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Using literacy-based behavioural interventions to teach self-regulation skills to young children

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ABSTRACT

Many young children receive developmental screenings because they do not perform basic self-regulation skills needed in preschool and home environments. Previous research on Literacy-Based Behavioural Interventions (LBBI) shows promise for promoting acquisition and maintenance of skills and routines; however, research has not yet examined the effectiveness of this intervention for self-regulation for young children. In this study, four children aged 2–4 referred for developmental screenings received an electronic LBBI story highlighting a visual timer to help them self-regulate. Results showed their self-regulation skills increased dramatically after using the LBBI stories with the timer, with strong effect sizes. These skills also generalized to other settings and increased engagement in activity and literacy centres. Three children maintained these skills after the LBBI was removed. This study extends previous research, incorporating an electronic book as the LBBI, and showing intervention effectiveness with young children not previously included in LBBI research.

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Literacy-based behavioural interventions; naturalistic teaching strategies; social narratives; developmental delays; preschool students; electronic books

Self-regulation involves actions that are specifically directed to the attainment or avoidance of goals, an important aspect of young children's development. Self-regulation skills can be learned through experiences, instruction, and practice (Paris & Paris, 2010), and most educators agree that a primary focus of preschool is to promote social-emotional learning, including the ability to self-regulate and increase one's attention to routines and tasks (Russell, Lee, Spieker, & Oxford, 2016). Teachers can provide opportunities and instruction to all students to make them strategic, motivated, and independent learners (Paris & Paris, 2010).

Play and self-regulation in young children

For preschool students, centre play is often a great motivator; it is child-centred, allows for peer engagement, and gives children the opportunity to choose from a diverse set of activities and materials that are meaningful to them. Unfortunately, these choices can also be overwhelming. For example, a classroom with multiple centres can overwhelm some children who want to play in each and every centre, but whose inability to self-regulate often results in running from centre-to-centre, never getting to enjoy their play or learn from it. Even once in a centre, the decision of what toy to play with or what book to read can be daunting. Teaching strategic self-regulation strategies to young children enables them to become more independent and access learning centres and activities in meaningful ways. Given the developmental diversity found among young children, this attention to teaching

young children to self-regulate increases the probability that many children will increase their abilities to learn and enjoy their early learning experiences (Brady, 2016; Guralnick, 2005).

Literacy-based behavioural interventions

As young children explore their worlds, manage abstract concepts, and develop self-regulation skills and routines, rehearsal and role-play are critical elements in their ability to learn (Lillard et al., 2013). Literacy-enabled rehearsal and role-play is particularly effective in increasing self-regulation in young children (Cavanaugh, Clemence, Teale, Rule, & Montgomery, 2016). A teaching strategy that combines literacy with rehearsal is the use of literacy-based behavioural interventions (LBBI). LBBI are a combination of words and visual in sequence that allow the student to see and rehearse the steps to completing a task (Bucholz & Brady, 2008). Unfortunately, the LBBI literature to date shows that few investigations have targeted young children or developmental outcomes involving self-regulation. In a comprehensive review of one type of LBBI (social stories), Test, Richter, Knight, and Spooner (2011) sought to establish the efficacy of these interventions in the empirical literature. Test et al. found that these interventions were frequently limited to children with autism spectrum disorders, primarily in elementary- and middle-school classes. Furthermore, problem behaviour reduction was the common focus of these studies. Test et al. also found that the application of these interventions *as instructional strategies* to teach new behaviours, skills, and routines was generally missing.

Since the concerns identified by Test et al., several investigators have explored the use of LBBI as a naturalistic teaching strategy to promote a range of positive outcomes in children and adults. One such study investigated the use of LBBI with adults who have developmental disabilities to teach work behaviours (Bucholz, Brady, Duffy, Scott, & Kontosh, 2008). In that study, two employees whose LBBI focused on requesting more work made significant improvements in their productivity; in a follow-up study, an elderly employee used an LBBI to reduce his transition time between breaks and work. Brady, Honsberger, Cadette, and Honsberger (2016) also investigated the efficacy of an LBBI as a teaching strategy delivered by peers. In this study, children read personalized stories with other children, and requested them to re-enact the routines presented in the stories. The stories and rehearsal were effective in increasing acquisition and maintenance of daily living skills in adolescents with autism. Finally, a study by Brady, Hall, and Bielskus-Barone (2016) showed the effectiveness of using peer-mediated LBBI to teach self-care skills (e.g. hand washing) to elementary students with intellectual disabilities.

Surprisingly, the empirical LBBI literature shows that these interventions are uniquely focused on paper-based storybooks. This contrasts sharply with other literacy media (e-books, interactive digital books) increasingly used by children of varying ages. Several recent studies show that electronic books can be an effective medium in promoting early literacy and vocabulary development in young children (Brown, 2015; Roskos, Sullivan, Simpson, & Zuzolo, 2016), and one study found that electronic and paper books both promoted task engagement in preschool children with autism (Kemp, Stephenson, Cooper, & Hodge, 2016). None, however, targeted self-regulation as a learning outcome.

The purpose of this study was to explore the further use of a literacy-based behavioural intervention as a strategy to teach new skills to a previously unstudied population (young children) using a previously unstudied medium (electronic storybook). Specifically, we investigated whether an LBBI might increase one component of self-regulation in young preschool children who had been referred for developmental screenings due to their difficulty staying with basic skills and routines. In addition, we investigated the efficacy of electronic delivery of the LBBI (via I-Pads) rather than the 3-ring binder stories used in previous LBBI research. We posed three research questions:

- (1) Will an LBBI delivered by an instructor via an I-Pad increase the acquisition of a self-regulation routine by young children referred for a special education evaluation?

- (2) If children acquire the self-regulation routine, will the LBBI also increase children's engagement during play, centre, or early literacy activities?
- (3) If the children acquire the new self-regulation routine and increase their engagement, will these improvements maintain and generalize with the removal of the LBBI story?

Method

Participants

Four children aged two and four years old participated. Ruby and Elijah attended a private preschool and were identified by their teachers as showing significant developmental delays in basic skills and routines. Both had been referred to early intervention agencies for developmental screenings, and both attended preschool classes with similarly aged, typically developing peers. Neither Ruby nor Elijah had completed a developmental screening or assessment. The other two children, Nora and Abby, did not attend any type of organized educational programme. Both spent the majority of their day at home in their mothers' care. Both mothers had expressed concerns about their children's development and were seeking information about developmental screenings and services. None of the four children received special education or early intervention services. All children provided assent to participate, and their parents provided consent prior to initiating the study.

All four children demonstrated the ability to look at books and mimic hand gestures. Ruby (2 years old) was non-verbal, and gained adults' attention by grabbing them. She frequently threw toys and materials rather than playing with them. Observations confirmed teacher reports that Ruby often remained isolated in class; in centres Ruby typically did not play with toys and instead wandered around the classroom and stared into space. When asked to participate in play and tasks (e.g. drawing on a chalkboard or building a tower), Ruby typically responded by throwing the items. Elijah (4 years old) was verbal but his conversations were limited to asking to go to the bathroom and getting a drink of water. When observed prior to the study, Elijah went to the bathroom approximately every 3–5 minutes, followed by getting a drink from the water fountain. Each time Elijah was approached by a teacher, his immediate response was to request a trip to the bathroom. He also delivered this request each time he completed a play task (e.g. building a tower with blocks) or a centre task (e.g. looking at a book). Teachers reported these behaviours in their rationale for requesting self-regulation strategies for Ruby and Elijah.

Nora (4 years old) was observed in her home prior to baseline, and observations confirmed that she spent most of her day throwing toys, running from room to room, and screaming. Her mother stated she had little control of Nora who 'ran the house and did what she wanted.' Mother stated that when she tried to encourage Nora to participate in learning activities, Nora would get physically violent before getting up and running away. A summary of Nora's Brigance profile using *Speech and Language* subtests showed that she was on age level for *Social Speech*, but other *Speech and Language* subtests indicated a developmental age of 3 years old. Nora's *Readiness with Books* subtest was at a 1.6-year-old developmental age. Abby (2 years old) also was observed prior to the study. These observations confirmed that she spent most of her time at home sitting and passively staring. Although Abby frequently smiled and mimicked basic motor and verbal behaviours, she did not initiate any social interactions with adults or peers. A summary of Abby's Brigance profile using *Speech and Language* subtests showed that she was at age level for *Verbal Directions*, but other *Speech and Language* subtests indicated a developmental age of 1-year-old. Her *Readiness with Books* subtest indicated a 1.6 developmental age.

Task and setting

A single self-regulation skill for the students was selected based on multiple criteria. First, the pre-school director, teachers, teacher assistants, and parents all identified their concerns regarding

each child's development. Second, the concerns were ranked in order of their disruptiveness to each child's education and development. Finally, the developmental level of the students was considered. Since none of the children attended to tasks (centre or early literacy activities), a self-regulation task fundamental to a play-based curriculum was selected. The specific task included using a visual count-down timer that signalled the beginning and end of an activity.

All instruction for Ruby and Elijah took place in an empty preschool classroom, with an eight-inch visual timer (Time Timer, 2016) in a prominent, child's eye-level location in the room. Additional observations of these two children were made in a second classroom (their regular classrooms) to assess potential generalization. In Ruby's generalization class, there were 10–15 typically developing children between the ages of two and three during the observations; these children were taught and supervised by two preschool teachers. Elijah's generalization class was a voluntary pre-kindergarten programme with approximately 20 students between the ages of 4 and 6. Each classroom was approximately 25' × 25' and contained typical children's furniture and centres, with play and instructional materials. All instruction for Nora and Abby took place in the living or dining rooms of their family homes using the same visual timer. A set of 10 books consisting of 5 *Caillou* and 5 *Curious George* beginning reader books were brought to the home on a rotating basis. For each session, four books, two from each character, were chosen at random by the investigator. From this pool of four books, Nora and Abby selected one or more books for their early literacy activity. Abby and Nora both had additional observations at the public library which served as their generalization setting. These sessions took place in the 'children's book area' at a small table. Although the library was open and other children and adults were present, none shared the children's table. The same set of 10 children's books was brought to the library to be used for these sessions.

The Time Timer was selected as the self-regulation tool for its combination of visual and auditory feedback. The timer had a red countdown track that progressively got smaller as the remaining time on the clock decreased. This enabled the children to see the approximate time remaining for their activity without relying on number concepts for time. For Elijah and Ruby, the timer provided an auditory *beep* two minutes before the time expired so the children received a cue that it was almost time to transition to the next activity. For Nora and Abby, the timer served as the cue to clean up. None of the children were familiar with this or other timers prior to the study.

Behavioural measure, data collection, observer agreement, and treatment fidelity

There were two behavioural measures for each child. First, a task analysis was developed listing the steps needed to use the timer. The task analysis contained six steps and, in turn, was used to construct the LBBi stories that formed the basis of instruction (see [Tables 1](#) and [2](#)). Data were collected for each student individually by observing the student set the timer and then engage in the activity. Each step for using the timers was scored as (a) correct and independent, or (b) not attempted or attempted but incorrect. A correct and independent step was defined as the child performing the step without any assistance from an adult. Attempted but incorrect was scored if an adult had to intervene and correct a step. This occurred, for example, if a child set the timer but entered the wrong time, and an adult had to correct the setting. An incorrect response was recorded when the child did not complete or omitted a step of the task analysis. Steps did have to be performed in a strict sequential order. Only steps that were both correct and independent were used for instructional decisions and included in the graphed results.

The second behavioural measure was each child's engagement during the activities. Ruby and Elijah were considered engaged when they were actively interacting with toys, materials, or peers in a centre. Children's play that included problem behaviour such as hitting, biting, or throwing things was not considered appropriate engagement. Nora and Abby were considered engaged when they were using early literacy skills including turning pages, pointing to pictures, labelling pictures, or paraphrasing a story. To collect data on engagement, a 15-second partial interval observation system was used, where an observer recorded whether the child had been appropriately

Table 1. Summary of Ruby and Elijah's LBBI (centre activity).

Page and story content	Pictures
(1) I can play.	(1) No photograph.
(2) I grab my timer. ^a	(2) Photograph shows a hand grabbing the Time Timer.
(3) I move the pointer to the star. ^a	(3) Photograph shows finger moving the pointer to the star placed at 5 minutes.
(4) I set down my timer. ^a	(4) Photograph shows a hand placing a timer down.
(5) I choose and go to my centre. ^a	(5) Photograph shows two buckets of toys and a finger pointing to one of the buckets.
(6) I play with the toys in my centre. ^a	(6) Photograph shows a hand playing with a dinosaur and zebra.
(7) I stay in my centre playing with my toys. When I hear the timer beep it is almost time to clean up.	(7) Photograph shows a Time Timer with no more red (set to 0).
(8) When my teacher says it is time to clean up I put my toys away. ^a	(8) Photograph shows a hand putting a toy elephant back in the bucket.
(9) I love to play.	(9) Photograph shows a smiley face.

^aIndicates the six steps in the task analysis.

engaged during any part of the interval. This resulted in the number of intervals of engagement, and was divided by the total number of intervals observed. The resulted data were reported as the percentage of intervals in which engagement was observed.

For both measures data were collected using paper–pencil recording sheets by live observers stationed away from the children, yet close enough to see and hear them during the data collection period. Typically, the distance between the children and observers ranged from 5 to 10 feet for Ruby and Elijah. For Nora and Abby observers' distance ranged from 2 to 4 feet. Both observers were experienced teachers currently enrolled in a graduate programme. Both were trained to criterion on the data collection system and practiced using the data sheets prior to the study. On 33% of all of the sessions (total), both observers recorded the children's performance simultaneously for purposes of assessing inter-observer agreement. This accounted for 38% of Ruby's sessions, 42% of Elijah's, 29% of Nora's, and 28% of Abby's sessions. Agreement across all children on the timer task analysis was 100%. Agreement for the percentage of intervals with engagement was 99%.

Treatment fidelity was collected on two of the four children. To collect fidelity, the IOA observer used a 5-point checklist to confirm that (a) all materials were present, (b) procedures matched the condition of the study, and (c) during intervention the LBBI was delivered as the only instruction. Data were collected during 29% of these sessions yielding 100% fidelity.

Data analysis

Data were analysed using traditional visual inspection procedures, including measures of central tendency for the dependent measures during baseline, intervention, and for three of the children,

Table 2. Summary of Nora and Abby's LBBI (early literacy activity).

Page and story content	Pictures
(1) I can play.	(1) No photograph.
(2) I grab my timer. ^a	(2) Photograph shows a hand grabbing the Time Timer.
(3) I move the pointer to the star. ^a	(3) Photograph shows finger moving the pointer to the star placed at 5 minutes.
(4) I set down my timer. ^a	(4) Photograph shows a hand placing a timer down.
(5) I choose a book. ^a	(5) Photograph shows a hand picking a book.
(6) I read my story.	(6) Photograph shows a hand opening a book.
(7) I point to the pictures and ask questions. ^a	(7) Photograph shows a finger pointing to pictures in the book.
(8) I keep reading until I hear the timer beep.	(8) Photograph shows a Time Timer with no more red (set to 0).
(9) When I hear the timer beep, I put my book away. ^a	(9) Photograph shows a hand putting a book back where it goes.
(10) I love to read.	(10) Photograph shows a happy child reading a book.

^aIndicates the six steps in the task analysis.

follow-up. Condition changes were made based on the steps correct of the timer use. Decisions to move from baseline to intervention required the data points to be low and stable. Decisions to remove the intervention were more specific, and required each student to show a minimum of three out of five sessions with 100% of the steps correct and independent.

In a *post hoc* analysis, we used an effect size estimate for single-subject design studies, Percent of Non-Overlapping Data (PND), to supplement the visual inspection of graphed data (Ledford, Wolery, & Gast, 2014; Scruggs & Mastropieri, 2013). PND was established separately for baseline-to-intervention, and from baseline-to-follow-up conditions. (For Ruby PND was only established for baseline-to-intervention.) Scruggs and Mastropieri (2013) use the following standards to define intervention effectiveness: (a) for *highly effective* interventions, 90–100% of data do not overlap with baseline, (b) for *moderately effective* interventions, 70–90% of data do not overlap with baseline, (c) for *minimally effective* interventions, 50–70% of data do not overlap with baseline, and (d) for *ineffective* interventions 50% or less of data fall below baseline.

Development of the LBBI

After the timer-setting routine was task analysed, an electronic storybook was constructed depicting how to set the timer, and visually displayed what the children should do when the timer is on and off. Although the task analysis contained six separate steps, one of the steps in the story was expanded so the book contained seven pages for the centre activity, plus a front and back cover. For the early literacy activity, the story was expanded so the book contained eight pages plus the front and back cover. For each page, one photograph was displayed of the task analysis step from a personal point-of-view (i.e. that page displayed the skill from the perspective of the child). This format followed guidelines advocated by Schreibman, Whalen, and Stahmer (2000) and replicated story construction conventions in previous LBBI studies (Brady, Hall, et al. 2016; Brady, Honsberger, et al., 2016; Hall, Brady, Kearney, & Downey, *in press*; Kearney, Brady, Hall, & Honsberger, 2017). One to two sentences were typed at the top of each page, describing the actions displayed in the picture. The vocabulary in the sentences was limited to commonly used words by their teachers and parents. Each page displayed 4–22 words (mean [M] = 7 words per page). Arial 44 size font was used for words in the story, and all photographs were between 2 × 3 inches and 4 × 4 inches in colour. All pages were represented by a PowerPoint slide, and an I-Pad with PowerPoint application was used to serve as a visual display of the book while the interventionist read the story. Summaries of the storybooks are found in Tables 1 and 2.

Experimental procedures

During baseline for Ruby and Elijah, an investigator at a table in the classroom asked each child to 'pick a center and go play.' During baseline for Nora and Abby, an investigator asked each child to 'pick a book and read the story.' An observer recorded each child's performance of the task analysis for the timer task, and the intervals in which the children were engaged during the subsequent activity. Observations during baseline were stopped after 5 minutes to avoid increasing non-instructional time for the children. Three baseline sessions were held for Ruby, four baseline sessions for Elijah, five baseline sessions for Nora, and six baseline sessions for Abby.

After baseline, the LBBI was delivered to the children individually with the i-Pad on the table, the student swiping to the next page, and the investigator reading. The LBBI was delivered once per day, for three to five days each week. Each session lasted approximately 8–13 minutes, with 3–5 minutes set aside for reading the story, followed by 5–8 minutes for observing the children's timer use and activity engagement. During the intervention, an investigator and child sat at a table in the class with the story displayed on an i-Pad in front of them. The investigator presented the story to the child using the following sequence of activities: (a) read a page, (b) point to the key actions on the page, (c) pause while the child viewed the page, (d) coach the child to practice the key action

until it was completed accurately, and (e) provide praise to the child for each step after it was completed correctly.

As soon as the investigator and child completed the LBBI, she asked the child to 'set your timer, pick a center, and go play' or 'set your timer, pick a book, and read the story.' The delay between the LBBI and the child's opportunity to engage in a centre or literacy activity was negligible. A star on the timer was placed at 5-minutes to provide a target for each child when setting the timer (Step 2 in the task analysis; Page 3 in the story – see [Tables 1](#) and [2](#)). While the child engaged in the activity, the investigator remained within five feet. If the child did not initiate a timer-setting step (from the task analysis) within approximately 30 seconds, the teacher reminded the student to do what she or he had seen previously in the LBBI storybook. No other peers or adults provided instruction on this or other self-regulation strategies, with or without the children's storybooks.

After at least three of five intervention sessions reached 100% for Elijah, Nora, and Abby, the LBBI was removed to evaluate whether their gains would maintain in the absence of the intervention. When the LBBI was removed, the investigator no longer read the story to the children, nor encouraged them to set the timer as they had seen in the story. The investigator was present in the room, but replicated the baseline conditions by delivering the request to 'pick a center (book) and go play (read the story).' Follow-up observations lasted 5–8 minutes, and were conducted for Elijah on 2, 6, and 14 days after the last intervention. For Nora and Abby follow-up was collected 3 and 4 weeks after the last intervention. For Ruby, the LBBI was removed after 10 intervention sessions (reaching the 3 of 5 at 100% criterion). Unfortunately, Ruby's family moved before follow-up sessions could be conducted which precluded an assessment of potential maintenance for her.

To assess whether the children might use the timer and engage in their activities, the children were also observed in settings in which the LBBI had never been delivered (i.e. their 'regular' classroom or public library). Any spontaneous use of the timer or increase in their engagement in these 'novel' settings suggested that the children had generalized their new self-regulation routines across settings. No effort was made to minimize distractions, and each setting contained the same materials (e.g. puzzles, music, science, blocks, books, and kitchen) as the training setting. Generalization observations lasted from 5 to 8 minutes and were held on three occasions for Elijah, on three occasions for Ruby, four occasions for Nora, and three for Abby.

Experimental design

Data on all baseline, intervention, and follow-up observations were collected each day during a single session. An overlapping, non-concurrent multiple baseline design across participants was employed to assess the effects of the LBBI with each child (Harvey, May, & Kennedy, 2004). This design delays the implementation of the intervention for each subsequent child to demonstrate that any changes in the child's behaviour occurs when (and only when) the intervention is applied. To show the temporal relations among the tiers of the design, dates were displayed representing condition changes on each child's graph. A follow-up condition without the LBBI was implemented for three of the four children to assess potential maintenance several days to weeks after the instruction was removed. Finally, generalization probes for all children allowed observation of their self-regulation routine and its potential impact on activity engagement.

Results

The effects of the electronically delivered LBBI for all children are shown in [Figure 1](#). During baseline, none of the children demonstrated the accurate use of the timer. Ruby never exceeded 17% accuracy on the timer task analysis; Elijah and Nora both performed the task analysis with the timer with 33% accuracy on one day and less than 17% during the rest of baseline sessions. Abby had 0% accuracy across all six of her baseline sessions. When the electronic LBBI was implemented, all showed a substantial improvement in accurate and independent performance with the timer. Ruby progressively

improved in her accuracy with the timer, reaching 100% during 3 of 10 intervention days. Elijah's improvement was more immediate, reaching 100% accurate and independent performance on the third day of intervention. Nora immediately had 100% accuracy with the timer and Abby made progress reaching 100% accuracy during her sixth intervention session, with 100% accuracy during three of nine sessions. These results answer research question 1 that an LBBI delivered via an i-Pad increases the acquisition of a self-regulation skill routine in young children. When Elijah's LBBI was removed, he continued to use the timer accurately and independently during follow-up

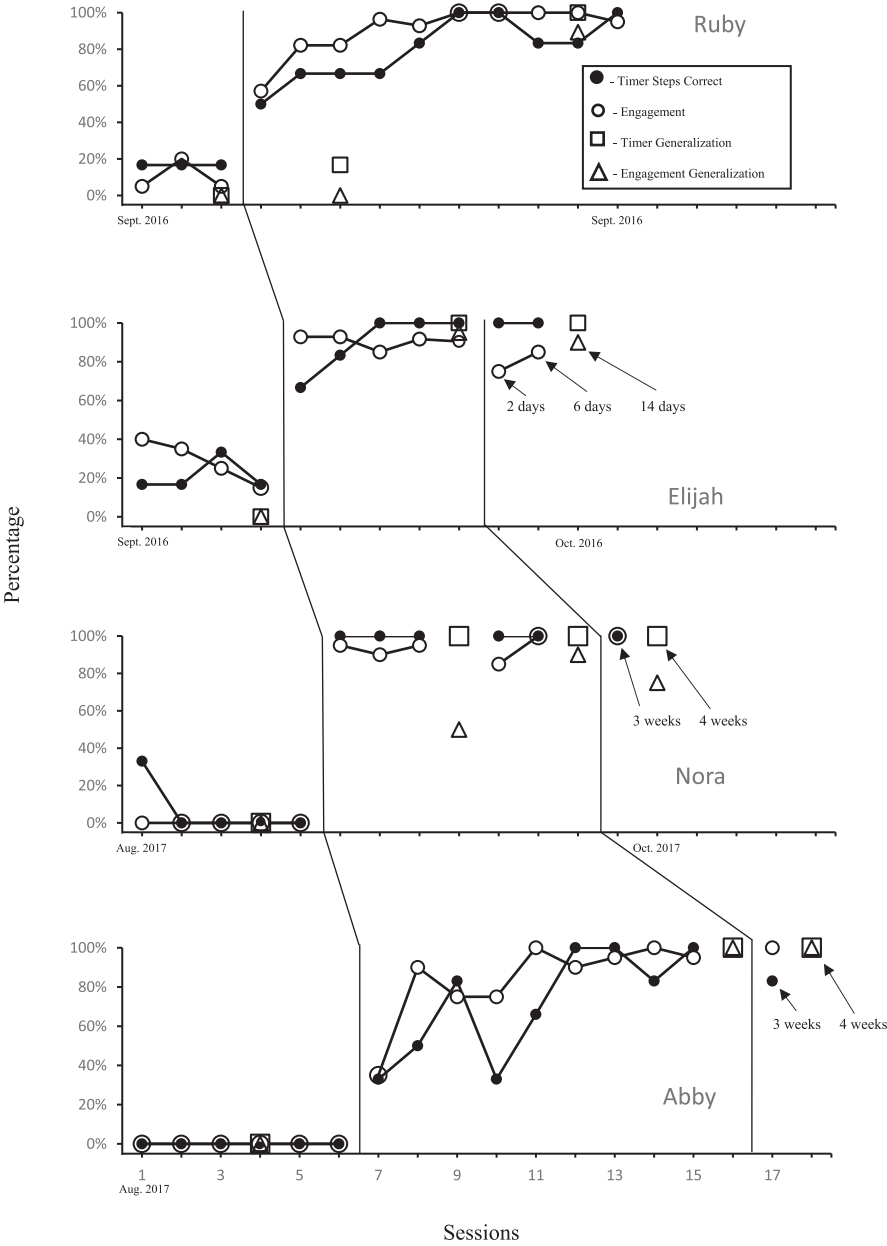


Figure 1. Percentage of correct and independent steps of the timer use task analysis, and the percentage of intervals during which children were engaged in the play or literacy activity centres.

probes across the next six days. Nora also continued to use the timer accurately after the intervention was removed during follow-up probes over the next three weeks. Abby used the timer with 83% accuracy three weeks after the removal of the intervention. Because Ruby moved immediately following the intervention, no follow-up observations were conducted.

Learning to use the timer to self-regulate also had a positive impact on all of the children's engagement in the play and activity centres, thus answering research question 2. During baseline, Ruby's engagement never exceeded 20% of the intervals. Once the LBBI was implemented, Ruby showed a steady increase in engagement, reaching 93% to 100% engagement during each of the final seven intervention sessions. Elijah's engagement during baseline ranged from 15% to nearly 40% but showed a decreasing trend. When the LBBI was implemented, Elijah immediately increased his engagement in the play and activity centres. During each of his five intervention days, Elijah was engaged at least 83% of the time. When the LBBI was removed, Elijah maintained his engaged behaviour, ranging from 75% and 85% during two follow-up probes. For Nora engagement was 0% during all baseline sessions. During intervention, her engagement ranged from 85% to 100%. When the LBBI was removed engagement was at 100% during the 3-week follow-up probe. Lastly, for Abby engagement was at 0% across all six baseline sessions. During the last eight intervention sessions, her engagement ranged from 75% to 100%. During the 3-week follow-up probe, her engagement remained at 100%.

Finally, several observations of the children were conducted in their regular classrooms (two children) or the library (two children) in which the LBBI had not been introduced (i.e. the generalization settings). During observations corresponding to the baseline condition, all four children performed at 0% for both timer accuracy and engagement. During her first generalization probe after three days of the LBBI intervention, Ruby performed the timer task at 17% accuracy but had 0% engagement. During her second generalization probe nine days after receiving the LBBI, Ruby performed the timer task with 100% accuracy and her engagement increased to 89%. During Elijah's single generalization probe during the intervention condition (five days after the LBBI was implemented), he performed the timer task with 100% accuracy and was engaged 95% of the time. Elijah also had a generalization probe during maintenance that occurred approximately two weeks after the intervention stopped. During this probe, Elijah scored 100% on the task analysis and his engagement was at 90%. Nora had 100% accuracy with the timer during both generalization probes taken during the intervention condition. During her first intervention generalization probe, which took place after three intervention sessions, she was engaged 50% of the time. During the second probe, she was engaged 90% of the time. A generalization probe was also taken four weeks after the removal of the intervention and at that time Nora had 100% accuracy with the timer and was engaged 75% of the time. Abby had one generalization probe during the intervention condition where she had 100% accuracy with the timer and was engaged 100% of the time. During a generalization probe four weeks after the removal of the intervention Abby still had 100% accuracy with the timer and was engaged 100% of the time. Because Ruby moved, data are available only for three of the four children; research question 3 indicates that all three children were able to maintain and generalize the skills. In addition, Ruby was able to generalize the skill into her classroom during intervention.

Effect size differences across conditions

A *post hoc* analysis of the findings using PND indicated that for the timer task and the impact on engagement, the LBBI was highly effective based on standards described by Scruggs and Mastropieri (2013). The effect size for all four children between baseline and intervention was 100%. Between baseline and follow-up for all three children who had follow-up observations, PND was 100%. When examining generalization data for both measures, for all children, across all conditions, there was 100% PND except for Ruby. Her PND for generalized engagement from baseline to intervention was 50%.

Discussion

All children who received the LBBI increased the accuracy and independence of using the timer to self-regulate, and substantially increased their engagement in play or early literacy activities. Elijah, Nora, and Abby continued to perform the new skills during subsequent follow-up observations, two days to three weeks after intervention, and during the generalization probes up to four weeks later. Just as important, the effects of the intervention were rapid; each of the students made substantial gains scoring 100% in acquiring the skill within one to six days of their first exposure to the LBBI. The results of this study strengthen the evidence base for the use of LBBI, and expand the efficacy of the intervention to younger children. The results also show the impact of the LBBI when the story format was delivered as an e-book instead of the more common teacher-made 3-ring binder stories. In addition, all students also increased their accuracy and independence in performing the new self-regulation skill, and increased their play and early literacy engagement in classroom and public settings that had never been part of the intervention. Before, during, and after intervention in the self-regulation timer setting, the children were provided with opportunities to perform the skill in novel settings, with peers and distractions that were not present during training sessions. All children met or exceeded their training performance in these generalization settings. Unfortunately, the relocation of one child immediately after the intervention did not allow for a maintenance phase, but her performance in the generalization classroom during intervention was encouraging none the less.

Similar to other LBBI research, the intervention in this study included a combination of instructional procedures that incorporated imitation, discrimination training, prompting, and behavioural rehearsal, combined with picture models for the various steps in the task analysis. As such, the LBBI is best described as an instructional package rather than a single component of instruction. Each page of the story demonstrated an important part of the skill, and provided information (written, verbal instructions) with a picture (visual model) of how that step should be performed and what the children were expected to do. The story, text, and pictures provided the children with a structured skill sequence, with prompts to rehearse the skill provided by the investigator.

The intervention also included general feedback, corrective feedback, and/or praise to the children as they worked their way through the storybook (such as: 'I like the way you did what was in the book.' or 'Next time lets really focus on doing what it says in the book.'). Thus the LBBI incorporated the common features of a well-designed explicit instruction lesson with a behavioural skills training protocol (Fetherston & Sturmey, 2014; Gersten, Carnine, & Woodward, 1987). There was no attempt to isolate various instructional procedures to see which might be most efficacious. Rather, the investigators explored the impact of the LBBI as a child-friendly instructional package to see if an e-book might be an effective medium to deliver an LBBI. Because the LBBI 'package' depends on observational learning and social awareness, it was not clear prior to the study whether an LBBI would be effective for younger students who had been referred for developmental screenings. Therefore, this study does not establish whether every individual component of the intervention (for example, picture models and rehearsal) is effective, efficient, or even necessary. Future research that incorporates a component analysis could help establish which components (or combination of components) of the LBBI are needed to promote rapid and durable learning in young children.

Although the findings were encouraging, this study had several limitations. First, only one self-regulation skill (timer use) was taught. This limits the effectiveness of the LBBI for young children to a single skill – a skill that some early interventionists might not embrace. To establish the effectiveness of an electronic LBBI as an instructional procedure, a wider range of skills and routines should be investigated, including skills beyond self-regulation activities. Second, the current study demonstrated the effectiveness of LBBI for promoting maintenance, once the intervention was removed. Like the Brady, Hall, et al. (2016), Brady, Honsberger, et al. (2016), Kearney et al. (2017), and Hall et al. (in press) studies, however, the durability of these findings was only assessed for a limited amount of time.

Given the challenges to generalization faced by most young learners, a more definitive exploration of whether an LBBI, particularly an electronic LBBI, might produce generalized outcomes is sorely needed. It is noteworthy that although Ruby's performance during the LBBI training far exceeded her baseline performance, Ruby reached 100% accuracy during only three of the last five intervention sessions. Although she appeared to enjoy the LBBI activity, and always showed a positive affect when the investigator approached her with the storybook, Ruby often failed to complete the step of cleaning up when centre time was over. Instead, she would point to the investigator and then point back at the toys. With this non-verbal message, it appeared that Ruby wanted to stay in the classroom and play rather than return to her regular class. This step precluded her from establishing complete independence (i.e. 100% accuracy) in the whole routine. From a research perspective, Ruby's performance demonstrates that the electronic LBBI had a powerful influence on her learning, but obviously did not establish complete experimental control over her performance. It is noteworthy that when given the generalization probe in her regular class Ruby did perform the cleanup step. It is not clear how the final cleanup step was differentially reinforced in the generalization environment in a way that it was not in the intervention environment.

Conclusion

These findings and limitations lead to several future research questions. For example, it is not clear which other forms of electronic LBBIs might be an effective teaching procedure for other student outcomes. Likewise, LBBIs appear to have strong potential as a naturalistic teaching procedure that could be applied to other language, academic, and social development, as well as to children's daily living routines. Research syntheses currently demonstrate the efficacy of LBBIs as a behaviour management strategy (Kokina & Kern, 2010; McGill, Baker, & Busse, 2015; Sansosti, Powell-Smith, & Kincaid, 2004). Few studies, however, show the value of an LBBI as an instructional strategy used to teach new skills and routines (Bucholz, 2012; Test et al., 2011; Weiss & Harris, 2001), particularly among children as young as those in this study. Furthermore, a natural extension of this study would incorporate the e-book with electronic media enhancements such as embedded video and/or audio. As these portable technologies become more accessible to young children, teachers and others might find that they can build realistic design features into stories about the skills and routines that they target for instruction (Hall et al. *in press*; Mechling, 2008). This, in turn, could increase the utility of LBBIs as instructional tools.

The current study expands the evidence base for LBBIs as an instructional strategy for young children. As the efficacy of these interventions expands, it is probable that future LBBI investigations will include additional forms of eBooks and other media. Electronic LBBIs appear to be novel and robust, and could join the ranks of other naturalistic teaching procedures for young children with, or who might have, developmental delays.

Disclosure statement

No potential conflict of interest was reported by the authors.

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