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Research Brief

A Randomized Trial of a Computer-Assisted Tutoring Program Targeting Letter-Sound Expression

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Abstract. Given that many schools have limited resources and a high proportion of students who present with deficits in early literacy skills, supports aimed at preventing reading failure must be simple and efficient and generate meaningful changes in student learning. We used a randomized group design with a wait-list control to extend the work of Volpe, Burns, DuBois, and Zaslofsky (2011), who found a computer-assisted tutoring program designed to teach young children letter sounds using incremental rehearsal to be an efficient and acceptable intervention for students who were slow to respond to class-wide early literacy intervention. In our study, a total of 30 kindergarten and first-grade students were randomly assigned to either 2 weeks of computer-aided tutoring or a wait-list control group. The effects of the intervention were investigated using multiple-level modeling over four assessment periods (pretreatment, 1 week of intervention, 2 weeks of intervention, and 1-week follow-up). Results were consistent across dependent measures, with rates of growth and follow-up scores significantly higher for the intervention group as compared with the control group. Given that these skills were enhanced in an efficient manner and maintained for at least 1 week, the computer-assisted tutoring intervention appears to be an appropriate support for rapidly improving early skill deficits related to letter-sound knowledge and decoding.

The importance of preventative instruction and intervention is highlighted by longitudinal studies showing the stability of early reading deficits. This research consistently finds that most children who struggle with reading during their first 3 years of school remain poor readers throughout their education (e.g., Phillips, Norris, Osmond, & Maynard, 2002). Because efforts to remediate deficits in reading become more challenging after third grade (Torgesen, 2002), preventing reading failure necessitates that supports be implemented as early as possible (Vadasy, Sanders, & Peyton, 2006).

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Early Literacy Targets and Intervention

Alphabetic skills, such as knowledge of letter sounds, are primary targets of early instruction and intervention given their capacity to support children's reading development (Piasta, Justice, McGinty, & Kaderavek, 2012). The sequential relationship between alphabetic skills and word reading is addressed in the four-phase model of sight-word development of Ehri (2005). In this model, all children begin in a prealphabetic phase in which they lack awareness of phoneme–grapheme relationships and often guess what words are on the basis of physical features (e.g., a brand logo) or context (i.e., logographic reading). In the partial-alphabetic phase, children acquire knowledge of grapheme–phoneme correspondences. With repeated exposure to grapheme–phoneme relationships, children enter a full-alphabetic phase in which they begin applying this knowledge fluently and accurately to text. In the concluding phase (consolidated alphabetic), children are able to exercise their skills to decode and articulate unfamiliar words. Therefore, knowledge of letter sounds can be conceptualized as a skill that provides the foundational underpinnings of activities that involve decoding and reading.

Many schools have a high proportion of students with gaps in alphabetic skills (U.S. Department of Education, 2001) and limited resources for remediation. Consequently, interventions designed to enhance early literacy skills must be efficient and generate meaningful changes in student learning (Skinner, 2008). One method of teaching fact-based information that requires few resources is flashcard drill procedures (Nist & Joseph, 2008). As an alternative to traditional drill (TD) procedures that exclusively present unknown information, interspersal drill techniques have been developed that present known units of information along with unknown information in varying ratios (Cates et al., 2003).

One type of interspersal procedure that has garnered much attention in research is incremental rehearsal (IR; Tucker, 1989). In IR, unknown facts are taught one at a time by systematically interspersing them among known facts in a high ratio of known to unknown (e.g., 9:1; see Burns, 2005). Numerous studies have shown IR to be effective across a range of academic content areas, including vocabulary (e.g., Burns & Sterling-Turner, 2010), math facts (Codding, Archer, & Connell, 2010), and letter identification (Bunn, Burns, Hoffman, & Newman, 2005). The mechanism of IR's efficacy likely rests in the incorporation of components that facilitate the movement of newly presented information from short-term memory to long-term memory. In particular, IR affords a high number of opportunities to respond (Burns, 2007; Volpe, Mulé, Briesch, Joseph, & Burns, 2011), which has been repeatedly shown to enhance acquisition and retention (Greenwood, Delquadri, & Hall, 1984; MacQuarrie, Tucker, Burns, & Hartman, 2002). IR also features distributed practice (Dempster, 1991), training to automaticity (Jones & Christensen, 1999), and errorless learning (Browder & Shear, 1996).

Tutoring Buddy

Although IR typically produces superior levels of maintenance when compared with TDs, the procedure is less efficient than TDs (i.e., less is learned per minute of instruction; Nist & Joseph, 2008; Volpe, Burns, et al., 2011). This finding is critical because successfully remediating skills within the limited time schools have for instruction requires interventions to be both highly effective and efficient (Skinner, 2008). Moreover, IR has also been found to have lower levels of social validity when compared with TDs (Nist & Joseph, 2008), and the procedure may be cumbersome for interventionists given the length of intervention sessions and the need to manipulate a large number of flashcards. Accordingly, a computer-assisted tutoring program was developed to teach letter-sound correspondences using IR (Tutoring Buddy; Volpe, 2009). Tutoring Buddy was designed to improve on traditional IR intervention by (a) increasing efficiency, (b) reducing the demands placed on interventionists, and (c) increasing student attention.

Efficiency

Tutoring Buddy may enhance the efficiency of IR in three ways. First, by presenting stimuli on a computer screen, the program eliminates the need to manipulate index cards. Second, the program presents students with a string of continuous letters. In addition to more closely approximating reading, this string allows children to move through the intervention more rapidly than when exposed to one letter at a time. Third, instead of the traditional 9:1 ratio of known to unknown facts, Tutoring Buddy uses a more challenging 4:1 ratio. This reduces the IR sequence from 54 units of information to 14 and meets the requirements for delivering a drill procedure at an instructional level with instructional support (i.e., 70%–85% known information; see Gickling & Thompson, 1985). This IR sequence has been used to enhance letter identification (Bunn et al., 2005) and letter-sound fluency (LSF) (Volpe, Burns, et al., 2011).

Facilitating Implementation

A primary rationale for developing Tutoring Buddy was to minimize the demands for interventionists delivering IR. As such, the program eliminates the need to prepare or manipulate paper flashcards, automates data collection, and shortens intervention sessions to about 5 min (from 15 min in traditional IR; Nist & Joseph, 2008). Given that Tutoring Buddy is easy to use, perceptions regarding its acceptability as a mechanism for improving letter-sound expression (LSE) are likely high (i.e., interventions that take less time, effort, and skill to implement typically receive high acceptability ratings; Witt & Elliott, 1985). Acceptability is critical to address in intervention design because it is a primary factor in determining whether a treatment will be used and to what degree it will be implemented with fidelity (Witt & Elliott, 1985).

Increasing Attention

The capacity to gain and hold a student's attention throughout instruction is critical because without attention, there can be no learning (Gagné & Driscoll, 1988). Using computers during instruction has consistently been found to increase and maintain student attention (e.g., Ota & DuPaul, 2002). Computers are thought to enhance attention by using multiple sensory modalities, stimulating interest through the use of large prints and colors, and providing immediate feedback (Ota & DuPaul, 2002). Accordingly, Tutoring Buddy incorporates these characteristics by using large fonts, saying and showing letters to children, and having tutors provide immediate feedback. Tutors also continuously monitor for attention to ensure that children remain on task for the duration of the intervention sessions.

Purpose of Our Study

In an initial investigation of Tutoring Buddy using a multiple baseline design across participants, Volpe, Burns, DuBois, and Zaslofsky (2011) found that the intervention increased the LSE and LSF of four kindergarten students who were unresponsive to a well-established class-wide peer tutoring program. Although these findings are encouraging, the sample size was small and replication of findings is needed. Accordingly, this study sought to replicate and extend these initial findings by using a randomized controlled trial with a wait-list control group to evaluate (a) the effects of Tutoring Buddy on LSE and (b) the effects of Tutoring Buddy on LSF and decoding skills.

Method

Participants and Setting

The participants consisted of 12 kindergarten and 18 first-grade students ($N = 30$) attending a 500-student public elementary school in an urban school district in the Northeastern United States (89% of students in the school were eligible for free or reduced-price lunch). All kindergarten and first-grade teachers in the school (three teachers in each grade) were asked to nominate students who were in need of an intervention targeting letter-sound knowledge. This process yielded a pool of 30

Table 1
Descriptive Statistics for Treatment Group and Wait-List (Control) Group

Variable	Treatment [% (*n*)]	Control [% (*n*)]
Age		
5 y	33 (5)	27 (4)
6 y	67 (10)	53 (8)
7 y	0 (0)	20 (3)
Grade		
Kindergarten	40 (6)	40 (6)
First	60 (9)	60 (9)
Gender		
Male	73 (11)	33 (5)
Female	27 (4)	67 (10)
ELL status		
ELL student	67 (10)	53 (8)
Non-ELL student	33 (5)	47 (7)
Race		
Hispanic	67 (10)	87 (13)
African American	33 (5)	13 (2)

Note. ELL = English-language learner.

students, including 18 English-language learners (ELLs; 8 in kindergarten and 10 in first grade). By use of a random number generator, 15 students were assigned to the treatment group. The remaining 15 students were assigned to the wait-list control group and received intervention on completion of the study (see Table 1 for group demographic data). None of the participants received additional literacy supports before or during the study.

Four school psychology graduate students served as the interventionists for the study. All interventionists were trained to use Tutoring Buddy by the first author during individual 1-hr training sessions that included didactic instruction and role play. Before serving as a tutor, all interventionists achieved 100% accuracy in implementing all intervention components. The four graduate students also assisted in collecting LSF and nonsense-word fluency (NWF) data. Data collectors were trained to collect LSF and NWF data during their graduate coursework.

Intervention

The Tutoring Buddy program was delivered one-on-one using a 17-in. laptop computer running Windows Vista (Tutoring Buddy can be used on any Macintosh or Windows machine because the RAM requirements for the program are minimal). The intervention consisted of three essential elements: (a) a preintervention assessment of LSE, (b) a setup screen, and (c) the IR procedure. During the preintervention assessment, the program presented 24 lower-case letters of the alphabet in 120-point Century Gothic font, one at a time, in random order (*x* and *q* were excluded). For each letter, the interventionist asked the student, “What sound?” The tutor recorded responses by using the up arrow (correct) or down arrow (incorrect) on the keyboard.

After the preintervention assessment, the program advanced to a setup screen where the interventionist selected, from pop-up menus, four known and two unknown letters (based on the preintervention assessment) for use in the IR session. The first unknown letter was then presented in isolation on the screen in 120-point Century Gothic font, and the interventionist introduced the sound by pointing and saying “This letter makes the [letter sound] sound.” The interventionist then asked, “What sound does it make?” and prompted the tutee to make the sound. Next, known and unknown letters were presented in a continuous string in 68-point Century Gothic font (black font against a white background) in the following order: first unknown, first known, first unknown, first known, second known, first unknown, first known, second known, third known, first unknown, first known, second known, third known, and fourth known. This process was repeated for the second unknown sound. However, for the second IR sequence, the first unknown became the first known and the fourth known from the previous string was eliminated. Therefore, each IR sequence used a 4:1 ratio of known to unknown letter sounds.

All errors were corrected using a standardized correction procedure (regardless of whether the letter was considered known or unknown). The interventionist said, "Stop"; modeled correct pronunciation; and asked, "What sound?" Once the student accurately pronounced the sound, he or she was instructed to return to the beginning of the IR sequence. Sessions ended when the students accurately completed the IR sequence two times for both targeted letter sounds.

Procedures

The Tutoring Buddy intervention was provided to the 30 students as a service to the school. Before this service was delivered, the school's principal obtained permission from parents to provide additional supports to children during their regularly scheduled literacy time. Institutional review board approval was obtained to analyze the data collected during the provision of the intervention.

To minimize delay of intervention for the wait-list group and to provide an intense dose of intervention, the treatment group received individual tutoring on eight consecutive school days over a period of 2 weeks. All sessions occurred during regularly scheduled morning literacy time in a quiet space immediately outside of each student's classroom. During each IR session, two letter sounds that were articulated incorrectly during the preintervention assessment were selected for intervention. If continuous sounds (e.g., /a/ and /o/) were unknown, two were randomly selected for intervention. If all continuous sounds were known, two stop sounds (e.g., /b/ and /g/) were randomly selected. To increase exposure to a variety of letter sounds and to prevent confusion, the same letter sounds were not trained during consecutive sessions and letters with similar visual features (e.g., /b/ and /d/) were trained during different sessions whenever possible.

Preintervention assessments lasted between 26 s and 117 s (M = 62 s, SD = 18 s). Intervention sessions lasted between 53 s and 11 min (M = 123 s, SD = 77 s). To measure treatment responsiveness, LSE, LSF, and NWF assessments were administered to all students on four occasions: immediately before the first intervention session for the intervention group, 1 week after the intervention began, 1 day after the final intervention session, and 1 week after the intervention was completed.

Dependent Measures

Letter-sound expression. LSE data were obtained for all students through the program's preintervention assessment. Sounds that were pronounced correctly within 3 s of their presentation were considered known. LSE scores could range from 0–24.

Letter-sound fluency and nonsense-word fluency. AIMSweb LSF progress-monitoring probes (NCS Pearson, 2005) were used. Scores were calculated as the number of correctly articulated letter sounds in 1 min. Similar measures correlate strongly with standardized measures of phonologic processing (Hintze, Ryan, & Stoner, 2003) and have shown strong alternate-form reliability (range, 0.74–0.89). In addition, DIBELS (Dynamic Indicators of Basic Early Literacy Skills) sixth edition NWF progress-monitoring probes (Dynamic Measurement Group, 2008), which are a measure of the alphabetic principle (Good & Kaminski, 2002), were used, and scores were calculated as the number of correctly articulated letter sequences in 1 min. The kindergarten and first-grade probes have shown strong alternate-form reliability (0.94 and 0.83, respectively; Good et al., 2004; Speece, Mills, Ritchey, & Hillman, 2003). The level of LSF and NWF progress-monitoring probes corresponded to the grade of each student, and different probes were used for each assessment. Following standard procedures, both LSF and NWF probes were administered 3 times during each assessment and the median score for each assessment served as the dependent measure.

Table 2
Descriptive Statistics Across Assessment Occasions for Transformed Data

	Pretreatment [*M* (*SD*)]		End-of-Intervention Week 1 [*M* (*SD*)]		End-of-Intervention Week 2 [*M* (*SD*)]		1-Week Follow-Up [*M* (*SD*)]	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
LSE	2.06 (0.23)	1.99 (0.40)	2.21 (0.12)	2.00 (0.38)	2.28 (0.10)	2.07 (0.27)	2.28 (0.09)	2.07 (0.30)
LSF	2.00 (0.40)	1.85 (0.56)	2.24 (0.27)	1.90 (0.58)	2.39 (0.26)	2.04 (0.43)	2.41 (0.22)	2.04 (0.48)
NWF	2.01 (0.35)	1.94 (0.53)	2.21 (0.36)	1.83 (0.61)	2.39 (0.26)	2.00 (0.49)	2.43 (0.24)	2.04 (0.45)

Note. LSE = letter-sound expression; LSF = letter-sound fluency; NWF = nonsense-word fluency.

Results

Treatment Integrity and Interobserver Agreement

Treatment integrity data were gathered using a 22-item procedural checklist that was completed by a graduate student observing the interventionist. These data were collected during 42% of intervention sessions. Treatment integrity was calculated by dividing the number of components observed by the total number of steps. The average integrity score across all intervention components was 99%. Interobserver agreement (IOA) data were collected for 25% of LSE, LSF, and NWF assessments. IOA was calculated by having a second graduate student score the assessments as they occurred. The total number of agreements on correct and incorrect responses was then divided by the total number of attempted items and multiplied by 100%. IOA was 97%, 98%, and 95% for LSE, LSF, and NWF, respectively.

Treatment Effects

Descriptive statistics across the four assessment occasions (pretreatment, end-of-intervention Week 1, end-of-intervention Week 2, and 1-week follow-up) are provided in Table 2 for the treatment and control groups (see also Figure 1). As a result of many low scores, data across the three dependent measures showed significant positive skew. Given the presence of zeros in the data set (a student in each condition had a baseline LSF score of 0; a student in the control condition had a baseline NWF score of 0), all values were transformed by adding a constant and then taking the natural logarithm (Tabachnick & Fidell, 2007). All subsequent statistical analyses were carried out on the transformed data. Given the use of a multistep analysis, Holm's sequentially rejective Bonferroni technique was used in which α levels for each hypothesis are calculated, ordered from smallest to largest, and then compared with significance-level cutoffs that are calculated in a stepwise fashion (i.e., α divided by n number of tests, where n equals the number of remaining tests after each rejection of the null hypothesis; Holm, 1979). Six comparisons were calculated in total; therefore, the initial p value was equal to α (.05) divided by 6 (.05/6 = .008). This cutoff was compared with the smallest obtained α value and was adjusted stepwise after each subsequent rejection of a null hypothesis.

All analyses were conducted using HLM 6 software (Raudenbush, Bryk, & Congdon, 2004). Given that the assumptions of multiple-level modeling were met (e.g., linearity, normality, homoscedasticity) and that intervention was hypothesized to generate medium to large effect sizes, multiple-level modeling was appropriate for this sample size (Maas & Hox, 2005). Separate analyses were conducted for each dependent variable. At Level 1 of each model, intercept (performance at follow-up) and linear slope were calculated

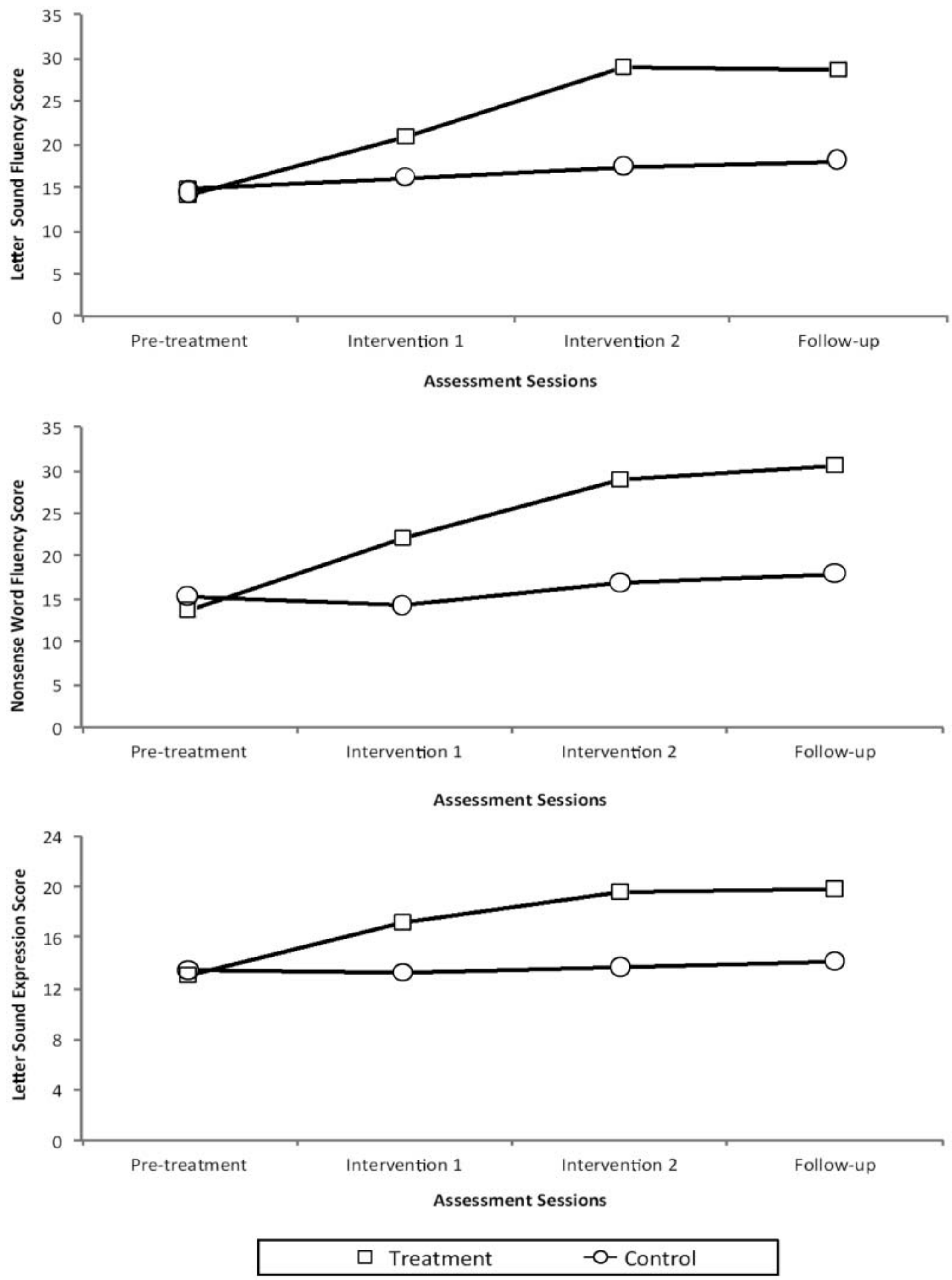

Figure 1. Letter-sound fluency, nonsense-word fluency, and letter-sound expression scores for treatment and control groups.

Table 3
Hierarchical Linear Modeling Analyses of Literacy Measures ($N = 30$)

Measure	Mean Intercept: Control (γ00)	Mean Change in Intercept: Treatment (γ01)	Mean Growth Rate: Control (γ10)	Mean Change in Growth Rate: Treatment (γ11)
LSE	2.08*	.24*	.03*	.05*
LSF	2.07*	.40*	.07*	.07*
NWF	2.03*	.45*	.05*	.10*

Note. LSE = letter-sound expression; LSF = letter-sound fluency; NWF = nonsense-word fluency.
*$p < .008$ to $p < .05$ (modified Bonferroni procedure).

for each participant. At Level 2, group-level parameters of individual change were examined, including mean follow-up performance for the control group (γ00), difference in mean follow-up performance between the control group and treatment group (γ01), mean growth rate (per assessment period) for the control group (γ10), and difference in mean growth rate between the control group and treatment group (γ11).

Table 3 presents values for the HLM analyses. For all three dependent measures, γ00 was statistically significant, indicating that, as a group, students in the control group showed a nonzero level of performance at follow-up. For all three dependent measures, γ01 was statistically significant, indicating a significant difference in follow-up performance between the treatment and control groups. For the control group, linear growth (γ10) was significant across all dependent variables. However, the rate of growth for the treatment group was superior to that of the control group, and the difference in trajectories (γ11) was statistically significant. The average rate of growth for students (using nontransformed data) in the control group was 0.33, 1.03, and 0.97 for LSE, LSF, and NWF, respectively, whereas the rate of growth for students in the treatment group was significantly higher (2.25, 5.23, and 5.85) for LSE, LSF, and NWF, respectively.

On average, students in the treatment condition learned 6.6 letter sounds during the course of the intervention (range, 4–10). Effect sizes were calculated as the difference between the mean follow-up (measured 1 day after the final intervention) and mean pretreatment scores divided by the pooled standard deviation. The indices reported in this article represent estimates of the magnitude of change from pretreatment to follow-up in standard deviation units (Cohen, 1988). The resultant effect sizes were in the medium range: 0.53, 0.59, and 0.67 for LSE, NWF, and LSF, respectively.

Treatment Effects for ELL Students

Exploratory post hoc analyses were conducted to examine possible differential treatment effects for ELL students. Each multiple-level modeling was repeated, but ELL status was entered as an additional predictor in Level 2 of each model. For LSF, ELL status was associated with greater growth over time. However, no statistical differences were found for level. Although the small sample of ELL students did not afford statistical power sufficient to detect differences in rate of growth or level of LSE and NWF, visual analyses of the data suggested that ELL students in the treatment group showed greater growth than non-ELL students in LSE and NWF.

Instructional Efficiency

Instructional efficiency was determined by summing the total amount that students learned during intervention (i.e., total number of sounds learned, gains in LSF and NWF), dividing these sums by the number of seconds spent in instruction, and multiplying by 60. Instructional efficiency for LSE was 0.46 letter sounds learned per minute of intervention. Efficiency for LSF and NWF was an increase of 1.06 correct letters per minute of instruction.

Maintenance

The mean LSF and LSE scores obtained during the follow-up assessment were identical to the mean scores obtained immediately after intervention, indicating no average loss in the skills obtained. The specific letter sounds students articulated correctly between the end-of-intervention assessment and 1-week follow-up was highly consistent (97% overlap). The mean NWF score was slightly higher during reassessment than immediately after intervention (see Table 2). These results suggest that, as a group, students maintained the skills they acquired during intervention for at least 1 week.

Discussion

Our results indicated that the treatment group had superior rates of growth across the three dependent measures and performed significantly better at follow-up than students in the control group. Adding to the initial findings of Volpe, Burns, et al. (2011), the utilization of more stringent experimental controls in our study provides further evidence regarding the impact of Tutoring Buddy on LSE and LSF. In addition, this study provides evidence that the intervention can be used to enhance decoding ability (NWF) because students were able to better use their extant decoding skills as a result of knowing more letter-sound correspondences. This finding provides additional evidence that explicitly targeting alphabetic skill during early intervention is critical in the prevention of reading difficulties because this skill supports competence in areas that are linked to later reading achievement (see Piasta et al., 2012). When the findings are taken together, Tutoring Buddy appears to be an effective tool for increasing the LSE, LSF, and NWF of kindergarten and first-grade students.

Exploratory post hoc analyses found that ELL status was associated with greater growth in LSF over time. Although no statistical differences were found for the intercept, this is meaningful given that ELL students had lower LSF scores than non-ELL students at baseline. In addition, visual analyses of the data suggest that ELL students in the treatment group made greater gains than non-ELL students in LSE and NWF. Although such findings are promising, future work is needed to more clearly understand the effects of Tutoring Buddy on ELL students.

Although efficacy is an important determinant in intervention selection, instructional efficiency also must be considered (Skinner, 2008). Because IR has been found to be less efficient than other drill procedures (Nist & Joseph, 2008), many researchers have been reluctant to endorse its use in schools. However, in our study, the Tutoring Buddy intervention showed impressive efficiency. Therefore, Tutoring Buddy appears to be an appropriate support for rapidly improving skill deficits related to letter-sound knowledge and decoding.

Limitations and Future Directions

In considering the findings of this study, one should note several limitations. First, the investigated sample was relatively small, the students were recruited from a single school, and the treatment group was mostly male. Although the findings are encouraging, future studies should investigate larger samples recruited from more diverse settings to facilitate examination of important predictors of treatment response. Using larger ELL samples will be particularly important given that many ELL students enter school with less developed literacy skills than native English speakers (Mulligan, Hastedt, & McCarroll, 2012). Finally, maintenance was measured 1 week after intervention. This period may not be sufficient to fully understand sustained effects.

The simplicity of Tutoring Buddy and its minimal training demands may afford implementation of the program by laypersons. Accordingly, future studies should investigate the use of the intervention by teachers, parents, or community volunteers. The use of community volunteers is an important consideration for schools with few resources and a high proportion of at-risk students because community members represent an effective (see Power, Dowrick, Ginsburg-Block, & Manz, 2004) and practical mechanism for increasing a school's instructional capacity (Invernizzi, Rosemary, Juel, & Richards, 1997). Although this study used Tutoring Buddy as a secondary intervention, the efficiency and feasibility of the intervention also make it amenable for teachers to use as a proactive Tier 1 intervention in their classrooms (e.g., as a literacy center where a paraprofessional or other adult is serving as the interventionist).

A child's home environment has been shown to influence early literacy development (Dodd & Carr, 2003). This understanding has led to recent efforts to train caregivers in effective literacy practices for the purpose of increasing the quality and quantity of parent–child reading activities (Fortman, Fisch, Phinney, & DeFor, 2003). Given the efficacy of this practice (e.g., Sloat et al., 2009), caregivers could be trained to use Tutoring Buddy to support their children's acquisition of letter sounds before entering kindergarten.

Theoretical Implications and Application to Practice

The results of this study provide additional support for the theoretical model of sight-word development of Ehri (2005). Specifically, the acquisition of letter-sound correspondences enhanced students' ability to decode and read novel, nonsense words. Because the ability to sound out words makes reading a productive activity (i.e., moves children beyond a logographic stage of reading), enhancing letter-sound knowledge must be a prominent target within early literacy intervention and curricula.

The results of this study also support the use of Tutoring Buddy as a Tier 2 intervention for students with low levels of letter-sound knowledge. However, given the efficiency of the Tutoring Buddy intervention and its impact on LSE and decoding, it may also represent a tool that could be used proactively. In a traditional response-to-intervention paradigm, intensive supports are typically reserved for students who show a dual discrepancy (low level of performance and shallow trajectory in skill improvement over several months of instruction; see Fuchs & Fuchs, 1998). However, the simplicity and efficiency of Tutoring Buddy may support use of the program on school entry for all students with deficits in LSE before waiting to see if they show slow growth over time (see Volpe, Burns, et al., 2011). By increasing LSE and decoding skills, these children may be better able to access early reading instruction (Dodd & Carr, 2003) and experience immediate school success. Importantly, student academic progress is linked to motivation (Zimmerman, Bandura, & Martinez-Pons, 1992) and behavioral functioning (e.g., McWayne & Cheung, 2009; Volpe et al., 2006). Conceptualizing growth in key academic skills should consider these transactional relationships (Lerner, Hess, & Nitz, 1991).

Overall, the results of this study provide support for a computerized intervention that can be used to address some of the needs of students with early literacy deficits. Although future investigations are needed to replicate these results with a broader range of students (e.g., preschool-aged children), these findings support the continued use of Tutoring Buddy in both research and practice.

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