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Preteaching Keywords to Increase Reading Performance of Students with Intellectual Disabilities

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Abstract:	The purpose of the current study was to determine the extent to which practicing keywords increased word recognition, reading fluency and comprehension for students with intellectual disabilities (ID). The dependent measures included word recognition (i.e., the percentage of previously unknown keywords read correctly in the given text), reading fluency (i.e., words read correctly in 1 minute), and reading comprehension (i.e., number of questions answered correctly out of five). The participants were three fourth-grade students who were identified as having ID in early childhood with IQ scores of 45, 62, and 78. Words from reading passages were practiced with Incremental Rehearsal (IR) using a multielement, single-case design. Practicing keywords led to higher subsequent in-text recognition and generalization for a high percentage of the taught words. Additionally, there was clear experimental control for increases in reading fluency. There was not a strong effect on reading comprehension. Implications for research and practice are discussed.

Practicing Keywords to Increase Reading Performance of Students with Intellectual Disabilities

Abstract

The purpose of the current study was to determine the extent to which practicing keywords increased word recognition, reading fluency and comprehension for students with intellectual disabilities (ID). The dependent measures included word recognition (i.e., the percentage of previously unknown keywords read correctly in the given text), reading fluency (i.e., words read correctly in 1 minute), and reading comprehension (i.e., number of questions answered correctly out of five). The participants were three fourth-grade students who were identified as having ID in early childhood with IQ scores of 45, 62, and 78. Words from reading passages were practiced with Incremental Rehearsal (IR) using a multielement, single-case design. Practicing keywords led to higher subsequent in-text recognition and generalization for a high percentage of the taught words. Additionally, there was clear experimental control for increases in reading fluency. There was not a strong effect on reading comprehension. Implications for research and practice are discussed.

Keywords: intellectual disabilities, keywords, reading intervention, Incremental Rehearsal

Practicing Keywords to Increase Reading Performance of Students with Intellectual Disabilities

Reading is a fundamental skill that all students must develop in order to be successful in school and throughout their lives. Reading is even more important for students with intellectual disabilities (ID), because reading skills help them become independent in multiple settings including school, work, home, community or social (Wilson & Hunter, 2010), and predict successful employment for individuals with disabilities (Carter et al., 2010). Research addressing academic instruction for students with ID is sparse due to the historical practice of focusing on social and vocational skills while de-emphasizing literacy instruction (Katims, 2000). The majority of research that does exist focuses on basic academic skills like using money and telling time (Spooner & Browder, 2015; Browder et al., 2006).

Reading comprehension is the goal for reading and involves the construction of representations described in text or spoken discourse (Cain & Oakhill, 2007). Students with ID often demonstrate deficits in reading comprehension relative to typically developing students (Di Blasi et al., 2019), and even relative to students with different types of disabilities (Bouck & Satsangi, 2015). Poor reading comprehension among students with ID could be due to several possible reasons including a general delay in language (Rondal, 2001), lower reasoning and inferencing skills (van Wingerden et al., 2014), the linguistic demands of the text (e.g., number of words, number of sentences, and amount of overlap of nouns between sentences; Fajardo et al., 2014), and the lack of foundational reading skills (van Wingerden et al., 2017). A synthesis of 14 studies of individuals with ID found mostly small effects for multicomponent interventions for reading comprehension, and larger effects for single-component intervention such as reciprocal teaching, story mapping, teaching the structure of texts, and paraphrasing strategies

(Shelton et al., 2019). Although reading fluency interventions increased reading comprehension (Burns et al., 2004; Morgan et al., 2012; Therrien et al., 2004), few studies focused on reading fluency interventions for students with ID (Morgan et al., 2012). Below, we will discuss the importance of reading fluency among students with ID and instructional approaches to achieve it.

Reading Fluency with Students with ID

Reading fluency occurs when students read with acceptable rate, accuracy, and expression (National Reading Panel, 2000). The relationship between reading fluency and comprehension has been well documented in research (Basaran, 2013; Burns et al., 2011; Klauda & Guthrie, 2008), even among students with disabilities (Burns et al., 2004; van Wingerden et al., 2017). In fact, the relationship between reading fluency and comprehension is so well documented, that reading fluency, as measured by the number of words read correctly per minute, can be considered an indicator of global reading proficiency (Fuchs et al., 2001; Petscher & Kim, 2011; Roehrig et al., 2008). Students with ID in grades 3 and 4 scored at benchmark proficiency standards on measures of reading fluency only 10% to 18% of the time using first-grade passages and less than 1.0% of the time when using grade-level passages (Lemons et al., 2013).

Although the exact relationship between reading fluency and reading comprehension is complex, fluency seems to predict comprehension better than comprehension predicts fluency (Lai et al., 2014). Moreover, increases in reading fluency over time led to increased scores on state administered measures of reading proficiency, and students who scored at or below the 10th percentile had a .06 to .48 probability of passing a high-stakes reading test (Wanzek et al., 2010). Students with ID performed relatively better in the reading accuracy aspect of reading fluency than in the reading rate component, and also demonstrated lower comprehension compared to

typically developing peers (Di Blasi et al., 2019). Lower reading rate and comprehension among students with ID may be linked to deficits in working memory (Schuchardt et al., 2010) or deficits in processing speed (Jacobson et al., 2011; van Wingerden et al., 2017), especially given that interventions that focused on increasing decoding and phonological awareness among students with ID increased the accuracy with which words were read, but did not generalize to changes in the rate component of fluency (Lemons et al., 2012). However, Lemons et al. (2012) did not examine comprehension and previous research found that interventions that targeted reading fluency were successful in increasing reading rate with students with disabilities while also leading to increased comprehension (Burns et al., 2004; Therrien, 2004), even among students with ID (Hua et al., 2012a).

Reading Fluency Instruction and ID

Repeated reading is likely the most commonly implemented reading fluency intervention and it led positive effects for fluency (d = 0.83) and comprehension (d = 0.67), even after only two reads (d = 0.57; Therrien, 2004). However, those estimates of effect were based on within-subject changes (from first to final read), which likely resulted in inflated estimates of effect in which a d less than 1.00 would be considered small and a d of 2.80 or higher would be considered large (Burns & Wagner, 2008). Moreover, four studies included students with a learning disability, but none included students with ID (Therrien, 2004).

A review of the literature found that only 28% (n = 36) of studies that examined reading instruction for students with ID included a measure of reading fluency (Browder et al., 2006), and none actually taught fluency. Meta-analytic research found 44 studies that focused on improving reading fluency for students with and without disabilities, but only 4 of those studies included students for whom ID was their primary disability (Morgan et al., 2012). Rereading,

previewing, and word-level reading interventions led to larger reading fluency gains than reinforcing fluency or peer tutoring, but students with ID made smaller gains overall than students without disabilities (Morgan et al., 2012).

Hua and colleagues (2012a; 2012b) implemented a reading intervention that targeted both reading fluency and comprehension for students with mild ID, severe learning disabilities, and autism. The intervention included components of repeated reading with instructional-level passages, decoding error correction, and accompanying comprehension questions (i.e., Reread-Adapt Answer-Comprehend). Upon implementation of the intervention, oral reading fluency scores increased, the number of errors made decreased, and the number of correct answers for factual and inferential comprehension increased. Explicit, systematic instruction of phonics increased the reading skills of students with Down Syndrome (Lemons & Fuchs, 2010) and moderate ID (Flores et al., 2004), and having students read text as part of the reading lesson led to increased reading fluency among students with ID (Allor et al., 2013). Students with ID who struggle with phonological awareness may benefit from focusing more on the whole word, which is not an uncommon research-based approach for students with ID (Lemons et al., 2018).

Practicing keywords is one of the most commonly studied interventions for increasing fluent reading with students with ID, and involves the interventionist reviewing the text to identify keywords, or words that are high frequency and central to the meaning of the text (Burns et al., 2004), and providing instruction and practice with the content preferably before the students receive formal instruction (Burns & Parker, 2014). Practicing unknown keywords before reading increased reading fluency and comprehension among students with (Burns, 2007; Burns et al., 2004; Rousseau & Tam, 1991) and without disabilities (Burns et al., 2011). Practice reading cards with keywords written on them between an initial and second reading also

significantly increased reading fluency over time with struggling readers and was more effective than reinforcing fluent reading or peer tutoring (Morgan et al., 2012). Teaching keywords is an effective way to support students with ID in reading grade-level text (Hudson et al., 2013), and sight-word instruction in general is a research-based approach to increasing the reading skills of some students with ID (Lemons et al., 2018). Burns et al. (2004) taught keywords from informational nonfiction texts to 20 students identified with a learning disability, which immediately increased reading fluency by 8 WCPM ($d = 0.38$) and almost doubled the number of comprehension questions answered correctly ($d = 1.76$). However, students were diagnosed with a learning disability rather than ID, and the study occurred in one session rather than over time.

Practicing keywords before or during instruction has increased accuracy in reading across subjects and led to retention of previously unknown content for students with ID after 1 week (Burns, 2007) and 2 weeks (Coulter & Lambert, 2015). Thus, practicing keywords is an intervention that requires minimal support but could lead to lasting effects for students with disabilities including ID. However, there are instructional factors that influence the effectiveness of practicing keywords including opportunities to respond (OTR; Szadokierski & Burns, 2008) and the amount of new information an individual can learn (i.e., acquisition rate; Burns, 2001). We will discuss both of these instructional factors below and an intervention accounts for both.

Opportunities to Respond

Opportunities to respond (OTR) is the desired and accurate student response to an instructional stimulus (Greenwood et al., 1984), and increasing OTR increases student outcomes. Burns (2007) compared two different conditions that varied in the amount of OTR when teaching words to a student with ID and found that the level of OTR was directly related to retention of the learned words. When teachers facilitated students' use of response cards (i.e., laminated cards

with four pictures related to instruction), it not only led to more OTRs but also higher general and correct academic responding for four students with ID (Cakirogu, 2014). Higher levels of OTR led to better learning outcomes and accounted for more variance in retaining and generalizing words than the percentage of items within the learning task on which students demonstrated mastery before instruction occurred (Szadokierski & Burns, 2008). Thus, students with and without disabilities can benefit from increased OTRs across subject areas.

Acquisition Rate

The second component of teaching keywords that can affect student outcomes is acquisition rate (Burns, 2001). Acquisition rate (AR) is defined as the amount of new information a student can process and learn before experiencing retroactive cognitive interference, which occurs when previously learned items cannot be recalled due to the introduction of subsequent items (Ceraso, 1967). An AR is assessed by rehearsing new items until the student makes three errors while rehearsing one new item, which resulted in delayed alternate-form reliability estimates of $r = .91$ for students in third and fifth grades (Burns, 2001).

AR is important to consider when designing and implementing academic instruction, because teaching a number of new items that matches a student's AR led to increased retention and generalization as compared to various other instructional set sizes (Burns et al., 2016; Haegele & Burns, 2015). Burns et al. (2004) taught key words to students with disabilities until they reached an AR, which led to increased fluency and comprehension for the passages read.

Incremental Rehearsal

Incremental Rehearsal (IR; Tucker, 1989) is a method of teaching keywords that incorporates high OTR and takes individual students' AR into consideration. IR is a flashcard technique designed to teach new items (i.e., words a student reads incorrectly) within a

sequenced group of known or mastered items at a ratio of one unknown item to seven to nine known items, as shown in Figure 1. After practicing the first unknown word, the second unknown word is introduced and the first unknown word is treated as the first known word in the sequence. New items are introduced until the student makes three errors while rehearsing any new items, and the number taught to that point is the AR (Burns, 2001). IR has been used to teach keywords (Burns, 2007; Burns et al., 2004; 2011), math facts (Codding et al., 2010), and letter sounds (Peterson et al., 2014). IR has been shown to increase multiple reading components such as word recognition (Petersen-Brown & Burns, 2011), decoding (Volpe et al., 2011), and comprehension (Burns et al., 2004; 2011) and was effective in teaching academic skills with students with ID (Burns, 2007; Burns & Boice, 2009).

IR relies on high OTR because each student sees the new item being rehearsed a number of times that equals the number of known items. For example, the first unknown word in Figure 1 would be seen nine times, because the first unknown is rehearsed each time a known word is added to the sequence and there are nine known words. In addition, the first unknown word is then used as the first known when teaching the second unknown word, which results in eight additional presentations. That pattern continues as additional unknown words are introduced (i.e., seven more presentations for the third unknown word, six more for the fourth unknown, etc.) so that an unknown word is seen 9, 18, 27, 36 etc. times. Moreover, words are continued to be taught with IR until the student demonstrates that an AR has been reached by making three errors while rehearsing one new unknown word, which is common practice in IR research (e.g., Burns et al., 2004; Klingbeil et al., 2017; Petersen-Brown et al., 2017).

Purpose

The purpose of the study was to determine the extent to which practicing keywords led to

increases in word recognition, reading fluency, and reading comprehension for three students with ID. The study replicated the approach used in Burns et al. (2004), but extended the research by implementing the intervention over time and by implementing it with students with ID instead of learning disabilities. The following research questions guided the study: (a) What effect does practicing keywords have on subsequent in-text recognition for students with ID? (b) What effect does practicing keywords have on reading fluency for students with ID? (c) What effect does practicing keywords have reading comprehension of nonfiction text for students with ID?

Method

The research questions were addressed with data from three students with ID who attended one elementary school in a Midwest, suburban city. Each student was tested in three pre-intervention sessions in order to establish a current level of performance for each participant. Next, each student received baseline and intervention conditions over the course of 6 weeks using a multielement single-case experimental design. The participants, setting, measures, and procedures are described below.

Participants and Setting

The participants were Gary, Olivia, and Madison, who attended the fourth grade at a suburban elementary school. All three participants were 10 years old at the time of the study. Olivia was a white, female student, Madison was a South Asian, female student, and Gary was a white, male student. They were enrolled in a self-contained special education classroom and spent a majority of the school day receiving special education support. All three participants were identified as having an ID in early childhood based on state criteria that included a score from a measure of cognitive development that fell at least two standard deviations below the average score and significant impairments in achievement and adaptive behavior. The students'

most recent re-evaluation data were available for review, which included measures of cognitive ability (i.e., *Weschler Scale for Children, fifth edition*; full scale IQ range 45-78) and records of their reading performance (i.e., *STAR reading*; standard score range of 74-82; percentile rank 1%). All three students had an individualized education plan in their school district. For more detailed demographic information of each student, refer to Table 1.

The interventionist was a white, female, second-year graduate student in a school psychology program. The interventionist had no prior teaching experience outside of her training and field placements within an Educational Specialist program at a Midwest university.

The study was implemented for 6 weeks with one intervention session each day. The intervention was conducted during noninstructional times in order to not interfere with academic service hours as outlined in the students' individualized education plans. Each intervention session occurred in a separate, quiet room while sitting at a small table and was implemented one-on-one with the interventionist sitting directly across from the participant.

Materials

A total of 20 passages were selected from www.readingAtoZ.com, and each student was randomly assigned eight unique passages to read throughout the study. The Reading A-Z program uses a leveling system in which student reading materials are categorized based on qualitative measures (e.g., predictability of text, text structure), quantitative measures (e.g., total word count, ratio of high frequency words to total words), and reader task considerations (e.g., reader background and interests; Learning A-Z, 2020). The special education teacher identified Reading A-Z levels B or C corresponding to a Lexile range between BR 40 and 160 as an appropriate representation of the participants' instructional level. Olivia was identified as reading at level B, while Gary and Madison read at level C. The Reading A-to-Z Lexile range for each

participant are shown in Table 1. In an effort to control for the passage effects and large Lexile range for levels B and C, the passages were randomly selected and assigned to each participant. A total of 10 level B passages were selected, and eight were randomly selected for Olivia to read. Level C represented an instructional level for Gary and Madison, so 10 passages were selected from Level C, and eight were randomly assigned to these two participants to read.

The passages were informational, non-fiction texts. Each passage was 10 pages long with one to two sentences and one illustration per page. More descriptive information on the Reading A-Z passages is included in Table 2. All of the passages included five multiple-choice reading comprehension questions that were inferential with one correct answer and two distractors.

Keywords were defined as being connected to the overall meaning of the passage and important for reading comprehension and/or occurred frequently in the passage (Burns et al., 2004; 2011). The unknown keywords were unique to the corresponding reading passage and the participant's individual reading ability. For example, Gary and Madison both read "What's for Breakfast," but Gary's unknown keywords were 'muffin,' 'cereal', and 'fruit' while Madison's unknown keywords were 'breakfast,' 'eat,' and 'fruit.'

Unknown keywords were identified through the first reading of the passage in the baseline condition. If the participants could not read a keyword correctly in 2 seconds the keyword was marked to use as a potential unknown in IR. For example, Gary read a passage titled "Space" and he did not correctly identify the words 'space' and 'planets,' so they were marked as potential keywords to practice in the intervention. Moreover, a word had to appear at least five times in the passage to be identified as a keyword and to be practiced. In the previous example, the words 'space' and 'planets' occurred at least 5 times and were used in the

intervention. A complete list of previously unknown keywords identified and practiced with each participant is included in Table 3.

Following the baseline reading and identification of unknown keywords, the interventionist wrote the unknown keywords on 3 x 5 index cards and practiced them with each student. The selected keywords were only practiced in one intervention session, because they were unique to the participants' reading passages. There were a few instances when the same keywords were practiced across multiple passages, especially high frequency words (e.g., 'those,' 'are,' 'there,' 'some').

Dependent Variables

The dependent variables measured in the current study were the number of previously unknown keywords that were correctly identify in subsequent passages (i.e., word recognition), post-intervention reading fluency (i.e., accuracy and rate), and number of comprehension questions answered correctly (i.e., reading comprehension). Each is described below.

Word Recognition

Word recognition was determined by counting the number of times the participants accurately read a practiced keyword(s) in the passages, divided by the total occurrences of the practiced keyword(s) and multiplied by 100 to obtain the percentage of previously unknown keywords read correctly. A word was considered accurately read if it was correctly read within 2 seconds of reading the word that directly preceded it in the sentence.

Fluency

Reading fluency was assessed with both accuracy and rate. Words were considered to have been read correctly if the student provided the correct pronunciation of the word within 2 seconds of it being presented. Accuracy was calculated by dividing the number of words read

correctly by the total number of words in the passage and multiplying by 100. Rate was determined by dividing the words read correctly by the seconds required to read the passage and multiplying by 60 to obtain a words-read-correctly-per-minute (WCPM) score. The rate score for each baseline measure for each student was correlated to obtain an estimate of alternate-form reliability, which equaled a coefficient of r = .85 and suggested adequate reliability for research.

Reading Comprehension

The Reading A-Z passages had accompanying comprehension questions, which consisted of five multiple-choice items that were inferential questions with one correct answer and two distractors. The participants' comprehension scores were determined by dividing the number of correct answers by the total number of multiple-choice questions (i.e., five). All comprehension questions were read orally to the students. A question was considered to have been answered correctly if the student provided the letter (i.e., a, b, c) that corresponded to the option that was the correct answer or the answer itself. Reliability estimates were not provided by the publisher. An alternate-form reliability estimate was calculated by correlating the total comprehension score for each baseline measure for each student, which equaled a coefficient of r = .70 and suggested adequate reliability for research.

Intervention

In the intervention condition, the participants practiced unknown keywords with IR. The unknown keywords were written in the middle of a 3 x 5 index card. Prior to implementing the IR procedures, the participants were shown each word on the index card to confirm whether they knew the selected unknown keywords. The intervention began when the interventionist presented and pronounced the first unknown word and asked the student to repeat the word.

The participants practiced unknown keywords with the procedure demonstrated in Figure 1, until they made three consecutive errors while rehearsing one word, which represented an AR and matched procedures in previous IR research (Burns, 2001; Burns et al., 2004; 2016). Any presentation of a word card that was not correctly responded to within 2 seconds was considered an error. The errors could have occurred on the new word being practiced, a word just learned, or one of the words that was used as a known during the IR intervention. If a participant practiced two unknown keywords via IR and then made three errors while practicing the third word, then the intervention was terminated at two words (Burns, 2001). Figure 1 illustrates an example of a known and unknown word sequence (with an AR of 3 words) during an intervention session with one of the participants. Once IR was completed, students read the passage and answered the accompanying comprehension questions.

Procedures

Each participants' reading level was determined with the Lexile score that represented an instructional level from a district-administered reading screener. The selection of reading passages was based on the participants' special education teacher request who previously identified the reading level each participant based on a group-administered reading test used for universal screening. A total of 20 passages was selected from that Lexile range and one passage was randomly assigned to the three participants for every session. There was some overlap between participants in the passages they read, but each participant was provided with a novel passage for every session. Gary and Olivia read eight passages across the study, but Madison only read six passages due to two absences.

Prior to the initiation of the study, participants' reading accuracy, fluency, and comprehension skills were measured in three pre-intervention testing sessions to establish their

present level of performance. Refer to Table 4 to review descriptive data from the pre-intervention testing. The intervention sessions involved a baseline and intervention condition for each student. The baseline condition was similar to the procedures in the pre-intervention testing; the participants read the passage independently and the interventionist read the comprehension questions to students for them to answer. As the participants read the passage in the baseline condition, the interventionist marked words read incorrectly, and any word not correctly read within 2 seconds was identified as unknown word. The interventionist noted when the participants missed keywords, which were used for IR in the intervention conditions. The intervention condition immediately followed the baseline condition with the same passage and comprehension questions. Intervention sessions occurred twice a week across 6 weeks, and each session began with the baseline condition that was followed by the intervention condition.

Fidelity and Interobserver Agreement

Treatment fidelity was evaluated using an intervention checklist, which was used by a second independent observer. The intervention checklist was created to align with procedures of IR and other components of the intervention. A total of 25% of the intervention conditions were observed by the second independent observer using an intervention checklist. The number of items observed was divided by the total number of items (14) and multiplied by 100 to compute a percentage for treatment fidelity. The result was 100% correct implementation for the intervention condition.

Interobserver agreement was also calculated for the interventionist's scoring. When a participant read a passage and answered the comprehension questions, a second independent observer scored the participant's accuracy for both reading and comprehension. The number of words that both raters rated as correct or incorrect was divided by the total number of words in

the passage and multiplied by 100. The number of comprehension questions consistently rated as correctly or incorrectly answered was divided by the total number of comprehension questions and multiplied by 100. The estimates of interobserver agreement was 95% agreement for reading accuracy and 100% agreement for comprehension accuracy.

Experimental Design

The study followed a multielement design where baseline and intervention conditions were implemented in each session to compare the conditions and evaluate the effect on reading performance. The baseline condition was administered first, and was immediately followed by the intervention condition.

Analysis

Descriptive data were calculated and examined to determine the percentage of keywords identified correctly in subsequent text. Due to the nature of the design and intervention used in the current study, word recognition was only measured in intervention conditions.

A visual analysis was conducted to determine whether the intervention affected the participants' reading fluency and reading comprehension. Visual analysis involved assessing the level, variability, trend, immediacy of effect, and overlap of the data (Riley-Tillman & Burns, 2009). The data between the baseline and intervention conditions were analyzed.

To further evaluate the effectiveness of the intervention on each dependent measure, the percentage of non-overlapping of all pairs data (NAP) was calculated as an indicator of effect. NAP summarizes data in two phases of a single-case design by summing the number of nonoverlapping pairs and dividing by the total number of data pairs. Moreover, NAP was selected because it may outperform other methods of calculating overlap (e.g., percentage of non-overlapping data, percentage of all non-overlapping data, percentage exceeding the median)

due to the use of visual judgement, size of confidence intervals, less influence from outliers, and its relationships with R^2 (Parker & Vannest, 2009). An effect size calculated by NAP is interpreted as strong if the number falls between 0.92 and 1.0, a medium effect falls between 0.66 and 0.92, and anything lower than 0.66 is a weak effect (Parker & Vannest, 2009).

A Tau-U was also calculated to determine the percent of data that showed improvement over time when considering all phase/condition nonoverlap and the intervention trend while controlling for the baseline trend (Parker et al., 2011b). NAP and Tau-U closely align with visual analysis, are a comprehensive indicator of effect, are sensitive to increasing trends within intervention phases, and control for undesirable trends in baseline in a single-case design (Parker et al., 2011a; 2011b).

Results

Data were collected for three dependent measures and reported for the pre-intervention sessions and baseline and intervention conditions. There was differentiation on all the dependent measures, which is shown in Table 5, Figures 2, 3, and 4, and discussed in detail below.

Research Question 1 – Word Recognition

Individual Students

Across the eight intervention sessions, Gary practiced 34 keywords via IR and his acquisition rate remained between 1 to 3 words. On average, Gary recognized 100% of the previously unknown keywords in subsequent text.

Across the eight intervention sessions, Olivia practiced 25 keywords via IR and her acquisition rate remained between 1 to 2 words. Olivia recognized 87% of the previously unknown keywords in subsequent text.

Across the six intervention sessions, Madison practiced 18 keywords via IR and her

acquisition rate was 1 word, although she reviewed 3 keywords in one intervention session. Madison recognized 73% of the previously unknown keywords in subsequent text.

Summary for Word Recognition

Word recognition in the intervention conditions was consistently at a higher level than in baseline conditions. Given the design of the intervention (i.e., identifying and selecting unknown keywords in the baseline condition to practice in the intervention condition), all the keywords were unknown in the baseline condition and resulted in 0% word recognition for all participants. The acquisition rates varied across participants but remained stable for each participant throughout the intervention conditions. Refer to Table 3 for a complete list of the keywords identified and practiced with each participant throughout the study.

Research Question 2 – Reading Accuracy and Rate

Gary

Gary's accuracy increased from the pre-intervention sessions average of 83% accuracy to 93% following the intervention, suggesting an immediate effect. During the baseline condition, Gary's reading accuracy followed a slight decreasing trend, and he read the passages with 61% to 97% accuracy across eight sessions. However, during the intervention condition, he read with 83% to 100% accuracy and his performance indicated a slight upward trend. In both conditions, the trend of his accuracy appeared to be affected by two sessions, but the level of the intervention condition remained higher than baseline. The NAP calculations resulted in 76.56% nonoverlap for Gary's accuracy score, which indicates a medium effect.

An immediate effect was observed on Gary's reading rate; his rate increase from an average of 45.07 WCPM in pre-intervention to 66.56 WCPM within the first post-intervention session. Gary's rate varied across baseline sessions with a slight increase in performance during

later sessions. During the baseline condition Gary's WCPM ranged from 44.80 to 121.62, and 65.56 to 144.71 WCPM in the intervention condition. While there was some variability in his reading rate in the intervention sessions, there was an increasing trend for the intervention condition. The level of performance in the intervention conditions was consistently higher than baseline. NAP was calculated for his baseline and intervention rate scores, which resulted in a 73.44% nonoverlap indicating a medium effect.

Olivia

An immediate effect was not observed between Olivia's pre-intervention reading accuracy and her performance in the first intervention session. During the baseline condition, Olivia's performance followed a slight decreasing trend that was mostly stable, and she read the passages with a range of 38% to 84% accuracy. One baseline session (i.e., Session 11) resulted in more variability for the baseline sessions. Her performance in the intervention conditions suggested an upward trend and was somewhat consistent with a range of 68% to 96% accuracy. The level of her performance in the intervention sessions was higher compared to baseline, although, there was one session when her accuracy was lower in the intervention condition (i.e., Session 10). Overall, there was 87.50% nonoverlap for the accuracy scores between the pre-intervention, baseline, and intervention conditions, which suggested a medium effect.

Similar to her reading accuracy, her reading rate was consistent and did not indicate an immediate effect. Olivia's reading rate was initially at a low level in both conditions, which slowly increased in later sessions. Olivia's WCPM ranged from 13.18 to 60.00 and from 26.58 to 127.06 WCPM in the baseline and intervention conditions respectively. Olivia's performance in the baseline and intervention conditions followed an upward trend but a steeper incline was present across in the intervention conditions. Her level of performance was higher in the

intervention condition. Olivia's rate scores resulted in 87.50% nonoverlap of all baseline and intervention pairs, which suggested a medium effect.

Madison

Overall, Madison's reading accuracy followed a decreasing trend in baseline but initially demonstrated an increase, which resulted in a wider range in her accuracy across baseline sessions. Immediacy of effect was observed between pre-intervention and the first intervention session, increasing from an average score of 56% accurate to 85% in the first intervention session. During the intervention condition, she read with 72% to 99% accuracy; she had an initial increase in accurate reading, but later sessions followed a clear a decreasing trend. However, her performance in the intervention sessions remained higher than baseline. One baseline session (i.e., Session 5) resulted in overlap with intervention sessions, which resulted in 83.33% nonoverlap and a medium effect size.

An immediacy of effect was not observed between the pre-intervention testing and the first intervention session. Madison's reading rate was stable in baseline at a low level, but her rate ranged 19.63 to 97.33 WCPM in the intervention condition, which suggested high variability. The trend of her performance across the intervention sessions was variable but overall indicated a slight decreasing trend for the intervention condition. Her rate remained at a consistently high level during the intervention compared to baseline, which resulted in no overlap between intervention and baseline. The NAP calculations resulted in 86.11% nonoverlap for Madison's rate scores, which indicated a medium effect.

Summary for Accuracy and Rate

The intervention had clear effects on all participants' reading fluency; their levels of performance remained higher in intervention conditions than in baseline. The Tau-U of 0.65

(95% CI = 0.29 to 1.00) suggested a moderate effect for accuracy and a 0.64 (95% CI = 0.28 to 0.99) for rate also represented a moderate effect.

Research Question 3 – Reading Comprehension

Individual Students

In every session, Gary responded to five comprehension questions after reading a passage. His performance in the baseline and intervention condition was highly variable, and he correctly answered 20-100% (i.e., 1-5 questions) of the comprehension questions across the intervention condition and 20-80% (i.e., 1-4 questions) across baseline. Immediacy of effect between the pre-intervention testing and first intervention session was not observed, because his comprehension score was lower. While the data are highly variable, overall, there were increasing trends for both conditions, and his performance in intervention was less variable and at a higher level than baseline. NAP was calculated to further examine the effect of the intervention, which resulted in 62.50% nonoverlap and a medium effect.

Olivia's performance in the first intervention session remained the same compared to her average pre-intervention performance, which indicated no immediate effect. In the intervention phase, she correctly answered the comprehension questions 40-100% (i.e., 2-5 questions) across the baseline sessions and 20% to 80% (i.e., 1-4 questions) in the intervention sessions. Overall, the trend line in baseline had a slight increase while a decreasing trend was observed for the intervention conditions. Her scores were highly variable and her level of performance was similar between conditions. Finally, there was considerable overlap between her performance in the baseline and intervention sessions. Olivia's nonoverlap of baseline and intervention comprehension scores resulted in 34.38%, which indicates a small effect.

Madison's comprehension scores demonstrated an immediate effect from pre-intervention to the intervention, as she increased from an average of 1 question (20%) answered correctly to 3 (60%). Similar to Gary and Olivia, her performance was highly variable with considerable overlap between baseline and intervention conditions. She correctly answered 20% to 40% (i.e., 1 and 2 questions) and 20% to 80% (i.e., 1-4 questions) of the comprehension questions correct in the baseline and intervention conditions respectively. Although she had evidence of higher performance in intervention, her trend line follows an increasing pattern in the baseline but was slightly decreasing across the intervention sessions. Similar to Olivia, a small effect was calculated for Madison's NAP of baseline and intervention comprehension, which indicated 38.89% nonoverlap.

Summary for Comprehension

The intervention did not appear to have an effect on the participants' reading comprehension. High overlap was observed between all conditions for all participants, with somewhat less overlap for Gary. The Tau-U of 0.13 (95% CI = -0.23 to 0.48) suggested a small effect.

Discussion

The purpose of the study was to determine the extent to which practicing keywords led to increases in word recognition, reading fluency, and reading comprehension for three students with ID. Practicing keywords and reading the passage a second time had an effect on the participants' word recognition and reading fluency (i.e., accuracy and rate), but a clear effect was not observed for reading comprehension. These findings have implications for research, practice, and policy, which are described below.

Implications for Research

Word recognition is often a target of reading instruction with students with ID (Browder et al., 2006). The current study is similar to previous research that supports the use of flashcard intervention strategies to increase acquisition of sight words among students with ID (Burns, 2007; Burns & Boice, 2009; Lemons et al., 2018). The current study used this strategy as well but extends on previous research by assessing how well students recognized the keywords in subsequent text as a measure of generalization of newly learned content.

The current data were also consistent with previous research that found that IR improved reading skills among students with disabilities (Burns, 2007; Burns et al., 2004). However, the current study did not find clear effects on students' reading comprehension like Burns et al. (2004; 2011). In fact, previous research found a larger effect for comprehension than fluency, while the current study supported the opposite (i.e., larger effects for fluency) for the three participants in the study. Previous research was most often implemented with students with learning disabilities. Thus, the different results here could be due to the different sample than in previous research, but that is a hypothesis in need of additional inquiry.

Implications for Practice

The current study practiced keywords with three students with ID, which was a simple and efficient strategy to deliver. The simplicity of the intervention could be advantageous because teachers may feel overwhelmed when designing and implementing instruction for students with disabilities (Scruggs & Mastropieri, 1996). The simple and efficient nature of the intervention also may encourage educators to try it with their students with severe disabilities. Teachers may think that students with ID cannot learn to read (Bochner et al., 2001), which may impede their willingness to provide adequate reading instruction. However, easy-to-implement practices and strategies may help debunk this belief. Although the current study did not examine

interventionists perception or resource, previous research found that practicing words with students with ID required minimal resources and was easy to implement (Hudson et al., 2013). The current design and intervention also allowed for simultaneous assessment of students' performance, which provided evidence that students with ID can learn academic skills.

The current intervention targeted several key skills within reading: word recognition, reading fluency and comprehension. IR is an effective practice for several subjects, but teaching keywords was targeted in the current study because vocabulary acquisition promotes fluent reading and informs comprehension. Teaching sight words is a common research-based practice with students with ID (Browder et al., 2006; Lemons et al., 2018), but the current study found effects on other fundamental reading skills and suggested that word instruction can have a meaningful impact on other skills. However, the current study had students recognize the practiced words in text that they had already read once, which may explain positive effects seen with fluency.

Limitations

Although the current data have potential implications for research and practice, they should be considered within the context of their limitations. First, the criteria for inclusion in the study was that participating students were identified as having an ID. All three students in the current study were identified as having ID early in childhood by school personnel. Future researchers might confirm students' disability. Second, the participants' maintenance of reading skills over time was not measured due to school closing, and as a result, the long-term effects of this intervention is unknown. Future research and practice should measure students' retention of keywords and monitor their fluency and comprehension skills to determine whether IR supports maintenance of these skills following the termination of the intervention. Maintenance phases

allow researchers to evaluate whether or not students can generalize acquired skills following termination of the intervention (Alberto & Troutman, 2006). This has been done in previous studies using IR where researchers tested students' generalization by having them read sentences with the newly learned words (Nist & Joseph, 2008). The current study tested for generalization in a similar fashion (i.e., students read previously unknown words in subsequent passages immediately after the intervention), but the short time delay between the intervention and test for maintenance may have not been sufficient for generalization. Measuring students' maintenance of the practice words two or more days following the intervention session would have provided more insight into whether or not the participants learned the words rather than memorizing the words for the intervention. While there were increases in the participants' word recognition and reading fluency, the degree to which students can recall the words later on is unknown.

It is also unclear whether the increases in reading fluency were solely a result of the intervention or if repeated reading alone influenced the results. Reading a passage multiple times increased reading fluency and comprehension (d = 0.57 to 0.95; Therrien, 2004). Students in the current study only read the passages twice, which led to small effects on fluency (d = 0.57; Therrien, 2004) and the effect on comprehension was not reported in the previous research, which suggested an area for future research. Thus, the study cannot differentiate the effect of practicing the keywords from reading the passage twice. Future research might include multiple interventions that involve reading the passage twice and reading it three or four times to evaluate the added effect of multiple readings. To further remove the potential effects of repeated reading, keyword recognition can be assessed through a new passage (i.e., a different passage than the first passage used and read in baseline). Another instructional strategy to prompt speed, accuracy, and comprehension is giving students cues for reading (e.g., read as quickly as you can

while still reading the words correctly, read to understand), which has also been found to be beneficial in increasing reading fluency and comprehension (Therrien, 2004).

There were several limitations associated with the materials. The Reading A-Z program classified level B and Level C passages as having a Lexile range of BR40 to 160L, but there were several B and C passages outside of this range. Additionally, the program did not provide reliability and validity coefficients for their measures and materials. Using consistent reading materials and psychometrically sound measures is recommended to control for passage effects. Several of the questions used to measure comprehension appeared to require prior background knowledge about the topic to answer the question correctly. Moreover, the type of comprehension questions (e.g., literal, inferential) were not controlled for in the current study. Fifth, the principal investigator read the comprehension questions and multiple-choice options orally to the participants, which likely involved listening comprehension instead of or in addition to reading comprehension. Future researchers should control for this by using methods described below (i.e., Hudson et al., 2013), or listening comprehension skills might be assessed in place of reading comprehension given that it is more often a target of instruction for students with ID (Hudson & Test, 2011).

Finally, future researchers should measure students' decoding skills and processing speed before implementing an intervention that targets fluency and comprehension. While the participants in the current study were recommended to participate by their classroom teacher, a pre-test measure of their decoding skills and processing speed would have potentially allowed for more precise conclusions about the effect the intervention had on their fluency or allowed further observations between students varying reading ability. Phonics instruction teaches students letter-sound correspondence as well as words that deviate from common letter-sound

rules in English (e.g., consider ‘ea’ in the words head, area, pear), which predicts word recognition and reading comprehension (Juel, et al., 1986). The keywords in the current study represented a variety of words and did not always follow common English rules in letter-sound correspondence. It is likely that practicing keywords helped increase vocabulary through exposure to novel words, but steps were not taken to include procedures that explicitly teach words with decoding. Other strategies could have been used to help support word acquisition and reading comprehension. Petersen-Brown and Burns (2011) included an explicit vocabulary component with IR and found increased reading performance. The current study did not do this and only practiced words for subsequent recognition at the word and passage levels. Other strategies include linking vocabulary to meaningful examples and activities (Spooner et al., 2012), and integrating picture prompts or creating augmented alternatives of text and comprehension questions may help to facilitate understanding of keywords (Hudson et al. 2013), all of which are areas for future research.

Conclusion

Practicing keywords with IR contributed to positive changes in word recognition and reading fluency for three students with intellectual disabilities. While this study supports the use of academic instructional strategies to support word recognition, accuracy, and reading rate with students with ID, continued research is needed. Reading is a fundamental skill that all students must develop in order to function academically and throughout their life. This is true for students with ID, because reading skills help them become independent in several settings including school, work, home, and community. If students with ID do not receive adequate reading instruction, then their ability to fully participate in society is limited (Lundberg & Reichenger, 2013), which suggests that additional research is warranted.

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Table 1

Demographic Data for the Three Participants

VARIABLES	Madison	Olivia	Gary
Age	10 years	10 years	10 years
	1 month	2 months	8 months
Gender	Female	Female	Male
Race/Ethnicity	South Asian	White	White
Lexile	20-160L	BR20-120L	20-230L
STAR Reading Standard Score	82	80	74
STAR Reading Percentile Rank	1	1	1
WISC-IV FSIQ	45	62	78
Acquisition Rate	1	1-2	1-3

Note. WISC-IV FSIQ = Wechsler Intelligence Scale for Children (5th edition) Full-Scale IQ. BR refers to beginning reader; Lexile rating with BR indicates the number of units a student is below 0L. For example, Olivia read a passage 20 units below 0L.

Table 2

Passages Selected from Reading A-Z

	Lexile	Reading A-Z Level	Total Words
Airplanes	100L	C	48
Amazing Caves	100L	B	40
At the Fair	100L	C	50
Boats	BR90L	B	32
Different Kinds of Sharks	150L	C	60
High or Low?	BR20L	B	48
How Many?	160L	C	72
I Love the Earth	70L	B	48
Mixing Colors	120L	B	40
My Brain	BR40L	B	48
New Again	150L	C	62
Rocks	230L	C	57
Space	20L	C	42
The Moon	120L	C	54
The Pet Rats	BR30L	B	33
Time for Soccer	60L	B	47
What is at the Zoo?	130L	C	76
What's for Breakfast?	0L	C	48
Where is Water?	10L	B	38
Wind Blows	90L	B	39

Note. BR refers to beginning reader; Lexile rating with BR indicates the number of units a student is below 0L.

Table 3

Previously Unknown Keywords Practiced in Treatment Condition for Each Student

Madison	Olivia	Gary
Ride	Soccer	Fair
Fair	Swim	Favorite
Favorite	Aunt	Painted
Wheels	Read	Wheels
Are	Brother	Some
Many	Caves	Airplane
Breakfast	Shiny	Sprinkler
Eat	Crystals	Things
Fruit	Does	Silly
There	Ears	Floppy
Many	Low	Wear
Five	Those	Winter
Cycles	Are	Sealions
Space	Turn	Zoo
Broke	Carries	Candles
Some	Police	Arms
Arms	Think	Smiles
Thing	Rivers	Planet
	Lakes	Space
	Wind	Are
	Blows	Zebra
	Has	Fins
	Use	Boulder
	Rats	Pebble
	They	There
		Muffin
		Cereal
		Fruit
		Tiny
		Eights
		Planes
		Trash
		Fort
		Bucket

Table 4

Descriptive Data for Pre-Intervention Testing for All Measures

	Madison	Olivia	Gary	Total
Measure	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Reading Accuracy	55.91 (3.67)	69.26 (10.32)	71.87 (7.39)	65.68 (9.93)
Reading Fluency	19.67 (1.21)	28.62 (13.06)	45.07 (4.42)	30.42 (14.17)
Comprehension	20.00 (20.00)	66.67 (11.55)	40.00 (34.64)	42.22 (29.06)

Notes. Reading Accuracy = percentage of words read correctly, Reading Fluency = number of words reading correctly per minute, and Comprehension = percentage of comprehension questions answered correctly.

Table 5

Descriptive Data for Baseline and Intervention Conditions for All Measures

	Madison		Olivia		Gary		Total	
	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention
	M	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Measure	*(SD)*	*(SD)*	*(SD)*	*(SD)*	*(SD)*	*(SD)*	*(SD)*	*(SD)*
Word Recognition	0.00	73.00	0.00	83.71	0.00	100.00	0.00	84.73
	(0.00)	(2.83)	(0.00)	(24.40)	(0.00)	(0.00)	(0.00)	(20.81)
Reading Accuracy	70.72	84.73	69.25	85.79	83.00	93.03	74.65	88.13
	(12.20)	(9.57)	(13.83)	(9.89)	(11.03)	(7.17)	(13.48)	(9.28)
Reading Fluency	27.66	52.87	33.09	69.91	72.64	107.27	45.99	78.82
	(5.73)	(26.40)	(17.48)	(30.65)	(27.95)	(39.43)	(28.28)	(39.11)
Comprehension	33.33	40.00	60.00	60.00	47.50	57.50	48.18	53.64
	(10.33)	(25.30)	(18.52)	(15.12)	(23.75)	(22.52)	(21.08)	(21.72)

Notes. Word Recognition = percentage of practiced words correctly read in text, Reading Accuracy = percentage of words read correctly, Reading Fluency = number of words reading correctly per minute, and Comprehension = percentage of comprehension questions answered correctly.

Figure 1

Example of the Presentation of Unknown Keywords and Known Words via Incremental Rehearsal

muffin, breakfast
muffin, breakfast, milk
muffin, breakfast, milk, what's
muffin, breakfast, milk, what's, kids
muffin, breakfast, milk, what's, kids, eat
muffin, breakfast, milk, what's, kids, eat, toast
muffin, breakfast, milk, what's, kids, eat, toast, for
muffin, breakfast, milk, what's, kids, eat, toast, for, you
muffin, breakfast, milk, what's, kids, eat, toast, for, you, bacon

cereal, muffin
cereal, muffin, breakfast
cereal, muffin, breakfast, milk
cereal, muffin, breakfast, milk, what's
cereal, muffin, breakfast, milk, what's, kids
cereal, muffin, breakfast, milk, what's, kids, eat
cereal, muffin, breakfast, milk, what's, kids, eat, toast
cereal, muffin, breakfast, milk, what's, kids, eat, toast, for
cereal, muffin, breakfast, milk, what's, kids, eat, toast, for, you

fruit, cereal
fruit, cereal, muffin
fruit, cereal, muffin, breakfast
fruit, cereal, muffin, breakfast, milk
fruit, cereal, muffin, breakfast, milk, what's
fruit, cereal, muffin, breakfast, milk, what's, kids
fruit, cereal, muffin, breakfast, milk, what's, kids, eat
fruit, cereal, muffin, breakfast, milk, what's, kids, eat, toast
fruit, cereal, muffin, breakfast, milk, what's, kids, eat, toast, for

Notes. This is an example of an IR sequence implemented with Gary during one of his intervention sessions. In this example, 'muffin', 'cereal', and 'fruit' were the unknown keywords (bolded), and the nonbolded words were the known words.

Figure 2

Percentage of Words Read Correctly Across Conditions

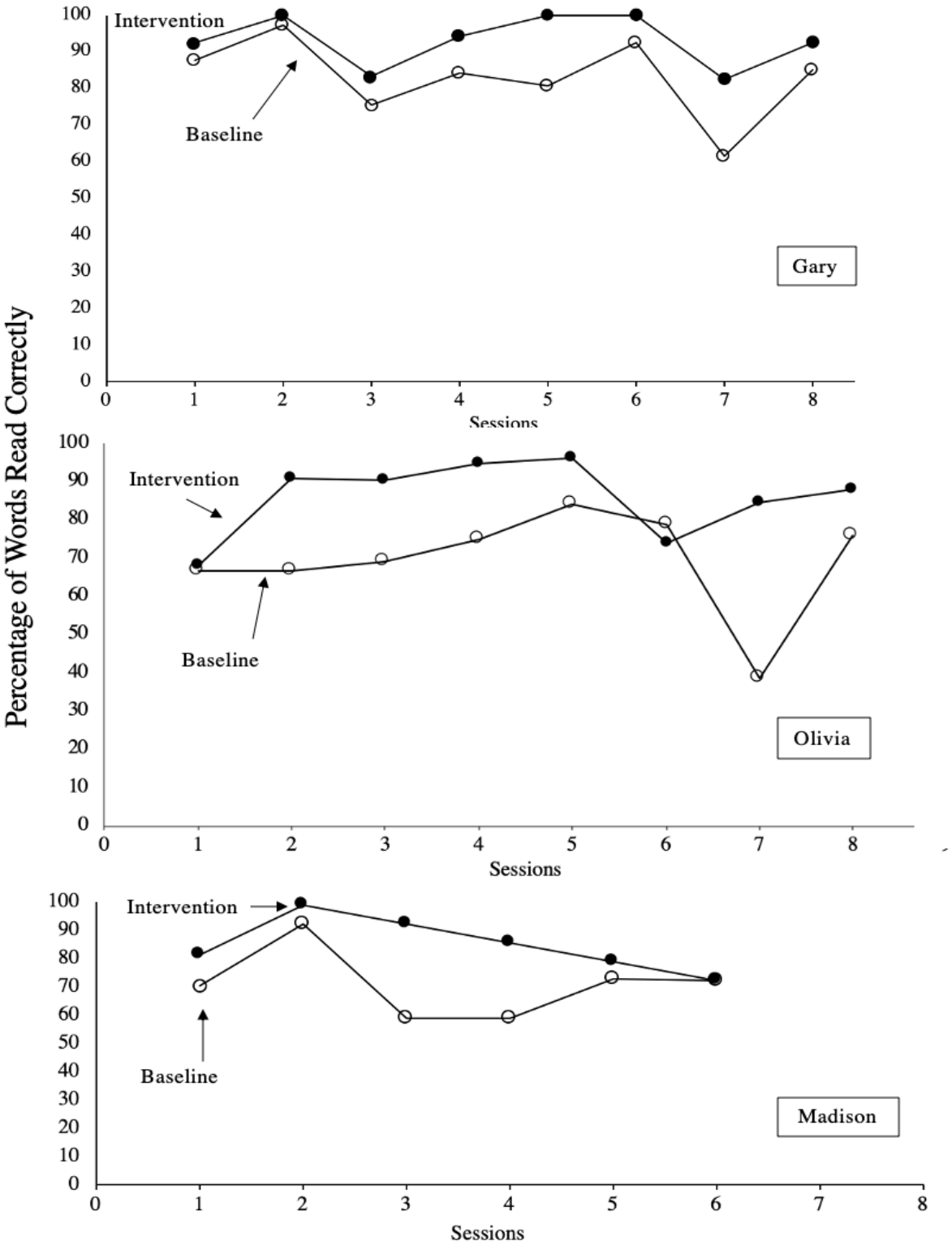

Figure 3

Words Read Correctly per Minute Across Conditions

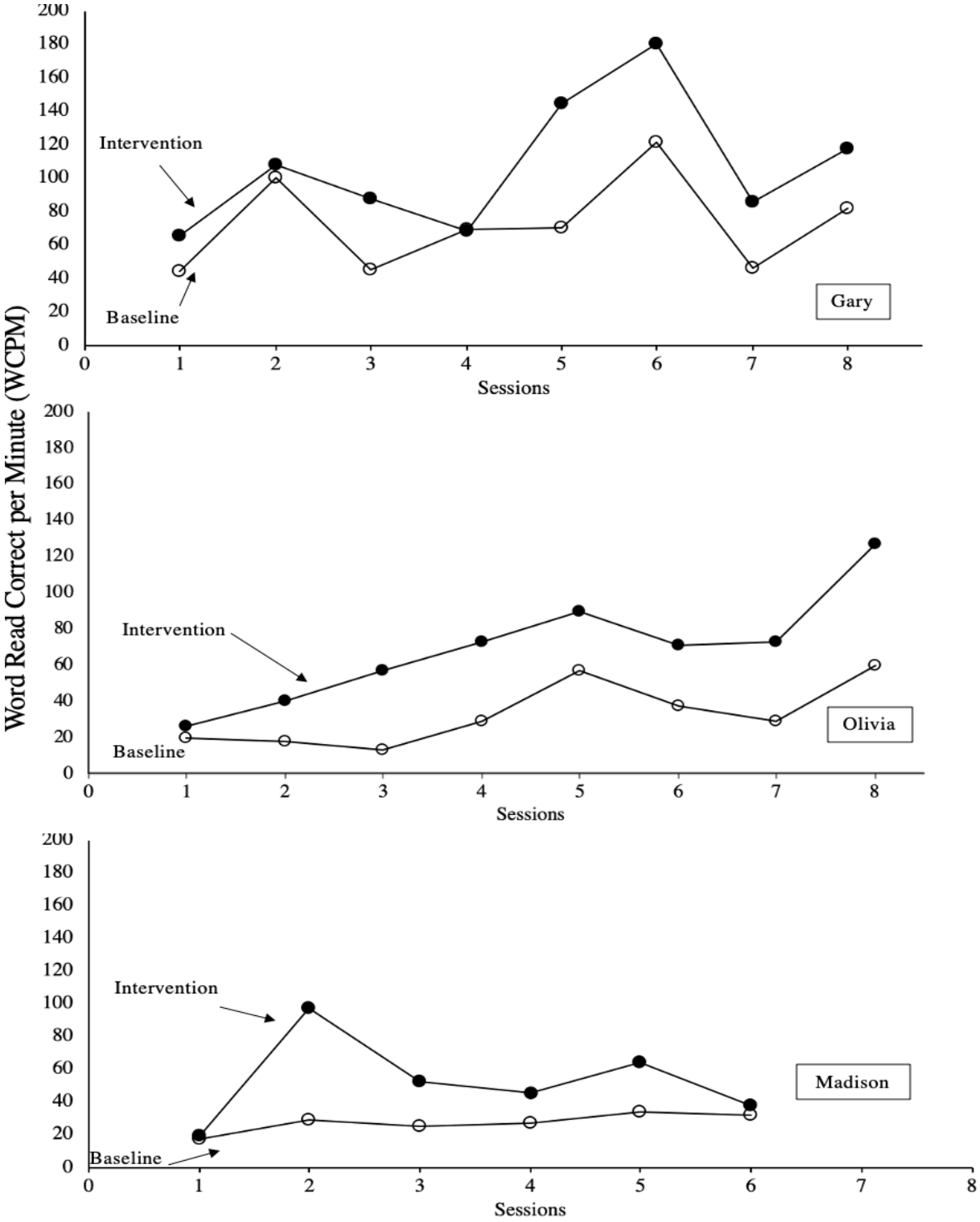

Figure 4

Percentage of Comprehension Questions Correct Across Conditions