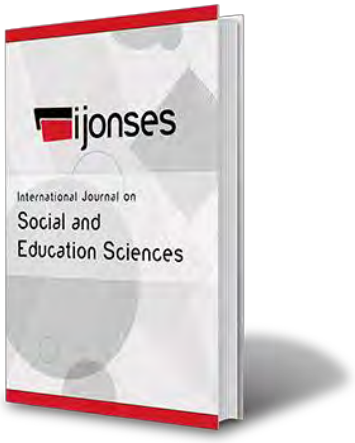

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Abstract

Working with a post-secondary student with intellectual disability, an adapted alternating treatments design was used to compare sight-word acquisition across three computer-delivered learning trial interventions: one with fixed 5-s response intervals, another with fixed 1-s response intervals, and a third with self-determined intervals. Visual analysis of session-series graphs suggest that all three interventions increased sight-word acquisition with the 5-s and self-determined interventions causing more steady and consistent learning per session than the 1-s intervention. Analysis of the time-series graph suggests that the self-determined intervention caused superior learning rates to the other interventions. From an applied perspective, the self-determined intervention is the most appropriate remedial procedure for this student because it resulted in the most rapid learning. Discussion focuses on the value of making relative-effectiveness decisions based on measures of learning as a function of time spent learning (learning speed) versus measures of learning as a function of sessions or trials.

Introduction

Although phonemic reading instruction is often beneficial, many students with intellectual disabilities struggle to gain phonemic awareness skills (Browder & Spooner, 2011; National Institution of Child Health and Human Development, 2000). For these students, a whole word or sight word approach focusing on developing their ability to read high-frequency words accurately or rapidly may be a better approach (Browder & Xin, 1998). Teacher-delivered flashcard interventions have been used to enhance sight word acquisition in students with intellectual disabilities (Browder & Lalli, 1991; Nist & Joseph, 2008; Ruwe, McLaughlin, Derby, & Johnson, 2011). One limitation associated with this approach is that it often requires a one-to-one student-to-teacher ratio. Flashcard interventions can also be delivered via computers, which can reduce teacher time spent in individual instruction and allow each student to work on idiosyncratic words while learning at their own pace (Cazzell et al., 2016; Hilton, Hopkins, Skinner, & McCane-Bowling, 2011; Kodak, Fisher, Clements, & Bouxsein, 2011). Computer-based flashcard reading (CFR) interventions have been used to increase sight-word reading in elementary, secondary, and adult students with intellectual disability (e.g., Cazzell et al., 2016; Cazzell et al., 2017; Yaw et al., 2012; Yaw et al., 2014). A typical flashcard learning trial consists of a stimulus (visual display of printed word), a response interval (time for the student to read the word), and another stimulus that provides

feedback such as an audio presentation of the word being read correctly.

One challenge associated with CFR interventions has been determining the response interval length (e.g., 1-s, 3-s, or 5-s) that maximizes learning. Shorter intervals can enhance learning by increasing learning trial speed, engagement, and attention to tasks (Hawkins, Skinner, & Oliver, 2005; Ingram & Elliott, 2014; Skinner, Belfiore, Mace, Williams-Wilson, & Johns, 1997; Yaw et al., 2014). However, when intervals are too short, students may not have time to respond, which can reduce learning (Black et al., 2016; Greenwood, Hart, Walker, & Risley, 1994; Riley, 1986).

Time required for responding may be a function of several within-student factors including processing speed and skill development (Bonifacci & Snowling, 2008; Naples, Katz, & Grigorenko, 2012), which may explain why some researchers found that 1-s response intervals were superior to longer intervals with some students (Yaw et al., 2014), but 5-s intervals resulted in more learning than 3-s and 1-s intervals with other students (Black et al., 2016). Also, a student may require more time to respond to some words than others. For example, a student may require more time to respond to a longer phonemically regular word that they attempt to decode or sound out, but less time to respond to a short, commonly used phonemically irregular word (Cazzell et al., 2017). As CFR learning trials are repeated, students can develop automaticity, which means they may require less time to respond to the same word as each session progresses and across sessions (Kostewicz, Kubina, Selfridge, & Gallagher, 2016). Thus, CFR interventions with fixed response intervals may not maximize learning across students or within students across words and across learning trials (Cazzell et al., 2015).

Recently, researchers addressed this problem by altering CFR interventions so that each student can self-determine each response interval (Cazzell et al., 2017; Cazzell et al., 2015). Specifically, a computer was used to deliver stimulus-response-stimulus learning trials. First, a word appeared on a screen (first stimulus) followed by a response interval which was student determined. Thus, after the student read the word correctly, incorrectly, or failed to read at all, the student would press the space bar to hear a recording of the word being read correctly. After 2 s the next word appeared on the screen. Cazzell et al. (2015) found that an adult student with intellectual disability learned sight words quickly when the CFR intervention with self-determined intervals was applied. Importantly, the student did not use her ability to control response intervals to take long pauses from responding. In a subsequent study, Cazzell et al. (2017) replicated these findings in three elementary students with intellectual disability.

The current study was designed to replicate and extend research on the pace (i.e., fast-paced, slower-paced and self-determined) of CFR interventions applied to students with intellectual disability (Black et al., 2016; Cazzell et al., 2015; Yaw et al., 2014). Specifically, an adapted alternating treatment design was used to evaluate and compare sight-word acquisition across three CFR interventions. The fast-paced intervention included fixed 1-s response intervals. The slower paced intervention included fixed 5-s response intervals. The third intervention allowed the student to self-determine each response interval; thus it was student paced. The number of learning trials was held constant across interventions and word acquisition was measured as a function of cumulative instructional sessions. Instructional time varied across interventions. To determine which intervention caused

the most rapid learning, word acquisition was also measured as a function of cumulative instructional seconds (Skinner, Belfiore, & Watson, 1995/2002; Yaw et al., 2014). After the adapted alternating treatments phase was completed, a five-session phase was applied to assess the student's intervention preference. Determining student preference was important because computer-based interventions may allow students to complete the learning activities independently and students may be more likely to choose to engage and persist in activities that they prefer (Black et al., 2016; Skinner, 2002; Skinner & McCleary, 2010; Yaw et al., 2014).

Method

Participants, Settings, and Materials

Sally, a 29-year old female college student enrolled in a post-secondary education program for adults with intellectual disability participated in this study. Sally was assessed with the Wechsler Adult Intelligence Scale-Fourth Edition (Wechsler, 2009), Woodcock-Johnson IV Tests of Achievement (Schrank, Mather, & McGrew, 2014), and the Vineland Adaptive Behavior Scales-Second Edition (Sparrow, Cicchetti, & Balla, 2005). Each scale had a mean of 100 and a standard deviation of 15. Sally's full scale IQ, reading comprehension, and adaptive behavior scores were 57, 61, and 63, respectively.

The primary experimenters were school psychology graduate students. All sessions took place in a quiet room adjacent to Sally‟s regular classroom. Experimenters created assessment flashcards with words printed in the center of white 3 x 5 inch index cards using Calibri, 72-point font. A personal laptop and Microsoft® PowerPoint® were used to create the three computer-based flashcard interventions. During the interventions, words were presented using Calibri, 44-point font centered on the computer screen.

Design and Dependent Variable

Following three assessment-only sessions, an adapted alternating treatments (AAT) phase was used to compare the three flashcard interventions (1-s, 5-s, and self-determined response intervals) with each other and a control series. The adaptation of a typical alternating treatments design includes a control series used to assess for threats to internal validity (Sindelar, Rosenburg, & Wilson, 1985). Specifically, collecting control series data (e.g., repeatedly assessing un-treated words), while the interventions were being applied allows researchers to assess whether events outside experimental conditions (i.e., history effects), repeated assessment of treated word (i.e., testing effects) and/or one treatment causing improvements on words assigned to another treatment (i.e., carryover effects) may account for improvements on treated words (Sindelar et al., 1985; Skinner & Shapiro, 1989). The AAT phase lasted 10 sessions, with Sally completing each intervention every session. Upon completion of the AAT phase, preference was assessed by conducting 5 sessions during which Sally chose which intervention she would complete.

The primary dependent variables were words acquired and word acquisition speed. Because a single correct response should never be considered an indication of acquisition (Cazzell et al., 2017; Haring & Eaton, 1978), a word was considered acquired when read correctly, within 3 s, across two consecutive assessments. Assessment

of all words (1-s, 5-s, self-determined, and control words) were conducted immediately before the next intervention, at least 17.5 hours after the previous intervention. Flow-list procedures were used so that after words were acquired, they were replaced with new unknown words (Yaw et al., 2014).

When students have deficits, one goal is to remedy the deficit as rapidly as possible (Skinner et al., 1995/2002). Thus, when comparing interventions, researchers have recommended comparing learning speed across interventions (Skinner, 2008). To calculate learning speed researchers have divided the measure of behavior change or learning (in the current study cumulative words acquired) by the cumulative seconds spent engaged in each intervention (e.g., Skinner et al., 1995/2002; Yaw et al., 2014). During each session, the time Sally spent in the 1-s intervention was 150 s, much less than the 270 s spent in the 5-s intervention. The time Sally would spend in the self-determined intervention was unknown and varied. To collect this data, researchers used a stopwatch, which they started when the first self-determined word appeared on the screen and stopped 2 s after the last word appeared on the screen.

To enhance Sally‟s opportunities to respond, after words were acquired they continued to be assessed. Although not a primary dependent variable, these data provided an indication of maintenance. Thus, the percent of trials Sally read acquired words correctly, within 3 s, was calculated for 1-s, 5-s, self-determined, and control words.

Procedures

Based on Sally‟s other classes and activities sessions were scheduled once daily, Tuesday through Friday, in the morning between 8:00 and 10:00 or in the afternoon between 1:30 and 2:30. Sally participated in three phases: baseline, adapted alternating treatments (AAT), and preference assessment. One experimenter administered procedures while another independently observed and recorded data used to assess procedural integrity and calculate interobserver agreement (see Appendix for Procedural Integrity Checklist).

Baseline Phase

During the baseline phase, three assessment-only sessions were used to identify a pool of unknown words. Because Sally had participated in earlier studies where she learned first-grade through fourth-grade words (Cazzell et al., 2016; Cazzell et al., 2015), fifth-grade Dolch words were used in this study (“Dolch List 5th Grade,” n.d.). First, 117 fifth-grade words were printed on index cards in 72-point Calibri font. Next, the experimenter escorted Sally to the designated room and allowed her to pick her own seat. The experimenter sat next to Sally and told her that she would be presented with flashcards and she should try to read each word aloud within 3 s. Each flashcard was presented in random order for 3 s. If a word was read correctly within 3 s, the experimenter placed the word in a pile separate from the words read incorrectly. Any word read correctly on any baseline assessment was eliminated from the pool of unknown words.

Pre-testing yielded a pool of 108 unknown words. Stratified random assignment was used to assign the words to one of the three treatment conditions (1-s words, 5-s words, and self-determined words) and a control condition

(27 words per condition). Words were stratified based on the number of letters in each word: four, five or six letters. Each list was then developed by randomly assigning words using a repeating four-letter, five-letter, and six-letter sequence. Table 1 displays the word sequences for each condition.

Table 1. Word Sequences for Each Condition

1 second	5 second	Self-Determined	Control (flashcards only)
pass	road	gate	mind
burnt	blood	paste	great
garage	either	hammer	puzzle
move	copy	drug	hour
begin	grain	catch	begun
double	golden	eleven	follow
post	bump	note	mend
chain	nurse	blind	cough
expect	minute	rubber	drawer
noon	none	iron	knee
juice	clear	grade	crowd
market	dining	lesson	nickel
lady	fell	past	dirt
music	child	peach	crown
mirror	reason	napkin	pillow
glad	laid	fork	rose
chief	bathe	north	forth
dinner	doctor	circle	rather
pain	cost	mile	bank
ocean	heard	ought	point
finish	church	danger	fellow
load	ache	fill	lamp
alone	chalk	heart	cloth
cousin	root	ribbon	season
rest	often	fair	date
bleed	choose	pants	cheek
except	forget	forgot	eraser

Adapted Alternating Treatments Phase

On the session following the last baseline session a brief training session was conducted. Immediately following this training, the adapted alternating treatments (AAT) phase began as the three CFR interventions were applied.

The AAT phase consisted of 10 sessions conducted over 16 days. A CFR intervention was created for each intervention (1-s, 5-s, and self-determined response intervals). During each AAT phase session, the student completed each intervention in random order. Each intervention targeted the first 10 unknown words from each list. As words were acquired, they were replaced with the next unknown word(s) from the appropriate list.

For training purposes, the experimenters created a three-word CFR intervention with known words. This intervention was used to practice the self-determined response interval intervention system. Because Sally had previously used the system with both fixed and self-determined response intervals (see Cazzell et al., 2016; Cazzell et al., 2015), this step was carried out in order to remind her how to use the system. During the brief training, Sally was first reminded that during some CFR interventions she merely had to try to read the word before she heard it and repeat it after she heard it. She was also reminded that with another CFR, she had to 1) press the space bar to make each word appear, 2) then try to read the word, 3) press the space bar again to hear the word, 4) repeat the word, and 5) press the space bar again to see the next word. After immediately demonstrating the ability to complete the self-determined intervention with the three known words, three trial per word, training ceased and Sally was exposed to the three treatments (1-s, 5-s, and self-determined response intervals) presented in random order.

For all subsequent AAT-phase sessions, each session began with an assessment using baseline-phase procedures (i.e., index card presented for 3 s in random order, word read correctly scored as correct). The first AAT-phase assessment included 40 words (i.e., the first 10 unknown and un-acquired 1-s, 5-s, self-determined, and control words) presented in random order. As Sally began to acquire words (i.e., read words correctly within 3 s across two consecutive assessments), they were removed from the CFR intervention and replaced with the next unknown word from the assigned list. If Sally acquired a control word, a new control word was added to the assessment condition. In order to enhance maintenance, acquired words were not removed from assessment procedures. In order to keep procedures constant across treatments, once words were acquired they were no longer available for intervention. Therefore, as Sally acquired words, the number of words assessed increased, but the number of words targeted during treatments remained constant at 10 un-acquired words per intervention, 30 total words.

Following each assessment, the three conditions were presented in counterbalanced order across sessions. During each intervention, 30 learning trials were conducted, in random order, with the 10 un-acquired words presented three times per session. Each intervention began with a word appearing on the screen. During the 1-s and 5-s interventions, Sally had a 1-s or 5-s response interval to read the word. After the response interval ended, a recording of the word was played automatically and Sally had 2 s to repeat the word before the next word appeared on the screen.

During the self-determined intervention, the first word appeared on the screen and Sally controlled the response intervals by pressing the space bar to hear the recording of the word. If Sally failed to press the space bar within 10 s, she was prompted to press the space bar to hear the word. After the recording played and Sally repeated the word, she once again pressed the space bar to make the next word appear on the screen. Again, if she failed

to press the space bar within 10 s she was prompted to press the space bar to see the next work.

Across all conditions, the only feedback provide to Sally was via the computer. In addition to receiving prompts to press the space bar during the self-determine intervention, Sally received prompts during the 1-s and 5-s interventions. Specifically, when she pressed the space bar Sally was reminded that she did not have to press the space bar during these interventions.

Prior to beginning each fixed-interval condition the experimenters read the following instructions created by Cazzell et al., (2016): We are going to read some words today with a computer program. When the word appears, you will have ___ (1 or 5) second(s) to try and read the word aloud, then the word will be read aloud to you. After hearing the word read aloud, repeat the word, then the computer program will move on to the next word. Do you have any questions?

For the self-determined intervention, the experimenter read the following instructions created by Cazzell et al. (2015) for the self-determined condition: We are going to have you read some words today with a computer program. When you are ready, press the space bar to see your first word. When the word appears, try to read the word aloud. After you read the word, press the space bar to hear the word read aloud to you. After hearing the word read aloud, repeat the word before pressing the space bar to move on to the next word. Do you have any questions? Experimenters recorded the number of seconds required to complete the self-determined intervention using a stopwatch, which they started when Sally pressed the space bar to begin the intervention and stopped 2 s after the final word appeared. The AAT phase ended when a holiday and student absences prevented any conditions from being conducted for nine consecutive days.

Preference assessment phase. Following the AAT phase and a holiday break, five forced-choice preference assessments were conducted targeting 10 unknown words selected from the list of unknown control words that were not assessed during the AAT phase. Preference assessments were conducted once per day, Tuesday through Friday, in the same setting as experimental procedures. During the first preference assessment, Sally was told that she would be working on a new list of words. Additionally, she was told that she could choose which CFR intervention she wanted to use, the 1-s, 5-s, or self-determined intervention. When asked, she commented that the 1-s intervention was fast, the 5-s was slower, and the self-determined was “the spacebar intervention”. After opening the computer, the experimenter asked Sally which intervention she would like to use and after she chose her intervention, one 30-trial treatment session was conducted and acquisition was assessed using procedures identical to the AAT phase.

Procedural Integrity and Interobserver Agreement

Each primary experimenter used a checklist to self-monitor their behavior (see Appendix). A second experimenter used this same checklist to independently record procedural integrity across 90% of the AAT phase intervention sessions and 80% of the preference assessment phase sessions. Both researchers also recorded prompts across sessions. The second experimenter also recorded words read correctly, within 3 s,

during assessments across 100%, 90%, and 80% of the baseline, AAT, and preference assessment phases, respectively. To calculate interobserver agreement per session, the researchers recorded agreement and disagreement on a word-by-word basis, divided the number of agreements by the number of agreements plus disagreements, and then multiplied by 100.

Analysis of all procedural integrity data revealed 100% integrity for each session and eight prompts delivered across all sessions. Two prompts reminded Sally that she needed to press the space bar during the self-determined intervention and six prompts reminded Sally that she did not need to press the space bar during the fixed interval interventions. Thus, Sally needed no additional prompts on 99.3% of her self-determined trials and 99% of her fixed-interval trials. Interobserver agreement for words read correctly within 3 s was assessed. Across assessments, average interobserver agreement 97.3%, with a range of 75% to 100%.

Results

Figure 1 depicts the number of words Sally acquired across sessions (i.e., session-series graph). After 3 intervention sessions (the 6th session overall), Sally began acquiring self-determined, 5-s, and control words. Following the 7th session, Sally began acquiring 1-s words. Across all sessions, Sally acquired 2 control words, 7 1-s words, 9 5-s words, and 12 self-determined words. Figure 1 shows similar increasing trends in self-determined and 5-s words acquired through session 11, during which Sally consistently acquired more 5-s and self-determined words per session than 1-s or control words per session. Until session 13, there is no clear difference in 1-s and control words acquired. Following session 12, Sally acquired 4 1-s words, which provided some evidence that the 1-s intervention increased word acquisition over the control, assessment-only condition.

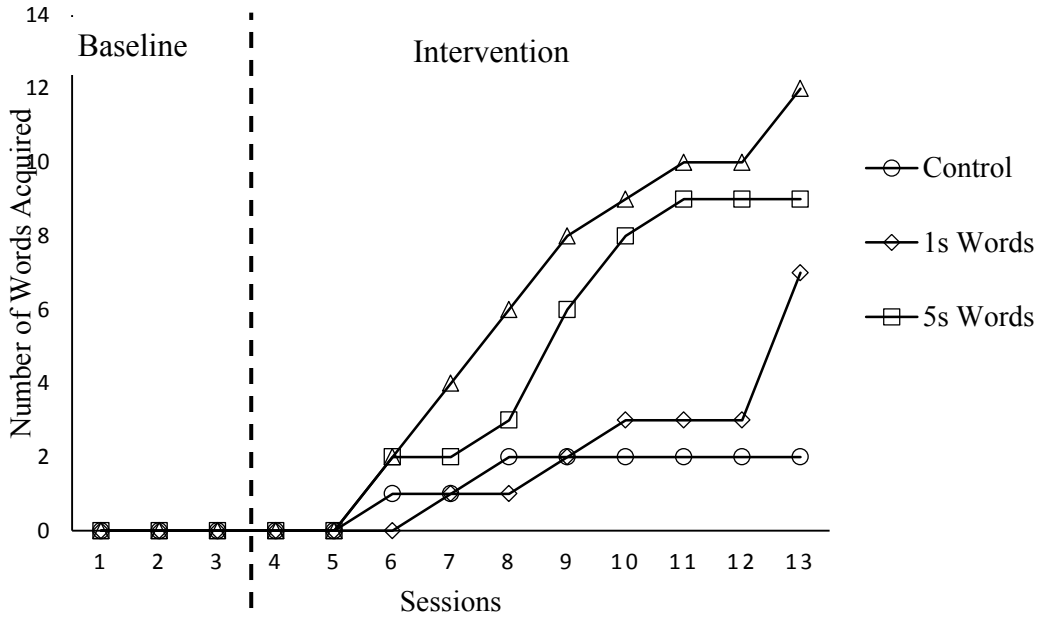

Figure 1. The Number of Words Sally Acquired across Sessions

To evaluate learning speed under each intervention, a time-series graph with words acquired plotted as a function of cumulative instructional seconds Sally spent working under each intervention was constructed (see Figure 2).

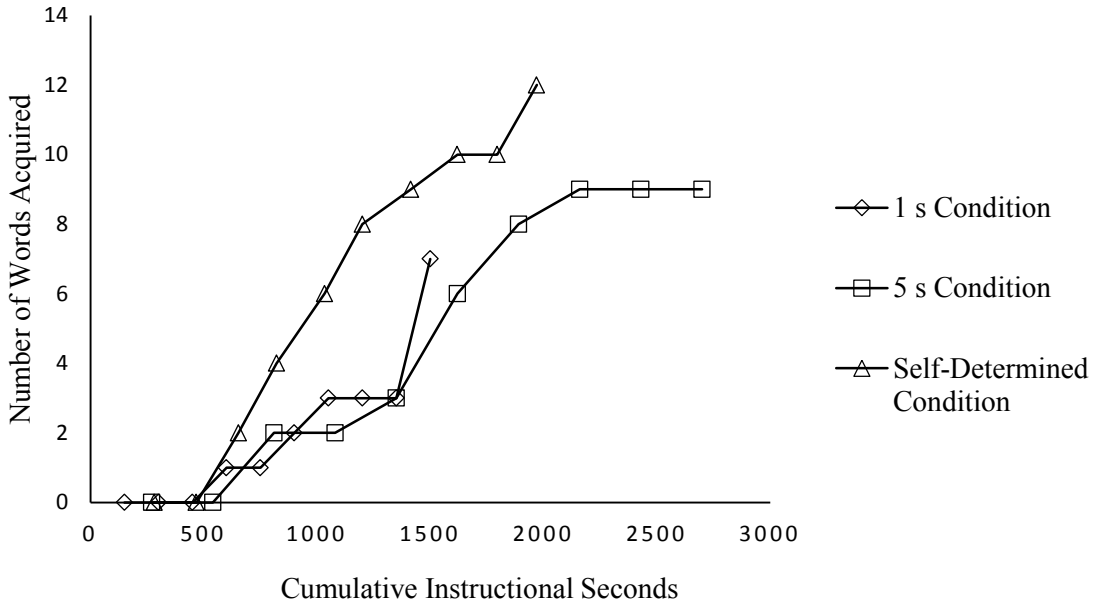

Figure 2. The Number of Words Sally Acquired across Instructional Seconds

Each 1-s intervention took 150 s, thus cumulative instructional time for the 1-s intervention was 1500 s. Each 5-s intervention took 270 s, thus cumulative instructional time for the 5-s intervention was 2700 s. The self-determine intervention time was not fixed. On average, each self-determine intervention took 197 s and cumulative instructional time was 1970 s. Visual analysis of Figure 2 shows that after Sally began acquiring words (after approximately 500 cumulative instructional s); the self-determined intervention resulted in consistently higher sight-word acquisition speed than the other two interventions until approximately 1450 s of cumulative instructional time. The consistency is evidenced by the growing separation between the trend lines. However, after approximately 1450 cumulative instructional s working with each intervention, the learning rates for 5-s and 1-s words increased, and was similar to or greater than the learning rates for self-determined words. Across the AAT phase, for each minute of instruction, Sally acquired 0.37 self-determined words, 0.28 1-s words, and 0.20 5-s words.

After words were acquired, they continued to be assessed. While this was done to enhance Sally‟s maintenance, they also serve as a measure of maintenance. Sally‟s acquired 7 1-s words, but 4 were acquired on the last day; consequently, only 3 were assessed post-acquisition. These data showed that she maintained her ability to respond accurately within 3 s on 12 of 13 (92%) 1-s word maintenance trials. Sally acquired 9 5-s words and none on the last day. She maintained her ability to respond accurately within 3 s on 29 of 37 (78%) 5-s word maintenance trials. Sally acquired 12 self-determined words, 2 on the last day. Across 49 self-determined word maintenance trials, Sally responded accurately, within 3 s, on 35 trials (71%). Finally, Sally acquired 2 control words, none in the last session. Her percent correct on maintenance trials for these 2 control words was 5/12

(41%). Following the AAT phase, a preference assessment phase was conducted. Across five sessions, one per day, Sally was allowed to choose which intervention she would complete. She chose the 5-s treatment condition three times (60%) and the self-determined condition two times (40%). Sally acquired four additional unknown words during this phase.

Discussion

The current study was designed to replicate and extend research on CFR interventions applied to post-secondary students with intellectual disability. Visual analysis of the session-series graph supports previous researchers who found that CFR interventions can increase sight-word acquisition in students with intellectual disability when response intervals are fixed (e.g., Cazzell et al., 2016; Yaw et al., 2014) and when the student is allowed to self-determine response intervals (e.g., Cazzell et al., 2017; Cazzell et al., 2015). However, because Sally acquired two control words, we cannot rule out the possibility that other factors also contributed to the increase in 1-s, 5-s, and self-determined words acquired (Sindelar et al., 1985).

With respect to relative effectiveness, a comparison of the time-series graph and the session-series graph supports different conclusions regarding relative effectiveness. With the exception of the last data point, the session-series graphs show that the 5-s and self-determined CFR interventions resulted in greater words acquired per session than the 1-s CFR intervention. The session-series graph also shows no consistent differences in words acquired per session between the 5-s and self-determine interventions. This would support the conclusion that the 5-s and self-determined interventions are similarly effective. The large increase in 1-s sight-words acquired following the final intervention provides some evidence that the 1-s intervention was more effective than the control condition, but this spike makes it difficult to compare the 1-s CFR intervention with the other two interventions.

The session-series graph suggests that the self-determined and 5-s interventions caused similar learning per instructional session; however, the time-series graph supports a different conclusion. Specifically, the time-series graph suggests that Sally acquired more words per unit of cumulative instructional time during the self-determined intervention relative to the 5-s intervention. Again, excluding the last session, the session-series graph suggests that the 5-s intervention was consistently more effective than the 1-s intervention. However, the time-series graph suggests that the 1-s and 5-s intervention caused similar increases in learning speed.

The current study serves as another example of how decisions regarding relative effectiveness are influenced by measurement scale (see Black et al., 2016; Cates et al., 2003; Nist & Joseph, 2008; Poncy et al., 2015; Skinner, 2008; Skinner et al., 1995/2002; Yaw et al., 2014). While session-series data suggest that the 5-s and self-determined interventions are equally effective, the time-series data suggest that Sally learned more rapidly during the self-determined intervention. Because idiosyncratic effects are not uncommon (Black et al., 2016; Daly, Martens, Dool, & Hintze, 1998), applied researchers working with students with learning problems may want to employ procedures similar to those used in the current study to determine which intervention is best for a particular student.

Session-series data, with learning trials held constant across interventions can be used to address important theoretical questions that may eventually influence practice in a manner that allows educators to better prevent and remedy learning problems (Skinner et al., 1995/2002). In the current study, the participant, Sally had weak reading skills; thus, the goal should be to select the intervention which results in the most rapid remediation or the most rapid learning (Skinner, 2010; Yaw et al., 2014). Because the session-series graph supports the conclusion that the 5-s and self-determined interventions were similarly effective, and for the most part, more effective than the 1-s intervention, one might conclude that either the 5-s or self-determined intervention is appropriate for Sally. However, the time-series graph provides evidence that the self-determined intervention resulted in more rapid learning than the other interventions. These findings suggest that for Sally the self-determined intervention is superior to the others because it would enhance Sally"s skills more quickly (Black et al., 2016; Skinner, 2008; Skinner et al., 1995/2002).

Other factors, such as student preference, may also influence decisions regarding which intervention to apply. This may be particularly important with technology-based interventions designed to allow students to participate in learning procedures independently. After all, no matter how effective such interventions are, students will not learn unless they choose to engage in effective interventions (Black et al., 2016; Skinner, 2002). During the preference assessment, Sally chose to complete the 5-s intervention three times and the self-determined intervention two times, but she never chose the 1-s intervention. As the time-series graph provide little evidence to choose either the 5-s or 1-s interventions over the self-determined intervention and Sally preferred either the 5-s or self-determine intervention, these results support the application of the self-determined intervention because it resulted in the most rapid learning (Skinner, 2008).

Percent correct on maintenance trials were 92%, 78%, and 71% for 1-s, 5-s, and self-determined words, respectively. While these percent data suggest that the 1-s intervention resulted in greater long term learning, these results must be considered in light of the number of words acquired that received maintenance assessments (i.e., 3 1-s words, 9 5-s words, and 10 self-determined words). Thus, while 92% appears to suggest better outcomes, 92% on only three words does not suggest more learning than 78% on nine words or 71% on ten words (Skinner, 2008). Regardless, future researchers may want to investigate this pattern which suggests that the more words acquired the lower percent correct on maintenance assessments. For example, this may be caused by interference (e.g., learning one word interferes with maintenance of another).

There are several limitations associated with the current study. Preference data did not distinguish between the 5-s and self-determine intervention. Perhaps more data would have indicated a clearer preference. The large increase in 1-s words acquired on the last session provides some evidence that this condition was more effective than the control, assessment-only condition, but it hinders our ability to evaluate this treatment. One possibility is that Sally had difficulty responding within the 1-s response interval, which reduced her opportunities to respond during this intervention (Black et al., 2016; Riley, 1986). Consequently, more cumulative trials may have been needed to obtain the necessary opportunities to respond needed for acquisition (Greenwood et al., 1994). To investigate this possibility, future researchers could collect data on responding within the intervention sessions. A related limitation was stopping sessions immediately after this spike. While scheduling conflicts

prevented additional data collection, it would have been interesting to determine if this sharp increase in 1-s words would have continued.

Sally acquired two control words which suggests that across conditions, threats to internal validity may have had some influence on Sally's acquisition of 1-s, 5-s, and self-determined words. While threat(s) to internal validity may have contaminated findings, because Sally acquired only two control words, evidence suggests that threats to internal validity could not account for the large increases in 1-s, 5-s, and self-determined words acquired. As researchers have found evidence that repeated sight-word assessments can enhance secondary students' sight-word reading (Shapiro & McCurdy, 1988; Skinner & Shapiro, 1989), future researchers may want to determine if testing effects account for this increase in control words.

The current study evaluated sight-word acquisition and included only one student. Researchers should continue to compare the effectiveness of CFR interventions with self-determined response intervals and fixed response intervals across more students with intellectual disabilities and different populations of students (e.g., students without disabilities, English Language Learners). During these studies researchers should continue examining adults with intellectual disability and their preference towards CFR interventions with fixed response intervals as well as self-determined response intervals. Additionally, researchers should consider conducting aptitude-treatment interaction and aptitude-preference interaction studies. For example, researchers may find that students with slower processing speed prefer the longer response intervals (e.g., 5-s) over very brief response intervals (e.g., 1-s) because they require more time to respond (Black et al., 2016; Cazzell et al., 2016). Finally, researchers should investigate generalized reading by comparing effectiveness of the three interventions to word readings accuracy when words are presented in sentences and paragraphs.

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Appendix. Procedural Integrity Checklist

Procedural Integrity Checklist

_____ The experimenter set up a workstation containing a laptop and three chairs.
_____ The student was instructed that she would be shown a series of flashcards, and that she should attempt to read the word on each card aloud within 3 s.
_____ The student went through the flashcards as the experimenters recorded correct and incorrect responses on datasheets.
_____The experimenter RECORDED ASSESSMENT TIME, date, and words correct at the bottom of the Excel document.
_____The experimenter recorded correct and acquired words in Excel with the letter c.
_____ The experimenter adjusted the PowerPoints to account for acquired words, adding in new words from the word file and deleting acquired words.

Intervention

_____ The experimenter checked the schedule to confirm the counterbalancing order for the session and recorded it in the excel sheet.

- RECORD TIME FOR ALL SELF DETERMINED SESSIONS
- RECORD ANY PROMPTS GIVEN IN THE EXCEL SHEET (RIGHT SIDE)
- IN SELF-DETERMINED CONDITION, PROMPT AFTER 10 SEC HAVE PASSED "LET'S GO ON TO THE NEXT WORD"

_____ The student completed the 3 computerized flashcard interventions in correct order.

a. Self-determine condition: TIME
    i. _____The student was instructed that upon pressing the computer space bar, a word would be displayed, and that she should try to read the word aloud. Upon pressing the space bar a second time, the word would be read aloud by the computer. The student is told to repeat the word after it is read by the computer.
    ii. _____ The student proceeded by pressing the space bar.
    iii. _____ The student attempted to read the word, pressed the space bar, and repeated the word again after hearing it read to her.
b. 1-s condition:
    i. _____The student was instructed that words would be presented, and she should attempt to read each word aloud within 1 s. Then the word would be read aloud by the computer. The student is told to repeat the word after it is read by the computer.
    ii. _____ The student attempted to read the word, and repeated the word again after hearing it read to her.
c. 5-s condition:
    i. _____The student was instructed that words would be presented, and she should attempt to read each word aloud within 5 s. Then the word would be read aloud by the computer. The student is told to repeat the word after it is read by the computer.
    ii. _____ The student attempted to read the word, and repeated the word again after hearing it read to her.

_____ After the student left the room, the experimenters compared their datasheets, checking for interrater agreement.

_____ The experimenter re-randomized the 3 slide shows.
_____The experimenter added newly acquired words to the assessment cards, and then shuffled the cards.