# Elementary Teachers' Intervention Fidelity in Relation to Reading and Vocabulary Outcomes for Students at Risk for Reading-Related Disabilities

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### Abstract

Teachers' implementation of differentiated supplemental instruction is critical to help students with or at risk for readingrelated disabilities acquire early reading and vocabulary skills. This study represents an initial investigation of whether classroom teachers' intervention fidelity (exposure, adherence, and quality) of targeted reading instruction (TRI, formerly called targeted reading intervention), a professional development program with embedded student intervention and weekly webcam literacy coaching support, was related to spring reading and oral vocabulary gains for students at risk for readingrelated disabilities. The study also examined whether teachers' years of participation in TRI (I year vs. 2 years) moderated associations between intervention fidelity and students' reading and oral vocabulary outcomes. Findings suggested that teachers' adherence to TRI strategies was directly associated with students' vocabulary gains as well as word reading skills for teachers in their second year of participation. Furthermore, when teachers provided students with more TRI exposure during their second year of participation, students made greater gains in word reading and reading comprehension.

### **Keywords**

intervention fidelity, professional development, differentiated instruction

General education teachers are frequently expected to learn and deliver supplemental interventions to accelerate students' reading growth (Wanzek et al., 2016), particularly during the early years of elementary school. Highquality reading instruction is critical for young children, whose educational trajectories are tied to learning essential reading skills by the end of third grade (Duncan & Murnane, 2011). Therefore, teachers' instructional efforts are a critical aspect of intervention effectiveness, and some research has demonstrated that students make limited gains when teachers implement interventions with low fidelity (Greenberg et al., 2005). Classroom teachers may find it especially challenging to understand how to provide differentiated instruction and supplemental interventions to help individual students who have or who are at risk for reading-related disabilities (Vaughn & Wanzek, 2014). Understanding relations among key intervention practices, intervention fidelity, and children's early reading outcomes has remained elusive despite decades of research. Measuring specific intervention practices and exploring which practices promote student reading gains is important to understand how and why programs produce effects for individual students (Guo et al., 2016).

This study focused on how kindergarten and first-grade classroom teachers' fidelity to the intervention practices of Targeted Reading Instruction (TRI; formerly called Targeted Reading Intervention) was related to students' reading and vocabulary outcomes. TRI was developed to provide initial and ongoing professional development (PD) support to early elementary classroom teachers, who are often unprepared to provide supplemental differentiated instruction for students who may be at risk for reading-related disabilities (Spear-Swerling & Cheesman, 2012). TRI's one-on-one intervention delivery mechanism, such that teachers use intervention practices with individual selected students, helps teachers learn how to differentiate their reading instruction to benefit these students. Efficacy studies of TRI have demonstrated that students at risk for reading-related disabilities made

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Cheryl Varghese, PhD, Department of Pediatrics, University of Texas Health Science Center at Houston, 7000 Fannin St, Houston, TX 77030, USA. Email: cheryl.a.varghese@uth.tmc.edu significant reading gains across the school year after they participated in one-on-one TRI lessons with their classroom teacher (Vernon-Feagans et al., 2013, 2018; Bratsch-Hines et al., 2020). Prior TRI studies have primarily focused on *if* TRI produced gains for students. In contrast, this study explored associations among treatment teachers' intervention fidelity (exposure, adherence, and quality) and students' reading and vocabulary outcomes, with years of program participation (1 vs 2 years) as a moderator, to begin to unpack *how* TRI produced gains for students.

# Intervention Fidelity and Students' Reading Outcomes

Researchers have studied multiple dimensions of intervention fidelity, with this study focusing on exposure, adherence, and quality of implementation (Hill & Erickson, 2019). Exposure has been defined as the intensity, frequency, and/or duration of implementation (O'Donnell, 2008; Sanetti & Luh, 2020). Adherence has been defined as the extent to which teachers implement the intervention components or steps (Sutherland et al., 2014). Researchers have conceptualized intervention *quality* in a variety of ways (Sanetti et al., 2014), but of particular relevance to this study is the quality of teachers' decoding and comprehension support. In the sections below, we review the limited empirical studies that have examined intervention fidelity of one-on-one or small group reading interventions but note that some of the study contexts occurred in clinical settings and/or resource rooms. Although those study contexts differ from the context of this study (general education classrooms), the mixed findings for associations between each of the intervention fidelity dimensions and students' reading outcomes highlight a need for further research in this area.

### Exposure

Higher intervention exposure has been conceived as an important way to determine how interventions produce reading gains for students (Denton et al., 2010). Teachers who implement an intervention at a higher frequency and/or over a longer duration have been hypothesized to be more effective in helping students gain reading skills (Wanzek & Vaughn, 2008). Studies have widely varied in how much exposure to reading interventions students received (Gersten et al., 2017), and the limited evidence examining exposure in relation to student outcomes has been mixed. In a recent meta-analysis, early elementary students who experienced a longer duration of reading intervention had higher reading outcomes (Wanzek et al., 2018). Yet, some studies have shown significant student reading gains even when class-room teachers provided far less reading intervention

exposure (Vernon-Feagans et al., 2018). For interventions providing less overall exposure (e.g., fewer sessions), the degree to which variation in that exposure is associated with reading gains for students remains unknown.

Adherence. For interventions grounded in research-driven evidence-based practices, teachers who implement the intended elements of the intervention may be more likely to enhance student's reading outcomes (Nelson et al., 2012). That is, when teachers implement effective research-based interventions with a high level of adherence to the core elements, students may be more likely to learn the requisite skills promoted by the intervention (Barnett et al., 2011). Limited work has formally tested the relation between adherence and student outcomes. Of this work, researchers have primarily explored associations between teachers' adherence to curriculum-based instruction or whole-group reading intervention rather than teachers' adherence to differentiated reading interventions (Hamre et al., 2010). More work is needed to understand whether observed adherence to the elements comprising intensive one-on-one reading interventions is associated with outcomes for students at risk for a reading-related disability.

Intervention Quality. Researchers have measured and defined intervention quality in a number of ways, but a primary concept has been how well delivery occurred (Sanetti & Luh, 2020; Sutherland et al., 2014). Measurement of intervention quality has varied, with some studies using observational measures that are specific to the instructional quality of lessons (Fogarty et al., 2014) and other studies using observed global indicators of teacherchild interactions during lessons (Hamre et al., 2010; Wasik & Hindman, 2011). In one-on-one differentiated reading interventions for early elementary students, teachers' abilities to use both decoding and comprehension strategies may be important intervention quality indicators, given prior research that has documented decoding and linguistic comprehension skills as necessary for proficient reading (Cho et al., 2019; Tunmer & Chapman, 2012). However, like other aspects of intervention fidelity, whether similar relations exist for one-on-one differentiated reading interventions in early elementary school remains unknown.

# Duration of PD Needed to Enhance Intervention Fidelity

Although most reading intervention studies have examined the impact of a PD program for classroom teachers over 1 year, reading interventions might be more effective if teachers were trained for 2 years because it can allow teachers to develop the necessary competencies or mastery over implementation (Landry et al., 2006). In one of the few studies examining multiyear participation in a PD program, Taylor and colleagues (2005) examined the CIERA school change framework over 2 years. They found that the effect of implementing elements of the CIERA model on students' growth in reading comprehension and fluency increased when examined over 2 years, suggesting the need for more than 1 year of PD to achieve maximal impact for teachers. The researchers hypothesized that changes in teachers' practices occurred in small increments across 2 years and that sustained efforts were needed to change teachers' reading instruction and teaching practices. Multiyear participation in PD related to reading interventions delivered to individual students has important implications for improving the impact of interventions for students, as teachers may have greater competency in implementing the intervention during the second year of training.

# Measuring Intervention Fidelity of Reading Interventions Delivered to Individual Students

As mentioned above, researchers have largely examined teachers' intervention fidelity of reading curricula or wholeclass instructional strategies, which generally have a broad scope and sequence and are often geared to larger groups of students in the classroom (Hamre et al., 2010). In these contexts, fidelity is usually measured at the teacher level because several students receive the same program or instruction from their teacher. In contrast, less research has focused on specific aspects of teachers' intervention fidelity of reading interventions with individual students. Compared to reading programs implemented in whole-class or smallgroup settings, interventions implemented in a one-on-one context are designed to help teachers understand how to differentiate instruction to meet individual student's needs. These types of reading interventions are frequently composed of core activities and specific strategies that are implemented with individual students who struggle with reading or who are at risk for reading-related disabilities. This differentiation may contribute to variability in how teachers implement reading interventions, and may mean interventions vary in fidelity at the student level (Wanzek et al., 2016). Capturing specific elements of fidelity at an individual student level can lead to an improved understanding of intervention effectiveness.

# Goals of the Current Study

Particular aspects of teachers' intervention fidelity of reading interventions have rarely been explored in relation to reading and vocabulary outcomes for students at risk for reading-related disabilities, with few studies measuring fidelity at the level of individual students. Our preliminary research study was guided by the following questions:

- Was teachers' TRI intervention fidelity (exposure, adherence, and quality) associated with students' spring reading and vocabulary outcomes, after controlling for fall pretest scores, student-level characteristics, and teacher qualifications?
- 2. Were the relationships between TRI intervention fidelity and students' spring reading and vocabulary outcomes moderated by teachers' year of participation in TRI?

## Method

#### Participants

This study was based on data from a randomized controlled trial of TRI conducted in 10 Title I schools across three rural school districts from 2011 to 2014 (Vernon-Feagans et al., 2018). Randomization occurred at the classroom level. All kindergarten and first-grade classrooms (n = 100) were randomized in each of the 10 schools, with approximately half randomized as treatment and half as control. This study only included TRI treatment kindergarten and firstgrade teachers and their students who were classified as being at risk for reading-related disabilities. A total of 66 treatment teachers participated in the study. All teachers were recruited to participate in the study for 2 years, although some attrition occurred (Vernon-Feagans et al., 2018). A total of 298 treatment students, approximately three per classroom, participated in the study. Students were only in the study for 1 year, with minimal attrition (Vernon-Feagans et al., 2018). Sample descriptive information is provided in Table 1.

Student screening and qualification. To qualify for the study, kindergarten and first-grade students were screened using grade-appropriate subtests from AimsWeb (Shinn & Shinn, 2002) and the Dynamic Indicators of Basic Early Literacy Skills, 6th Edition (DIBELS; Good & Kaminski, 2002). Kindergarten students were screened using AimsWeb Letter Sound Fluency (LSF) and DIBELS First Sound Fluency (FSF) subtests. First-grade students were screened using DIBELS Phoneme Segmentation Fluency (PSF) and Nonsense Word Fluency (NWF) subtests. We used the gradelevel and fall time point AimsWeb/DIBELS benchmarks to categorize all students as being at high risk, some risk, or low risk for reading difficulties. Consented students from the *high risk* or, as needed, *some risk* group were randomly ordered to receive additional assessments on two subtests (Letter-Word Identification and Word Attack) of the Woodcock Johnson Diagnostic Reading Battery III (WJ-III; Woodcock et al., 2004). Students identified as at risk for reading-related disabilities were required to score below 35% on the grade percentile score for one or both WJ subtests (Vernon-Feagans et al., 2018).

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Demographic and outcome variables	n	% or M	SD	Range	
Grade ( $0 = kindergarten, I = first grade$ )	298	51.01		0.00	1.00
Student-level variables					
Maternal education	285	12.16	2.23	8.00	22.00
Child gender ( $0 =$ female, $1 =$ male)	298	55.37		0.00	1.00
Child race ( $0 =$ student of color, $I =$ White)	291	25.43		0.00	1.00
Child home language ( $0 = \text{non-English}$ , $1 = \text{English}$ )	293	12.63		0.00	1.00
Teacher-level variables					
Teacher education ( $0 = Bachelor's$ , $I = Masters or above$ )	63	30.16		0.00	1.00
Teacher experience at grade level	63	4.85	5.46	0.00	23.00
Year of participation ( $0 = $ first, $I = $ second)	66	54.55		0.00	1.00
Outcome measures					
Letter-word identification, fall	298	362.93	36.44	270.00	446.00
Letter-word identification, spring	278	409.10	28.3 I	310.00	478.00
Passage comprehension, fall	282	411.66	20.19	360.00	465.00
Passage comprehension, spring	278	435.40	25.74	370.00	517.00
Oral vocabulary, fall	291	6.44	2.73	1.00	13.00
Oral vocabulary, spring	278	6.94	2.32	1.00	14.00

**Table I.** Descriptive Information for Student Sample (n = 298) and Teacher Sample (n = 66).

# Procedures

At the beginning of each year, students who participated in the study returned questionnaires from their parents or primary caregivers, which included consent to participate in the study and information about child and family demographics. In the fall and spring of each study year, teachers completed questionnaires about their professional background, classroom characteristics, and information specific to selected students. Student assessments were administered in the fall and spring. The TRI assessors took part in two 8-hour training sessions led by a TRI assessment trainer to become a certified assessor for the project. Assessors completed the full battery of assessments with nonparticipating students to become reliable.

### TRI Description

In TRI PD, teachers are trained to use instructional reading strategies with students at risk for reading-related disabilities. Classroom teachers learn how to differentiate reading instruction by working with one student at a time in daily 15-minute lessons over 6 to 8 weeks. Teachers typically work with three selected students across the academic year. Once a week, a literacy coach uses webcam technology to provide the teacher real-time feedback on how to differentiate instruction to meet the needs of the target student.

TRI consists of evidence-based diagnostic reading activities that are situated in the context of words and texts and are based on the student's instructional level (Vernon-Feagans et al., 2013). All TRI activities are embedded within four levels (*Pink, Blue, Green*, and *Purple*) that progress in difficulty and teachers select the level, words, and texts considered to be most appropriate for their students based on data from classroom assessments or performance from previous lessons. At the *Pink* level, the focus is on three-sound words (e.g., bag); at the Blue level, four to six-sound words (e.g., trip); at the Green level, longvowel words and words with r-controlled sounds and diphthongs (e.g., tape and mouth); and at the Purple level, multisyllable words (e.g., pancake). Each level includes corresponding word lists, texts, and lesson guides, which teachers use to plan and implement TRI lessons. Teachers transition students to the next level when students have achieved 70% to 75% mastery of the words and texts at the previous level to maintain a fast pace to accelerate student learning. At all levels, students learn to segment and blend words, define words, read fluently, and comprehend and summarize texts.

Each 15-minute TRI instructional lesson is composed of three overarching activities: *Rereading for Fluency, Word Work*, and *Guided Oral Reading*. In *Rereading for Fluency*, the teacher has the student re-read part of a text read during the *Guided Oral Reading* from the previous day. *Word Work* consists of multisensory activities such as *Segmenting Words; Change One Sound*; and *Read, Write, and Say*. In *Read, Write, and Say*, for example, the student attempts to read a word independently, and the teacher ensures that the student understands the word's meaning. After demonstrating sufficient understanding of the word, the student writes each letter of the word on a white board while saying each sound of the word. In *Guided Oral Reading*, the teacher selects a text that is aligned with the instructional focus of *Word Work*. The teacher helps the student decode, summarize, predict, make inferences, and answer questions about the text they have read. The teacher would also use TRI strategies such as *Blend as You Go* (e.g., blend the first two sounds before blending the remaining sounds) when a student struggles to read a word in any TRI activity. By implementing TRI activities and using a TRI Diagnostic Map to chart the student's most pressing needs, the teacher is able to differentiate instruction in explicit and systematic ways that promotes students' rapid reading progress.

*Coach training.* All TRI coaches attended an intensive coach training prior to each implementation year. As part of the coach trainings, TRI coaches practiced TRI activities and strategies and were expected to demonstrate mastery in implementing TRI activities and strategies (through video recordings submitted to TRI's Intervention Director). The TRI coaches also attended trainings on coaching pedagogy and effective coaching practices as well as trainings that described TRI-specific coaching protocols. Throughout the year, coaches met with TRI's intervention director to problem-solve issues that emerged during coaching sessions and received feedback to improve their coaching practices.

Classroom teacher training and coaching. TRI teacher training (see S1) consisted of annual 3-day training institutes and weekly webcam coaching sessions. The training institutes were led by the intervention director and literacy coaches and consisted of demonstrations and hands-on practice opportunities. Teachers learned and practiced TRI activities and strategies with other teachers and students and had opportunities to receive direct feedback from the trainers. Teachers had opportunities to plan TRI lessons with trainer support and ask clarifying questions throughout the training. Teachers had access to TRI's website, which included TRI activity lesson guides and a video library of TRI activity and strategy demonstrations. In addition, teachers met with an assigned TRI coach via webcam on a weekly basis. Using webcam technology, the TRI coach observed a TRI lesson between the teacher and selected student and provided immediate feedback during and after the lesson. Every TRI coaching session began with coaches and teachers briefly (2–3 minutes) talking about the teacher's TRI lesson plan for the day. Coach feedback during TRI lessons was primarily focused on helping teachers to implement TRI lessons with fidelity. Coaches were expected to provide in-the-moment feedback during TRI lessons for a variety of reasons (e.g., teacher incorrectly implemented an activity or missed an activity step, student struggled to respond to teacher cues for prolonged periods of time, or teacher asked clarifying questions). After the TRI lesson, coaches spent approximately 5 to 10 minutes debriefing the TRI lesson and student progress with teachers. During these coachteacher debriefs, coaches typically provided performancebased feedback, during which they helped teachers reflect on whether the TRI lesson matched the needs of the students and clarified any misunderstandings related to teacher implementation. Coach feedback also incorporated ways to modify lessons to improve fidelity to TRI instructional practices. After coaching sessions, the TRI coach emailed summary feedback of the lesson.

### Measures

TRI intervention fidelity. Intervention fidelity was measured at the student level rather than the teacher level to capture every student's experience with his or her teacher's use of TRI intervention practices. We focused on three aspects of fidelity: (a) student exposure to TRI, (b) teacher adherence to TRI activities, and (c) teacher quality of decoding support and comprehension support during TRI lessons. TRI exposure was reported by teachers, whereas TRI adherence and quality were coded using video-recorded coaching sessions. In this process, two video sessions for each student and his or her teacher were randomly selected to be coded for fidelity adherence and quality. To allow for variation in student and teacher familiarity with TRI, the first video was selected from the student's second or third video-recorded TRI session, and the second video was selected from the student's sixth or seventh video-recorded TRI session, which resulted in approximately six videos per teacher. A student's second or third and sixth or seventh videorecorded TRI sessions generally captured the student's overall TRI experience with his or her teacher. By the second or third session, most teachers had a sense of areas to focus on during the lesson and by the sixth or seventh session, most teachers had developed a comfort level with TRI activities and strategies for that student. The values for adherence and quality codes were averaged across the two video-recorded sessions for each individual student. Research assistants coded each TRI video for adherence and quality of implementation using specific coding indicators that were related to the intervention components. Prior to coding, research assistants double coded 15% of the videos to establish reliability, with Cohen's kappa required to be above .70 across all indicators prior to independent coding. Inter-rater reliability ranged from 0.77 to 0.87 for all indicators of adherence and quality of implementation.

*Exposure.* During weekly TRI coaching sessions, each treatment teacher reported the number of TRI lessons they implemented the previous week with the individual student, and this information was recorded by the TRI coach. *Exposure* was calculated as each student's total number of TRI lessons with his or her teacher.

Adherence. Adherence measured teachers' completion of the procedural elements of each TRI activity that he or she selected to make up a TRI lesson. For example, adherence to the procedures of one TRI activity, *Read, Write, & Say*, included the following indicators: (a) teacher wrote word on board, (b) teacher directed student to read word, (c) teacher prompted student to write word on board and say sounds of the word while writing each letter, and (d) teacher prompted student to re-read the word after writing the word on the board. Each indicator was coded as either observed (score = 1) or not observed (score = 0). Across a full lesson (Rereading for Fluency, Word Work, and Guided Oral Reading), the adherence variable was coded as the proportion of observed indicators over the total number of possible indicators, with a score of 1 corresponding to higher adherence. See the supplemental file Table S2 for a full table of TRI adherence indicators across TRI levels.

Quality. Quality of TRI implementation was measured as two separate variables: (a) quality of decoding support and (b) quality of comprehension support. *Quality of decoding* support measured teachers' use of TRI intervention practices related to helping students independently decode words and texts. Quality of decoding support consisted of the same two indicators for each selected TRI Word Work activity as well as during Guided Oral Reading: (a) teacher encouraged the student to independently read (or attempt to read) developmentally appropriate words in the activities prior to providing any assistance to the student, and (b) teacher used TRI's Blend as You Go strategy to help the student when they struggled to read a word. Each indicator was coded as either observed (score = 1) or not observed (score = 0) across a majority of the time spent in each Word Work or Guided Oral Reading activity. This coding system was slightly different from that of the adherence variable because the adherence indicators were more easily identifiable, and thus were more easily coded. In contrast, the quality of decoding support was more nuanced, and it was easier to code for indicators across the majority of the activity rather than for each word and text within each selected activity. Across Word Work and Guided Oral Reading, quality of decoding support was coded as the proportion of observed indicators over the total number of possible indicators, with 1 corresponding to higher quality of decoding support.

*Quality of comprehension support* measured teachers' use of TRI practices related to helping students understand the meanings of words and texts. Quality of comprehension support was measured globally (rather than proportionally) and consisted of two indicators across all selected Word Work and Guided Oral Reading activities: (a) teacher checked that the student understood the meaning of words and texts, and (b) if the student did not understand word meanings or was unable to comprehend the text, the teacher used at least one strategy to support comprehension (e.g., provided a student-friendly definition, provided a picture clue using the TRI Picture Dictionary,

helped the student attend to a picture in the book to make meaning of the story). Quality of comprehension support was coded using a 3-point Likert-type scale (low comprehension support = 0, medium comprehension support =1, high comprehension support = 2). If a teacher did not check whether the student understood the meaning of the words/text throughout Word Work and Guided Oral Reading, quality of comprehension support was rated as 0. If a teacher occasionally checked whether the student understood the meaning of the words/text (e.g., did this primarily during Guided Oral Reading, but not during Word Work activities), the quality of comprehension support was rated as 1. If a teacher checked whether the student understood the meaning of the words/text throughout Word Work and Guided Oral Reading, quality of comprehension support was rated as 2. Descriptive information about the fidelity variables is presented in Table 2.

Reading and vocabulary outcomes. In the fall and spring of each study year, assessors administered the WJ III and the Test of Language Development, Fourth Edition (TOLD; Newcomer & Hammill, 2008). WJ letter-word identification and passage comprehension subtests measured reading. Letter-word identification measured students' skills of letter and word recognition. The median reliability of this subtest for the normed sample was .98 in the 5- to 7-year age range. Passage comprehension measured students' abilities to match a symbol with an actual picture or to provide missing key words within a passage at the more advanced levels. The median reliability of this subtest for the normed sample was .83 in the 5- to 7-year age range (McGrew et al., 2007). We calculated w scores (representing an equal-interval scale) for WJ subtests using Compuscore, provided from the commercial test provider. The TOLD oral vocabulary subtest measured students' ability to define English words without the use of picture prompts. Test-retest reliability of this subtest for the normed sample was 0.82 in the 5- to 7-year age range (Newcomer & Hammill, 2008). We calculated standard scores for the oral vocabulary subtest.

Year of participation. As our study spanned 2 years in kindergarten classrooms and 2 years in first-grade classrooms, teachers could participate in the study for 1 or 2 years. We examined year of participation (0 = first year, 1 = second year) as a potential moderator of the relationship between teacher intervention fidelity and student reading outcomes.

**Control variables.** Grade level (0 = kindergarten, 1 = first grade), student demographics, and teacher characteristics were included as control variables. Student demographics included maternal education (continuous), child gender (0 = female, 1 = male), child race (0 = student of color),

Construct (captured from)	Variable	Description	М	SD	Range
Exposure (teacher- report)	Number of TRI sessions	Number of TRI sessions teacher completed with invidual student at risk for reading-related disabilities	17.34	14.36	0–75.00
Adherence (video-recorded TRI session)	Adherence to TRI	Proportion of indicators that were coded as <i>observed</i> across all TRI re-reading for fluency, word work, and guided oral reading activities selected by teacher	0.84	0.11	0.31-1.00
Quality (video-recorded TRI session)	Quality of decoding support	<ul> <li>Proportion of indicators that were coded as observed across majority of word work and guided oral reading activities selected by teacher; indicators included:</li> <li>I. Teacher encouraged the child to independently read developmentally appropriate words</li> <li>2. Teacher used the TRI strategy of Blend as You Go</li> </ul>	0.63	0.32	0-1.00
	Quality of comprehension support	<ul> <li>Global indicator coded as (0) low, (1) medium, or (2) high, based on whether the teacher monitored:</li> <li>I. Children's understanding of individual words in Word Work activities</li> <li>2. (and/or) Children's understanding of connected text during <i>Guided Oral Reading</i></li> </ul>	0.65	0.57	0–2.00

Table 2. TRI Intervention Fidelity Codes.

Note. TRI = targeted reading instruction.

1 = white student), and English learner (EL) status (0 = non-EL, 1 = EL). Students were considered to be ELs when either (a) their first language was a language other than English and English was not spoken in the home or (b) their first language was a language other than English, and although English was spoken in the home, the family reported that the student received ESL services at school and/or the family received a Spanish consent form (Amendum et al., 2018). For teacher qualifications, we included teacher education (0 = bachelor's degree, 1 = master's degree or higher) and teacher experience at the current grade level (continuous).

### Analytic Strategy

To answer our research questions, we analyzed two-level hierarchical linear models (HLM) to account for students nested within classrooms (Raudenbush & Bryk, 2002). The SAS v. 9.4 software was used to conduct all analyses. We used multiple imputation and then deletion (MID; von Hippel, 2007) procedures to account for missing data, which ranged from 0% to 7%. Imputation models included the fall and spring scores on student assessments; grade; maternal education; student gender, race, and EL status; teacher education and teacher experience; and exposure, adherence, quality of decoding support, and quality of comprehension support. Imputation models were stratified by year of participation to account for moderation analyses (von Hippel, 2007). Following imputation, cases with imputed Y values (n = 20) were excluded from inferential models, which aids in the accurate estimate of associations (von Hippel, 2007).

For the first research question, we created three HLM models, which predicted to each outcome separately. At Level 1, we included fixed effects for the student-level variables of maternal education, gender, race, EL status, exposure, adherence, quality of decoding support, and quality of comprehension support. At Level 2, we included grade and year of participation. For our second research question that examined moderation by year of participation, we created separate Level 2 interaction terms for year of participation by exposure, adherence, quality of decoding support, and quality of comprehension support predicting to each of the three outcomes. Significant interactions were probed by testing simple slopes at the moderator (year of participation) values of 0 and 1. All predictors were centered with mean of 0 and standard deviation of 1 prior to analyses. Effect sizes were calculated using Hedge's g.

# Results

# **Descriptive Findings**

As shown in Table 1, the average maternal education was approximately 12 years (high school diploma or equivalent). Over half of the students were male and approximately one quarter were White, half were Black, and one sixth were Latino/a. Treatment teachers who participated in the study were predominantly White and female. On average, teachers had 5 years of teaching experience at their current grade level, and approximately 30% of teachers had a master's degree. A little over half of the teachers (55%) participated in the study for 2 years.

As shown in Table 2, treatment students received an average of 17 TRI lessons with their teacher. Per study

Table 3. Multil	evel Model	Main and	Moderation	Effects (	(N =	305)
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	Letter-word identification	Passage comprehension	Oral vocabulary
Multilevel models	B / SE	B / SE	B / SE
Model I—main associations			
Intercept	409.30*** / 1.44	435.39*** / 1.11	6.96*** / 0.15
Pretest	21.93*** / 2.42	6.73*** / 1.34	0.90*** / 0.15
Grade (0 = kindergarten, 1 = first grade)	-1.86 / 2.49	12.47*** / 1.33	0.05 / 0.16
Maternal education	2.43 / 1.35	3.95** / 1.28	0.15 / 0.15
Child gender ( $0 =$ female, $1 =$ male)	-0.11/1.13	-0.37 / 1.10	0.02 / 0.12
Child race (0 = student of color, $I = white$ )	0.30 / 1.25	2.02 / 1.16	0.14 / 0.13
Child English learner status (0 = non-EL, $I = EL$ )	3.00* / 1.36	1.46 / 1.27	-0.14 / 0.15
Teacher education	-0.23 / 1.50	-1.83 / 1.15	-0.25 / 0.16
Teacher experience	-1.14 / 1.55	1.55 / 1.20	0.12/0.16
Exposure	0.93 / 1.16	0.66 / 1.11	0.09 / 0.12
Adherence	0.84 / 1.34	1.17 / 1.27	0.36* / 0.14
Quality of decoding support	-0.31 / 1.34	0.07 / 1.26	-0.01 / 0.14
Quality of comprehension support	2.13 / 1.30	1.92 / 1.21	0.03 / 0.14
Year of participation ( $0 =$ first year, $I =$ second year)	1.95 / 1.23	-0.05 / 1.19	-0.16 / 0.13
Model 2—interactions			
Exposure $ imes$ year of participation	3.59* / 1.37	2.68* / 1.31	0.26 / 0.15
Adherence $ imes$ year of participation	3.77* / 1.43	0.65 / 1.38	0.08 / 0.15
Decoding support $ imes$ year of participation	-0.34 / 1.32	-1.74 / 1.28	-0.07 / 0.14
Comprehension support $ imes$ year of participation	-1.57 / 1.21	0.64 / 1.17	0.20 / 0.13
Variance components			
Level 2 (classroom)	57.10* / 26.80	4.77 / 16.07	0.57* / 0.28
Residual	316.92*** / 31.52	318.51*** / 31.15	3.57*** / 0.36

Note. EL = English learner.

p < .05. p < .01. p < .001.

design, the average number of weeks that teachers worked with an individual student was 8, which meant that students received roughly three TRI lessons per week. Coders rated teachers as having approximately 84% adherence to TRI activities (see adherence indicators in Supplemental Table S2). Coders rated teachers as providing decoding support 63% of the time and comprehension support 65% of the time during TRI lessons with individual students.

### **HLM** Findings

Letter-word identification. As shown in Table 3, in Model 1, TRI intervention fidelity variables did not have significant main associations with letter-word identification scores. In Model 2, interactions between teachers' year of participation and TRI exposure (B = 3.59, SE = 1.37, p = .01, see Figure 1A), as well as TRI adherence (B = 3.77, SE = 1.42, p = .01), were significant in association with students' spring letter-word identification scores. The two interactions indicated an identical pattern of relationships. As shown in Figure 1A, the relationship between intervention exposure and students' letter-word identification varied by

teachers' year of participation in the study. The upward slope indicated that students who received a higher number of TRI lessons and whose teachers were in their second year of participating in TRI had higher letter-word identification scores (g = 0.20). In addition, students whose teacher used TRI with higher adherence and whose teachers were in the second year of participating in TRI also had higher letter-word identification scores (g = 0.19). In sensitivity analyses, a three-way interaction among exposure, adherence, and year of participation was not significant.

**Passage comprehension.** In Model 1, TRI intervention fidelity variables did not have significant main associations with passage comprehension scores. In Model 2, an interaction between teachers' year of participation and TRI exposure was significant (B = 2.68, SE = 1.31, p = .04), in association with students' spring passage comprehension scores (see Figure 1B). This interaction, similar to the one depicted in Figure 1A for letter-word identification, showed that students who received a higher number of TRI lessons and whose teachers were in their second year of participating in TRI had higher passage comprehension scores (g = 0.17).



**Figure I.** Graphs depicting between TRI exposure and year of participation as related to (A) letter-word identification scores and (B) passage comprehension scores. Note. TRI = targeted reading instruction.

Oral vocabulary. In Model 1, higher adherence to TRI strategies was positively related to students' spring oral vocabulary scores (B = 0.36, SE = 0.14, p = .01, g = 0.15). Exposure, quality of decoding support, and quality of comprehension support were not significantly associated with oral vocabulary scores. In Model 2, no significant interaction findings emerged.

### Discussion

Calls for empirical investigations to understand the effective aspects of interventions (Center on the Developing Child, 2016) have warranted more research on how teachers' implementation of reading interventions (e.g., exposure, adherence, quality) is related to students' early reading outcomes. This study represented an initial investigation of fidelity in relation to student reading and vocabulary gains to extend previous findings of TRI as an effective reading intervention for students at risk for reading-related disabilities (Vernon-Feagans et al., 2013, 2018). Although TRI was specifically developed for classroom teachers, and despite extensive coaching support, not all teachers demonstrated 100% fidelity to TRI. Given this variation, our primary findings included the following: (a) higher teacher adherence to TRI was directly associated with oral vocabulary and also associated with letter-word identification, but only when teachers were in their second year of TRI implementation; and (b) greater student exposure to TRI was related to word reading and reading comprehension, but only when teachers were in their second year of TRI.

# Intervention Fidelity and Students' Reading and Vocabulary Outcomes

Our first research question examined whether teachers' intervention fidelity was related to students' spring reading and vocabulary outcomes. Of the four measured constructs of teachers' implementation, we found that teachers' greater adherence to TRI was positively related to students' spring oral vocabulary skills. Teachers who demonstrated stronger adherence to TRI may have been more likely to use prompts that required students to verbally engage in the activities. As shown in Supplemental Table S2, many TRI activities also required students to respond to teachers' verbal instructions, which may have also positively contributed to increased vocabulary skills for students of teachers with high TRI adherence.

Combined with a nonsignificant association with passage comprehension, findings from our study provide mixed evidence for the associations between adherence and students' reading and vocabulary scores. In the few other empirical studies examining these associations, researchers have not found significant associations between adherence and students' reading scores (e.g., Domitrovich et al., 2010). The more prescriptive, intensive, and short-term nature of differentiated interventions was thought to require greater adherence to produce effects on students' reading outcomes compared to general curriculum, but this was not fully supported by this study. Our study, like others, suggests that implementing the activities and strategies as prescribed, regardless of whether it is a reading curriculum or reading intervention, may be an important but nonetheless limited determinant of students' reading and vocabulary growth.

We did not find evidence of main associations between exposure and student outcomes. Teachers were expected to implement TRI four to five times a week. Ideally, individual students would have received between 30 and 40 lessons over 8 weeks (7.5–10 hours of intervention). However, teachers on average implemented less than three times a week, for an average of 17 TRI lessons with each individual student (4.25 hours of intervention). Although there were teachers at the lower and higher ranges of implementation, there was limited variability across individual students within each school year. Prior to randomization, key research staff had met with teachers and administrators to describe implementation procedures, and schools were invited to participate if there was consensus among teachers and administrators to participate in the intervention. Despite securing participant buy-in prior to the start of implementation, teachers reported facing challenges such as limited resources (e.g., support staff) and competing demands, which may have contributed to lower levels of exposure (Bryk et al., 2015).

We also did not find evidence that teachers' quality of decoding support or comprehension support were related to students' reading or vocabulary outcomes. These constructs were more nuanced to capture compared to the more straightforward constructs of adherence and exposure. In our quality fidelity measures, we primarily focused on teachers' decoding and comprehension support, which are theoretically important elements of reading successfully (Language and Reading Research Consortium, 2015). Nonetheless, these constructs may not have adequately represented the essential TRI elements that would have been associated with gains in students' word-identification skills. Other indicators of intervention quality during supplemental reading instruction with individual students (e.g., teachers' pacing of the lesson or feedback) may have also been important. Prior efficacy studies have shown that TRI is effective in improving both word identification and reading comprehension skills (Vernon-Feagans et al., 2018), which warrants further study of how to more effectively measure aspects of the intervention that helped to promote students' word reading, reading comprehension, and vocabulary gains.

### Moderation by Second Year of TRI Participation

In our second research question, we examined whether teachers' 1- or 2-year participation in TRI moderated associations between intervention fidelity and reading outcomes. As recommended by others (Taylor et al., 2005), we designed the study to have teachers implement over 2 years with the hope that TRI impacts would be greater in the second year. In our study, teachers in their second year of TRI who provided students with more TRI exposure had students with higher letter-word identification and passage comprehension spring scores. In addition, teachers in their second year of TRI who demonstrated greater adherence to TRI activity procedures also had students with higher letterword identification scores. A second year of participation in TRI may have allowed teachers to become more familiar with TRI activities and strategies and, as they implemented more lessons during their second year, could have led to them being more effective in promoting reading growth. However, as these moderation findings did not consistently extend to the adherence indicators and to any of the quality fidelity indicators, replication studies are warranted to

understand how multiple years of teacher training in combination with intervention fidelity produce student reading gains.

### Study Limitations

Findings of this study should be interpreted in light of its limitations. We did not find consistent positive effects of adherence or quality, which suggests that there may be limitations in how we measured these aspects of teachers' implementation. Considering that previous efficacy studies have highlighted the effectiveness of TRI, we may not have adequately captured sufficient variation in the adherence and quality of teachers' implementation of TRI. That is, we may not have fully captured the essence of TRI and the ingredients that make it effective for students' reading and vocabulary skills (Quinn & Kim, 2017). For example, we measured "quality" as decoding and comprehension support, yet other markers delineating how well teachers implemented TRI may be more accurate. Furthermore, the measurement of decoding support as binary (i.e., observed versus not observed) may have underestimated nuances in teachers' quality of decoding support. In future work, it may be important to re-conceptualize this (or other quality indicators) as continuous scores to capture how well teachers implemented certain aspects of TRI in high-quality ways. Future work should also examine whether TRI's measure of adherence is replicable in other samples of teachers and students. The lower range of the inter-rater reliability estimates for the adherence and quality indicators were considered to be moderate (McHugh, 2012). Although a baseline of .70 Cohen's kappa was used in addition to the inter-rater reliability estimates, a higher baseline would have been optimal. TRI exposure was a teacher-reported variable, which may not have fully reflected the extent to which teachers implemented TRI lessons on a daily basis. The use of secondary data limited our abilities to collect data that may have been important in analytic models. For example, although we controlled for a variety of child-level demographic variables, we were unable to include other potentially important child-level information (e.g., preschool attendance) due to lack of access to these data.

In previous publications, TRI has been conceived as a Tier 2, or targeted intervention, support in the response to intervention (RTI; now frequently called multitiered systems of support, or MTSS) framework. However, the participating schools in these rural districts were not yet fully implementing RTI, and some schools did not have adequate systems in place for identifying students in need of Tier 2 intervention, particularly during the earliest elementary years. Thus, we were unable to study TRI in the context of a larger RTI framework. Instead, we screened all students in each kindergarten and first-grade classroom to determine which students would benefit from supplemental reading instruction from their classroom teacher. Furthermore, this study did not capture the quality or content of Tier 1, or core instruction, in participating classrooms. Future work should collect data related to RTI/MTSS implementation, including students' exposure to core instruction, to understand the effectiveness of intervention programs within larger systems of support and potentially variable core instruction.

In future studies, we also plan to develop and include more robust measures of fidelity, expanding on the work of this study. The sampling plan in this study was based on assumptions that (a) two video recordings per teacher–student dyad was sufficient and (b) fidelity across two TRI lessons generalized to the teacher's overall fidelity to TRI. In addition, we had only collected one video per week of teachers implementing TRI lessons (approximately seven videos per teacher–student dyad), even though teachers reported implementing an average of 17 TRI lessons with each individual student over the course of 6 to 8 weeks. In future studies, collecting and coding a larger sample of teacher videos may be needed to capture the full extent of teachers' intervention fidelity.

We also did not collect data about the duration of TRI lessons. Although teachers were encouraged to implement TRI for 15 to 20 minutes, lesson length varied based on students' needs and teachers' circumstances. In future studies, collecting duration data for teacher-reported TRI lessons would enhance our understanding of students' exposure to TRI activities and strategies. Finally, the magnitude of effects in this study were small. This may be due to the error associated with the fidelity measures, which may have limited how precisely we were able to capture aspects of teachers' implementation of TRI. In future studies, modifications to the fidelity measure may capture additional variation and nuances of teachers' implementation.

### Implications for Future Research and Practice

One priority for future research related to implementation of TRI's PD model is to identify ways to make TRI sustainable, feasible, and replicable across contexts. For example, although some teachers have anecdotally reported that they have adapted the intervention to different instructional contexts (e.g., small group), future research efforts may explore how to explicitly develop and adapt TRI activities so teachers can implement TRI in small-group contexts. In addition, research efforts may focus on whether TRI effects are evident beyond 1 year and to help school districts to adopt and/ or adapt TRI at the district level. Finally, in future studies, we plan to develop and include more robust measures of fidelity, expanding on the work of this study. For example, developing a coach fidelity measure to examine the quality of coaching practices and adherence to TRI's coaching model may serve as another tool schools can use to sustain and monitor implementation of TRI.

# Conclusion

Classroom teachers' implementation of differentiated reading intervention often determines its effectiveness in improving early reading skills for students at risk for reading-related disabilities (Swanson et al., 2013). In line with existing research, *how* teachers implement reading interventions is an important part of understanding *why* interventions are or are not successful. Ongoing PD for teachers can help teachers implement interventions more effectively, which can thereby improve student reading outcomes. In future intervention studies, researchers should continue to disentangle components and aspects of interventions that may yield the greatest influence on students' reading development.

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#### Supplemental Material

Supplemental material for this article is available on the *Journal of Learning Disabilities* website along with the online version of this article.

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