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Reading Intervention for Students with ASD in the Middle Grades: An Alternating Treatment Study of Embedded Interests Reading and Expository Text Conditions

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ABSTRACT

Aim: We conducted two separate but related multiple baseline with alternating treatment single-case design studies to investigate the effect of the same reading intervention for students with autism spectrum disorder being implemented under different conditions.

Method: We conducted a researcher-implemented study in a public school (Study 1) and a teacher-implemented study in a specialized private charter school for children with ASD (Study 2). In each study, we compared a typical intervention approach with interest-based text intervention that included reading on each child's interest area. The treatment included systematic vocabulary instruction and main-summarization strategy instruction.

Results: Findings from Study One showed consistent increases in comprehension and vocabulary outcomes compared to baseline. In Study Two the baselines phases were unstable with small differences in mean scores detected for vocabulary during the intervention phase favoring the interest-based treatment for three of four participants.

Conclusion: The results across studies were mixed indicating the importance of taking into account contextual factors including student characteristics and learning environment.

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Autism; reading comprehension; vocabulary; interest.

Introduction

Concerns regarding the lack of effective evidence-based reading interventions to address the diverse needs of children with Autism spectrum disorder (ASD) have been recognized by teachers, parents, and researchers for several decades.¹ Reports indicate that students with ASD have slower rates of progress with developing reading proficiency compared to students with learning disability.² The significant difficulties in socialization and restricted interests are characteristics of ASD³ and often provide additional challenges to reading instruction. It is important that researchers continue to investigate reading interventions specifically for children with ASD to address the unique and heterogeneous needs identified in recent reader profile studies.⁴⁻¹⁰

Globally, the prevalence rates of ASD has been estimated to equate to 7.6 per 1000 or one in 132 persons.¹¹ In the United States, the prevalence rates of ASD continue to increase dramatically (1 in 88 children in 2008, 1 in 68 in 2014, and 1 in 54 in 2016, according to the Centers for Disease Control).¹² With the recent clarification regarding the Free and Appropriate Education (FAPE) clause, school personnel are now required to provide educational services to promote growth of IEP goals and objectives rather than the previous standard of “de minimis.”¹³ In light of this, there is a need for researchers to develop and validate reading interventions to specifically meet

the needs of children with ASD. Further, advocates for children with ASD suggest that improving academic performance may be just as important as social skill development.¹⁴

Reading Intervention Research and ASD

Systematic reviews of reading interventions for students with ASD conducted over the last 15 years have contributed to the understanding and efficacy of particular instructional approaches.¹⁵⁻²¹ Within this literature base, we located six single-case design studies indicating improvements with vocabulary²²⁻²⁶ and seven studies indicating improvements with reading comprehension including questioning strategies and main-idea summarization instruction.²⁷⁻³³ These studies show that when targeted vocabulary and reading interventions are provided, students with ASD show improvements in performance. See Table 1 for a summary of the empirical underpinnings.

Studies of Embedding Interest of Individuals with ASD

The characteristics of ASD are described as deficits in pragmatic language and often with repetitive or restricted behaviors and interests.³ For students with ASD, these interests may be different than those of neurotypical peers,³³ and may be a source of interference with developing pivotal skills.³⁴

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Table 1. Empirical underpinnings.

Instructional Target (Authors)	Study Design	N	Measures	Outcomes ^a	Implementer (group size)
Vocabulary					
Dugan et al., 1995	SCD – ABAB design	2	Pre-posttest of items learned	Mean knowledge scores increased 39%	Paraprofessional (1:1)
Grindle et al., 2013	SCD – pre-post design	3	Pre-posttest of WRAPS	Mean knowledge scores improved 47.5%	ABA tutor (1:1)
Kamps et al., 1995	SCD- reversal design	3	Pre-posttest – vocabulary	Mean academic gains scores improved 23.6%	Peer tutor (1:1)
Williamson et al., 2014	SCD – multiple baseline	3	Inferential knowledge	Mean knowledge scores increased 39.3%	Sped teacher (1:3)
Reading comprehension					
Bethune & Wood, 2013	SCD – multiple baseline	3	Literal and inferential questions	Mean scores on questions increased by 96%	Researcher (1:1)
Howorth et al., 2016	SCD – multiple baseline	4	Literal, inferential, and main idea questions	Mean scores on questions increased ^a by 20%	Sped teacher (1:1)
Knight et al., 2014 ^b	SCD – multiple probe	4	Comprehension questions, Vocabulary CBMs	Means scores on comprehension questions increased by 32%. Mean vocabulary scores improved by 43.4%	Researcher (1:1)
Reutebuch et al., 2015	SCD – multiple baseline	3	Comprehension questions	Mean scores on comprehension questions increased by 14%	Peer tutor (1:1)
Solis et al., 2016b	SCD – alternating treatment	2	Question development CBMs	Mean scores on question development CBMs increased by 26%	Researcher (1:1)
Solis et al., 2019 ^b	SCD – simultaneous replication	5	Vocabulary CBMs, Main idea CBMs	Mean vocabulary scores improved 23.5%, Mean main idea scores improved 23.7%	Sped teacher (1:3)
Whalon & Hanline, 2008	SCD – multiple baseline	3	Question generation and response	Mean question generation PND = 78%, Mean response PND = 80.3%	Researcher (1:1)

CBMs = Curriculum-based measurement, PND = percent nonoverlapping data, SCD = single case design, WRAPS = Word Recognition and Phonics Skills Test
^aPercent increase scores = grand mean final treatment score minus grand mean baseline score divided by points possible. ^bOutcomes in vocabulary and reading comprehension

However, to promote interest in low-preferred or difficult tasks, the integration of the interest of students with ASD embedded within curriculum and instructional activities³⁵ supports a strength-based approach to intervention.³⁶

Harrop and colleagues³⁷ conducted a systematic review of the use of circumscribed interests within interventions used for individuals with ASD. Circumscribed interests were defined as subcategory of restricted and repetitive behaviors characterized with intense and focused interest on a narrow topic. Studies were included that investigated dependent variables of behavior, social interaction, social skill development, and academic performance. Of the 31 studies included, 18 focused on participant samples of children in grades K-12 with only two studies focused on dependent variables associated with reading comprehension.^{27,38}

Similarly, Ninci and colleagues³⁶ conducted a meta-analytic review of 20 single-case design studies of interventions that embedded interests of individuals with ASD within the treatment. The dependent variables of social communication behaviors, targeted task-engagement, and targeted positive affect we included. Ninci and colleagues³⁶ reported mixed findings with only some of the studies showing benefits to students with ASD. From this meta-analytic review and our own search of the literature, we located three studies of reading interventions with the use of embedded interests as part of the treatment.^{27,38}

Solis et al.,²⁷ employed a single-case alternating treatment pilot study with a second grader with ASD. An interest-based reading treatment was compared to a non-interest reading treatment on the dependent variables (DVs) of comprehension questions and retell. The accuracy of responding improved during the interest-based treatment when compared to the non-interest treatment. With both DVs the initial performance

was higher with the interest-based treatment and was generally maintained at the same level over the 22 sessions. With the comprehension questions DV the non-interest treatment was initially low with a moderate upward trend. With the retell DV the non-interest treatment was initially lower than the interest-based treatment and remained so throughout with a high degree of variability.

In a dissertation study³⁸ reported on a replication and extension of the Author et al.²⁷ alternating treatments pilot study. This study examined this approach with two high school students with ASD. The retell DV for the first participant showed an initial downward trend for both treatments followed by a strong upward trend and stabilization of scores for both treatments. For the second participant the retell DV was highly variable for both treatments with no discernable pattern of performance. Results for participant one on the comprehension questions DV showed and moderate upward trend and consistently higher performance with the interest-based treatment compared to the non-interest treatment for participant one. Findings for participant two showed a slight downward trend for both treatments. In summary, findings from this study were mixed and similar to conclusions drawn from across this literature base.³⁶

Taking a slightly different approach, Author et al.²⁷ conducted two alternating treatment studies with embedded interests as a subcomponent of techniques of applied behavior analysis (ABA) plus reading comprehension treatment compared to reading comprehension only treatment. Study one compared a question development only treatment to a question development plus techniques of ABA for two participants with ASD in grade 5. For both participants the initial performance with the questions development plus ABA

treatment was much higher than the question development only treatment and was maintained for the remainder of the sessions. The question development only treatment was initially lower with a moderate upward trend over the course of the sessions.

In study two an anaphoric cueing plus ABA treatment was compared to an anaphoric cueing only treatment for two participants with ASD in grades 3. Consistent with findings from study one, the anaphoric cueing plus ABA treatment was initially higher compared to the anaphoric cueing only treatment. The anaphoric cueing only treatment findings were mixed across participants. One participant had variable performance that was stable within a certain range. The anaphoric cueing only treatment for the second participant showed stable performance with an upward trend toward the end of the treatment. In summary, findings across these three alternating treatment studies indicated a pattern of students initially performing higher with interest-based interventions and also with upward trends over time of the non-interest treatment conditions.^{27,38}

Rational and Purpose

The findings regarding the use of an embedded interest as component of reading intervention for students with ASD shows mixed results with some initial promise. The studies to date employed an alternating treatment design without establishing baselines phases as part of experimental control. Under consideration of the mixed findings of using embedded interests,³⁶ we set out to further investigate this approach of embedded interest with reading intervention to better understand for whom and under what conditions this approach might be efficacious.

We replicated two separate studies to evaluate the overall and relative effects of the same alternating treatments (interest-based reading and expository reading) under two different conditions: researcher-implemented public-school setting (Study 1), teacher-implemented in a specialized school (Study 2). The purpose of Study 1 was to compare an expository text condition to an interest-based text condition with a vocabulary and main idea intervention with researchers delivering the treatment in a public-school setting. The purpose of Study 2 was to compare an expository text condition to an interest-based text condition with a vocabulary and main idea intervention with teachers delivering the treatment in a specialized charter school setting. Our aims for both studies were (1) to compare the combined treatments to baseline performance, and (2) to further contribute to the understanding of whether an embedded interest-based text condition may enhance meeting the instructional needs of students with ASD compared to the expository text or non-preferred reading.

We hypothesized that the most effective intervention initially would be the interest-based treatment and that performance would increase over time with the expository treatment. The studies addressed the following research questions: Research Question 1: Does vocabulary and main idea reading intervention for interest-based and expository text conditions result in improved performance of curriculum-based measures (CBMs) for students with ASD compared to

baseline performance with comprehension outcomes? Research Question 2: Does vocabulary and main idea reading intervention with an interest-based text condition result in improved performance of curriculum-based measures (CBMs) for students with ASD compared to an expository text condition with comprehension outcomes? Research Question 3: Does vocabulary and main idea reading intervention for interest-based and expository text conditions result in improved performance of curriculum-based measures (CBMs) for students with ASD compared to baseline performance with vocabulary outcomes? Research Question 4: Does vocabulary and main idea reading intervention with an interest-based text condition result in improved performance of curriculum-based measures (CBMs) for students with ASD compared to an expository text condition with vocabulary outcomes?

General Method

In these two single-case design studies, we employed a concurrent multiple baseline with alternating treatments design to investigate the effect of a vocabulary and main idea-summarization intervention for students with ASD across different text types and under different conditions. In both studies we compared an interest-based text condition to an expository text condition. We established baselines and compared the relative effects of the alternating treatments (interest-based text compared to expository text) and the overall effects to baseline. The alternating treatments were randomly selected over four session cycles. The 30–40 min sessions took place 4 to 5 times per week.

Participants

Participants met criteria for participation if they met the following criterion: (1) student is in grade 4 through 8, (2) student has a school diagnosis of Autism Spectrum Disorder (ASD), (3) student demonstrates average cognitive functioning, and (4) student received a failing score on the state-administered language arts assessment or the student is receiving an Individualized Education Plan (IEP) objective related to reading. Exclusion criteria included the following: (a) not English proficient or English learner in a newcomer program, (b) visual impairment/blindness or hearing impairment as a disability category in the IEP, and (c) primary mode of communication other than speech. Parent consent and student assent forms were collected for all participants as approved by the Institutional Review Board of the designated universities.

Measures

Descriptive Measures

Students were initially assessed with three standardized measures as part of the screening process and before baseline data collection began. We used the data from these measures to begin the laborious process of putting together the interest-based text materials to align with the expository text condition. All assessments were individually administered during a one-

hour block or spread out in smaller blocks of time as indicated as an adaptation on their individualized education plan.

Gilliam Childhood Autism Rating Scale, Second Edition.³⁹ GARS-2 is a standardized assessment, divided into three subscales, used to assess individuals who have severe behavioral problems that might be indicative of ASD. The subscales describe specific, observable, and measurable behaviors related to stereotyped behaviors, communication, and social interaction. The internal consistency reliability coefficients of each subscale range from 0.84 to 0.88 and 0.94 for the total test.³⁹

Kaufman Brief Intelligence Test, 2nd Edition – Verbal Subtest (KBIT-2).⁴⁰ The KBIT-2 is a measure of verbal and nonverbal intelligence; it assesses participant's word knowledge, range of general information, and ability to solve new problems. The internal-consistency reliability for verbal knowledge weighted mean is 0.87 and 0.88 weighted mean for the nonverbal score.⁴¹

Woodcock–Johnson III Tests of Achievement Form C/Brief Battery, Broad Reading Cluster (WJ III Form C/Brief Battery).⁴⁰ The WJ III Form C/Brief Battery, Broad Reading cluster includes three tests: Letter-Word Identification, Passage Comprehension, and Reading Fluency. The three tests provide a measure of reading decoding, ability to comprehend connected text, and reading rate. The median reliability is 0.92 for the 5 to 19 age range.⁴²

Dependent Measures

Researcher-developed vocabulary and reading curriculum-based measures (CBMs) were used to assess student performance. The CBM was based on six questions, two points each, providing a total of 12 possible points. The vocabulary CBMs included three questions: 1) what does [the word] mean? 2) what is another word for [the word]?, and 3) tell me a sentence using [the word] to assess understanding of the target word. The reading CBMs included three questions: (1) what was the most important who or what in this passage?, (2) what is the most important idea about that who or what?, and (3) tell me the main idea about this reading. The reading CBM data guided the researchers' decision-making of phase changes from baseline and intervention.

Students answered the questions orally, the instructor recorded participant responses and scored responses based on a 3-point scale (0–2). Example responses were created to aid in scoring. Scores were assigned based on the following criterion: (0) no response or response that is not associated with text, (1) the response is partially correct, or (2) the response is fully correct. The readability level and passage content aligned with the alternating treatments by utilizing text outside of the passages used for instruction.

Instructional Materials

Reading Passages

QuickReads passages,⁴³ which contains six different readability levels of were used for the expository text condition. The pre-identified readability levels were determined from scores on the WJ-LWID subtest by matching grade equivalent readability

scores of each participant with equivalent difficulty level of the expository text passages. All materials were prepared well in advance of conducting the study, mitigating the opportunity to make shifts with materials based on response. Passages were within each student's established Lexile range and equivalent in word count (e.g., 70–150 words/passage).

Interest-based reading passages were located and adapted based on each student's identified interest area. A 10-question interest survey was developed to identify a focus of content for the interest-based condition. Students were asked these questions in an interview format and included questions such as "what kinds of stories are the most fun to read in class?," "during my free time, I like to?," "my favorite thing to talk about is?," "as a reward I like to?" The answers from the questions were used to derive the strongest interest area based on the number of times it appeared in the student's answers and was also verified by case managers as a known topic of interest. The same topic was used for the passages throughout the intervention. The topics identified by the participants included the following: space exploration, animals (i.e., cats), super heroes, dragons, funny stories, fashion, video games, and history. The interest-based text passages were created to be equivalent to the *QuickReads*⁴³ passages; equivalence was established based on the passage word count (e.g., 130–150 words), sentence length and Lexile level. The Lexile Framework for Reading (www.Lexile.com) analyzes text to provide a measure of reading ability and text complexity.

Vocabulary

Researchers chose one word from the interest-based text and one from the expository text condition to be used during vocabulary instruction. The selection of vocabulary words included high-utility words that appear across a variety of academic domains. We chose these words by following the guidelines for identifying Tier 2 words developed by Beck and colleagues.⁴⁴ Vocabulary instructional sheets were developed for each target word which included a simplified definition, a visual representation of the word, synonyms, an example sentence with the target vocabulary word from the passage, and 2 discussion questions.

Description of Intervention

Vocabulary Component

A detailed procedure was provided in lesson plans developed by the research team. The vocabulary component included instructional materials of one target word from the passage. The instructor introduced the vocabulary word and reviewed the definition visual representation, and synonyms with the student. The participant read the example sentence using the vocabulary word, and the instructor and participant reviewed two discussion questions to spark relevant background knowledge of the target vocabulary word. Following vocabulary instruction, the instructor provided main idea summarization instruction using either the interest-based reading or expository text reading.

Expository Text and Interest-based Text Reading Component

During intervention, the intervention materials were randomly alternated for every 4 sessions between expository text using

QuickReads passages and researcher created interest-based passages. The instructor used a scaffolded reading of the text approach to guide the participant in identification of the most important who or what and the most important idea about that who or what in the passage. Followed by generation of a main idea statement of 10–15 words that summarize the passage.

Using a think aloud strategy, the instructor modeled how to identify (1) the most important who or what, (2) the most important idea about that who or what, and (3) generating a main idea statement. The student is then prompted to use the same strategy with the instructor's support to generate a main idea statement. Throughout this step, the instructor provides scaffolded support such as directing the student to re-read specific portions of the passage. Following two instructional lessons of the reading component, the instructor used a third passage or third paragraph from the passage to measure the participant's reading comprehension using the CBM.

Procedures

Baseline

During the baseline phase, each student read a passage that aligned with the expository text treatment with the pre-identified readability level for each student. For each baseline passage a target vocabulary word was identified using the same procedure for identifying words for intervention. After reading the passage, the teacher read aloud the question prompts, recorded student answer, and scored their response. CBM administration took 5–10 minutes to complete.

Intervention

During intervention, each participant worked one-on-one with the instructor. Intervention began with a vocabulary instruction, followed by an expository text or interest-based text reading utilizing the same instructional procedures, and administration of daily data collection using the CBMs. Intervention sessions occurred 4–5 times per week for 30–40 minutes. Students received between 19 and 26 intervention sessions.

Tutor Training

The tutors completed one full day of training with senior researchers located at both sites. Training included an overview of the study, delivery of the intervention and use of materials. The tutors also completed administration reliability with the senior researchers at both sites serving the gold standard.

Interobserver Agreement

In a preceding pilot study, we used a similar dependent measure. After conducting all the baseline and intervention sessions, we calculated interobserver agreement by randomly selecting 30% of the data points within each phase, as recommended by Kratochwill and colleagues.⁴⁵ The interobserver agreement score for the pilot study was 77%, which is below the typically acceptable minimum standard of 80%.

To address this issue in the current study, we conducted interobserver agreement of dependent measures daily for 100% of the baseline and intervention sessions by having two

researchers independently score and compare their interscorer agreement. A second observer used the audio recorded sessions to re-score the CBMs and scores were compared from scores assigned by the interventionist. Prior to starting interobserver agreement data collection, the two researchers, who also served as instructional coaches, developed and refined the rubric for determining accuracy of student responses. Reliability training included scoring example student responses and discussing discrepancies to establish acceptable definitions of no credit (0 points), partial credit (1 point), or full credit (2 points). All discrepancies in scores were resolved and agreement obtained through daily discussion between scorers. All of the CBMs were independently scored by two independent coders. Item-by-item scores were calculated daily by taking the total number of agreements divided by total number of agreements and disagreements and multiplied by 100.

Fidelity of Implementation

All sessions were audio recorded to measure fidelity of intervention implementation and interobserver agreement of the dependent measure. Intervention sessions included an alternating treatment design with expository and interest-based text materials. From the total number of sessions, 30% from both text conditions during intervention were randomly selected from each phase and coded by a researcher using an Implementation Validity Checklist (IVC). The had 13 items outlining the instructional procedures that were expected to be present. Global quality indicators were also scored for instructional quality.

Data Analysis

Visual analysis of the data was used to examine the extent of significant changes in vocabulary knowledge and main idea summarization across phases. The level, trend, variability, immediacy of the effect, overlap and consistency of data patterns across similar phases will be examined to assess the effects of the intervention compared to baseline performance.^{45,46} We also calculated the means and ranges across phases for each participant. The mean scores were calculated and reported to the tenth place by rounding from the hundredths place (i.e., scores < .05 round the tenth place down).

Study One

Method

Study 1 compared an interest-based text treatment to an expository text treatment with the intervention being delivered by a researcher in a public-school setting.

Setting and Participants

The study took place in urban school district in the southwest United States. Participants were recruited from an elementary campus in an urban area. The district enrollment of 46,000 students are predominately Hispanic (98.57%), economically disadvantaged (95.74%), and at risk (66.84%). Intervention sessions were conducted 1:1 by research personnel in a conference room with no other students present.

Instructor. Instruction was provided by a tutor hired, trained, and supervised by a senior member of the research team. The senior member of the research team completed daily interobserver agreement coding with the tutor and was present for all tutoring sessions.

Participants. Based on the student selection criteria, district personnel identified three Hispanic males with ASD in grade 4 who participated in the study. See Table 2 for a summary of participant demographics and Table 3 for summary of performance on standardized descriptive measures.

Interobserver Agreement

Interobserver agreement data were collected on 100% of all sessions on a daily basis. A senior researcher used the audio recorded sessions to re-score the CBMs and scores were compared from scores assigned by the researcher serving as the interventionist. The mean agreement across observers was 98.6% for item by item analysis.

Fidelity of Implementation

A senior researcher and a graduate research assistant with knowledge of the treatments coded 30% of the audios with an implementation validity checklist (IVC) from each phase for both conditions. Interrater reliability was established by researchers independently coding audios and comparing answers to resolve any discrepancies for three audios. Utilizing the gold standard sheet,⁴⁷ reliability scores were 92% for the first two audios and 100% was for the third audio. The IVC had six items for vocabulary and six items for reading comprehension. The vocabulary items included the following: (a) presented the vocabulary word, (b) presented the definition, (c) discussed the visual, (d) presented synonyms, (e) reviewed the sentence, (f) asked the discussion questions. The reading items included the following: (a) text reading occurred, (b) one or more instructional scaffolds provided, (c) main idea question asked, (d) second text reading occurred, (e) one or more instructional scaffolds provided, (f) main idea question asked. Utilizing a point-by-point method coders scored each item as being present or not. The items were aligned with the instructional procedures. The overall adherence to treatment across both teachers was 94% for the sessions coded.

Table 2. Study one participant demographics.

Participant	Age (years)	Grade	Race/ethnicity	IEP
Nesto	9.9	4	Hispanic	ASD
Eduardo	10	4	Hispanic	ASD
Gil	9	4	Hispanic	ASD

IEP = individualized education plan; ASD = autism spectrum disorder

Table 3. Study one standardized descriptive measures.

Participant	KBIT verbal ^a	GARS-3	WJ-III LWID ^a	WJ-III PC ^a	WJ-III RF ^a
Nesto	56	75	97	68	80
Eduardo	45	69	91	76	90
Gil	56	108	103	73	76

KBIT = Kaufman Brief Intelligence Test; GARS-3 = Gilliam Autism Rating Scale, Third Edition; WJ-III LWID = Woodcock-Johnson III Letter Word Identification; PC = Passage Comprehension; RF = Reading Fluency; ^aReported as standard scores. ^bReported as Autism index scores.

Table 4. Study one implementation fidelity.

Student	Vocabulary instruction ^a	Comprehension instruction ^a	Instructional quality ^b
Nesto	86%	100%	3.00
Eduardo	84%	100%	3.00
Gil	88%	100%	3.00

^aImplementation validity checklist percent correct. ^bScale from 1 to 5 with 3 representing average quality.

The instructional quality score was a combination of the overall percent score from the IVC averaged with a coder score of quality. Coders used the following guidelines to determine the coder score of quality: score of 5 (excellent) = exceeded the expectation with engaging, individualized instruction with no feedback necessary for improvement, 4 (high average) = most of the teaching was excellent but still a few areas of improvement with some feedback need, 3 (medium average) = the instructional procedures were implemented with little effort to engage or individualize instruction with feedback needed, 2 (below average) = instructional procedures were missing with feedback needed. See Table 4 for a summary of fidelity of implementation for each participant.

Results: Study One

Comprehension Outcomes

Figure 1 displays the comprehension scores during Experiment 1 for Nesto (top panel), Eduardo (middle panel), and Gil (bottom panel) the *interest-based* and *expository* conditions across the baseline and intervention phases. Nesto exhibited zero correct responses during all four sessions during the baseline phase. During the intervention phase, Nesto's scores improved with both treatments ($M = 2.5$; range = 0–6) compared to baseline (see Table 5). His scores improved during both the interest-based ($M = 2.2$; range = 0–4) and expository ($M = 3.0$; range = 2–6) conditions. No consistent differentiation between Nesto's scores in the interest-based and expository conditions was observed (see Table 6).

Eduardo's scores during baseline were relatively low and stable ($M = 2.3$; range = 2–3) with slight increase with both treatments ($M = 2.7$; range = 0–6) compared to baseline (see Table 5). Following the initiation of the intervention phase, Eduardo's scores were low initially but they increased with a steady and consistent upward trend during the course of intervention in both the interest-based ($M = 3$; range = 0–6) and expository ($M = 2.6$; range = 0–6) conditions. Some overlap was observed between the data paths in baseline and intervention initially with differentiation in the data eventually emerging with higher scores observed during the respective intervention conditions. Similar to Nesto's results, no consistent differentiation between Eduardo's scores in the interest-based and expository conditions was observed (see Table 6).

Gil exhibited scores of zero during 11 of 13 baseline sessions and scores of 2 during the other two sessions ($M = 0.3$; range = 0–2). His scores increased for both treatments compared to baseline ($M = 2.5$; range = 0–6) (see Table 5). Following the initiation of the intervention phase, Gil's scores were low initially during the expository condition with scores

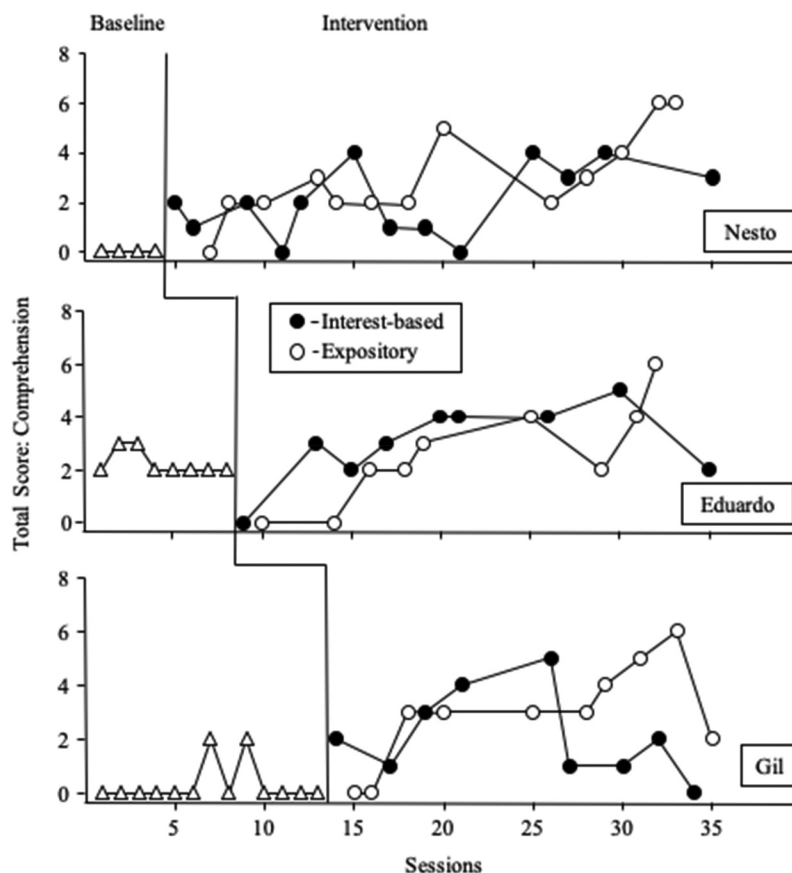


Figure 1. Study one total scores on comprehension outcomes.

Table 5. Study one combined reading comprehension and vocabulary mean scores and ranges for accuracy of students responding to curriculum-based measures.

Participant	Measure	Baseline <i>M</i> (R)	Intervention <i>M</i> (R)
Nesto	Comprehension	0.0 (0–0)	2.5 (0–6)
	Vocabulary	0.3 (0–1)	3.1 (0–6)
Eduardo	Comprehension	2.3 (2–3)	2.7 (0–6)
	Vocabulary	0.5 (0–2)	4.3 (0–6)
Gil	Comprehension	0.3 (0–2)	2.5 (0–6)
	Vocabulary	2.0 (0–6)	3.8 (0–6)

M = mean; *R* = range.

Table 6. Study one comparisons of expository and interest-based conditions on reading comprehension and vocabulary mean scores and ranges for accuracy of students responding to curriculum-based measure.

Participant	Measure	Interest-based <i>M</i> (R)	Expository <i>M</i> (R)
Nesto	Comprehension	2.1 (0–4)	3.0 (0–6)
	Vocabulary	2.9 (0–6)	3.6 (0–6)
Eduardo	Comprehension	3.0 (0–5)	2.6 (0–6)
	Vocabulary	4.0 (2–6)	4.8 (2–6)
Gil	Comprehension	2.1 (0–5)	2.9 (0–6)
	Vocabulary	3.8 (2–6)	3.9 (0–6)

M = mean; *R* = range.

of zero in the first two sessions. They remained low in the first two sessions of the interest-based condition (i.e., scores of 2 and 1, respectively, during sessions 14 and 16). Subsequently, Gil's scores increased in the interest-based and expository conditions with little differentiation observed between the two conditions until the final nine sessions of the intervention

phase; scores during the final five sessions in the expository condition were clearly higher than the final four sessions of the interest-based condition (see Table 6). Overall scores in the interest-based ($M = 2.1$; range = 0–5) and expository ($M = 2.9$; range = 0–6) were higher than those observed during baseline.

Vocabulary Outcomes

Figure 2 displays the vocabulary scores during Experiment 1 for Nesto (top panel), Eduardo (middle panel), and Gil (bottom panel) during the *interest-based* and *expository* conditions across the baseline and intervention phases. Nesto exhibited zero or near-zero correct responses during all four sessions during the baseline phase ($M = 0.3$; range = 0–1). During the intervention phase, Nesto's scores improved with both treatments ($M = 3.3$; range = 0–6) compared to baseline (see Table 5). His scores improved during both the interest-based ($M = 2.9$; range = 0–6) and expository ($M = 3.6$; range = 2–6) conditions (see Table 6). No consistent differentiation between Nesto's scores in the interest-based and expository conditions was observed.

Eduardo's scores during baseline were also relatively low and stable ($M = 0.5$; range = 0–2) with some variability. His scores with both treatments increased ($M = 4.4$; range = 0–6) compared to baseline (see Table 5). Following the initiation of the intervention phase, Eduardo's immediately increased above baseline levels, continued on an upward trend through the

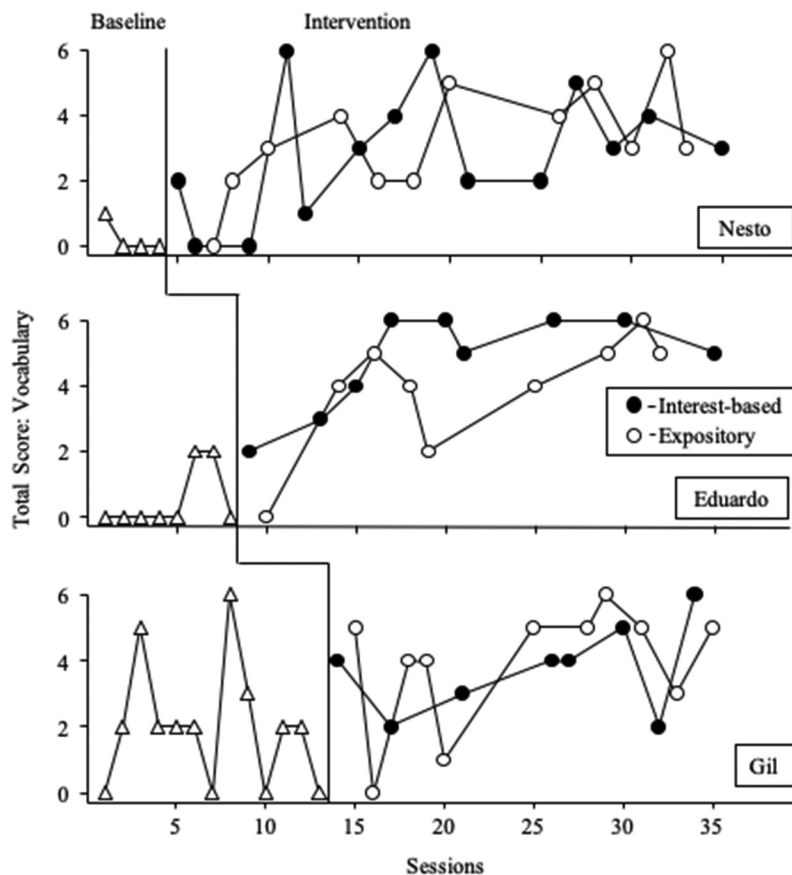


Figure 2. Study one total scores on vocabulary outcomes.

course of the phase, and remained elevated in both the interest-based ($M = 4.8$; range = 2–6) and expository ($M = 4.0$; range = 0–6) conditions with minimal overlap with baseline (see Table 6). Some differentiation appeared in the data between the interest-based and expository conditions but it was temporary as the two data paths converged toward the end of the intervention phase.

Gil exhibited inconsistent scores during baseline that ranged from low to relatively high during the course of the phase ($M = 2$; range = 0–6). Following the initiation of the intervention phase, Gil's scores increased immediately with some variability before increasing to relatively high and stable levels during the course of the phase in both treatments ($M = 3.8$; range = 0–6) (see Table 5). Differentiation in scores was not observed between the interest-based ($M = 3.8$; range = 2–6) and expository ($M = 3.9$; range = 0–6) conditions (see Table 6).

Table 7. Study two participant demographics.

Participant	Age (years)	Grade	Race/ethnicity	IEP
Ivan	10	4	Hispanic	ASD
Hector	9.8	4	White	ASD
Adam	10.6	4	Hispanic	ASD
Ben	9.1	4	Native American	ASD

IEP = individualized education plan; ASD = autism spectrum disorder

Study Two

Method

Study Two compared an interest-based text condition to an expository text condition with the intervention being delivered by teachers in a private educational therapy center.

Participants and Setting

Study Two took place in a private educational therapy center and school district in the western United States. Participants were recruited from the suburban elementary school campus. The district serves 23 students in grades K-8. Schoolwide demographic data were not available.

Instructors. Instruction was provided by four teachers employed by educational therapy center. The instructors all had training as behavior technicians and were overseen by a Board-Certified Behavior Analyst (BCBA) credentialed staff person. Teachers completed daily interobserver agreement coding with each other for all tutoring sessions. All intervention sessions were conducted 1:1 in a conference room with no other students present. A researcher was present as needed during sessions to provide the instructor feedback and support.

Participants. Based on the student selection criteria, district personnel identified two Hispanic males, one Native American, and one White student with ASD ($N = 4$) in grade 4 participated in the study. See Table 7 for a summary of participant

Table 8. Study two standardized descriptive measures.

Participant	KBIT verbal ^a	GARS-3 ^b	WJ-III LWID ^a	WJ-III PC ^a	WJ-III RF ^a
Ivan	81	92	82	76	71
Hector	110	105	100	91	111
Adam	93	108	88	91	97
Ben	102	77	101	97	111

KBIT = Kaufman Brief Intelligence Test; GARS-3 = Gilliam Autism Rating Scale, Third Edition; WJ-III LWID = Woodcock-Johnson III Letter Word Identification; PC = Passage Comprehension; RF = Reading Fluency; ^aReported as standard scores. ^bReported as Autism index scores.

demographics and Table 8 for summary of performance on standardized descriptive measures.

Table 9. Study two implementation fidelity.

Teacher	Vocabulary instruction ^a	Comprehension instruction ^a	Instructional quality ^b
Ivan	NR	NR	NR
Hector	40%	100%	3.38
Adam	90%	100%	4.42
Ben	100%	100%	4.35

NR = not reported. ^aImplementation validity checklist percent correct. ^bScale from 1 to 5 with 3 being average quality.

Interobserver Agreement

Interobserver agreement data were collected on 100% of all sessions on a daily basis. The teachers who participated in the study were paired up to double score the CBMs from audio recordings of the sessions. The mean agreement across observers was 84.2% for item by item analysis.

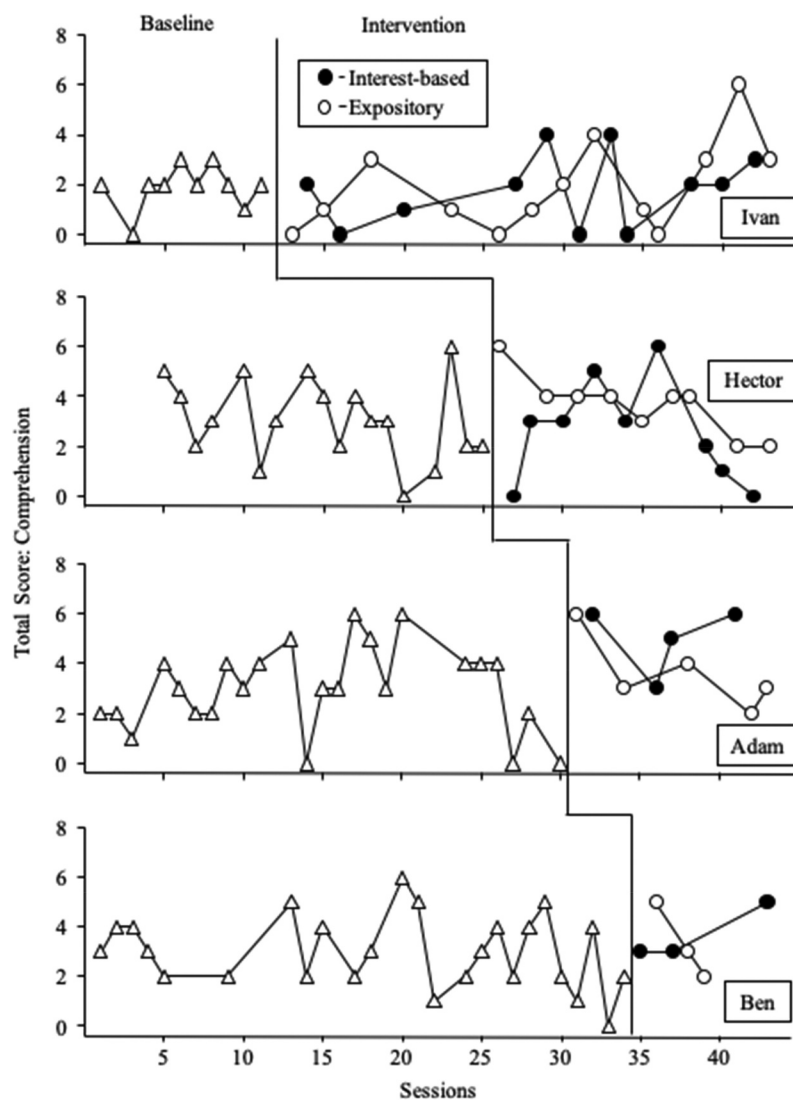
Fidelity of Implementation

Two graduate research assistance double scored a total of 30% of the sessions from audio recordings. At the end of the study, the audio files were corrupted for one participant and we were unable to retrieve the data. To compensate, we scored additional audio from the other participants to capture 30%. The overall adherence to treatment across both teachers was 90% for the sessions coded. See Table 9 for a summary of fidelity of implementation for each participant.

Results: Study Two

Comprehension Outcomes

Figure 3 displays the comprehension scores during Experiment 2 for Ivan (top panel), Hector (second panel),

**Figure 3.** Study two total scores on comprehension outcomes.

Adam (third panel), and Ben (bottom panel) the *interest-based* and *expository* conditions across the baseline and intervention phases. Ivan exhibited relatively low and stable scores during baseline ($M = 1.9$; range = 0–3). During the intervention phase, Ivan's scores occurred within the same range for both treatments ($M = 1.9$; range = 0–6) (see Table 10) as those observed during baseline with some the exception of some sessions toward the end of the intervention phase in both the interest-based ($M = 1.8$; range = 0–4) and expository ($M = 1.9$; range = 0–6) conditions. No consistent differentiation between Ivan's scores in the interest-based and expository conditions was observed (see Table 11).

Hector exhibited somewhat inconsistent scores during baseline that ranged from low to relatively high during the course of the phase ($M = 3.1$; range = 0–6). For both treatments ($M = 2.6$; range = 0–6) (see Table 10), Hector's scores continued to occur similarly to those observed during baseline during both the interest-based ($M = 2.6$; range = 0–6) and expository conditions ($M = 3.7$; range = 2–6) (see Table 11). Although Hector's scores during the expository condition were relatively higher than those observed in the interest-based condition, a high amount of overlap was observed between the two conditions.

Similar to Hector, Adam exhibited somewhat inconsistent scores during baseline that ranged from low to relatively high during the course of the phase ($M = 3$; range = 0–6). Following a decrease to zero and near-zero levels during the final three sessions of baseline, the intervention phase was initiated and Adam's scores immediately increased to moderate-to-high levels ($M = 4.22$; range = 2–6) (see Table 10) and remained in that range for the remainder of intervention in both the interest-based ($M = 5$; range = 3–6) and expository conditions ($M = 3.6$; range = 2–6) (see Table 11). There was a high amount of overlap between scores in both intervention conditions relative to baseline; and there was little differentiation between the two

intervention conditions (with the exception of the final 5 sessions in which scores were higher in the interest-based condition).

Similar to Hector and Adam, Ben exhibited scores during baseline that ranged from low to relatively high during the course of the phase ($M = 3$; range = 0–6). Following a relative downward trend during the final 6 sessions of baseline (with a slight upward trend with the last session of the condition), the intervention phase was initiated and Ben's scores immediately increased to moderate levels ($M = 3.5$; range 2–5) (see Table 10) and remained in that range for the remainder of intervention in both the interest-based ($M = 3.7$; range = 3–5) and expository conditions ($M = 3.3$; range = 2–5) (see Table 11). No consistent differentiation between Ben's scores in the interest-based and expository conditions was observed.

Vocabulary Outcomes

Figure 4 displays the vocabulary scores during Study Two for Ivan (top panel), Hector (second panel), Adam (third panel), and Ben (bottom panel) during the *interest-based* and *expository* conditions across the baseline and intervention phases. Ivan's scores during baseline were variable and ranged from low to high ($M = 3.5$; range = 1–6) with a slight increase with both treatments ($M = 3.91$; range = 0–6) (see Table 10). During the intervention phase, Ivan's scores during the interest-based condition ($M = 4.7$; range = 0–6) immediately increased and remained at high levels with the exception of one session (i.e., session 29). Although some overlap was observed in the data, the scores during the interest-based condition were consistently higher than baseline throughout the intervention phase. In contrast, Ivan's scores were low relative to baseline initially during the expository condition. However, scores during the expository condition ($M = 3.2$; range = 0–6) increased during the course of the intervention phase to high levels before decreasing somewhat toward the end of the phase. Some overlap in the scores was observed between the interest-based and expository conditions; however, generally scores were higher in the interest-based condition (see Table 11).

Hector exhibited relatively high scores during baseline ($M = 4.1$; range = 0–6) with a couple of exceptions (i.e., zero scores during sessions 5 and 8). During intervention, Hector's scores for both treatments continued to occur similarly to those observed during baseline ($M = 5.00$; range 0–6) (see Table 10), and also during both the interest-based ($M = 5.4$; range = 4–6) and expository conditions ($M = 4.6$; range = 0–6) (see Table 11). No consistent differentiation between Hector's scores in the interest-based and expository conditions was observed.

Similar to Ivan and Hector, Adam exhibited somewhat inconsistent scores during baseline that ranged from low to relatively high during the course of the phase ($M = 2.8$; range = 0–6) with small increases across both treatments ($M = 3.77$; range = 2–6) (see Table 10). During the intervention phase Adam's scores increased to relatively high levels during the interest-based condition ($M = 4.8$; range = 3–6) and moderate levels during the expository condition ($M = 3$; range = 2–4) (see Table 11); high levels of overlaps were observed between scores during both intervention conditions and baseline. Clear differentiation was observed between the interest-based and

Table 10. Study two combined reading comprehension and vocabulary mean scores and ranges for accuracy of students responding to curriculum-based measures.

Participant	Measure	Baseline M (R)	Intervention M (R)
Ivan	Comprehension	1.9 (0–3)	1.9 (0–6)
	Vocabulary	3.5 (1–6)	3.9 (0–6)
Hector	Comprehension	3.1 (0–6)	2.6 (0–6)
	Vocabulary	4.1 (0–6)	5.0 (0–6)
Adam	Comprehension	3.0 (0–6)	4.2 (2–6)
	Vocabulary	2.8 (0–6)	3.8 (2–6)
Ben	Comprehension	3.0 (0–6)	3.5 (2–5)
	Vocabulary	3.3 (0–6)	4.8 (2–6)

M = mean; R = range.

Table 11. Study two comparisons of expository and interest-based conditions on reading comprehension and vocabulary mean scores and ranges for accuracy of students responding to reading curriculum-based measure.

Participant	Measure	Interest-based M (R)	Expository M (R)
Ivan	Comprehension	1.8 (0–4)	1.9 (0–6)
	Vocabulary	4.7 (0–6)	3.2 (0–6)
Hector	Comprehension	2.6 (0–6)	3.7 (2–6)
	Vocabulary	5.4 (4–6)	4.6 (0–6)
Adam	Comprehension	5.0 (3–6)	3.6 (2–6)
	Vocabulary	4.8 (3–6)	3.0 (2–4)
Ben	Comprehension	3.7 (3–5)	3.3 (2–5)
	Vocabulary	4.3 (2–6)	5.3 (4–6)

M = mean; R = range.

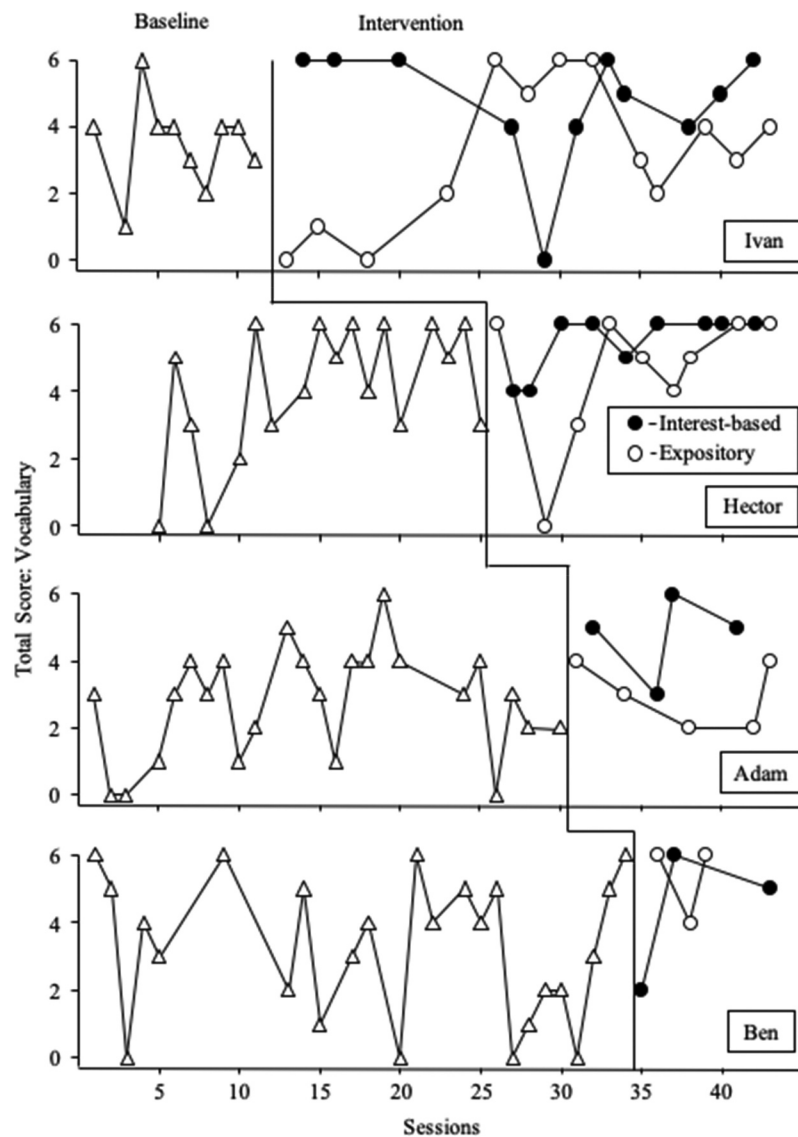


Figure 4. Study two total scores on vocabulary outcomes.

expository condition with scores clearly higher during the interest-based condition.

Similar to Hector, Ben exhibited scores during baseline that ranged from low to relatively high during the course of the phase ($M = 3.3$; range = 0–6) (see Table 10). Following an upward trend during the final 4 sessions of baseline, the intervention phase was initiated and Ben's scores remained high in both the interest-based ($M = 4.3$; range = 2–6), with some variability initially, and expository conditions ($M = 5.3$; range = 4–6) (see Table 11). No consistent differentiation between Ben's scores in the interest-based and expository conditions was observed.

Discussion

The purpose of these two studies was to investigate the use of an embedded interest as part of reading intervention for students with ASD in the middle grades. In Study One the hypothesis of the interest-based treatment having initially

higher scores with the expository treatment having an upward trend over time was confirmed with for two of three participants for comprehension outcomes and for one of three participants for vocabulary. Stable baselines were established with increases in performance during the intervention for both treatments followed by moderate upward trends observed for the dependent variables of reading comprehension for all three participants. Similar patterns of performance as described above also occurred for the dependent variable of vocabulary for two of the three participants. Improved performance with the interest-based treatment compared to expository treatment occurred for one participant with the reading comprehension DV. Overall, there were no discernable differences in performance between the interest-based treatment and the expository treatment for the three participants for either dependent variable.

Despite utilizing the same procedures for materials development and materials being created by the same research team and tutors receiving the same training protocol, in Study Two we were unable to establish stable

baselines limiting experimental control prior to comparing the alternating treatments. The variability was particularly notable with the vocabulary DV and also included a ceiling effect with several of the baseline data points. In Study Two, the hypothesis of the interest-based treatment having initially higher scores with the expository treatment having an upward trend over time was confirmed with only one of the four participants. Increases in reading comprehension compared to baseline occurred for one of the four participants with no discernable difference for the other participants. Increases in vocabulary compared to baseline occurred for two of the four participants with no discernable differences for the other participants. These findings must be interpreted with caution when taking into account the instability of performance during the baseline phases.

In regards to the comparison in performance between the interest-based and expository treatments, there were no discernable differences for the participants in performance with the dependent variable of comprehension. However, three of the four participants performed better during the interest-based treatment compared to the expository treatment with the dependent measure of vocabulary.

The results of these two studies align with the findings from the meta-analytic review of embedded interest interventions by Ninci and colleagues³⁶ that showed mixed findings for the efficacy of this approach. These results also align with findings from reader profile studies of students with ASD which indicate a high degree of variability with reading and related outcomes for students with ASD.^{4-9,11} These studies have informed the field of reading and ASD in regards to the importance of (a) the neurodiversity of students with ASD in both the word reading and linguistic comprehension components of the SVR, (b) the importance of taking into account language, and (c) the evidence suggesting that cognitive phenotype and social communicative factors (i.e., ADOS-2 scores) may inform predictions of reading comprehension for students with ASD.

In light of this, the findings from the descriptive measures may suggest some plausible explanations to contextualize the differences in findings across the two studies. In fact, we see marked differences in KBIT verbal subtest between the two studies with Study One participants having much lower verbal scores than Study Two. This may explain the marked differences in performance, specifically for the vocabulary outcomes. We determined the readability levels of the materials for the study based on the WJ-LWID subtest to control for discrepancies with word reading ability which can cause interference with comprehension. With the exception of one participant the WJ-LWID are within 1.0 standard deviations from the normative average. In addition, there were marked differences for two of the three participants showing much greater levels of symptom severity according to their GARS-3 scores. These factors are representative of the neurodiversity that is typical of the spectrum and provide plausible explanations of confounds that impacted the results.

Differences between Study One and Study Two

The field of intervention research in education is increasingly recognizing the important contributions of study replications which provide opportunities for more nuanced interpretations of the work.⁴⁸ In Study One, we had much more experimental control by only having one interventionist who was hired, trained, and supervised by the senior research personnel. In Study Two we had four interventionists that served as behavior technicians and academic instructors for the study participants. Due to unforeseen logistical problems, fidelity data was not fully available for one participant. With the exception of low fidelity for one participant on vocabulary for Study Two, the levels of fidelity of implementation across the two studies were very similar, however there were marked differences with the IOA scores. The teachers struggled with scoring the measures and when discussing discrepancies would often refer to conversations with the participants that occurred outside of the CBM administration for justification of their answers. The rapport with the instructors may also have contributed to the differences in results across the two studies.

Limitations

This study contributes to the small yet growing body of research of reading interventions for students with ASD. Although some of the findings support the promise of this area of research there are limitations to consider. When assessing an abstract construct such as reading comprehension related outcomes, issues of measurement quality and error will limit the findings. In these studies, we measured student's ability to summarize sections of text. We acknowledge that reading comprehension is a broad multi-dimensional construct that we operationalized narrowly with the discrete skill of identifying main ideas which limits the generalizability of the data. Findings are also limited by a lack of understanding of the strength of the interest-area for each child, the interest being limited to one topic area, and the possibility that students may have lost some interest on the topic over the duration of the study. Despite employing procedures to have adequate leveling of readability across passages, differences in the materials utilized across treatments also limit the findings as does the labor involved in locating and preparing the interest-based materials for instruction. The leveling of readability procedures did not take into account text structures, differences across genres, and the background knowledge necessary to access text.

Implications for Practice and Research

The findings from these studies converge with the recommendations from Ninci and colleagues (2019) that practitioners should approach the use of an embedded interest as part of intervention with caution and understand the findings from research are mixed which is cause for determining appropriateness on a case by case basis. Researchers and practitioners should also take into account the time necessary to locate appropriate interest-based passages and prepare them for instruction. This limits

the generalizability of the interest-based treatment. However, in some instances this may be an appropriate option to consider depending on the individualized IEP goals and objectives and current levels of performance for academics and behavior.

Although the growth was modest, these findings do support the use of a multicomponent intervention at the word and paragraph level. Findings also support the idea of school personnel using data to determine appropriate intervention approach and instructional materials. Future research should take into account the verbal ability of students when considering appropriate readability levels of text. Researchers should consider more targeted approach to vocabulary instruction by pre-identifying unknown words and providing intervention only for unknown words. While the vocabulary and reading comprehension interventions used in these studies have been validated through randomized controlled trials (RCTs) and meta-analytic reviews,⁴⁹ further research is needed to better understand how to remediate reading problems for students with ASD.

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All the authors of this article declare that they have no conflict of interest.

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Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Review Board approvals of the sponsoring institutions.

Informed Consent

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

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