Education and Training in Autism and Developmental Disabilities, 2018, 53(3), 287–298
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Word Study Intervention for Students with ASD: A Multiple Baseline Study of Data-Based Individualization

Michael Solís
University of California Riverside

Farah El Zein
Brescia University College

Marie Black, Alexandra Miller, William J. Therrien, and Marcia Invernizzi
University of Virginia

Abstract: This multiple baseline across participants study examined the efficacy of a data-based individualization word study intervention for students with autism spectrum disorder (N = 5) and low word reading skills. An experienced interventionist provided 1:1 word reading instruction in 30-minute sessions five times per week for an average of 10 sessions per participant. Intervention effects for directly taught words and words with similar spelling patterns were estimated using visual analysis and calculation of mean differences across baseline and intervention phases. Results indicate immediate and consistent improvements in word reading outcomes across all participants.

Recent reports suggest that as many as one in three students with autism spectrum disorder (ASD) have reader profiles of low decoding skills and comprehension (Nation, Clarke, Wright, & Williams, 2006; Wei, Christiano, Yu, Wagner & Spiker, 2014). Nation et al. (2006) reported 42% of students with ASD in their sample as having low decoding skills in addition to low reading comprehension. More recently, Wei et al. (2014) reported a similar finding of 32% of students with ASD having low decoding. Despite this being the case, reading interventions for students with ASD over the last 10 years have primarily focused on reading comprehension (Chiang & Lin, 2007; El Zein, Solis, Vaughn, & McCulley, 2014; Whalon, Al Otaiba, & Delano, 2009). The overwhelming focus on comprehension instruction is not surprising considering the influential reader profile studies conducted over several decades which described average or above average decoding skills with low comprehension for students with ASD (Frith & Snowling, 1983; Goldberg, 1987; Minshew, Goldstein, Taylor, & Siegel, 1994; O'Connor & Hermelin, 1994; Pattie & Lupinetti, 1993). While there does appear to be agreement among many researchers on the pervasive difficulties students with ASD experience with reading comprehension (Fluery et al., 2014), it is also important to note the needs of students with ASD that do not fit this typical profile. Beyond comprehension needs, it is also important to investigate other challenges faced by students with ASD with less typical reader profiles such as those who face challenges with decoding and word reading.

The authors would like to thank Hannah Mathews for her hard work on materials development and data collection. This research was supported by the *Institute of Education Sciences*, U.S. Department of Education, through Grant R324A160299 to the University of California Riverside. The opinions expressed are those of the authors and do not represent the views of the *Institute* or the U.S. Department of Education. Correspondence concerning this article should be addressed to Michael Solis, Graduate School of Education, University of California Riverside, Riverside, CA 92521. E-mail: michael.solis@ucr.edu

Code-Based Reading Intervention Research for Students with Autism Spectrum Disorders

Whalon and colleagues (2009) conducted a synthesis of reading interventions for students with ASD that identified eleven studies providing instruction in decoding, fluency, vocabulary, and comprehension. Of these 11 studies, only three pre/posttest design and one single-case design study investigated code-based in-

terventions (Basil & Reyes, 2003; Coleman-Martin, Heller, Chihak, & Irvine, 2005; Heimann, Nelson, Tjus, & Gilberg, 1995; Tjus, Heimann, & Nelson, 1998). Three of the studies used modified versions of the same computer assisted instructional software program (Basil & Reyes, 2003; Heimann et al., 1995; Tjus et al., 1998). The software program provides opportunities for students to select words and word groups to form sentences with tasks over time requiring increasingly more complex grammatical structures. Across these studies, the findings showed some promise yet were inconclusive due to a number of methodological issues including small sample sizes with large age ranges, unclear screening procedures, and lack of comparison or control conditions.

Basil and Reyes (2003) investigated the software program along with a scaffolding approach in a pre/posttest design. Two students with ASD, ages 8 and 14, received 12 hours of instruction in 30 min. sessions twice per week. While both students "mastered" the lessons according to the software-based proximal measure, only one student made significant gains from pre to post-test on measures of phonological awareness (PA) and word spelling. Heimann et al. (1995) investigated the software program with a larger sample size of students with ASD (N = 11) ranging in age from 6 to 14 years old. Significant gains in reading was reported, however, no significant gains were detected on PA measures. Tjus et al. (1998) also reported mixed results for students with ASD with significant gains on PA and reading measures reported on initial posttests but no significance differences found on delayed post-test measures.

Utilizing a multiple condition design with drop-down baselines, Coleman-Martin et al. (2005) investigated a computer-assisted instructional (CAI) approach using a nonverbal reading approach for word identification for one student with a dual diagnosis of ASD and moderate intellectual disability. Researchers compared baseline phases to teacher only, teacher plus CAI, and CAI only. The student, 'Carrie', had low mean scores on percent of words identified correctly (M = 13.3%) during baseline. The remaining baseline phases stayed consistently low (M = 0.0%). Across the three treatment conditions the teacher only phase had the steepest slope with a clear upward trend ending with Carrie scoring 80% correct on three of her last four scores. Initially during the teacher plus CAI condition the scores dropped to 60% correct. However, at the end of this phase Carrie scored 100% correct on her last two scores. During the CAI only phase, scores ranged from 60% to 80% correct with the exception of a few outliers.

Following the synthesis by Whalon et al. (2009) some additional studies were conducted that investigated word study interventions for students with ASD. Infantino and Hempenstall (2006) investigated a direct instruction intervention of word reading that used standardized protocols for the basis of instruction (Infantino & Hempenstall, 2006). After 23 hours of instruction, one student with ASD did not show significant gains in decoding skills with no differences in percentile rank, age and grade equivalents. In a multiple baseline across probes design, Whitcomb, Bass, and Luiselli (2011) reported improved accuracy with word lists after one student with ASD participated in five intervention sessions provided through computer assisted instruction. Similarly, in a multiple baseline across probes study, Yaw et al. (2011) reported an immediate increase in sight word reading across 16 intervention sessions delivered to one grade 6 student through computer assisted instruction.

Rationale and Hypotheses

Initial data on reading performance for this study were taken from a larger observation study investigating issues of reading instruction for students with ASD (Solis, Black, Romig, & Miller, in development). The district personnel informed us of their concern with students' word reading skills rather than reading comprehension, which were further confirmed from our testing results. We then worked with district personnel to design a study that would integrate in with their current efforts to address the problem rather than supplant any attempts at intervention. Utilizing the techniques described by the National Center on Intensive Interventions (2013), we adapted the word study reading program that was in use by the school district, *Words Their Way* (Bear, Invernizzi, Templeton,

& Johnston, 2016), by infusing explicit instruction and corrective feedback through a data-based individualization (DBI) approach to intervention. The Words Their Way DBI (WW-DBI) approach was designed to address the most intense instructional needs for students who have not responded to previous interventions (National Center on Intensive Interventions, 2013).

The purpose of this study was to determine if adaptations of the district adopted word study curricula would increase performance word study skills for words directly taught and for words that followed the same spelling patterns. The study addressed the following research hypotheses: The WW-DBI intervention will result in improved performance on words directly compared to baseline performance. The WW-DBI intervention will result in improved performance on words not taught but that followed the same word patterns as those taught compared to baseline performance.

Method

Setting and Instructor

All participants were from one rural school located in a southeastern state. According to data from the State Department of Education, the racial and ethnic population of students in the district at the time of the study included the following: Caucasian, 73.9%; African American, 13.0%; Hispanic, 6.90%; two or more races, 5.0%; Asian, 0.50%; Native American, 0.30%. All intervention sessions were conducted in a small room adjacent to the school library. No other students were present during the intervention. Sessions were held during students' intervention or resource period and scheduled for 30 minutes per day, five days per week.

The instructor was a retired special educator who previously worked at the school district for 30 years. She had extensive background in teaching reading to children with disabilities. She was hired, trained, and supervised by the research team.

Participants

Students. Four male students and one female student with ASD (as identified by the school district through the multi-disciplinary team process) in grades 5–7 participated in the study ($N = 5$). All students were Caucasian. According to school district personnel, students all received a combination of general education and special education classes with minimal behavior supports provided as needed. Parent consent and student assent were acquired for all participants as approved by the Institutional Review Board from the university of the first author. As part of the screening procedure, participants were administered two standardized reading measures: the Test of Sentence Reading Comprehension (TOSREC) (Wagner, Torgesen, Rashotte, & Pearson, 2010) and the Test of Word Reading Efficiency (TOWRE) (Torgesen, Wagner, & Rashotte, 1999). The Kaufmann Brief Intelligence Test Verbal (KBIT-2) (Kaufman & Kaufman, 2004) was also administered to provide descriptive data. To qualify for the study, students needed to meet the following criteria: TOSREC standard score ≤ 85, TOWRE standard score ≤ 80. To determine the appropriate starting point for intervention, each students was administered the spelling inventory placement test from *Words Their Way* to identify their current word part knowledge. See Table 1 for a summary of participant information including age and grade placement.

Materials

Individualized pool of unknown words. We adapted the procedures described by Ferkis, Belfiore, and Skinner (1997) to guide the development of the word lists. Using words selected from *Words Their Way* (Bear et al., 2016), we developed a pretest probe to determine unknown words for each participant. Prior to administration of the pretest, the words were leveled for frequency using the Corpus of Contemporary American English (COCA; http://corpus.byu.edu/coca/) with high frequency words being removed. These unknown words, in turn, were used to develop the word banks included in the baseline probes, intervention materials, and intervention probes of taught words. The initial word probe was delivered on an iPad using standard-sized PowerPoint slides. Each slide contained 10 words from a single developmental level of the *Words Their Way* scope and sequence (Bear et al., 2016). Each student's

TABLE 1

Participant Information

Participant	*Age (years)*	*Grade*	*KBIT Verbal**	*TOSREC**	*TOWRE**	*WWSI*
Edward	11	6	79	68	77	Late syllable with affixes
Tony	13	7	78	76	76	Early within word
Richard	13	6	87	85	63	Late within word
Julia	12	6	66	61	54	Middle letter name
Justin	10	5	80	64	77	Early within word

Note: * = Reported as standard scores; KBIT = Kaufman Brief Intelligence Test; TOSREC = Test of Sentence Reading Efficiency and Comprehension; TOWRE = Test of Word Reading Efficiency; WWSI = Words Their Way Spelling Inventory placement information.

level was determined by the *Words Their Way* spelling inventory placement test (Bear et al., 2016) (see Table 1), and each student's scope and sequence was individualized accordingly.

Scope and sequence development. In order to develop each student's individualized scope and sequence, we compiled and sorted all unknown words by spelling feature. Using the principles of word study and minimally discriminant pairs, we developed weekly word sorts that followed the developmental spelling sequence established in *Words Their Way* (Bear et al., 2016). Each sort contained 15 words, 10 words established through the pre-assessment as unknown to the student, and a set of five generalization words following the same spelling pattern. This scope and sequence was used to develop the lessons, baseline and intervention probes, and curriculum-based measures.

Measures

Screening and descriptive measures. Three standardized measures were administered to students prior to baseline data collection. The Test of Sentence Reading Comprehension (TOSREC), Test of Word Reading Efficiency–Second Edition (TOWRE–2), and the Kaufman Brief Intelligence Test – Second Edition (KBIT-2).

Test of Silent Reading Efficiency and Comprehension (TOSREC; Wagner et al., 2010*).* The TOSREC is a 3 min, group-administered assessment of reading fluency and comprehension. Students are presented with a series of short sentences and asked to read silently and assess whether the sentences are true or false. Average alternate-form coefficients range from 0.84 to 0.95.

The Test of Word Reading Efficiency (TOWRE: Torgesen et al. 1999*).* The TOWRE consists of two individually administered 45-second subtests of sight word reading and phonemic decoding efficiency. Each list of words and nonwords starts with the least-difficult items and gradually increases in difficulty. The alternate-forms reliability coefficients were reported as 0.91 to 0.97 (Torgesen et al., 1999).

Kaufman Brief Intelligence Test–Second Edition (KBIT-2; Kaufman & Kaufman, 2004*).* The KBIT-2 is individually administered in approximately 15 min; it assesses both verbal and nonverbal ability in people from 4 through 90 years of age. The KBIT-2 is composed of two separate scales. The Verbal Scale contains two kinds of items—Verbal Knowledge and Riddles—both of which assess crystallized ability (knowledge of words and their meanings). The items cover both receptive and expressive vocabulary, and they do not require reading or spelling. Composite internal consistency reliabilities were ranged from 0.89 to 0.96. Validity studies yielded moderate to high correlations with both construct and concurrent validity studies (Kaufman & Kaufman, 2004).

Dependent measures. Based on the individualized pool of unknown words, daily 20-word probes were administered during the baseline phase. During the intervention phase, each probe contained 10 words that were directly taught as a part of the word sort, five words that were not included in the word sort but followed the same spelling patterns as those in the sorting activity, and five distractor words

Daily Probe – Annotated Example

Name _____ Date_____

Unite (T)	Visor (T)	Confide (T)	Excite (NT)
Deprive (NT)	Sustain (D)	Decide (T)	Recite (T)
Voucher (D)	Incite (NT)	Minor (NT)	Advise (T)
Derive (T)	Vital (NT)	Despite (T)	Rival (T)
Siren (D)	Collide (T)	Dreary (D)	Coax (D)
T= _____/10	**NT=_____/5**		

Figure 1. Teacher copy of the daily word probe.

used to control for cueing during the probes. The daily probes contained two dependent measures. The first measure was students' identification of the 10 explicitly taught words. These words served as a measure of students' acquisition of directly taught words. The second measure consisted of five words not directly taught. These words served as a measure of students' ability to generalize taught spelling patterns to novel, unknown words.

Probes were delivered using a single word list each day. Directly taught words remained the same for the 5-day instructional cycle, generalization words varied across days of the week. When recording word reading accuracy, the tutor allowed 5 seconds per word for a student response and allowed for unprompted, self-corrections within those 5 seconds. One point was awarded for each correctly pronounced word. See Figure 1 for an annotated example of a daily probe.

Procedure

Tutor training. We trained one tutor, a retired special educator with up-to-date teacher certification, in two 2-hour sessions. The first day of training consisted of reviewing the principles of word study (Bear et al., 2016), the principles of explicit instruction (Archer & Hughes, 2011), and error correction procedures established by the first author of the study. The second day of training consisted of detailing the specific instructional routine and materials and having the tutor conduct mock sessions of the intervention until she demonstrated mastery of the instructional sequence. Throughout the training, the tutor was encouraged to balance following the instructional routines along with maintaining some instructional flexibility which is a core feature built into *Words Their Way* (Bear et al., 2016).

Intervention. The word study intervention WW-DBI consisted of daily teacher-directed word sorts and guided practice in word feature analysis. The intervention was an adapted version of the word study instructional routine detailed by Bear et al. (2016). To better align to the needs of students with ASD, we made the following modifications: instruction was provided one to one instead of in groups, increased teacher modeling and guided feedback (Archer & Hughes, 2011) during exploration, additional instructor prompts and scaffolds during guided practice, and increased intervention duration. The tutor used the current behavior management system of positive reinforcement as outlined on each student's individualized education plan.

Students met individually with the tutor for five days per week for 15- to 20-minutes of instruction (30 min with probe administration). Words used in each sort were 50% known and/or high frequency words and 50% unknown to the student. During instruction, the following 7-step process was followed.

Intervention Fidelity Checklist

Yes or No	Teacher Action
	Turned on audio recorder
	Explicitly stated the student friendly goal for the week
	Teacher read all words at the initiation of the sort
	Clearly established the categories/feature of interest
	Used sentence frames as an explicit model for student talk
	Modeled sorting by sound
	Prompted/ensured that the student used the "say and lay" approach
	Provided corrective feedback on student reading and sorting (as needed)
	Modeled sorting by sight
	Prompted/ensured that the student used the "say and lay" approach
	Provided corrective feedback on student reading and sorting (as needed)
	Had student re-read all words at the end of the sort
	Provided corrective feedback on student reading and sorting (as needed)
	Provided prompt for the summary of the lesson; linked back to goal
	Recorded summary on the student's flip chart
	Asked student to generate other words that would fit with their categories
	Gave student the INTERVENTION: Daily Probe. Began with prompt: *"Before we move on, let's practice reading some words that follow our pattern for today. Read these words aloud to me please."*
	Turned off audio recorder

Figure 2. Fidelity checklist for day one of intervention instruction.

(1) The instructor delivered a goal statement for the lesson, and after session one, a review was provided on the previous day's word sort. (2) The tutor reviewed the new sort by establishing word categories and reviewing the words' pronunciations and meanings. (3) The tutor demonstrated how to sort the words by sound and repeated the process for sorting by sight or spelling patterns. (4) Using a teacher-directed, closed sort, the tutor guided the student through the process of sorting the words under the given headers, working through the words one at a time. Using the sentence frames provided as a meta-cognitive guide, the instructor introduced each word and prompted discussion about the words regarding position of spelling features within the word, frequency, and related words. (5) The tutor gradually released this responsibility to the students, providing praise and corrective feedback. (6) The students led the sort (independent practice) while the tutor prompted the student to say the words and compare them as they sorted. (7) Following completion of the sort, the tutor guided the students through a reflection process. During the reflection process, the tutor prompted the student to compare and contrast the words and their features. Sentence frames such as "I notice that . . ." and "When I read these words, I hear . . ." were used to promote students' use of feature analysis. To encourage students to think about their rationale for sorting words and making connections to the words' sounds, spellings, and meanings, the tutor asked the student to explain why they sorted the words as they had. This explanation of students' thinking was recorded on a flip chart to be used during the following day's lesson.

Procedural Integrity and Reliability

All intervention and assessment sessions were audio-recorded. We used these recordings to check a random sample of 20% of the intervention sessions for procedural integrity and reliability. From the audio recordings, a researcher familiar with the intervention used an implementation validity checklist of the core instructional steps of the intervention to determine the percent of expected instructional steps. See Figure 2 for an example of treatment integrity protocol. The integrity

and reliability of implementation was 82% for the coded sessions.

Reliability of assessment data was assessed for 28% of the sessions by rescoring the sessions' dependent measures and comparing the scores obtained to the scores reported by the tutor. A total of 35 sessions were dual coded by two raters. Interobserver agreement was then determined by calculating the total number of agreements divided by the total number of agreements and disagreements multiplied by 100. The mean agreement across observers was 96.1%.

Experimental Design and Data Analysis

A single-case multiple baseline design across participants was used to evaluate the effects of the intervention on participants' abilities to read words in isolation. The advantage of a multiple baseline design, unlike a reversal design, is it allows for the empirical examination of dependent measures (i.e., word reading) that do not reverse upon removal of the intervention (Tawney & Gast, 1984). Furthermore, the sequential implementation of the independent variable parallels the practices of teachers and generalization of the behavior change is monitored through the design (Gast, Lloyd, & Ledford, 2014).

Researchers have traditionally used the visual analysis method to interpret single case study results (Kratochwill et al., 2010). Currently, there is not consensus regarding one statistical analysis procedure to interpret results from single-case design studies (Kratochwill et al., 2010). For these reasons, we analyzed data based on visual inspection of the graph for each participant. Visual inspection of the graphs was based on the (a) level, (b) trend, (c) variability, (d) overlap, (e) immediacy of the effect, and (f) consistency of data patterns across similar phases (Kratochwill et al., 2010).

Results

Edward

Edward's word reading data are presented in Figure 3. During baseline, Edward's scores on daily reading probes ranged from 20% to 60% with a mean of 45%. Upon implementation of WW-DBI intervention, Edward's level of taught and untaught word reading accuracy increased to means of 86% and 68% respectively. Scores for taught words ranged from 60% to 100%, and scores for untaught words ranged from 0% to 100% (See Table 2). Upon introduction of the intervention, an immediate increase in Edward's score is observed for taught words and a gradual increase is observed for untaught words. Visual inspection of the graph reveals an upward trend for both taught and untaught words during the intervention phase. Calculation of overlapping data between intervention and baseline phases shows 5% overlap for taught words and 58% overlap for untaught words.

Tony

Tony's word reading data are presented in Figure 3. Tony's scores on daily reading probes ranged from 20% to 50% during baseline phase, with a mean of 38%. Upon implementation of WW-DBI intervention, Tony's level of taught and untaught word reading accuracy increased to means of 98% and 71% respectively. Scores for taught words ranged from 90% to 100%, and scores for untaught words ranged from 40% to 100% (See Table 2). Upon introduction of the intervention, an immediate increase in Tony's score is observed for both taught and untaught words. Visual inspection of the graph reveals an upward trend for both taught and untaught words during the intervention phase. Calculation of overlapping data between intervention and baseline phases shows 0% overlap for taught words and 8% overlap for untaught words.

Richard

Richard's word reading data are presented in Figure 3. During baseline, Richard's scores on daily reading probes ranged from 15% to 55% with a mean of 29%. Upon implementation of WW-DBI intervention, Richard's level of taught and untaught word reading accuracy increased to means of 95% and 74% respectively. Scores for taught words ranged from 70% to 100%, and scores for untaught words ranged from 40% to 100% (See Table 2). Similar to Edward's results, upon introduction

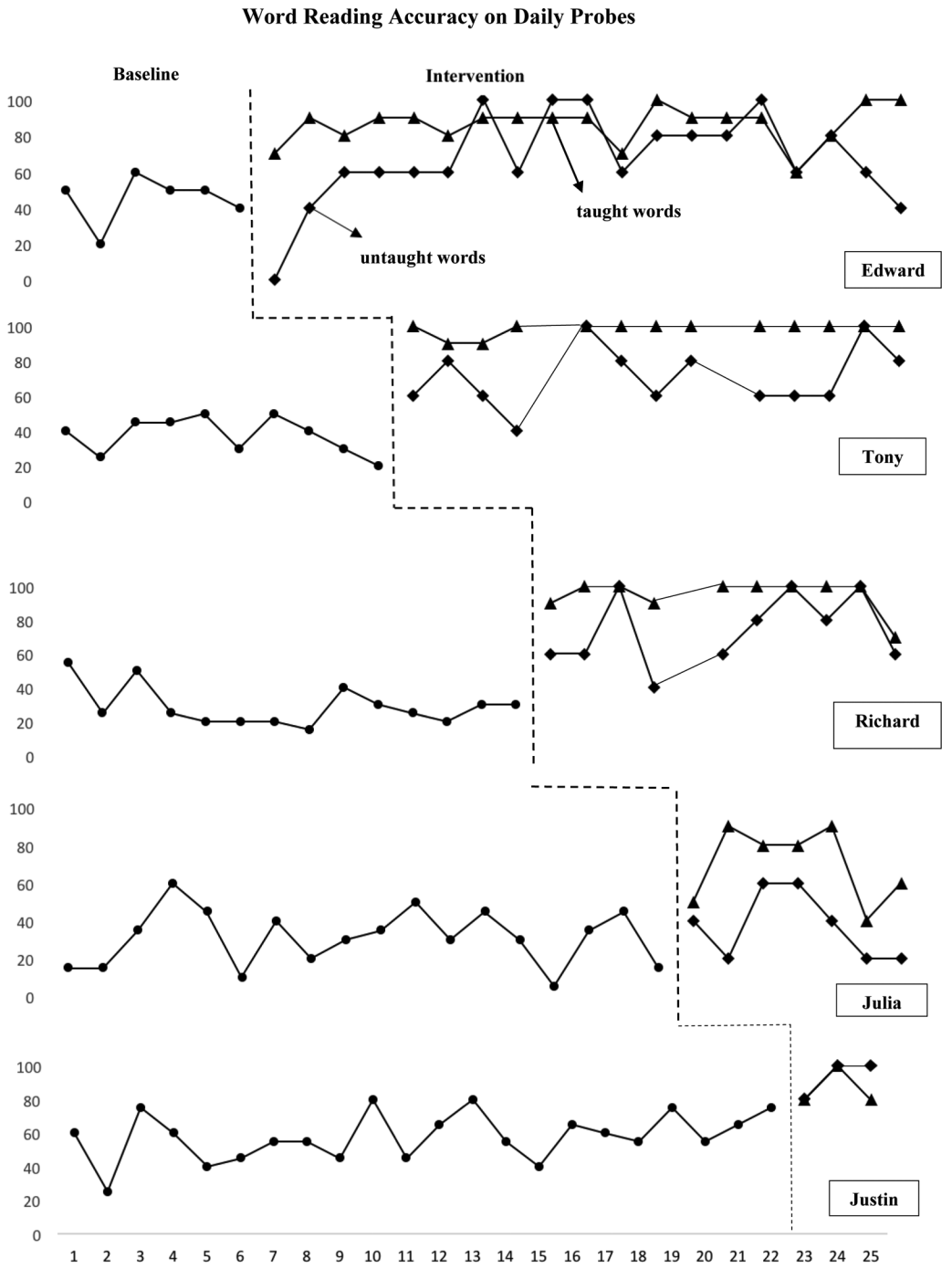

Figure 3. Word reading accuracy reported as percentage of words read correctly.

of the intervention phase, an immediate increase in Richard's score is observed for taught words and a gradual increase for untaught words. Visual inspection of the graph reveals an upward trend for both taught and untaught words during the intervention

TABLE 2

Word Reading Accuracy on Daily Reading Probes

Participant	*Baseline (%)*	*Taught (%)*	*Not Taught (%)*
Edward	45	86	68
Tony	38	98	71
Richard	29	95	74
Julia	31	70	37
Justin	58	87	93

Note: Scores represent percentage of words read correctly during the daily reading probes.

phase. Calculation of overlapping data between intervention and baseline phases shows 0% overlap for taught words and 10% overlap for untaught words.

Julia

Julia's word reading data are presented in Figure 3. During baseline, Julia's scores on daily reading probes ranged from 5% to 60% with a mean of 31%. Upon implementation of WW-DBI intervention, Julia's level of taught word reading accuracy increased to a mean of 70%, and her untaught word reading accuracy increased to a mean of 37%. Scores for taught words ranged from 40% to 90%, and scores for untaught words ranged from 20% to 60%. Upon introduction of the intervention, a gradual increase then drop in Julia's score is observed for both taught and untaught words. Visual inspection of the graph reveals a neutral trend for both taught and untaught words during the intervention phase. Calculation of overlapping data between intervention and baseline phases shows 43% overlap for taught words and 100% overlap for untaught words.

Justin

Justin's word reading data are presented in Figure 3. During baseline, Justin's scores on daily reading probes ranged from 25% to 80% with mean of 58%. Upon implementation of WW-DBI intervention, Justin's level of taught and untaught word reading accuracy increased to means of 87% and 93% respectively. Scores for taught and untaught words ranged from 80% to 100%. Upon introduction of the intervention, a gradual increase in Justin's score is observed for taught and untaught words. Visual inspection of the graph reveals an upward trend for untaught words and a neutral trend for taught words. Calculation of overlapping data between intervention and baseline phases shows 67% overlap for taught words and 33% overlap for untaught words.

Discussion

The purpose of this study was to examine the impact of an adapted version of a widely used word study program on the word reading skills of students with ASD. Our aim was to examine the effectiveness of the intervention of words directly taught and words not directly taught that followed the same spelling patterns when implemented by a tutor hired, trained, and supervised by researchers. We hypothesized that with adaptations to the program, this approach is likely to improve performance for students with a history of very low performance with word reading (TOWRE, standard score $M = 69.4$).

Effectiveness of Intervention

Results indicate that the WW-DBI intervention was generally effective for improving performance with words directly taught and moderately effective with untaught words for students with ASD with low word reading skills. These gains in word reading skills are similar to findings reported in previous work (Coleman-Martin et al., 2005; Infantino & Hempenstall, 2006; Whitcomb et al., 2011; Yaw et al., 2011). During the baseline condition, students on average read 45.8% words correctly. During the intervention condition, students read an average of 87.2% words directly taught correct and an average of 68.6% of words not directly taught. All five participants had mean scores of words taught well above their baseline performance, and four of the five participants had mean scores of words not directly taught above their baseline performance.

There was a clear immediacy effect from baseline to intervention across all five participants. The average baseline score just prior to

beginning intervention was 36% for words taught with the average score of words taught when starting intervention was 78%. The data indicate clear intervention effect at five points in time across baseline and intervention with each phase having three or more data points. In fact, the data "meets standards" as outlined by Kratochwill et al. (2010) for demonstrating an effect by having four phases with at least five data points per phase. Across four of the five participants the variability was relatively low for words directly taught with more variability with words not directly taught. It should also be noted that findings from the screening measures indicated much lower performance for the one participant that did not perform similarly to the others. Across both dependent measures, there was a neutral trend during the intervention phase of higher performance compared to baseline for four of the five participants. These findings suggest that when difficult words are targeted and explicitly taught to students, their performance in completing the task almost doubles. Even more compelling is evidence that the particular skill being instructed did in general transfer to words not directly taught. In other words, the adaptations to the word study program used by the school district appear to have improved performance for all participants.

We expected the procedural integrity to be above 90% during the sessions. The lower score of 82% still indicates that overall the instructional routines were followed the majority of the time. The lower score may be reflective of the flexibility that was emphasized during the training. Because of the heterogeneity and behavioral issues that are often typical of students with ASD, we wanted to make sure that the tutor felt empowered with a certain level of flexibility to address the uniqueness of each student.

Limitations and Implications for Research

There are several limitations to be considered when interpreting the results of this study. First, the tutor was very experienced with both the word study program that was adapted and with working students with ASD. The rapport between the students and the tutor may have resulted in higher outcomes and may also explain why little to no behavior management issues were reported. Future studies should consider use of school-based personnel including paraprofessionals that would likely be utilized for providing one to one interventions. Second, the length of the intervention was short considering the severity of students' word reading difficulties. To overcome standard scores that are on average 2.0 SD below the normative sample on the TOWRE, students would most likely need intensive interventions of 80 sessions or more (Wanzek et al., 2013). An intervention with longer duration should also consider adding more distal outcomes measures such as weekly probes and pre/posttest standardized measures. Third, due to time constraints, we were unable to systematically capture social validity data from the students' perspective. While the tutor did report that students appeared to enthusiastically participate, not having a social validity measure limits the external validity of the study. Finally, while we did not have access to assessment data defining the samples with respect to executive functioning variables (e.g., self-regulation, attention, memory), future researchers may want to consider how customizing interventions for students with ASD to align with their basic reading processes or executive functioning needs might influence students word reading outcomes.

Implications for Educational Practice

This study provides evidence for the value of adapting previously developed programs in order to increase the intervention's intensity via smaller group size, lengthening intervention sessions, and developing an individualized instructional scope and sequence based on detailed assessment of previous performance. School personnel should consider these adaptations as an alternative to the use of separate programs that may incidentally cause confusion because of differences in instructional approach and the sequence of skills taught. With systematic and explicit instruction, students with ASD with low word reading skills in the upper grades can improve their word reading ability. Practitioners should keep in mind the intensity necessary to fully remediate word reading deficits and should consider providing more intensive interventions.

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Received: 21 June 2017
Initial Acceptance: 16 August 2017
Final Acceptance: 17 October 2017