although "drill and practice" with flash cards has been demonstrated to have a positive impact on the single-word reading skills of children with disabilities (e.g., Fossett & Mirenda, 2006; Lane et al., 2015), there is a need to identify instructional activities that are not only effective but also developmentally appropriate for young children (ASHA, 2008; NAEYC, 2009). Especially important for the area of literacy intervention are three principles of developmentally appropriate practice: Learning activities should (a) promote development across multiple domains, (b) support positive interactions with peers and adults, and (c) provide multiple opportunities to practice new skills (NAEYC, 2009).

Shared reading, a literacy activity in which adults and children interact while reading a text together, is one example of a developmentally appropriate practice that facilitates growth across multiple domains. In a shared reading activity, learning in the domains of language development (e.g., learning vocabulary), cognitive development (e.g., learning print concepts), and social–emotional development (e.g., developing social interaction skills) is supported, as well as potential literacy learning. Shared reading has been shown to promote language and literacy development for children with and without disabilities (Boyle et al., 2019; Justice et al., 2005; Trussell et al., 2018) and can be used to support positive interactions with peers (Therrien & Light, 2018).

The challenge for interventionists is to adapt shared reading activities to support a broad range of literacy goals. The adapted activity should maintain attention to principles of developmentally appropriate practice, while incorporating instructional support for the acquisition of new skills, and multiple opportunities for practice within meaningful and motivating contexts. One recently suggested approach is the creation of e-books using *visual scene displays* (VSDs) to support participation and communication for children with disabilities (Mandak et al., 2019; Therrien & Light, 2018). In this method, a tablet computer and specialized software are used to program photographs with "hot spots" (i.e., VSDs) that, when touched, produce a prerecorded word or phrase. The interventionist can assemble a series of VSDs as "pages" to create an e-book; the e-book can contain photos of the pages of a traditional book or original photographs to create a personalized book.

To support the learning of single words during shared reading with e-books created using VSDs, Light et al. (2014) suggested the use of a new software feature, termed the *transition to literacy (T2L) feature*.[1] Using the T2L feature, the programmed hot spot in the VSD produces both speech output and dynamic presentation of the text when touched (see Figure 1). For instance, when a child touches the hot spot programmed on the image of the pig, the child sees the printed word "pig" appear dynamically on the tablet screen and hears the word "pig" simultaneously. The T2L feature provides support for four processes that facilitate reading: orthographic (i.e., knowledge of letters and letter patterns), phonological (i.e., identification of speech sounds), meaning (i.e., knowledge of word meaning), and contextual (i.e., use of background knowledge; Adams, 1994). The presentation of text is dynamic, which draws visual attention to the text to support orthographic processing (Light et al., 2014). The written word is paired with the spoken word to support phonological processing, as the written word originates from the image and provides contextual support for learning (Light et al., 2014).

Past research (Boyle et al., 2017; Holyfield et al., 2019; Mandaket al., 2019) provides initial evidence of the effectiveness of the T2L feature. Additional research is needed, however, to examine the impact of the intervention on children with a wider range of disabilities and during reading activities in inclusive preschool settings (Light et al., 2019). The current study, therefore, addresses two main questions: (a) What is the effect of shared reading activities using e-books with the T2L feature on single-word reading for young children with developmental disabilities during shared reading activities with peers with typical development? and (b) What are the perceptions of stakeholders (teachers, children with disabilities, typically developing peers) regarding the social validity of the intervention?

Method

Participants

Participants were recruited from an inclusive preschool center in Pennsylvania. Ethics approval was obtained from The Pennsylvania State University Office for Research Protections, and informed consent was provided by the parents or guardians of each participant before the study began. All children recruited in this study were from English-speaking

[1]The T2L software feature was initially developed under a grant to the Rehabilitation Engineering Research Center on Augmentative and Alternative Communication by InvoTek (http://www.invotek.org). Commercially available augmentative and alternative communication apps that support the creation of e-books with the T2L feature include GoVisualTM (Attainment Company; http://www.attainmentcompany.com/govisual) and Snap Scene (Tobii Dynavox; http://www.tobiidynavox.com/en-US/software/iPad-apps/snap-scene/).

Figure 1. Illustration of a visual scene display (VSD) with the "transition to literacy" feature during one hot spot activation.

The hot spot is selected from the VSD. | The text label appears and grows in size gradually. | The text remains on the screen for 3 s, is spoken aloud, and then recedes.

homes and used speech to communicate. Participants with disabilities met the following criteria: (a) identified as having a developmental disability by early intervention personnel, (b) had an Individualized Education Program or individualized family service plan, (c) were between 3 and 6 years old, (d) were able to match pictures of a similar image (e.g., two pictures of a duck) at adult request, (e) had vision and hearing within normal limits (with or without correction), (f) had motor skills sufficient for reading and touching a 9 in. × 11 in. tablet screen, and (g) demonstrated engagement in a preferred play activity for at least 5 min. The characteristics of the children with disabilities are summarized in Table 1.

Peers with typical development met the following criteria: (a) were 3–6 years old, (b) were classmates of children with disabilities, (c) had no history of negative interactions with the children with developmental disabilities, (d) had vision and hearing within normal limits (with or without correction), and (e) had no identified disability. The typically developing peers included four boys and two girls and ranged in age from 3;10 to 4;10 (years;months).

For this study, six dyads were created by the researcher. Each dyad included a child with a disability and a typically developing peer. The child with the disability attended the same inclusive preschool classroom as the typically developing peer and had interacted with him or her throughout the year.

As reported by the teachers, the curriculum for the preschool focused on social–emotional learning. The most frequent literacy activity consisted of an adult reading to children in small or large groups, and there were no formal instructional activities focused on phonological awareness, decoding, or reading single words.

Design

This study made use of a single-subject, multiple-probe design (Horner & Baer, 1978) across one set of three dyads, with a concurrent replication across an additional set of three dyads. The independent variable was the introduction of the e-book with the T2L feature. The dependent variable was the number of words (from the 10 words introduced during the intervention) matched to the corresponding correct image by the participant with disability during the probes at baseline, intervention, and generalization.

The study involved two main phases, namely, baseline and intervention, with one generalization probe (which consisted of matching single words to an image different

Table 1. Characteristics of children with disabilities.

Characteristics	Cathy	Mira	Ed	Tara	Bren	Susie
Age (years;months)	4;8	4;9	4;8	3;11	5;4	3;10
Gender	F	F	M	F	M	F
Race/ethnicity	White/non-Hispanic	White/non-Hispanic	White/non-Hispanic	White/non-Hispanic	White/non-Hispanic	White/non-Hispanic
Disability	Developmental delay (with autism features)	Down syndrome	Developmental delay	Developmental delay	Developmental delay	Developmental delay
PPVT-4[a]	27 (91)	4 (73)	9 (80)	25 (90)	2 (68)	1 (63)
EVT[b]	47 (99)	21 (88)	27 (91)	30 (92)	1 (64)	10 (81)
TOPEL Early Literacy Index[c]	25 (90)	< 1 (59)	30 (92)	9 (79)	< 1 (51)	2 (70)

Note. Scores are reported as percentiles. F = female; M = male.

[a]Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007); scores are reported as percentiles and (standard scores). [b]Expressive Vocabulary Test (Williams, 2007); scores are reported as percentiles and (standard scores). [c]Test of Preschool Early Literacy (Lonigan et al., 2007); scores are reported as percentiles and (standard scores).

from the one used in intervention) conducted during each phase. Dyads participated in sessions approximately 2 times per week across a period of 13 weeks. Baseline sessions included a probe. Intervention sessions included a probe and then a shared book reading session.

Two sets of books were prepared for each dyad. Intervention began with Set 1 books. When the participant with a disability in the dyad identified four out of five Set 1 words in three consecutive single-word probe sessions, the dyad was provided with Set 2 books for the next four instructional sessions and then the Set 1 books for an additional (fifth) session, which served as a review session for Set 1 words. If the participant then identified four out of five Set 1 words, the participant returned to books featuring Set 2 vocabulary. If they identified three or below, the participant resumed use of Set 1 books until he or she once again identified four out of five Set 1 words in three consecutive single-word probe sessions.

Materials

Word Selection and Screening

The target images or words were selected based on animals that commonly appear in early childhood curricula. Animal vocabulary was selected because farm and zoo animals are typically acquired early in language development (Fenson et al., 2007) and are easily imaged nouns.

The single-word vocabulary chosen for each dyad was based on the results of a screening activity, in which each participant with developmental disability was screened on 15 possible words (i.e., farm and zoo animals) for instruction on three separate testing trials. In the first trial, each child was presented with pictures of four different animals and asked to point to an animal for which a verbal label was provided (e.g., "Show me the horse"). Each animal was tested as a target vocabulary item on two separate trials. Animals that the child identified correctly 2 times (with no errors) were then used in two additional testing trials. In these two trials (separated by a minimum of 2 days), the child was asked to point to an animal for which the printed word was provided. Ten instructional vocabulary items were drawn from those words for which the participant with a disability did not make a correct match on either of the two single-word testing trials.

The 10 target words were then separated into two sets of five words for each dyad. The first set consisted of farm animal words ("cat," "pig," etc.), and the second set consisted of zoo animal words ("fox," "tiger," etc.). Each set was also designed to meet the following criteria: (a) All words were between three and five letters, and (b) no words in the same set started with the same initial letter sound. For example, one child received "cat," "duck," "horse," "pig," and "sheep" for Set 1 and "bear," "fox," "lion," "snake," and "tiger" for Set 2.

During all screening and probe sessions, the target words were each presented in text form on one 1.25 in. × 3.5 in. card with a yellow background, with a target word printed in black, Arial, 60-pt. font. Four 3 in. × 3 in. color images of animals were placed on a series of 8.5 in. × 11 in. white pages (with locations and options randomized) to provide a method of response.

e-Books and T2L App

For the intervention, e-books with the T2L feature (Light et al., 2014) were programmed on a Samsung Galaxy TabPro tablet[2] using an app called EasyVSD.[3] The e-books were based on the characteristics of the *I Spy* books (e.g., Scholastic, 2018)—children's books in which children look for an identified item (e.g., a tiger) in a photograph containing multiple images (e.g., a tree, a bicycle, a house).

Six e-books (three e-books for each of the two word sets) were created for each dyad. On each page of the e-book, one image (e.g., a pig) was programmed as a hot spot. When the child touched the hot spot, the T2L feature in the app was activated, and the word appeared dynamically in text form, presented as yellow font on a black background (see Figure 1); the written text was paired with a recording of the spoken label (e.g., "pig"). As is customary in *I Spy* books, text was provided on the bottom of the page to direct the child to look for the target image or word.

Procedure

This study took place in two inclusive classrooms in a preschool center in rural Pennsylvania. The context of the intervention was a shared reading activity with another child and an adult who provided prompts and expansions. During intervention, shared reading with the e-books was presented as a center activity and occurred at a table in each classroom during center play. Probe sessions (i.e., baseline, intervention, and generalization) took place in a quiet area outside the classroom with only the researcher and one child present.

Probe Procedures

All 10 words in the dyad's instructional set were probed once in random order during each probe. The researcher showed the written words one at a time to the participant and then prompted the participant to read the word and match the word to the correct picture (i.e., "Match the word to the picture"). If the participant did not respond within 5 s, the researcher repeated the prompt. When the participant responded, the researcher thanked and encouraged the participant with a neutral statement (e.g., "Thank you," "Good job following directions!") but did not provide corrective feedback.

Baseline

Each participant with a disability completed at least five single-word probes during the baseline phase. Each

[2]Samsung Galaxy TabPro is an Android tablet computer developed by Samsung Electronics (http://www.samsung.com).
[3]EasyVSD is an augmentative and alternative communication app created by InvoTek (2018; http://www.invotek.org/).

typically developing peer also completed a single probe prior to the beginning of instruction (and a second probe following the end of instruction).

Intervention

Probe sessions also were conducted before each shared reading session for participants with disabilities to assess the effect of the intervention. The probes were followed by the small-group shared book reading sessions in which the researcher guided both children in the dyad in using and sharing the e-books (created using EasyVSD software) on the tablet.

During the intervention phase, the researcher read an e-book with each dyad of children an average of 2.1 times per week (range: 1–3). The shared book session was approximately 5 min in length (range: 4–6).

At the beginning of each intervention session, the researcher first asked one of the two children to choose a book on the tablet, alternating between the children in the dyad. For each page, the researcher then read the text at the bottom of the page, held the tablet in proximity to the first child, and paused for up to 5 s. This provided an opportunity for the first child to activate the hot spot of the target word. An activation consisted of touching the image (resulting in the target word appearing for 3 s while being spoken by the device simultaneously). If the child did not activate the hot spot of the word within 5 s, the researcher implemented a least-to-most prompting hierarchy: (a) A spoken prompt (e.g., the researcher said "Find the picture of the cat") was provided, (b) an additional spoken prompt and a visual cue (e.g., the researcher said "Find the picture of the cat" while pointing toward the image of the cat on the tablet) were provided, and (c) a spoken cue (e.g., "Let's find the picture of the cat together") and a hand-over-hand prompt were provided. The prompting hierarchy was discontinued when the child had activated the hot spot once (i.e., one activation).

The researcher then provided a prompt to the second child to activate the hot spot (e.g., "Now it's your turn. Find the picture of the cat"). If the second child did not activate the hot spot within 5 s, the researcher again implemented the least-to-most prompting hierarchy until he or she activated the hot spot once.

Next, the researcher followed the same procedures to have the first child activate the hot spot again. Lastly, the researcher provided an expansion using a descriptive word (i.e., a color, a size, or an emotion) before asking the second child to activate the hot spot again (e.g., "That's a yellow duck," "That's a big lion," "That's a happy cat").

If needed, the researcher provided brief praise for on-task behavior (e.g., "Good job waiting for your turn!" "I like how you looked for the duck right away"). Additionally, if either of the children commented after activating the hot spot (e.g., "Oink! Oink!"), that comment was acknowledged and expanded by the researcher ("Yes, the pig goes oink!"). These procedures were repeated for the target image or word on each page of the e-book.

Each of the five target images (for a word set) occurred on two pages in each book; each book, therefore, contained 10 pages. The target image was activated 4 times on every page on which it appeared (eight activations per intervention session). When the hot spot image was activated, the written word appeared for 3 s, for a total of 24 s of exposure per intervention session (eight exposures of 3 s each). Therefore, participants heard and saw each word in a set 8 times per intervention session.

Generalization

The participants with disabilities completed one generalization probe during the baseline phase and another generalization probe at the end of the intervention phase in order to determine generalized comprehension of the single word. These generalization probe sessions followed the same procedures as the probe sessions in baseline and intervention conditions, except that different animal pictures were used.

Procedural Integrity and Interobserver Agreement

All baseline, intervention, and generalization maintenance sessions were videotaped. To calculate procedural integrity, the fourth author used an experimenter-created checklist to check a randomly selected 20% of probe and intervention sessions. The percentage of probe and intervention steps completed correctly equaled 99%. To calculate interobserver agreement of data, the participants' responses were scored in a randomly selected 20% of probes from baseline and intervention. Interobserver agreement averaged 99.5% for scoring of responses on probes across all conditions.

Measures

The researcher conducted a probe with the participant with a disability at the start of each baseline or intervention session. Each probe contained one trial for each of the dyad's 10 target words, in which the participant was asked to match the written word to one of four pictures in a field in which the one image depicted the written word (e.g., "cat") and three other images depicted other words in the child's 10-word instructional set (e.g., "dog," "fox," "pig"), including both Set 1 and Set 2 words. The dependent variable was the number of words identified correctly by the participant. A response was marked *correct* when the participant pointed to the target image, touched the target image, released the target word card onto the target image, or said the target word within 5 s.

Data Analysis

Data were graphed and analyzed visually for trend, level, and variability (Kazdin, 2011). Data were also analyzed to calculate Tau-U, an effect size measure of data nonoverlap across two phases (i.e., baseline and intervention). A Tau-U score ranges from 0 to 1 and can be interpreted as follows: .20 or lower, a small effect; .21–.60, a moderate

effect; .61–.80, a large effect; and above .80, a very large effect (Vannest & Ninci, 2015).

Social Validity

The two preschool teachers (Teacher A and Teacher B) were individually shown a video of the children from their class participating in the shared book reading intervention, as well as the data for their students' performances. They then completed an eight-item social validity questionnaire, consisting of rating statements on a 5-point Likert-type scale and open-ended responses.

Participants with disabilities and typically developing peers were also asked to use a *talking mat* to answer the following questions: (a) Did you like reading on the tablet? and (b) Did you like reading with your partner? Following procedures described in the literature (Talking Mats; Murphy & Cameron, 2008), a talking mat was created by the researcher: an 8.5 in. × 11 in. sheet of paper with a photograph of a child looking happy on the top-left side and a photograph of a child looking unhappy on the top-right side. The researcher modeled the use of the talking mat with photographs of preferred and nonpreferred activities. Participants' understanding of the use of the talking mat was validated by asking them to place photographs of three preferred activities and three nonpreferred activities on appropriate sides of the talking mat.

Results

All six participants with disabilities demonstrated an increase in the total number of correct responses during the single-word reading probes. Figure 2 presents the graphs representing the correct responses for the participants with disabilities during baseline and intervention phases.

All six participants with disabilities scored below chance levels in baseline (M = 1.7, range: 1.2–2.4 correct responses out of 10). The six participants demonstrated a treatment effect after an average of 6.3 sessions. For all participants, the scores on their final three probes (M = 5.9, range: 5–7.3) were higher than any score in baseline. The average Tau-U score for the six participants was .94 (range: .84–1), evidence of a very large effect (Vannest & Ninci, 2015).

Three participants with disabilities (Cathy, Ed, and Tara) participated in both pre- and postintervention generalization probes. The mean score on the preintervention baseline generalization probes was 1.67 words correctly identified (range: 1.0–2.0). For the postintervention generalization probes, the mean score was 6.0 (range: 4.0–8.0), a gain of 4.33 words. These results provide evidence that these participants were able to match the words they acquired with pictures that differed from those presented in the intervention phase.

Although all participants demonstrated gains across time, because of the end of the school year, none of the children reached criterion performance (eight out of 10 for 2 days in a row), so no maintenance data were collected. In addition, the performance of two participants requires additional explanation. After eight instructional sessions, Cathy reached criterion performance on Set 1 words (i.e., identified four out of five words in three probe sessions), and use of the Set 2 books started at Session 9. Cathy displayed continuous improvement until a drop at Session 13, which occurred after she returned from a 13-day absence. At that session, she only correctly identified one Set 1 word, and thus, the use of Set 1 books was incorporated again for her dyad. After the return to the use of Set 1 books, Cathy then made continuous improvement and attained her previous level at Session 17.

Mira was unable to participate in the study after her sixth instructional session due to scheduling conflicts. Thus, Mira did not reach criterion performance on Set 1 words, did not transition to Set 2 books, and did not participate in generalization probe sessions.

Although not a focus of this study, four peers with typical development each participated in both a single pre- and postintervention probe (two peers did not participate in both probes because of scheduling issues). The four peers demonstrated a mean gain of 2.3 words (range: 1–4) following intervention.

Social Validity

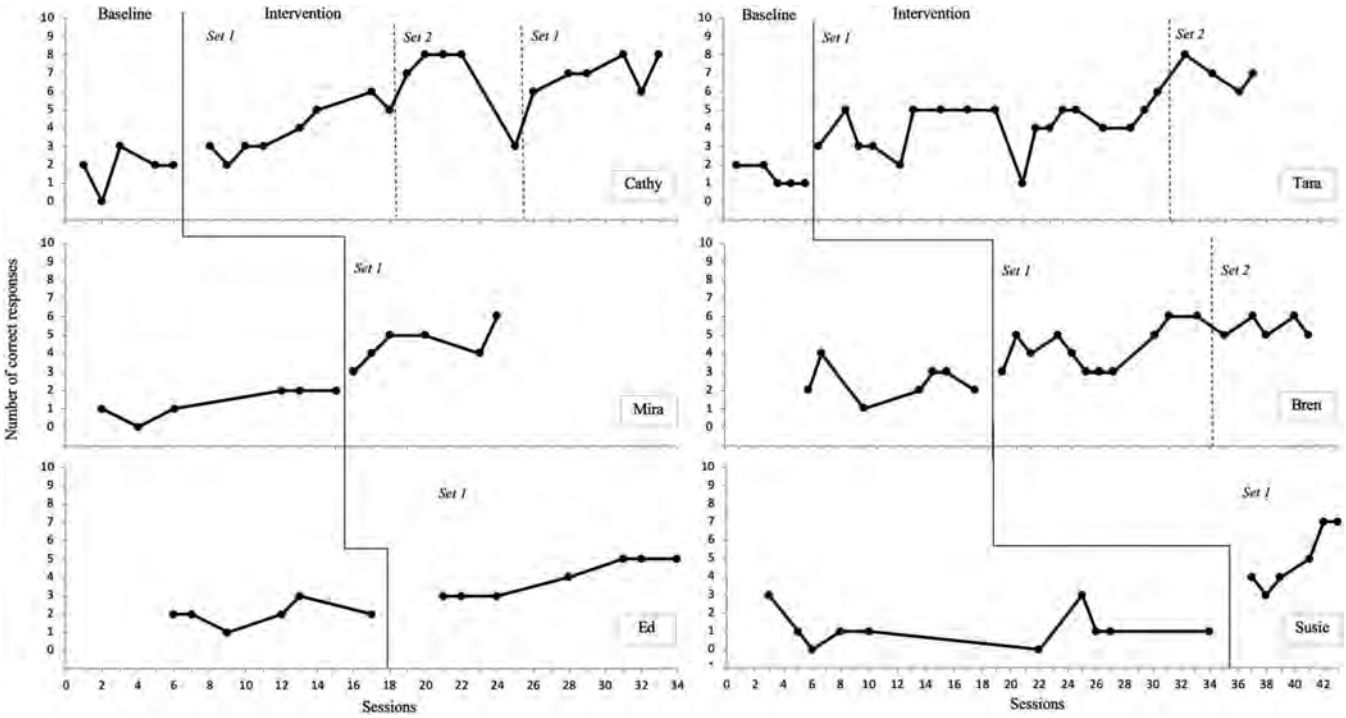
Participants

All participants participated in the social validity activity using the Talking Mats procedure (Murphy & Cameron, 2008). When asked "Did you like reading on the tablet?" and "Did you like reading with your partner?" all participants placed pictures used to represent these topics (i.e., a photograph of the tablet, a photograph of the dyad) underneath the picture of the happy child. Participants also offered unprompted responses. For example, Cathy said the tablet was "All fun things!" while her partner stated "Yes! I like it!"

Teachers

Both Teacher A and Teacher B participated in answering a social validity questionnaire, rating statements on a 5-point Likert-type scale ranging from *strongly disagree* (1) to *strongly agree* (5). Both teachers indicated that they strongly agreed with the statement "It's important to include both children with and without disabilities in activities" (ratings of 5) and agreed with the statement "Students seemed to enjoy the instructional activity" (ratings of 4). Both teachers also indicated that they agreed with the statement "Teaching students sight words is an important early literacy skill" (ratings of 4). For the statement "I would use the tablet technology in my classroom," Teacher A indicated that she strongly agreed (a rating of 5), whereas Teacher B indicated she was neutral (a rating of 3), stating that she would require training in using it. Finally, both teachers indicated that they strongly agreed with the last statement, that is, "Students seemed to benefit from the instructional activity" (ratings of 5). In the open-ended response activity, Teacher A and Teacher B agreed that implementing a similar intervention would be feasible for them. Lastly, when asked if they wished to make additional comments

Figure 2. Number of correct responses for the participants with developmental disabilities.



about the intervention, both teachers had positive responses. Teacher A summarized her feelings as "I'm really impressed with the results. Here's proof that they are just as able to learn as other kids!" whereas Teacher B remarked "It went well."

Discussion

The goal of this study was to investigate the effects of providing single-word reading instruction using e-books with the T2L feature in an inclusive shared reading activity. The results expand upon past research (Boyle et al., 2017; Mandak et al., 2019) and suggest that the T2L feature is an effective method for teaching single-word reading to young children with developmental disabilities and that the activity is well received by both children and early intervention specialists.

The use of e-books with the T2L feature in a shared reading activity resulted in increases in single-word reading for young children with disabilities. The mean Tau effect across participants with disabilities during the intervention phase was .94, which indicates a very large effect. In their last three probe sessions, participants with disabilities provided an average of 5.9 correct responses (range: 5.0–7.3). This is a gain of 4.2 words above the baseline average of 1.7 correct responses (range: 1.2–2.4).

In order to maintain this activity as a shared reading activity (as opposed to a formal literacy instruction activity), the participants in the current study on e-books with the T2L feature were only exposed to the active pairing and dynamic presentation of written and spoken words during the shared reading activity and were not given explicit feedback as to the accuracy of their responses (i.e., told if they were correct or incorrect). Providing children with opportunities to practice single-word reading skills and receive feedback during additional instructional activities in the current study may have boosted the number of words acquired.

Social Validity

The results of the participant and teacher questionnaires provided some initial evidence that both children and teachers perceived the use of digital technology with the T2L feature in shared reading activities to be a socially valid method of reading instruction. Specifically, both participants with disabilities and their typically developing peers indicated that they liked reading on the tablet and reading with their partner, indicating that the goal of providing an inclusive shared reading activity resulted in an enjoyable literacy experience for both sets of children. Additionally, both teachers agreed that the participants benefited from the activity.

Implications for Practice

The T2L feature provides an evidence-based tool for supporting the acquisition of single-word reading vocabulary by children with disabilities during interactive reading activities with typically developing peers. When implemented

in an e-book, the T2L feature provides a match between an image, its spoken label, and the printed word for targeted vocabulary. While a skilled adult reading partner can engage in similar reading activities with a child (i.e., drawing attention to a word in the text while speaking it aloud, pointing to an image and then its text label), the T2L feature provides consistent support for four processes (i.e., orthographic, phonological, meaning, and contextual) known to facilitate reading (Adams, 1994). Phonological processing (i.e., the identification, manipulation, and memory of the sound structure of speech) is supported by speech output of the words, whereas orthographic processing (i.e., the knowledge of letter patterns) is supported by dynamic text. This matching of speech output and dynamic text promotes participation in the repeated and accurate reading needed for fluent word recognition (Ehri, 2014). In addition, the dynamic presentation of the text label from the image may serve to both draw the child's attention and provide additional contextual support for the match between the text and its referent. As such, the T2L feature is an additional example of how e-books can be designed to support the acquisition of literacy skills for beginning readers (Rvachew et al., 2017).

Equally important is the fact that all children reported enjoying the activity. T2L materials can be quickly developed using available classroom storybooks (Bhana et al., 2020; Caron et al., 2016), enabling speech-language pathologists, teachers, and others to provide inclusive classroom experiences that engage children in high-interest, developmentally appropriate materials (ASHA, 2008; NAEYC, 2009) while also providing single-word reading instruction.

Limitations and Future Research

This study provides an initial investigation of the impact of a new software feature, namely, dynamic text with speech output, on the single-word reading of children with developmental disabilities during a shared e-book reading activity with typically developing peers. Despite the positive findings of the study, there are a number of limitations the reader should consider in interpreting the results. First, the study only included six participants with developmental disabilities and relatively similar profiles. Future researchers should investigate a larger number of individuals with a wider variety of diagnoses, learning abilities, and communication skills.

Another limitation is that the target words were displayed on the texts and being activated by hot spots in the T2L feature (i.e., a text beneath the image read "Where is the pig?" and the image of the pig acted as a hot spot for the word "pig," which was visually and orally presented). It is therefore possible that participants matched target words to the corresponding images because of this presence of the target word in the text and the use of the T2L feature in pairing the target word with the image. In addition, the intervention was ended before any of the participants had achieved criterion performance on their total word list (eight out of 10 target words). Maintenance data were not collected as the intervention was not completed. Future research should investigate the impact of books in which the target word is not presented in text form beneath the image, a longer intervention period, and the collection of maintenance data. Finally, it is well recognized that single-word reading instruction should only be one part of a comprehensive literacy intervention (Terrell & Watson, 2018). Although this study embeds single-word reading instruction within an activity that incorporates a variety of developmentally appropriate practices (e.g., interaction with typically developing peers, participation in an interactive shared reading activity with an adult partner), future research should examine the contribution of single-word reading instruction to other valued early literacy outcomes (e.g., phonological awareness, letter–sound correspondences).

Conclusions

The use of e-books with the T2L feature in inclusive shared reading activities had a positive effect on single-word recognition for young children with disabilities and their typically developing peers. The social validity findings highlight that this was an enjoyable, inclusive activity for young children with disabilities and their typically developing peers. Additional research is needed to more fully evaluate the effect of the intervention on single-word reading for participants with and without disabilities as well as to investigate teacher implementation of similar activities. The results for this study, however, contribute to the growing literature on the positive impact of literacy and communication interventions based on developmentally appropriate literacy and language supports for children with disabilities (Justice et al., 2005; Light et al., 2019; Trussell et al., 2018).

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