

A Comparison of Two Flashcard Interventions for Teaching Sight Words to Early Readers

Stacy-Ann A. January¹ · Mary E. Lovelace² ·
Tori E. Foster³ · Scott P. Ardoin³

Published online: 28 November 2016
© Springer Science+Business Media New York 2016

Abstract Strategic Incremental Rehearsal (SIR) is a recently developed flashcard intervention that blends Traditional Drill with Incremental Rehearsal (IR) for teaching sight words. The initial study evaluating SIR found it was more effective than IR for teaching sight words to first-grade students. However, that study failed to assess efficiency, which is important to consider when evaluating and selecting interventions. Therefore, the current study evaluated both the efficiency and effectiveness of SIR compared with IR for teaching sight words to 4 general education students (3 in second grade and 1 in first grade) who were enrolled in 1 of 2 schools. An alternating treatments single-case design was used to compare the effects of SIR and IR interventions implemented 4 days per week across 4 or 5 weeks. Students' accuracy with words that were introduced during the week was assessed on Fridays, and maintenance of these words was assessed the following Friday. Results indicated that both interventions were effective for teaching students sight words, but that SIR was slightly more effective and efficient than IR for 3 of the 4 students. Findings have implications for the selection of flashcard interventions for teaching sight word vocabulary to early elementary students.

Keywords Reading intervention · Sight word instruction · Strategic Incremental Rehearsal · Incremental Rehearsal

✉ Stacy-Ann A. January
sajJanuary@sc.edu

¹ University of South Carolina, Columbia, SC, USA

² Madison County School District, Danielsville, GA, USA

³ University of Georgia, Athens, GA, USA

Introduction

Nearly two-thirds (64%) of fourth-grade students do not read proficiently (National Center for Education Statistics 2015). Of even greater concern is that early reading difficulties are likely to persist (Juel 1988) and may lead to negative outcomes such as grade retention, school dropout, and emotional and behavioral problems (Daniel et al. 2006; Darney et al. 2013). By intervening early, educators can remediate reading difficulties and decrease the likelihood that children with reading difficulties develop long-term reading problems (Vellutino et al. 2006). One approach to intervening with struggling beginning readers is to focus on increasing their sight word vocabulary (Ehri 2005; Ehri and McCormick 1998).

Despite a lack of consensus on a single definition, the term “sight word” is generally used to denote a word that is stored in memory and read automatically as a unit (Ehri 2005). By having a large bank of words that they can read automatically (i.e., by sight), students spend less effort attempting to decode words and can devote greater cognitive resources to text comprehension (LaBerge and Samuels 1974; Perfetti and Hogoboom 1975), which is the ultimate goal of learning to read (National Institute of Child Health and Human Development [NICHD] 2000). Indeed, research indicates that flashcard interventions, which are often used in sight word instruction, can lead to improvements in sight word recognition and subsequently, reading comprehension skills (Tan and Nicholson 1997). Therefore, providing instruction on words until they become “sight words” is beneficial for students learning to read (Ehri 2005).

Flashcard Interventions

Two flashcard techniques for teaching sight words are Traditional Drill (TD) and Incremental Rehearsal (IR; Tucker 1988). When implementing TD, all target words are previously unknown to the student. In the first trial of the initial session of TD, each target word is modeled (e.g., “The word is ____.”) and the correct response is prompted (e.g., “Say the word.”). When all the target words are modeled, the first trial is complete. Next, each word is presented again, the student is prompted to say the word (without a model), and corrective feedback is provided when words are read incorrectly. Subsequent trials begin with shuffling the words, prompting the student to say each word, and providing corrective feedback as needed. Typically, instruction continues until the student is able to read all of the target words or a predetermined criterion is met (e.g., number of minutes of intervention). In contrast to TD, in which all target words are previously unknown, IR involves presenting known and unknown words at a ratio of nine (known) to one (unknown). Similar to TD, IR procedures begin with the presentation, modeling, and prompting of an unknown word. However, the nine known words are then interspersed incrementally (e.g., unknown word, known word; unknown word, two known words; unknown word, three known words) until the previously unknown word is practiced nine times. At this time, the previously unknown word becomes a known word, and the ninth known word (the last word presented) is removed. This process continues with the introduction of a new unknown word.

Evidence indicates that instruction with TD or IR produces gains in sight word vocabulary (Joseph et al. 2012; Joseph and Nist 2006; MacQuarrie et al. 2002; Nist and Joseph 2008; Tan and Nicholson 1997). However, it is also important to consider the efficiency of an intervention, or the amount (e.g., number of words) learned divided by the instructional time required to implement the intervention (Skinner 2008; Skinner et al. 2002). A number of researchers have investigated the efficiency of TD compared with flashcard methods (e.g., IR) that intersperse known words with unknown words. Although some work by Volpe and colleagues suggests minimal differences in the efficiency of TD over IR (Volpe et al. 2011a; Volpe et al. 2011b), the preponderance of evidence indicates that, after considering intervention instructional time, students learn more words when instructed with TD (Burns and Sterling-Turner 2010; Cates et al. 2003; Joseph and Nist 2006; Nist and Joseph 2008). Moreover, these effects maintain over time (Mulé et al. 2015; Nist and Joseph 2008) and when controlling for instructional time across conditions (Forbes et al. 2013; Joseph et al. 2012). Evidence that TD is more efficient is due, at least in part, to the fact that TD involves the presentation of only unknown words, which is a distinct advantage that TD has over IR. Although TD is more efficient, IR instruction may lead to improved generalization of words (Joseph et al. 2012; Nist and Joseph 2008).

Theory and empirical research suggest several benefits associated with teaching sight words via IR as compared with TD. First, because previously unknown words are interspersed with known words and become “known” over time, IR provides increased opportunities to respond to words targeted for instruction, facilitating learning and retention (Burns 2007; MacQuarrie et al. 2002; Szadokierski and Burns 2008). Moreover, IR involves distributed practice (i.e., unknown words are introduced over time), which enables words to be encoded in multiple contexts as opposed to the massed practice (i.e., all unknown words are introduced together) involved in TD, in which words are encoded in a single context (Cepeda et al. 2006; Schutte et al. 2015). Relatedly, procedures in IR involve expanded practice (i.e., presentation of an increasing number of known words between the unknown words), which also facilitates encoding of words within multiple and varied contexts (Taylor and Rohrer 2010; Varma and Schleisman 2014).

Despite its advantages, there are drawbacks associated with IR. Given that IR procedures involve exactly nine presentations of each unknown word, IR operates under the assumption that a word becomes learned after a set number of exposures; in reality, however, a student may need greater or fewer than nine practice trials to master specific words. Another drawback associated with IR as compared to other flashcard techniques (e.g., TD) is that it requires considerably more instructional time (Burns and Sterling-Turner 2010; Cates et al. 2003; Joseph et al. 2012) and involves more complicated instructional procedures. Finally, because 90% of the words presented in IR are previously known, procedures limit the number of new words that can be introduced during each session.

Strategic Incremental Rehearsal (SIR)

In an effort to address the shortcomings of IR, Kupzyk et al. (2011) developed Strategic Incremental Rehearsal (SIR), a modified version of IR that incorporates

elements of TD. SIR is similar to TD in that only unknown words are presented to students. However, like IR, instruction with SIR involves distributed practice, as unknown words are introduced incrementally. For example, after the first trial of SIR, new unknown words are introduced only when the student practices the existing instructional words without any errors. Another similarity between IR and SIR is that both procedures include the removal of words targeted for instruction. However, SIR is unique in that the procedure for removing a word is based upon each student's performance with the target words on which instruction is being provided. Finally, SIR is different from IR and TD in that each discarded word is periodically probed to assess maintenance and replaced back into the instructional word pile if the student does not read it accurately.

Using an A-B-A-B single-case design, Kupzyk et al. (2011) provided four first-grade students with either IR or SIR instruction (in counterbalanced order) for five consecutive sessions across 4 days per week. Assessment results obtained the following day and after a 2-week delay indicated that instruction with SIR resulted in greater gains in sight word acquisition as compared to IR. Although results of Kupzyk et al. (2011) provided preliminary evidence that SIR is a viable method for teaching sight words to early readers, replication of these findings is necessary, given the importance of replication in advancing science and practice in education (Makel and Plucker 2014). Therefore, the efficiency of SIR compared to other flashcard interventions needs to be investigated.

Purpose

Many resources are required to provide early intervention services to students; therefore, interventions that have straightforward procedures and require less time but still maintain robust effects are desirable. Furthermore, efficiency is particularly salient when educators are remediating reading problems, given the importance of learning to read (NICHD 2000). Thus, to best support the academic competence of students, school-based professionals must have knowledge of interventions that are efficient as well as effective. In light of the promise of SIR (a modified IR procedure that blends components of TD and IR), the present study had two objectives. First, this study aimed to add to the intervention evidence base by evaluating whether SIR would produce gains in sight word reading for struggling early readers. The second purpose was to evaluate whether SIR would be a more efficient intervention than a traditional IR procedure. Additionally, this study extended (Kupzyk et al. 2011) by shortening the duration of each intervention, employing an alternating treatments design, and slightly modifying IR instructional procedures.

Method

Participants and Settings

Participants included four general education students who were identified by their teachers as struggling readers. Three participants were in second grade: Albert

(Hispanic/Latino male), Jay (African-American male), and Taylor (Caucasian female). The fourth participant, Gary (Caucasian male), was in first grade. Students did not receive special education services or any additional interventions. Participants were enrolled in one of two Title 1 schools within the same district in the Southeastern United States. School A, a public primary school, served approximately 400 students in pre-kindergarten through second grade, and School B, a public elementary school, enrolled approximately 500 students in kindergarten through fifth grade. Individual socioeconomic data were not available; however, 31% of students at School A and 26% of students at School B were eligible for free or reduced-price meals, which is often used as a proxy for socioeconomic status.

Materials

All sight words used in the current study were drawn from the Dolch (1936), Dale-Chall (<http://opi.mt.gov/pub/rti/Forms/School/Choteau/The%20Dale-Chall%20Word%20List.doc>), and Fry New Instant (Fry 1980) word lists. During assessment, sight words were presented on 8½-in × 11-in sheets of paper. Words targeted for intervention were printed singly in a landscape orientation on 3-in × 5-in pieces of heavyweight paper.

Research Design

The current study employed an alternating treatments single-case design, presenting both interventions within a single session each day, with no time delay between each intervention. This design allowed for direct comparison between IR and SIR (Barlow and Hayes 1979). Intervention presentation was counterbalanced both within and across participants. Albert's and Taylor's first sessions consisted of instruction with IR then SIR, whereas Jay's and Gary's first sessions consisted of instruction with SIR then IR. Students received intervention Monday through Thursday across 4 or 5 weeks. To help control for treatment duration across conditions, new words were not introduced after 6 min of intervention elapsed.

Procedures

Pre-assessment

Prior to beginning intervention, students were pretested using words from the Dolch, Dale-Chall, and Fry word lists. A word was selected as a target (unknown) word if a student erred (i.e., read the word incorrectly or did not respond within 3 s) on the same word on three separate pretest occasions. Unknown words were randomly assigned to an intervention condition. Words were identified as known if a student read them accurately within 3 s. To control for incidental learning of potential target words during the course of the study, students were re-assessed on Fridays each

week to ensure that potential target words for the following week remained unknown.

Incremental Rehearsal (IR)

Instructional procedures for IR were similar to prior research (e.g., Mulé et al. 2015) and consisted of presenting, modeling, and prompting the first unknown word (UK1). Next, UK1 was presented again, followed by the incremental addition of known words (e.g., UK1, K1; UK1, K1, K2) until K9 was introduced. Then, before introducing a new unknown word (i.e., UK2), the most practiced known word (i.e., K1) was removed and replaced with UK1. The procedures for practicing words were repeated with the systematic introduction of new words, incremental presentation of known words, and replacement of the most practiced word with the most recently introduced word. IR procedures were, however, modified slightly. That is, in an effort to eliminate the possibility of students responding correctly to a word due to order of presentation and to potentially improve generalization, the interventionist quickly shuffled the flashcards after each round after three words were introduced. For example, after UK1, K1, and K2 were practiced, cards were shuffled before K3 was added to the instructional word pile (of known and unknown words) and again before every additional word was introduced.

During the presentation of each word, if the student did not provide the correct response within 2 s, the interventionist provided modeling and error correction. Each intervention session was a minimum of 6 min, as presentation of new unknown words was discontinued after 6 min of intervention. Total session duration, however, was generally longer than 6 min, as the incremental presentation of known words was continued until K9 was presented. Finally, in an effort to mimic procedures employed within schools, all unknown target words and known words from Thursday of one week carried over to Monday of the following week.

Strategic Incremental Rehearsal (SIR)

During the first SIR session, the interventionist presented the first target word, modeled the correct response (i.e., “The word is ____.”), and prompted the student to say the word (i.e., “Say the word.”). If the student said the word correctly, s/he was praised (e.g., “Good!”). Error correction was provided if the student made an error (i.e., “No, the correct response is _____. Say it.”). After the student provided the correct response to the first target word, the interventionist presented the second target word in an identical manner. This process was repeated at least one more time until the student responded accurately to both words without error correction. Next, words were shuffled and students were given the opportunity to practice the words. To practice target words, the interventionist presented the first word and prompted the student to give the correct response. If the student provided an incorrect response or did not respond within 2 s, the correct response was modeled, and the student was prompted to repeat it. Then, the interventionist presented the second target word in the same manner. After the student responded correctly (i.e., within 2 s and without a model provided) to both target words without delayed prompts on

either word, words were shuffled, and a new target word was introduced. After placing the new word at the front of the target word pile, the interventionist modeled and prompted the correct response, providing error correction if needed. Next, the remaining target words were presented (with error correction provided as needed), all words were shuffled, and all target words were presented again. Finally, if the student responded correctly to all words without error correction, a new target word was presented in the same manner described above.

Procedures for all subsequent intervention sessions began with the shuffling and presentation of all target words from the previous session (with error correction provided as needed). If the student responded accurately during the initial presentation of all target words, the interventionist added a new target word (with modeling and prompting). If the student made an error, error correction was provided, and words were reshuffled and practiced until no errors were made. After a new target word was introduced and practiced without error correction, the remaining words were presented, all the words were shuffled, and then the target words were presented to the student again. When a student responded accurately to all the target words without error correction, a new target word was introduced. This process was repeated until the end of the SIR session. Similar to IR, instructional sessions lasted for at least 6 min, with no new target words being introduced after 6 min had elapsed, and the words from Thursday of one week were carried over to Monday of the following week.

Criteria for the removal of known target words in the SIR condition were different than those in the IR condition. That is, when a student responded correctly to a word without a delayed prompt during three consecutive instructional sessions (i.e., across 3 consecutive days), the word was removed and placed into a “discard” group of words. Words from the “discard” group were assessed on Mondays and Wednesdays outside of SIR instructional sessions. This assessment involved the presentation of the “discard” words, with prompting and error correction as needed. Words on which students erred were replaced immediately into the target word pile for use during the next instructional session but were not modeled prior to re-introduction. The total number of words that had to be re-introduced after having been discarded was low for all participants (i.e., Albert-4, Jay-5, Taylor-3, Gary-8).

Assessments

Students' sight word accuracy was assessed at the end of each week, on Fridays, using two word lists. The IR assessment list contained all of the new (unknown) words presented during IR intervention that week. The SIR assessment list included all of the new words that were introduced during SIR intervention that week. The two assessment lists were presented in counterbalanced order within and across participants. After a 1-week delay, these same assessment lists were used to measure maintenance of intervention effects. Words were marked as incorrect if they were misread or not read within 3 s. Students were provided with prizes of small monetary value (e.g., eraser, pencil) after each weekly assessment.

Dependent Variables

There were four primary dependent variables: words read correctly (WRC), percent accuracy, average session length, and average number of words learned per min. To measure the effectiveness of each intervention, WRC during each weekly assessment were calculated and then summed to determine the cumulative number of new words learned during each intervention. WRC were then divided by the total number of target words introduced each week to produce a percent accuracy for each weekly assessment. The same procedures were used to calculate WRC and percent accuracy for the maintenance assessment data. We chose to calculate cumulative WRC in this study to be consistent with the manner in which school psychologists practicing in schools would likely summarize resultant data (e.g., Nist and Joseph 2008). Intervention efficiency was assessed first by determining the average length of each intervention session. This was calculated for each participant by dividing the total number of min spent receiving each intervention by the number of intervention sessions. Then, students' learning rates (Cates et al. 2003; Skinner 2008) were calculated. Students' weekly learning rates per min were calculated by dividing cumulative WRC on weekly assessments by the total number of minutes of instruction for each intervention. Likewise, students' maintenance learning rates were calculated by dividing cumulative WRC on the maintenance assessment by the total number of min of instruction for each intervention.

Treatment Integrity and Inter-Observer Agreement

Three graduate students enrolled in a doctoral-level school psychology program delivered the interventions to participants. The second author trained interventionists during one 90-min session. Training consisted of a detailed explanation of the interventions, modeling, and practice conducting the interventions until each interventionist was 100% reliable in implementing the procedures. Prior to having them implement the interventions independently, the second author observed each interventionist implementing one IR and SIR session and provided performance feedback. Each interventionist followed condition-specific protocols that also served as procedural checklists. Approximately 28% of the intervention sessions for both conditions were scored for treatment integrity and inter-observer agreement by an independent observer. Treatment integrity was calculated by dividing the number of accurately completed steps by the total number of steps and multiplying by 100 to yield a percentage. Treatment integrity averaged 99% across all sessions (range = 98–100%). For inter-observer agreement, the observer indicated agreement or disagreement regarding whether each word presented during the instructional session was read correctly or incorrectly. Inter-observer agreement was calculated by dividing the total number of agreements by the total number of agreements and disagreements and multiplying by 100 to obtain a percentage. Overall inter-observer agreement averaged 98% across all participants (range = 94–100%).

Results

Intervention Effectiveness

Cumulative Words Learned

The cumulative number of new words learned after each weekly assessment and maintenance assessment for Albert, Jay, Taylor, and Gary is presented in Figs. 1, 2, 3, and 4, respectively. In each figure, participants' cumulative WRC across each weekly assessment are displayed just above each data point on the line graphs, whereas the cumulative WRC across each maintenance assessment are displayed at the bottom of each bar graph. As illustrated in Figs. 1, 2, and 3, during Week 1, the level of WRC in the SIR condition generally exceeded that in the IR condition for Albert, Jay, and Taylor. This difference in level remained consistent, and there was an increasing trend for both interventions, suggesting that, although both interventions were effective, each participant read as many words correct, if not more, in the SIR condition as compared to the IR condition at the end of each week. The one exception was after Taylor's fourth maintenance assessment, in which she read more words correct in the IR condition than in the SIR condition. Data shown in Fig. 4 indicate that Gary's level of WRC in the SIR condition exceeded that of the IR condition in Week 1, and there was an increase in trend for both interventions

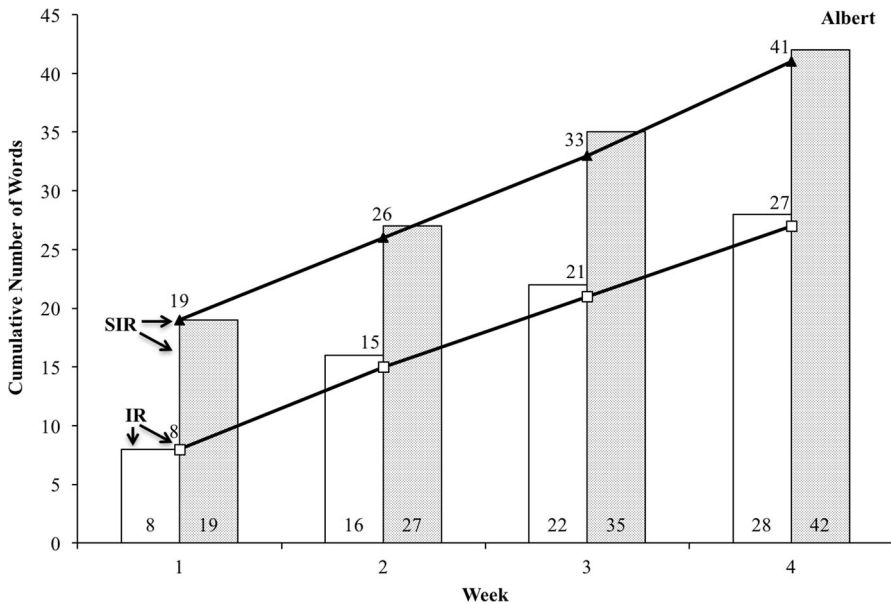


Fig. 1 Albert's cumulative number of words read across each weekly assessment is displayed just above each data point on the *line graphs*, and his cumulative number of words read across each maintenance assessment is displayed at the bottom of each *bar graph* for the Incremental Rehearsal (IR) and Strategic Incremental Rehearsal (SIR) interventions

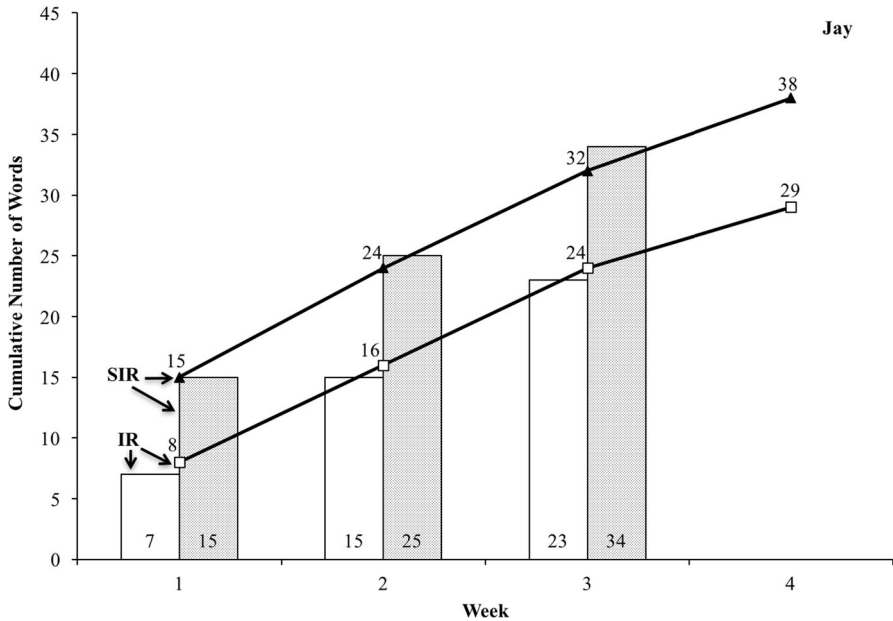


Fig. 2 Jay's cumulative number of words read across each weekly assessment is displayed just above each data point on the *line graphs*, and his cumulative number of words read across each maintenance assessment is displayed at the bottom of each *bar graph* for the Incremental Rehearsal (IR) and Strategic Incremental Rehearsal (SIR) interventions

through Week 5. By the end of intervention, however, Gary's level of cumulative WRC in the IR condition exceeded that of his level of WRC in the SIR condition. This indicates that, although both interventions were effective for Gary, he learned more words in the IR condition than in SIR. Of note, Jay's family moved out of the district and withdrew him from the school prior to the fourth maintenance assessment (but after the completion of the intervention procedures).

Percent Accuracy

Across all weekly assessments, Albert correctly read 27 of 33 words (81.82%) that were presented in the IR condition and 41 of 44 words (93.18%) that were presented in the SIR condition. Based upon cumulative maintenance data, Albert retained 28 of 33 words (84.85%) from the IR condition and 42 of 44 words (95.45%) from the SIR condition. Jay correctly read 29 of 33 words (87.88%) from the IR condition and 38 of 42 words (90.48%) from the SIR condition on weekly assessments. Jay retained 23 of 25 words (92.00%) that were presented in the IR condition and 34 of 34 words (100.00%) that were presented in the SIR condition during the first 3 weeks. Across the weekly assessments, Taylor correctly read 28 of 34 words (82.35%) in the IR condition and 41 of 44 words (93.18%) in the SIR intervention. Based upon cumulative maintenance data, Taylor retained 29 of 34 words (85.29%) from the IR condition and

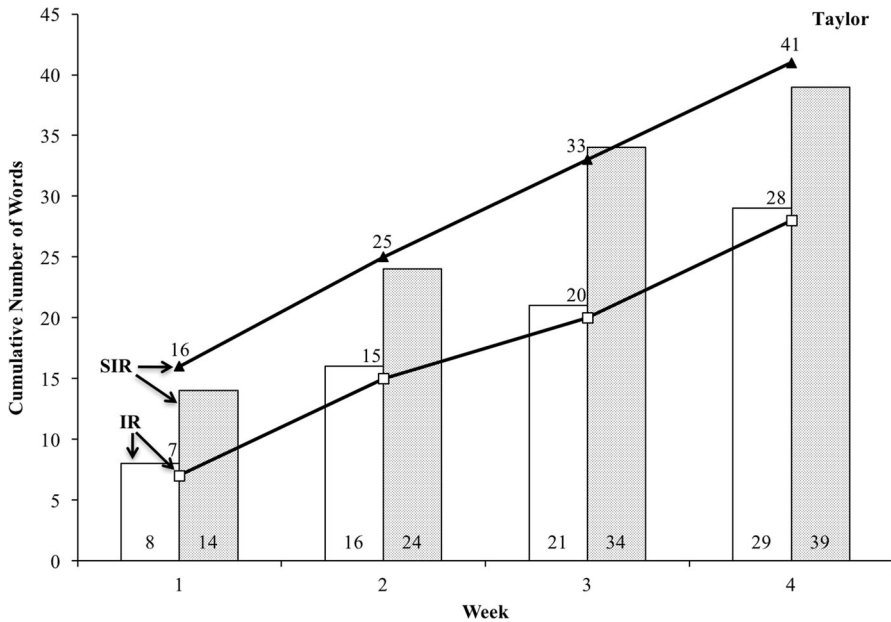


Fig. 3 Taylor’s cumulative number of words read across each weekly assessment is displayed just above each data point on the *line graphs*, and her cumulative number of words read across each maintenance assessment is displayed at the bottom of each *bar graph* for the Incremental Rehearsal (IR) and Strategic Incremental Rehearsal (SIR) interventions

39 of 44 words (88.64%) in the SIR condition. After 5 weeks of weekly assessments, Gary read 34 of 39 words (87.18%) instructed with IR and 29 of 32 words (90.63%) instructed with SIR. Gary’s cumulative maintenance assessment data indicated that he retained 32 of 39 words (82.05%) in the IR condition and 26 of 32 (81.25%) in the SIR condition.

Intervention Efficiency

Session Length

Examination of efficiency data indicated that, on average, Albert spent 6.51 min receiving IR instruction and 6.85 min receiving SIR instruction during each day of intervention (see Table 1). Jay’s average daily session length was 6.70 min in the IR condition and 7.14 min in the SIR condition. On average, Taylor received 6.53 min of IR instruction and 7.06 min of SIR instruction each day. For Gary, average daily IR session length was 7.02 min, and average SIR session length was 8.31 min. Therefore, for all but Gary, the difference between average intervention session length for the SIR and IR conditions was approximately 30 s or fewer.

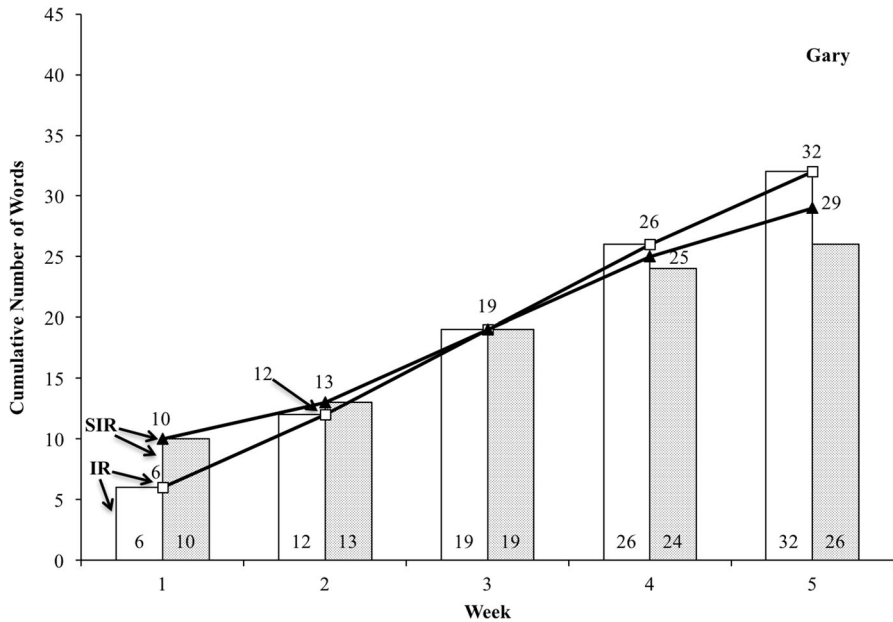


Fig. 4 Gary's cumulative number of words read across each weekly assessment is displayed just above each data point on the *line graphs*, and his cumulative number of words read across each maintenance assessment is displayed at the bottom of each *bar graph* for the Incremental Rehearsal (IR) and Strategic Incremental Rehearsal (SIR) interventions

Table 1 Efficiency of Incremental Rehearsal (IR) and Strategic Incremental Rehearsal (SIR)

	Session length				Words learned per minute (weekly assessment)				Words learned per minute (maintenance assessment)			
	IR		SIR		IR		SIR		IR		SIR	
	<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>
Albert	6.51	1.06	6.85	0.85	0.26	0.05	0.37	0.22	0.27	0.05	0.38	0.21
Jay	6.70	1.44	7.14	1.31	0.27	0.05	0.33	0.12	0.28	0.04	0.41	0.07
Taylor	6.53	0.55	7.06	0.69	0.27	0.05	0.37	0.15	0.28	0.05	0.35	0.15
Gary	7.02	0.76	8.31	1.56	0.24	0.04	0.18	0.09	0.23	0.03	0.16	0.10

Learning Rates

Based upon the weekly assessments (see Table 1), Albert's learning rate was 0.26 words per min (WPM) in the IR condition and 0.37 WPM in SIR, which was consistent with his learning rates based on maintenance data (IR = 0.27 WPM; SIR = 0.38 WPM). Jay's learning rate was 0.27 WPM for IR and 0.33 WPM for SIR based upon weekly assessments. On maintenance assessments, Jay learned 0.28

WPM in the IR condition and 0.41 WPM in the SIR condition. Using data from weekly assessments, Taylor's learning rate was 0.27 WPM in the IR condition and 0.37 WPM in SIR, which was consistent with her learning rates on maintenance assessments (IR = 0.28 WPM; SIR = 0.35 WPM). Gary's weekly learning rate was 0.24 WPM when instructed with IR and 0.18 WPM when instructed with SIR. Similarly, Gary's maintenance learning rates were 0.23 WPM for IR and 0.16 WPM for SIR.

Discussion

Educators often use flashcard interventions to remediate reading problems due to students' poor sight vocabulary. Not only must interventions be effective, they must also be efficient (Skinner 2008). The present study evaluated the effectiveness of SIR, a recently developed flashcard intervention that blends components of IR and TD, and compared the efficiency of SIR with IR. This study was the second to investigate the effectiveness of SIR and the first study to examine its efficiency in comparison with IR for early struggling readers. Findings indicated that both interventions were effective for teaching sight words; however, SIR was more effective and efficient than IR for most students.

Results from this study revealed that SIR is an effective and efficient approach for teaching sight words to early readers. Consistent with Kupzyk et al. (2011), three of the four participants learned more words in the SIR condition than in the IR condition on both weekly and maintenance assessments. Furthermore, all participants retained a greater percentage of words presented in the SIR condition compared to the IR condition on weekly assessments, with this difference maintained over time for most participants. Findings also indicated that learning rates associated with SIR were slightly higher than those associated with IR for three participants. Although the effectiveness and efficiency for SIR were only somewhat greater than IR, SIR may be more advantageous given that students retained more words over time with SIR and that implementation procedures are simpler and less time-consuming than IR.

Extant research may explain the reasons for the effectiveness and efficiency of SIR. SIR was likely more effective and efficient than IR because it involves only unknown words, similar to TD. Given that instructional time was similar across conditions, SIR provided students with more opportunities to respond than did IR, in which 90% of instructional words are known. This is not surprising given that previous research comparing TD with IR demonstrated that when instructional time is held constant, TD provides a considerably greater number of opportunities to respond than does IR (Forbes et al. 2013; Joseph et al. 2012). Another benefit to SIR that likely contributed to its effectiveness and efficiency is that the initial presentation of unknown words varies based upon student responding, ensuring that a student learns a target word before being introduced to more unknown words. Thus, by adapting to student responding in this manner, SIR provides students with distributed practice, which aids in learning (Schutte et al. 2015; Varma and Schleisman 2014). Furthermore, given that SIR allows for the removal of

words when they are considered mastered (i.e., words to which students responded correctly on 3 consecutive days), there is the potential that more new unknown words may be introduced with SIR.

It is important to note that SIR was not the most effective or efficient sight word intervention for one participant, Gary. Anecdotally, Gary required more attempts to respond accurately to all of the words in the SIR target word pile, which was a prerequisite to introducing a new target word. This likely explains why his SIR sessions were longer than the SIR sessions for other participants and why he was introduced to, and thus given the opportunity to learn, fewer new target words. Future research might investigate factors associated with differential effectiveness of SIR.

Another important consideration is that students learned more words during the first week of SIR instruction than during each of the subsequent weeks. This is potentially due to the procedures in SIR that required students to practice the entire target word pile without errors prior to introduction of a new target word. In contrast to Kupzyk et al. (2011), we carried target words over from one week to the next in order to mimic typical procedures in schools; therefore, students had fewer words to practice during the first several days of instruction than during later sessions, given that SIR does not involve a set number of instructional words as does IR (i.e., ten words). Despite this imbalance, most students learned more words and also retained more words over time. A final consideration is that although SIR procedures include rules for removing words that are considered learned, it might be that a student masters a word prior to responding correctly to it across 3 consecutive days. Furthermore, SIR procedures require that previously discarded words are regularly re-assessed and words that students do not maintain are immediately replaced into the target word pile. This procedure ensures that students retain all discarded words. In the current study, each student only had three to eight words re-introduced over the duration of the intervention.

Although not the primary aim of this study, findings add to the extant body of research (e.g., Burns et al. 2012; MacQuarrie et al. 2002; Nist and Joseph 2008), demonstrating that IR is an effective and efficient flashcard method for teaching sight words. Participants in this study learned 27–34 words over the course of the 4- or 5-week intervention period and maintained learned words at high levels. Over the course of the intervention, students in this study learned 0.24–0.27 WPM. These learning rates are similar to those reported in previous research (e.g., Nist and Joseph 2008; Volpe et al. 2011b), adding to existing evidence that IR is an efficient flashcard method.

Limitations and Future Directions

Although the results presented in the current study provide evidence that SIR is an effective and efficient intervention, several limitations should be acknowledged. First, the present study employed a small number of participants (i.e., four); therefore, generalization (i.e., external validity) may be limited. Second, given that there was no baseline condition, it may be difficult to determine a functional relation

between the intervention condition and the number of words learned. However, we did pre-assess words on three separate occasions prior to beginning intervention to ensure that words targeted for intervention were unknown. Relatedly, there may be a chance that students in the current study were exposed to target words during general classroom instruction. However, we reduced this possibility by re-assessing potential target words on Fridays before each coming week. Additionally, the manner in which participants were selected for the present study is a limitation, as we relied on teachers' nominations of students in need of additional intervention as opposed to identifying them in a more systematic way, such as through direct assessment of reading skills. A final limitation is that social validity was not assessed in this study. However, we chose not to measure social validity from the perspective of participants, as we did not expect them to differentiate between interventions given their age and that interventions were delivered in an alternating manner without a time delay. Similarly, although teachers were aware of the different interventions that were being compared, they did not observe intervention implementation and would not have known which words were being instructed under each condition.

In light of the present findings and limitations of the current study, there are several potential avenues for future research. The present study focused on developing students' accuracy with reading sight words and did not assess their generalization of the targeted skill. Future research should investigate students' ability to generalize accurate reading of words learned during intervention to grade-level reading passages to which they were not previously exposed. Furthermore, although results of the current study indicated that SIR instruction can result in gains in students' sight word vocabulary in approximately 7 min per session, it is designed to be delivered to students individually. Thus, SIR requires a trained professional to work one-on-one with a student several days per week for several weeks. Given the personnel resources required to deliver this and similar flashcard interventions, an investigation of modified SIR procedures that can be delivered to a small group is warranted. Additionally, given that SIR is newer than other flashcard interventions, studies should investigate its effectiveness and efficiency with students at different grade levels, with students receiving special education services, and within different academic areas (e.g., mathematics). Finally, future research should compare the effectiveness and efficiency of SIR and TD.

Conclusions

Within Multi-Tiered Systems of Support frameworks, it is important that school-based professionals identify and implement interventions with empirical evidence supporting their efficiency, as well as their effectiveness. Findings from the present study suggest that, when selecting an intervention to teach sight words, SIR should be considered along with other methods (e.g., IR), as results of this study indicate that it is more efficient and at least as effective as IR. This is particularly salient given that SIR procedures are less complicated than IR procedures and likely require less training time for interventionists. Thus, those who are involved in the

planning and delivery of interventions are encouraged to consider using SIR as an intervention for students who are having difficulty acquiring sight word vocabulary.

Compliance with Ethical Standards

Conflict of interest Stacy-Ann A. January, Mary E. Lovelace, Tori E. Foster, and Scott P. Ardoin declare that they have no conflicts of interest.

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Barlow, D. H., & Hayes, S. C. (1979). Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. *Journal of Applied Behavior Analysis, 12*, 199–210. doi:10.1901/jaba.1979.12-199.
- Burns, M. K. (2007). Comparison of opportunities to respond within a drill model when rehearsing sight words with a child with mental retardation. *School Psychology Quarterly, 22*, 250–263. doi:10.1037/1045-3830.22.2.250.
- Burns, M. K., & Sterling-Turner, H. E. (2010). Comparison of efficiency measures for academic interventions based on acquisition and maintenance. *Psychology in the Schools, 47*, 126–134. doi:10.1002/pits.20458.
- Burns, M. K., Zaslofsky, A. F., Kanive, R., & Parker, D. C. (2012). Meta-analysis of Incremental Rehearsal using Phi coefficients to compare single-case and group designs. *Journal of Behavioral Education, 21*, 185–202. doi:10.1007/s10864-012-9160-2.
- Cates, G. L., Skinner, C. H., Watson, T. S., Meadows, T., Weaver, A., & Jackson, B. (2003). Instructional effectiveness and instructional efficiency as considerations for data-based decision making: An evaluation of interspersing procedures. *School Psychology Review, 32*, 601–616.
- Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin, 132*, 354–380. doi:10.1037/0033-2909.132.3.354.
- Daniel, S. S., Walsh, A. K., Goldston, D. B., Arnold, E. M., Reboussin, B. A., & Wood, F. B. (2006). Suicidality, school dropout, and reading problems among adolescents. *Journal of Learning Disabilities, 39*, 507–514. doi:10.1177/00222194060390060301.
- Darney, D., Reinke, W. M., Herman, K. C., Stormont, M., & Ialongo, N. S. (2013). Children with co-occurring academic and behavior problems in first grade: Distal outcomes in twelfth grade. *Journal of School Psychology, 51*, 117–128. doi:10.1016/j.jsp.2012.09.005.
- Dolch, E. W. (1936). A basic sight vocabulary. *Elementary School Journal, 36*, 456–460. doi:10.1086/457353.
- Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading, 9*, 167–188. doi:10.1207/s1532799xssr0902_4.
- Ehri, L. C., & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading & Writing Quarterly: Overcoming Learning Difficulties, 14*, 135–163. doi:10.1080/1057356980140202.
- Forbes, B. E., Skinner, C. H., Black, M. P., Yaw, J., Booher, J., & Delisle, J. (2013). Learning rates and known-to-unknown flash-card ratios: Comparing effectiveness while holding instructional time constant. *Journal of Applied Behavior Analysis, 46*, 832–837. doi:10.1002/jaba.74.
- Fry, E. B. (1980). The new instant word list. *Reading Teacher, 34*, 284–289.
- Joseph, L., Eveleigh, E., Konrad, M., Neef, N., & Volpe, R. (2012). Comparison of the efficiency of two flashcard drill methods on children's reading performance. *Journal of Applied School Psychology, 28*, 317–337. doi:10.1080/15377903.2012.669742.

- Joseph, L. M., & Nist, L. M. (2006). Comparing the effects of unknown-known ratios on word reading learning versus learning rates. *Journal of Behavioral Education, 15*, 69–79. doi:[10.1007/s10864-006-9008-8](https://doi.org/10.1007/s10864-006-9008-8).
- Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology, 80*, 437–447. doi:[10.1037/0022-0663.80.4.437](https://doi.org/10.1037/0022-0663.80.4.437).
- Kupzyk, S., Daly, E. J., III, & Andersen, M. N. (2011). A comparison of two flash-card methods for improving sight-word reading. *Journal of Applied Behavior Analysis, 44*, 781–792. doi:[10.1901/jaba.2011.44-781](https://doi.org/10.1901/jaba.2011.44-781).
- LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*, 293–323. doi:[10.1016/0010-0285\(74\)90015-2](https://doi.org/10.1016/0010-0285(74)90015-2).
- MacQuarrie, L. L., Tucker, J. A., Burns, M. K., & Hartman, B. (2002). Comparison of retention rates using traditional, drill sandwich, and incremental rehearsal flash card methods. *School Psychology Review, 31*, 584–595.
- Makel, M. C., & Plucker, J. A. (2014). Facts are more important than novelty: Replication in the education sciences. *Educational Researcher, 43*, 304–316. doi:[10.3102/0013189X14545513](https://doi.org/10.3102/0013189X14545513).
- Mulé, C. M., Volpe, R. J., Fefer, S., Leslie, L. K., & Luiselli, J. (2015). Comparative effectiveness of two sight-word reading interventions for a student with autism spectrum disorder. *Journal of Behavioral Education, 24*, 304–316. doi:[10.1007/s10864-015-9220-5](https://doi.org/10.1007/s10864-015-9220-5).
- National Center for Education Statistics. (2015). The Nation's Report Card: 2015 Mathematics and Reading Assessments. Washington, DC: Institute of Education Sciences, U.S. Department of Education. Retrieved from: <https://nces.ed.gov/pubsearch/pubinfo.asp?pubid=2015136>.
- National Institute of Child Health and Human Development. (2000). Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups (NIH Publication No. 00-4754). Washington, DC: U.S. Government Printing Office.
- Nist, L., & Joseph, L. M. (2008). Effectiveness and efficiency of flashcard drill instructional methods on urban first-graders' word recognition, acquisition, maintenance, and generalization. *School Psychology Review, 37*, 294–308.
- Perfetti, C., & Hogoboom, T. (1975). Relationships between single word decoding and reading comprehension skills. *Journal of Educational Psychology, 67*, 461–469. doi:[10.1037/h0077013](https://doi.org/10.1037/h0077013).
- Schutte, G. M., Duhon, G. J., Solomon, B. G., Poncey, B. C., Moore, K., & Story, B. (2015). A comparative analysis of massed vs. distributed practice on basic math fact fluency growth rates. *Journal of School Psychology, 53*, 149–159. doi:[10.1016/j.jsp.2014.12.003](https://doi.org/10.1016/j.jsp.2014.12.003).
- Skinner, C. H. (2008). Theoretical and applied implications of precisely measuring learning rates. *School Psychology Review, 37*, 309–314.
- Skinner, C. H., Belfiore, P. J., & Watson, T. S. (2002). Assessing the relative effects of interventions in students with mild disabilities: Assessing instructional time. *Journal of Psychoeducational Assessment, 20*, 346–357. doi:[10.1177/073428290202000403](https://doi.org/10.1177/073428290202000403).
- Szadokierski, I., & Burns, M. K. (2008). Analogue evaluation of the effects of opportunities to respond and ratios of known items within drill rehearsal of Esperanto words. *Journal of School Psychology, 46*, 593–609. doi:[10.1016/j.jsp.2008.06.004](https://doi.org/10.1016/j.jsp.2008.06.004).
- Tan, A., & Nicholson, T. (1997). Flashcards revisited: Training poor readers to read words faster improves their comprehension of text. *Journal of Educational Psychology, 89*, 276–288. doi:[10.1037/0022-0663.89.2.276](https://doi.org/10.1037/0022-0663.89.2.276).
- Taylor, K., & Rohrer, D. (2010). The effects of interleaved practice. *Applied Cognitive Psychology, 24*, 837–848. doi:[10.1002/acp.1598](https://doi.org/10.1002/acp.1598).
- Tucker, J. A. (1988). *Basic flashcard technique when vocabulary is the goal*. Unpublished teacher material. University of Tennessee at Chattanooga. Chattanooga, TN.
- Varma, S., & Schleisman, K. B. (2014). The cognitive underpinnings of incremental rehearsal. *School Psychology Review, 43*, 222–228.
- Vellutino, F. R., Scanlon, D. M., Small, S., & Fanuele, D. P. (2006). Response to intervention as a vehicle for distinguishing between children with and without reading disabilities: Evidence for the role of kindergarten and first-grade interventions. *Journal of Learning Disabilities, 39*, 157–169. doi:[10.1177/00222194060390020401](https://doi.org/10.1177/00222194060390020401).

- Volpe, R. J., Burns, M. K., DuBois, M., & Zaslofsky, A. F. (2011a). Computer-assisted tutoring: Teaching letter sounds to kindergarten students using Incremental Rehearsal. *Psychology in the Schools, 48*, 332–342. doi:[10.1002/pits.20557](https://doi.org/10.1002/pits.20557).
- Volpe, R. J., Mulé, C. M., Briesch, A. M., Joseph, L. M., & Burns, M. K. (2011b). A comparison of two flashcard drill methods targeting word recognition. *Journal of Behavioral Education, 20*, 117–137. doi:[10.1007/s10864-011-9124-y](https://doi.org/10.1007/s10864-011-9124-y).