The Effects of a Computerized Reading Intervention Program on the Oral Reading Fluency of At-Risk Urban First Graders

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Abstract
Research regarding the importance of early reading instruction and intervention abounds. However, some teachers may require additional assistance to ensure that students are able to read proficiently. Oftentimes, other school personnel provide this assistance, but recently, technology has come to play an important role. The purpose of this study was to examine the effectiveness of a supplemental repeated reading intervention delivered through a computer-assisted instruction (CAI) program on the oral reading fluency (ORF) of first-grade students (seven year olds) who were at risk for reading failure. In particular, would the CAI be effective under traditional school conditions where there might be more distractions than in a quiet researcher-led setting? Four African American male students in an urban charter school engaged in the Read Live(RL) intervention for 7 to 13 lessons. Results revealed medium to strong effectiveness of the CAI program for all four participants. Based on the results, the researchers conclude that CAI is a viable option for increasing students’ reading skills. However, concern should be taken to ensure that reading interventions are delivered in environments most conducive to student learning. Furthermore, schools should equip teachers with necessary materials to produce more significant gains in students’ academic achievement.

Keywords: computer-assisted instruction, oral reading fluency, urban students, early intervention

INTRODUCTION
Reading is a complex skill comprised of multiple subskills or prerequisites in order to be considered an established or proficient reader. Students with reading difficulties often have deficits in one or more subskills, which effects overall reading proficiency. This is especially true for minority students, African Americans in particular, who attend urban schools. The most recent data reported by the National Assessment of Educational Progress (Vanneman, Hamilton, Baldwin Anderson, & Rahman, 2009) indicates there is still an achievement gap between African American students and their counterparts. Only 18% of Black students in the fourth grade and 16% of Black students in eighth grade scored at or above proficient in reading, compared to 46 and 44% of White students, respectively (National Center for Education Statistics, [NCES], 2015). This gap is even further pronounced for students living in large urban environments. Research has consistently affirmed reading difficulties for students in low-achieving schools, schools serving minority students, and impoverished homes (Lyon, 1998; Musti-Rao & Cartledge, 2007a; Reis et al., 2007; Teale, Paciga, & Hoffman, 2007), among other indicators. Therefore, it is of the utmost importance students, especially in urban environments, develop reading skills early in primary grades.

The National Reading Panel (NRP, 2000) cites oral reading fluency (ORF) as one of the five big ideas in reading instruction. Oral reading fluency is comprised of accuracy, automaticity, and prosody. Stahl (2004) points out that students who lack decoding skills will have difficulty reading words accurately in both word lists and connected text. Chard, Vaughn, and Tyler (2002) note students with learning or reading disabilities tend to struggle with decoding and automaticity. Therefore, it is vital children are taught how to recognize words automatically. Lastly, prosody, or reading with expression, is often a neglected component of fluency. Dysfluent readers often read in a more monotone voice and combine words into meaningless phrases or sentences (Hasbrouck, Ihnot, & Rogers, 1999; Hudson, Lane, & Pullen, 2005). This meaningless chunking impacts not only ORF, but comprehension as well. One mode of increasing ORF is computer-assisted instruction (CAI).

Recently, CAI has been used to improve various reading skills (Cassady & Smith, 2004; Gibson, Cartledge, & Keyes, 2011; Gibson, Cartledge, Keyes,
& Yawn, 2014; Keyes, Cartledge, Gibson, & Robinson-Ervin, in press; Lee & Vail, 2005; Macaruso & Rodman, 2011; Mitchell & Fox, 2001; Torgesen, Wagner, Rashotte, Herron, & Lindamood, 2010). Torgesen and colleagues note that CAI has the potential to impact struggling readers skills due to its embedded instruction, practice, cost effectiveness, and high fidelity. However, the authors point out that computers should not replace teacher instruction, but rather supplement teacher-led reading instruction. Teachers can use CAI as an intervention tool to help increase skill deficits.

One supplemental CAI reading program is Read Naturally (RN, Read Naturally, 2015), which embeds three empirically-validated techniques: teacher modeling of reading, repeated reading (RR), and assessments and progress monitoring (Hasbrouck et al., 1999). Samuels (1979) notes RR should accompany existing reading instruction; and it can also be used to improve skills such as word recognition, comprehension, reading rate, and expression (Johnston, 2000).

STATEMENT OF THE PROBLEM
In several recent studies (Gibson et al., 2011; Gibson et al., 2014; Keyes et al., in press), researchers examined the effects of RN as an ORF intervention in clinical settings (e.g., researcher with one or two students in a quiet room). In all of the studies, the first and second graders (seven-to eight-year-olds) increased their ORF skills across measures. However, the researchers were concerned if these results could be replicated under “normal” school conditions.

PURPOSE
The purpose of the current study was to determine the effectiveness of Read Live (RL) to increase the ORF of first grade students in an environment more consistent with typical school conditions (e.g., multiple students in the room). In particular, would students increase ORF skills when engaging with the program in a classroom or computer lab with competing contingencies (i.e., other students)?

METHODS AND PROCEDURES
Participants and Setting
The study took place at a charter school in a large, urban Midwestern city, with a high percentage of minority children from low-income families. Four first-grade seven-year-old African American male students participated in the study. The school did not use a published, evidence-based core reading curriculum. The district provided the teachers with a map of reading skills to be taught, and the teachers decided how to teach those skills. Students selected for this study met the following criteria: (a) scored below grade level on reading four subtests of the Woodcock-Johnson Test of Achievement – Third Edition (WJ-III ACH; Woodcock, McGrew & Mather, 2001); (b) scored below benchmark on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good& Kaminski, 2002) ORF assessment; (c) received teacher recommendation; and (d) obtained parent consent and student assent.

MATERIALS
To implement this study, the experimenter used the online reading intervention program Read Live (RL, Read Naturally, 2015), desktop computers, headphones, a digital timer, video-recorder, preferred tangible items as reinforcers for motivation, and data collection sheets. The participants used level 1.0 of RL.

Dependent Variables
The primary dependent variables (DV) included the number of correct and incorrect words per minute (CWPM and IWPM), respectively, during 1-min readings of intervention passages. Words were marked as correct if the student read the word correctly or self-corrected within 3 s. Words were scored as incorrect if the student did not read the word within 3 s of the last word, if they mispronounced or omitted a word, or if they added or substituted a word.

Independent Variable
The independent variable in this study was a repeated reading intervention delivered through a commercial CAI program. All intervention sessions were conducted in the elementary or middle school computer lab. The participants completed RL individually; however, intervention sessions were conducted with all participants in the computer lab at the same time. Each participant completed 7-13 lessons, according to the point at which the participant entered intervention. The intervention sessions lasted between 20-45 min each.

Baseline and training. In baseline, the experimenter presented each participant with a RL passage retyped in a Word document on the computer. The participant read the story for 1 min to determine the number of CWPM and IWPM. The experimenter presented baseline probes in this manner until the participants achieved a steady state of responding. Immediately after baseline, the experimenter trained the participants on RL, and the participants were considered trained if they could go through an entire story sequence without prompting from the experimenter. All students required only one training session.

Computer-assisted repeated reading. Every intervention session followed the same procedure (e.g., participants enter password, select story). The participants followed an instructional sequence that included: key words, a cold timing, read along, practice reading, quiz questions, retell, and pass
timing. See Keyes et al. (in press) for a detailed explanation of each step in the sequence. The experimenter only interacted with RL when typing a password before the pass timing (intervention probe) and typing the number of IWPM at the end of the 1 min pass timing.

EXPERIMENTAL DESIGN
A multiple baseline across participants design was used for this study. This single-case design is commonly used with students in Special Education. According to Cooper, Heron, and Heward (2007), with this design all participants begin in baseline and data should be collected until a stable or steady state of responding. For this study, the two students who had stable responding and the lowest ORF performance entered the intervention phase first. The remaining participants continued baseline until a sufficient increase in performance was detected for both participants already receiving the intervention. Once this increase was confirmed using visual inspection of the data, the next two students entered into the intervention phase of the study.

RESULTS
Over the course of the intervention, Jamal completed 12 RL stories, Kenny completed 13, and Aiden and Bobby both completed seven RL stories. The experimenter calculated the Nonoverlap of All Pairs (NAP) to determine the overall effect of RL on the participants’ performance. NAP demonstrates the overlap between each data point in Phase A and with each point in Phase B (Parker & Vannest, 2009), in this study, baseline and intervention. As cited in Vostal and Lee (2015), NAP range from .5 to 1, with .65 or less being weak intervention effects; .66-.92 as medium effectiveness; and .93 and above reflecting strong effectiveness (see Parker and Vannest for a description of calculating NAP). Table 1 shows every participant’s average correct words per minute on RL baseline and intervention probes, as well as the NAP effect size.

Table 1. Average CWPM during baseline and intervention; and NAP scores

<table>
<thead>
<tr>
<th>Student</th>
<th>BL CWPM</th>
<th>INT CWPM</th>
<th>NAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamal</td>
<td>11</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Kenny</td>
<td>11</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>Aiden</td>
<td>20</td>
<td>37</td>
<td>.89</td>
</tr>
<tr>
<td>Bobby</td>
<td>13</td>
<td>39</td>
<td>.87</td>
</tr>
</tbody>
</table>

Jamal
Jamal’s data in Figure 1 show a variable trend on RL probes. Based on the data, the RL intervention had a strong effect on Jamal’s ORF.

Kenny
Kenny’s data in Figure 1 show a somewhat variable trend on RL probes. The data show that RL was strongly effective for Kenny.

Aiden
Aiden’s data in Figure 1 show an extremely variable trend on RL probes; however, most of the intervention data points are above baseline. His ORF scores reveal that the RL intervention had a medium effect on Aiden’s reading skills.

Bobby
Bobby’s data in Figure 1 show a somewhat variable trend on RL probes. The data show that the RL intervention had a medium effect for Bobby.

DISCUSSION
The purpose of this study was to determine the effectiveness of a CAI reading program under more typical school conditions. Even though we had a small sample size and a brief intervention period, we still established a functional relation between the RL intervention and participant gains, as each participant’s ORF did not increase until the intervention was implemented. Jamal and Kenny increased their average ORF by over 30 CWPM during the brief intervention, and Aiden and Bobby increased their average CWPM by 17 and 26, respectively. NAP calculations revealed strong intervention effects for Jamal and Kenny, while Aiden and Bobby’s NAP showed medium effects for the RL intervention. These results support the use of repeated reading as an intervention strategy, which has been demonstrated as a successful ORF intervention (Dowhower, 1987; Chard et al., 2002; Welsch, 2007). The results also expand upon current research regarding the effectiveness of RN (Gibson et al., 2011; Gibson et al., 2014; Keyes et al., in press). Furthermore, the results of the current study provide preliminary evidence as to the effectiveness of RL under more “typical” school conditions (e.g., with distractions).

Surprising, even with the ORF gains, the students still did not meet grade level standards at the end of the year, which, according to DIBELS, students should be reading at least 47plus CWPM by the end of first grade. Even though each participant’s data points show scores within that range, those were on the pass timing at the end of the instructional sequence, having read along with the computer modeling fluent reading of the story, and having practiced the story several times. Students should be able to read at least 47 or more CWPM on a “cold” read, the first time seeing a story. The participants in this study were often below 47 CWPM on the cold read portion of the RL instructional sequence. However, with such dramatic gains over a brief intervention period, one can speculate that the participants would have met grade level standards provided more time.
Sessions
Figure 1. Oral Reading Fluency on RL Intervention Probes.

One point of interest is that participants in this study struggled with sight word recognition and decoding skills. Students need to be able to read words accurately and automatically in order to increase ORF skills. As readers become proficient with decoding, they begin to read words automatically and faster, chunking words into phrases (Stevens, 2006), which will increase their ORF. Therefore, it is imperative that students are taught how to recognize words automatically, which can be achieved by providing children with ample opportunities to practice these skills. At-risk students in urban schools would benefit from explicit instruction in ORF and its prerequisite and subskills, including teaching phonemic awareness and the alphabetic principle directly, explicitly, and systematically (Musti-Rao & Cartledge, 2007b). Thus, had the participants in this study received explicit, systematic decoding and sight word instruction, it is likely they would have made greater gains.

LIMITATIONS AND RECOMMENDATIONS
Promising results notwithstanding, there were some limitations in the current study. The first limitation...
was that the intervention was brief. We encountered multiple delays common in working with schools (e.g., administration changes, breaks, attendance). Second, even though the intervention sessions were completed when the experimenter had the lab reserved within the school’s computer lab schedule; oftentimes, other classes or students would come in at the same time. Therefore, there was more noise and social interference, which impacted the attention, and sometimes performance, of the participants. It would be fitting for teachers to ensure that their classes have an optimal intervention environment so struggling readers are more able to focus on the academic task at hand. The third limitation was that the researchers implemented the intervention. While the conditions were more “typical” of schools, ideally, classroom teachers should implement the intervention themselves. Last, an extraneous variable was that the school lacked a core reading curriculum. Even though the students made ORF gains, the experimenters suspect that more gains would have been made if the children had also been receiving high-quality classroom instruction.

Despite the aforementioned limitations, this study has some implications for students at risk for reading failure, and urban schools in particular. Schools must equip teachers with necessary materials and professional development in order to increase academic success. To that end, Torgesen et al. (2010) purport that ineffective instruction for at-risk students is often due to lack of teacher knowledge and skills, as well as a lack of resources. Thus, schools need to reallocate resources (e.g., money and personnel) to maximize outcomes for at-risk students. For example, Lo, Wang, and Haskell (2009) reported that trained teachers and assistants were able to implement an early reading intervention with high fidelity. The students increased growth rates on measures of early literacy. Therefore, well-trained support staff can be used to implement reading interventions like the CAI in the current study.

It is also of the utmost importance that students receive a solid reading foundation, including phonics skills and sight words. As previously mentioned, these were skills the participants struggled with, like many impoverished minority students entering formal schooling (Musti-Rao & Cartledge, 2007a). For interventions to be most effective, teachers must provide instruction on core components of reading, including phonological awareness and phonics. For instance, Therrien and Kubiha (2006) state that RR is appropriate for students whose instructional reading level is between first and third grade as these students have already acquired a basic foundation in reading (i.e., blending). Stahl (2004) notes that a strong knowledge of the alphabetic principle increases the likelihood that children will read words accurately. RN (2015) states that students should not engage with RL unless they can read at least 50 sight words. Taken together, one can reason that once students have learned basic reading skills, supplemental support provided by humans or computers will be more beneficial.

CONCLUSIONS
The findings of this study demonstrated that computer-assisted instruction does indeed increase students’ reading skills. This strengthens the case for technology-based early reading interventions involving repeated reading. However, in order for students to be most successful, teachers must implement evidence-based practices in the general education classroom so that students have solid foundational reading skills. Furthermore, when teachers implement interventions, they must make sure students have an optimal environment that is conducive to learning.

REFERENCES


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