The Importance of Baseline Word Reading Skills in Examining Student Response to a Multicomponent Reading Intervention

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Authors' Note:

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Support for this research was provided by Award Number R01HD087706 from the Eunice Kennedy Shriver National Institute of Child Health & Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health and Human Development or the National Institutes of Health.

Journal of Learning Disabilities

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Journal:	*Journal of Learning Disabilities*
Manuscript Type:	Article
Keywords:	reading < comprehension, decoding < reading, intervention < reading

IMPORTANCE OF BASELINE WORD READING SKILLS

Abstract

To address the needs of a diverse group of students with reading difficulties, a majority of researchers over the last decade have designed and implemented multicomponent reading interventions (MCRIs) that provide instruction in multiple areas of reading yielding mixed results. The current study evaluates if students' baseline word reading skills predict their response to a MCRI. Data from a randomized controlled trial for third and fourth grade students with reading difficulties (N = 128) were analyzed. Results demonstrate that baseline word reading was a significant predictor of students' end-of-year reading comprehension performance. Treatment group students who had lower baseline word reading compared with those students with comparatively higher word reading scores performed significantly lower on posttest reading comprehension. Findings denote the importance of word reading instruction for upper elementary students who are below-average word readers and also indicate the need for tailoring reading intervention to align with individual reader needs.

Keywords: word reading, reading comprehension, reading difficulty, upper elementary, multicomponent reading intervention

The Importance of Baseline Word Reading Skills in Examining Student Response to a Multicomponent Reading Intervention

Reading theories are unequivocal on the central role of word reading skills in the development of reading comprehension (Gough & Tunmer, 1986; Perfetti, 1992). Evidence from past studies align with these theoretical frameworks (Gough & Tunmer, 1986; Perfetti, 1992) and suggest that students' performance on word reading measures in early grades predicts their reading comprehension in later grades (e.g., Stanley et al., 2018; Tighe et al., 2015). Similarly, results from intervention studies demonstrate that students' relative performance on word reading measures may be the best predictor of their response to multicomponent reading interventions (MCRIs) (e.g., Wanzek et al., 2017). The focus of the current study is to evaluate how initial word reading predicts students' response to a year-long MCRI.

Theoretical Framework

According to the simple view of reading (Gough & Tunmer, 1986), reading comprehension is a product of an individual's word reading and linguistic comprehension abilities. The word reading component is described as the ability to translate print into language and can be observed through measures of word reading, pseudo-word reading, and reading fluency. Linguistic comprehension, on the other hand, is the ability to extract and construct meaning from oral language and is assessed using measures of listening/oral comprehension and vocabulary, whereas reading comprehension is defined as the ability to extract and construct meaning from language represented in print form (Hoover & Tunmer, 2018). The simple view of reading holds that when word reading and linguistic comprehension skills are high, individuals will also demonstrate high performance on reading comprehension measures. Conversely, reading comprehension is impaired when an individual has difficulty reading words and/or has

poor linguistic comprehension. Multiple studies have empirically tested the theory of the simple view of reading and found considerably supporting evidence (e.g., Catts et al., 2006; Lonigan et al., 2018; Tilstra et al., 2009). In other words, these studies have reported that the two components—word reading and linguistic comprehension—explain a large proportion of variance in students' reading comprehension scores.

Association Between Word Reading and Reading Comprehension

Word reading is the ability to decode written letters and words into their associated phonetic code (Perfetti, 1985). The accurate and automatized retrieval of the phonological code for printed words is deemed a fundamental skill for the development of reading comprehension (Perfetti, 1992). Students with weak and laborious word reading skills find their ability to comprehend text impeded for two possible reasons. First, misidentification of words leads to poor comprehension of the text (Hoover & Tunmer, 2018). Second, according to the verbal efficiency theory, when word reading is slow, more cognitive resources are devoted to word reading, leaving fewer cognitive resources to process the meaning of text (Perfetti, 1985). As more cognitive resources are engaged in reading the text, fewer cognitive resources are available for comprehending the text; this cognitive imbalance negatively impacts the level of text comprehension. Furthermore, in addition to rapid word identification skills, the lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002) posits that knowledge of word forms and word meanings allows individual's to not only identify words but also reliably connect words to their right contextual meaning, which is key to reading comprehension. Thus, reading theories (Perfetti, 1992; Perfetti, 2007; Perfetti & Hart, 2002) suggest that students' reading comprehension difficulties may be traced back to readers' poor proficiency in reading words accurately.

Transfer of Word Reading Gains to Gains in Reading Comprehension

Intervention studies that have aimed to improve upper elementary students with reading difficulties' word reading ability have also reported students' transfer of word-reading skill gains to improvement in reading comprehension (e.g., Compton et al., 2005; Torgesen et al., 2007; Toste et al., 2019). For example, in a sample of 53 Grade 3 to 5 below-average word readers, Compton et al. (2005) reported that in response to a word reading intervention, treatment group students made significant gains (d = 1.15) on a standardized reading comprehension measure. More recently, Toste and colleagues (2019) reported that in response to a multisyllabic word-reading intervention, treatment group students outperformed controls on proximal and distal measures of word reading. Treatment group students also outperformed controls on reading comprehension (ES = 0.26). However, in the Toste et al. (2019) study, treatment group students were not significantly different from controls on the Woodcock Johnson Passage Comprehension subtest (Woodcock, McGrew, & Mather, 2001); other past word reading intervention studies that aim to improve upper elementary students with reading difficulties' word reading proficiency have also *not* reported gains on comprehension measures for treatment group students (Ehri et al., 2009; Torgesen et al., 2007; Toste et al., 2017). Overall, results indicate that, under certain conditions, it is possible for improvement in word reading proficiency to positively impact reading comprehension. These conditions could be the extent to which word reading skills are targeted in an intervention, individual differences in baseline word-reading ability, the amount of instructional time devoted to developing word reading and also the type of reading measure used.

A recent theoretical approach, called the decoding threshold hypothesis (Wang et al., 2018), provides a possible explanation of the varying effects of word reading interventions on students' reading comprehension outcomes. According to the decoding threshold hypothesis

(Wang et al., 2018), the association between word reading and reading comprehension is discernable only beyond a certain decoding threshold or cutoff score. In their analysis of extant data, for a sample of over 40,000 middle and high school students, Wang and colleagues (2018) demonstrated that there was a weak correlation (r = .06) between word reading and reading comprehension when students' word reading proficiency was below a certain threshold. In other words, for a sample of students who were poor word readers, the association between word reading and reading comprehension was nonlinear. For Grades 5–12 students identified as above threshold word readers, the association between word reading and reading comprehension was much higher (r = .48). Therefore, the application of the decoding threshold hypothesis (Wang et al., 2018) can help postulate that students with reading difficulties who receive word reading only interventions may only show improvement in reading comprehension when they surpass the minimum word reading threshold. However, it is important to note that this hypothesis has not been tested with elementary grade-level students, and it is unclear if similar trends will be observed with students in the early stages of reading development when word reading proficiency greatly influences reading comprehension (e.g., Foorman et al., 2018).

Profiles of Students with Reading Difficulties

Past studies that have explored the reading skill profiles of students in upper elementary and later grades have demonstrated that a significant proportion of students with reading difficulties perform poorly on measures of word reading (e.g., Brasseur-Hock et al., 2011; Buly & Valencia, 2002; Cirino et al., 2013). For instance, in a sample of 66 fourth grade students with reading difficulties, Leach and colleagues (2003) reported that a large proportion of the sample had a word reading deficit (42%) or a word reading and reading comprehension deficit (40%); only a small percentage of fourth grade students with reading difficulties had deficits only in

reading comprehension (18%). Similarly, in a sample of 846 middle school students with reading difficulties, it was reported that approximately 50% had deficits in word reading, 84% had deficits in comprehension, and 78% had deficits in comprehension and fluency (Cirino et al., 2013). There are two prominent takeaways from these studies. One, a substantial proportion of upper elementary and later grade students with reading difficulties have word reading deficits. And two, students with reading difficulties in upper elementary and later grades are a heterogenous group in terms of the area of reading skill deficit with potential deficits in more than one area of reading.

To address the needs of this heterogenous group, research on reading interventions for upper elementary and later grade students with reading difficulties have predominantly focused on MCRIs (Scammacca et al., 2016). MCRIs focus instruction on addressing two or more of the components of reading (e.g., phonemic awareness, phonics, fluency, vocabulary, and reading comprehension) to maximize learning for all students comprising the heterogenous population of students with reading difficulties. However, few studies have explored how participants' baseline word reading skills influence their differential response to uniform instruction.

Multicomponent Reading Interventions

As shown in Table 1, results from the past 20-years of research on the effects of MCRIs for upper elementary students with reading difficulties is mixed. While some studies reported no significant differences between conditions, others reported significant positive outcomes for treatment group students. In the description of interventions provided by the authors (see Table 1), the variations in these MCRIs are difficult to discern beyond describing the components in the intervention. One drawback of interpreting study results based on effect sizes is that they

generalize treatment and control group differences and fail to provide information of response to intervention for different reader profiles within either condition.

Some past studies have shown that students' response to multicomponent interventions may depend on their baseline reading skills (e.g., Clemens et al., 2019; Wanzek et al., 2016, 2017). These studies help identify for whom (i.e., which reader profile) a certain multicomponent intervention is effective. For students with reading difficulties in Grades 3–5, researchers have explored students' baseline reading comprehension (Wanzek et al., 2016), word reading (Vadasy & Sanders, 2008; Vaughn et al., 2019; Vaughn et al., 2020; Wanzek et al., 2017), reading fluency (O'Connor et al., 2002), and listening comprehension scores (Lovett et al., 2008; Vaughn et al., 2019), to predict changes in posttest comprehension outcomes. In general, studies that have explored baseline characteristics have reported that students' pre-intervention status matters.

Wanzek and colleagues (2017) reported that fourth grade students with reading difficulties' baseline word recognition scores moderated the association between treatment assignment and posttest reading comprehension scores; treatment group students who began the intervention with higher word recognition scores made greater gains in reading comprehension compared to peers with lower word recognition scores at baseline. Other recent studies have also corroborated these findings (Vaughn et al., 2019; Vaughn et al., 2020). In their study, the authors (Vaughn et al., 2020) reported that students identified as *very low word readers* (Standard score < 80) made significantly less growth compared to *adequate word readers* (Standard score > 90) on three end-of-year standardized reading comprehension measures.

In summary, MCRIs have shown promise in improving reading outcomes for students who struggle to read and comprehend texts. Bearing in mind that students with reading

difficulties generally have deficits in more than one area of reading, MCRIs are designed to meet the needs of a large proportion of students with reading difficulties through integration of components that target different areas of reading. However, preliminary evidence suggests that students with reading difficulties, typically identified for reading intervention studies based on their performance on standardized comprehension measures, respond differently to different multicomponent interventions based on their baseline word-reading proficiency.

Study Purpose

Reading theories are unequivocal on the central role of word reading skills in the development of reading comprehension (Gough & Tunmer, 1986; Perfetti, 1992). Evidence from past studies align with these theoretical frameworks (Gough & Tunmer, 1986; Perfetti, 1992) and suggest that students' performance on word reading measures in early grades predicts their reading comprehension in later grades (e.g., Stanley et al., 2018; Tighe et al., 2015). Similarly, results from intervention studies demonstrate that students' relative performance on word reading measures may be the best predictor of their response to MCRIs (e.g., Vaughn et al., 2019; Vaughn et al., 2020; Wanzek et al., 2017).

One challenge with predicting posttest reading comprehension using baseline word reading skills is that single measures of these constructs can lead to over- or under-estimation of their association (e.g., Cutting & Scarborough, 2006; Keenan et al., 2008). A recommended practice is to use multiple variables for each construct. The current study proposes to use latent variable modeling to construct latent word reading and reading comprehension variables from multiple measures of each construct. A clear advantage of using latent variable over any single measure of a construct is that it uses multiple measures and only reflects the most common aspects of these multiple variables to generate a more accurate measure of the construct.

For upper elementary students with reading difficulties, only one past study (Wanzek et al., 2017) has used latent variables to measure the effect of fourth grade students' baseline word reading skills on posttest reading comprehension in response to a multicomponent intervention.

The current study is a conceptual replication of the Wanzek et al. (2017) study which measured the impact of a MCRI on students' reading related outcomes. The results of the randomized controlled trial (Wanzek et al., 2017) indicated moderation effects wherein pretest word reading skills significantly moderated the effect of treatment on students' posttest reading comprehension. The current study provides support for further examination of the moderating effects of pretest word reading skills on students' response to a MCRI measured by their end of year reading comprehension performance. Table 2 shows the similarities and differences between the Wanzek et al. (2017) investigation and the current study in terms of student and study characteristics.

The process of replication is a vital element of the empirical process. Conducting replication studies adds to the validity and reliability of scientific findings and builds on our knowledge of broader theories (Coyne et al., 2016). In the field of special education, a recent review (Lemons et al., 2016) reported that only 0.41% of all published articles were replication studies; highlighting the vastly underrepresented literature base of replication studies. Conceptual replications differ in one or more attributes from the original study (Schmidt, 2009).

Thus, the focus of the current study is to evaluate how initial word reading predicts response to a MCRI. Latent variables will be used for both baseline word reading and end of year reading comprehension. Data for these analyses are taken from a year-long randomized controlled trial. We hypothesized that third and fourth grade students with reading difficulties' baseline word reading scores will predict their response to a MCRI wherein students who have

comparatively higher baseline word reading skills will perform better on comprehension measures, at the end of year one, compared to their peers with comparatively lower baseline word reading skills.

Methods

Research Design

Data for this study is taken from a multisite, blocked, randomized controlled trial that examined the effects of a MCRI on multiple reading outcomes for students with reading difficulties in Grades 3 and 4. Randomization occurred at the student-level, and intervention groups were grade-specific. Thus, Grade 3 students within each teacher were randomly assigned to treatment or control conditions, and similarly, Grade 4 students within each teacher were randomly assigned to one of the three conditions.

Participants

Third- and fourth-grade students at each school were screened using the Gates-MacGinitie Reading Comprehension subtest (GMRT-4, MacGinitie, et al. 2000). Across the three participating schools, 495 students were screened for the study; 128 students met screening criteria. Students who met the screening criteria performed at or below a standard score of 92 on the GMRT-4 reading comprehension subtest. The study sample included 72 Grade 3 and 56 Grade 4 students from 31 different classrooms across the three schools. Table 3 provides demographic information for all participants included in the study.

Intervention Implementation Procedures

Treatment group students were randomly assigned to two treatment conditions: Reading + Math or Reading + Anxiety. In both treatment conditions, students received approximately 25 minutes of the exact same reading-related instruction during each session. For the remaining 5-

minutes of instruction time, students in the Reading + Math group engaged in solving math problems. In contrast, the Reading + Anxiety group received instruction to recognize signs of anxiety/stress and strategies to cope with anxiety/stress. Considering the focus of this study is to understand students' reading performance, in the next section we describe each component of the MCRI.

Multicomponent Reading Intervention

In the two treatment groups, interventionists delivered reading instruction for 25-30 minutes for four to five days a week in small groups ranging from two to five students. A total of 80 lessons were completed with both treatment groups over two academic semesters (i.e., Fall and Spring). Eleven tutors were recruited for the project and received approximately 20 hours of training on implementing lessons. All tutors had prior teaching experience.

Treatment group students were instructed in practices aimed at improving word reading (~13% of the total intervention time), fluency (~26% of the total intervention time) and reading comprehension (~61% of the total intervention time). Word reading instruction included systematic decoding of words and reading word lists to improve sight word development. Fluency instruction was similar to repeated reading practices allowing students to read the passage more than once. Comprehension related instruction included strategy instruction (e.g., summarizing, self-questioning, etc.), text-based approaches (i.e., pronoun references & identifying text structure), and content-related discussions. Vocabulary instruction was embedded within comprehension instruction and involved quickly preteaching the meaning of unknown words and facilitating use of context clues to determine the meaning of unknown words. All instructional practices were centered around explicit instruction (modeling, guided practice, and independent practice) to promote the gradual release of responsibility.

Control Group Instruction

Students continued to receive school-based instruction. Of the 41 control group students, 24 (59%) received small group, supplemental reading intervention at their schools. Teachers audio recorded a small number of supplemental reading intervention sessions for the research team. All teacher session recordings were coded. Instruction in control condition classes for these students included instruction on reading text fluently (21% of instruction time), decoding words (21% of instruction time), learning new vocabulary (3% of instruction time), and instruction to improve comprehension of the text (55% of instruction time). More details on control group instruction are reported in Authors et al. (Under review).

Treatment Fidelity

We coded treatment adherence by rating each of the instructional activities on a 4-point Likert type rating scale ranging from 1 (*low*) to 4 (*high*). The average adherence scores across the reading instruction activities (i.e., fluency, systematic decoding, word study, isolated comprehension skill component, etc.) and interventionists at the end of the year was 3.18 out of 4. More details on the fidelity of implementation are reported in Authors et al. (Under review).

Measures

Reading Comprehension Measures

Gates MacGinitie Reading Test (GMRT-4; MacGinitie et al., 2000). The GMRT-4 is a group administered standardized reading test that is norm referenced for Grades K-12 and adulthood. Internal consistency for this assessment ranges from .91 to .93, and alternate form reliability is reported as .80 to .87.

Test of Silent Reading Efficiency and Comprehension (TOSREC; Wagner et al., 2010). The TOSREC test is a group-administered standardized measure of reading fluency and

comprehension. Results demonstrate that TOSREC is more strongly associated with reading comprehension than other fluency-type measures (Denton et al., 2011). The TOSREC test also has an average correlation coefficient that is greater than .76 with various standardized reading comprehension measures. For Grades 3-4, alternate-form reliability exceeds .86.

Kaufman Test of Educational Achievement (KTEA-3; Kaufman & Kaufman, 2014). The KTEA-3 is an individually administered test that is norm referenced for persons aged four through 25 years. Internal consistency of the reading comprehension subtest for Grades 3 and 4 students ranges from .88 to .91, and alternate form reliability is reported as .76.

Word Reading Measures

Test of Word Reading Efficiency (TOWRE-2; Torgesen et al., 2012). The TOWRE-2 sight word efficiency (SWE) subtest is a standardized, individually administered timed test that requires students to read a list of printed words in 45-seconds. The test measures an individual's ability to decode real words fluently. The test-retest reliability is .90 for a sample of third- and fifth-grade students while alternative-form reliability exceeds .90.

Woodcock Johnson Test of Achievement (WJ-III; Woodcock et al., 2001). Two untimed subtests, WJ-III Letter Word Identification and the WJ-III Word Attack, were administered to assess students' word-level reading skills. Internal reliability ranges from .87 to .94 while the test-retest reliability ranges from .81 to .85 for both subtests.

Analytic Plan

First, we determined if the two treatment conditions (i.e., reading + math and reading + anxiety) were significantly different on the pretest word reading and the posttest reading comprehension latent variables. We wanted to account for any added benefits of the 5-minutes of math or anxiety treatment on students' reading outcomes. It could be that receiving 5-minutes of

math intervention improved students' reading outcomes as the two constructs have been shown to be associated. Similarly, reducing students' reading-related anxiety may also have added benefits on students' reading outcome. Thus, we compared both treatment groups on latent variables. The results showed no significant differences on the pretest word reading ($B = 0.34$, $SE = 0.95$, $p>.05$) or posttest reading comprehension ($B = 1.62$, $SE = 1.38$, $p>.05$) latent variables. We collapsed both treatment groups for all further analyses.

The intervention study's research design was partially nested with cross classification. We ran unconditional models to estimate the intraclass correlation coefficients (ICCs) for each level of the study design. We evaluated ICCs on the posttest reading comprehension measures to determine if the statistical model needed to account for partial nesting in the data structure. We used Snijders and Bosker's (2004) recommendation to determine if ICCs were significant ($F > 1$ = significant ICC), which would indicate the need to model partial nesting in the analyses. If ICCs are not significant (i.e., $F < 1$), then single level models can be estimated. The F-test scores for all posttest measures at both the tutor and teacher levels were not significant ($F < 1$), indicating that there was no significant effect of teacher- or tutor-level clustering on students' posttest reading comprehension outcomes. Given that tutor- and teacher-level ICCs were not significant, we conducted single-level analysis.

In figure 1, the model specifies the paths for the framework of this study—how baseline word reading skills influence students' response to a multicomponent intervention as measured by their performance on end of year one reading comprehension tests. To fit the SEM model, we conducted confirmatory factory analysis (CFA) to test a two-factor model of students' word reading and reading comprehension proficiencies, and specified regression paths between the latent constructs to estimate the parameters of the model. We regressed the posttest reading

comprehension latent variable on the pretest word reading latent variable. Additionally, we added an interaction term between word reading and treatment condition to measure the moderating effect of group assignment and pretest word reading proficiency on posttest comprehension. Next, we assessed the fit of the model. The model was evaluated using various fit indices that include model chi-square, comparative fit index (CFI), Tucker-Lewis index (TLI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). We followed standard guidelines to assess the adequacy of model fit (Hooper, Coughlan, & Mullen, 2008): chi-square $p > .05$; RMSEA < .07; SRMR < .08; TLI > .95; and CFI > .95.

Results

Descriptive statistics for all observed variables are provided in Table 4, and Table 5 shows the correlation between variables. We fit the model using Mplus 8 (Muthen et al., 2016) using the full information maximum likelihood estimation for the missing data. The observed variables fit the data closely; all indicators showed significant positive loadings, with standardized coefficients ranging from .60 to .87. Figure 1 shows the standardized loadings for 2-factor confirmatory model. The measurement model outcome suggested an adequate fit model according to the fit indices with χ^2 (8) = 12.38 (p = .13), RMSEA = .06, SRMR = .03, TLI = .96, and CFI = .98. In summary, the hypothesized CFA model appears to be a good fit.

Results from Main Data Analyses

The primary objective of the study was to provide supporting evidence for the path model that hypothesizes an association between pretest word reading skills and posttest reading comprehension proficiency. As shown in Figure 1, there was no significant main effect of treatment on students' reading comprehension outcomes at posttest (ß = .09, *SE* = .08, $p > .05$).

In other words, treatment and control group students did not differ significantly on the posttest latent reading comprehension variable.

Next, the same structural model measured the effect of pretest word reading skills on students' posttest reading comprehension proficiency. The finding demonstrates that controlling for condition, pretest word reading was a significant predictor of students' posttest reading comprehension (ß = .69, *SE* = .09, $p < .01$). That is, regardless of the condition to which students were assigned, a positive change of one standard point in students' pretest word reading was associated with a 0.69 standard point gain in students' posttest reading comprehension scores. Similarly, students' pretest GMRT scores was also a significant predictor of their posttest reading comprehension scores (ß = .18, *SE* = .08, $p < .05$).

We also examined whether pretest word reading moderated the effect of the intervention. The interaction term between pretest word reading and condition allowed us to evaluate if the effect of treatment on students' posttest reading comprehension was associated with students' pretest word reading. The interaction term was not significant (ß = .20, *SE* = .17, $p > .05$) indicating that the effect of pretest word reading on posttest reading comprehension was not moderated by condition (i.e., treatment or control); to present a parsimonious model we dropped the interaction term from the final model.

Discussion

This study examined the influence of baseline word reading proficiency on students with reading difficulties' response to a MCRI. More specifically, we were interested in examining if the impact of the multicomponent intervention, as measured by the end-of-year standardized reading comprehension assessments, was similar or different for students who started the

intervention with varying levels of word reading proficiency. The current study utilized latent variables to investigate the research question.

Does Baseline Word Reading Influence End-of-year Reading Comprehension?

Supporting our hypothesis that students with comparatively higher baseline word reading proficiency would perform better on end-of-year reading comprehension measures, we found significant effects of baseline word reading proficiency on end-of-year reading comprehension performance in the present study. As shown in Figure 1, when controlling for the condition students were randomly assigned to, baseline word reading ability was a significant predictor of students' end-of-year reading comprehension performance. We also assessed the degree to which the results from the current replication study align with the effects demonstrated in the original study (Wanzek et al., 2017). The results are similar to Wanzek et al.'s (2017) findings that baseline word reading proficiency significantly predicted students' end of year reading comprehension. That is, students who started the intervention with higher baseline word reading scores performed significantly better on the end-of-year reading comprehension assessments compared to peers who started with comparatively lower baseline word reading scores. However, unlike Wanzek et al.'s (2017) findings, the current study showed no significant main treatment effect on students' comprehension scores. Moreover, there was no significant interaction between baseline word reading and condition to which students were assigned.

A key finding from the current study is that the influence of baseline word reading was significant on end-of-year reading comprehension performance regardless of the condition students were assigned to. One interpretation of this finding is that word reading predicts reading comprehension regardless of the instruction students received in the treatment or control condition. More specifically, for treatment group students, the one-year long multicomponent

intervention that was delivered in small group settings was not powerful enough to override variance in word-reading proficiency at the start of the treatment.

Multiple reading theories such as the simple view of reading (Gough & Tunmer, 1986), the verbal efficiency theory (Perfetti, 1985) and the lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002) posit that when word reading is slow and/or error prone then reading comprehension is negatively impacted. The current study's results suggest that even when students receive high quality instruction to improve their reading comprehension proficiency, the benefits may be minimal depending on their baseline word reading proficiency. In a recently published study, Vaughn and colleagues (2020) demonstrated that students with reading comprehension difficulties who were identified as below-average word readers benefited less from a reading comprehension intervention compared to students with reading comprehension difficulties who were identified as near-adequate word readers. These findings suggest that students word reading proficiency needs to be above a certain threshold for them to benefit from comprehension related instruction. Indeed, Wang and colleagues' (2018) study of upper elementary and later grades students' longitudinal reading data supports their decoding threshold hypothesis, which posits that, students who are below a certain threshold of word reading proficiency fail to make meaningful gains in reading comprehension. For example, fifth grade students who performed below the decoding threshold demonstrated marginal growth in reading comprehension in later grades while fifth grade students above the decoding threshold demonstrated significant gains in comprehension performance in later grades (Wang et al., 2018). Thus, these theoretical frameworks, along with the current study's finding, highlight the need for identifying upper elementary and later grades students who are below average word readers and delivering targeted instruction to improve their word reading proficiency.

Past studies of the profile of students with reading difficulties has generally shown that there is a lot of heterogeneity in this population of students (e.g., Leach et al., 2003). Student reading profiles generally show difficulty in comprehending text only or difficulty in comprehending and decoding text. A small proportion of student profiles show difficulty in word reading but not comprehension. To address the needs of diverse reading profiles of students with reading difficulties, more recent approaches to improve student reading outcomes have generally focused on providing MCRIs that target different areas of reading instead of focusing on a single reading domain (Scammacca et al., 2016). However, recent randomized controlled trials have reported small effects of multicomponent interventions for upper elementary students with reading difficulties (e.g., Wanzek et al., 2017).

Students with low word reading ability may need prolonged exposure to word study instruction to demonstrate similar gains in comprehension outcomes compared to peers with higher levels of word reading proficiency. Compton and colleagues (2005) implemented a seven-month long decoding-intervention targeting below-average word readers in Grades 3–5 and reported large gains on treatment group students' word reading and reading comprehension scores indicating that heavier focus on word recognition may be beneficial for poor word readers. However, not all word-reading only focused interventions have demonstrated gains in reading comprehension for this student population (Ehri et al., 2009; Torgesen et al., 2008; Toste et al., 2017).

Study Limitations

A limitation of the current study is that it may be low powered, which makes it hard to detect significant effects. Kyriazos (2018) stated that factors that can reduce the required sample size are: continuous variables, normally distributed data, high reliability of indicator measures,

simple models, and no missing data. Accordingly, the SEM model in this study utilizes: continuous variables that are mostly normally distributed, standardized measures with high reliability, and a relatively simple model. Additionally, there is minimal missing data. Thus, we believe that although our sample is relatively small, other factors in the analysis mitigate the need for a large sample to run a stable SEM model. Furthermore, the fit indices output suggests that the model adequately fits the data. Another limitation of the current study is that a majority of the sample identified English as their home language. Results from this study may not generalize to upper elementary students with reading difficulties who speak a language other than English at home, especially, students who speak languages that have orthographies dissimilar to English. Additionally, student data related to socioeconomic status were not available at the time of this study, therefore, it is unclear if the current study's finding can be generalized to all students regardless of family income levels.

Practical Implications

One of the key reasons for this study was to understand if students with different levels of baseline word reading respond similarly to a MCRIs comprising evidence-based practices. An important takeaway for practitioners is that when implementing evidence-based reading interventions with students with reading difficulties, practitioners need to be cognizant of students' word reading levels. For instance, if a teacher is implementing an evidence-based MCRI and a student is not demonstrating progress in their reading comprehension scores in response to treatment, practitioners should evaluate students' word reading proficiency. If performance is below average on word reading measures, then teachers should consider providing supplemental word reading instruction to develop students' word reading proficiency.

The results of this study underscore the importance of implementing word reading instruction for below-average word readers in upper elementary grade-levels. While multicomponent interventions have shown promise in improving students' reading outcomes, when designing these interventions, it may be beneficial to allow flexibility in the amount of instructional time devoted to each reading component. In context of the current multicomponent intervention, students who were below-average baseline word readers may have benefited from increased intervention time dedicated to word study. On the other hand, adequate word readers could have benefited from less word reading instruction and an increased focus on other domains of reading such as fluency, vocabulary, building background knowledge, and strategy instruction.

Future Research

A more nuanced approach is also needed to understand the effects of reading interventions for students with reading difficulties. A significant proportion of students with reading difficulties have deficits in word reading in addition to reading comprehension. When analyzing the sample data for effects of reading interventions, it may be beneficial to disaggregate the results to measure effect sizes for students who are below-average and adequate word readers. Disaggregated results can help identify whether a particular reading intervention is more or less beneficial for students with below-average or average word reading proficiencies. A key consideration for reliably conducting these analyses is to estimate study power to account for these subgroup analyses.

Another area of future research would be to evaluate if baseline word reading proficiency continues to predict students' response to multicomponent interventions in middle and high school. Only one past study has explored the impact of baseline word reading on middle school

students with reading difficulties' response to a multicomponent intervention (Clemens et al., 2019). No past study has reported the impact of baseline word reading variability on high school students with reading difficulties' response to MCRIs.

Finally, there is a real paucity of interventions targeting word reading at the middle and high school levels. Considering that a significant proportion of students with reading disabilities in middle and high school continue to perform below-average on word reading measures (e.g., Wang et al., 2018), it may be beneficial for the field to develop and implement interventions that target word reading development in this student population.

Conclusion

While reading comprehension is the ultimate goal of reading, word reading proficiency is an essential component in students' success with reading comprehension proficiency. By drawing on past reading theoretical frameworks (Gough & Tunmer, 1986; Perfetti, 1985, 1992) and research literature on effective reading interventions for upper elementary students with reading difficulties, this study highlights the need for a more nuanced approach to evaluating intervention effectiveness. Despite evolving evidence of the effectiveness of MCRIs in improving students' reading-related outcomes, results from this study highlight that even when students receive instruction in various reading components, the benefits of these instructional practices in enhancing their reading comprehension may vary depending on students' pre-intervention word reading proficiency. Thus, it is important for reading researchers to identify sub-samples for whom a particular intervention is more or less effective and increase the dosage of word reading for students lacking proficiency in this most fundamental skill.

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Table 1

Summary of Multicomponent Group Design Reading Intervention Studies for Upper Elementary Students with Reading Difficulties Published in the Last 20-years

Study (sample size)	Grade-level	Intervention components	Measure type	Treatment group significantly outperformed controls			
				WR	Fl	Voc	RC
Guthrie et al., 2009 (*n* = 63)	5	Fluency + Word reading + Inferencing instruction + Motivational practices + Writing	Std	Y	N[a] Y	-	Y
Kim et al., 2010 (*n* = 294)	4–6	Fluency + Word reading + Vocabulary + Reading comprehension strategies	Std	N	N	N	N
O'Connor et al., 2002 (*n* = 46)	3–5	Fluency + Word reading + Reading comprehension strategies + Spelling + Writing	Std	Y	Y	-	Y
Rasinski et al., 2011 (*n* = 1032)	4–5[b]	Fluency + Word reading + Reading comprehension	Std	-	-	-	N
Ritchey et al., 2012 (*n* = 123)	4	Fluency + Reading comprehension strategies + Vocabulary + Motivational practices	Std, RD	N	-	-	[1]N Y*
Roberts et al., 2018 (*n* = 419)	3–5	Phonemic awareness + Word reading + Fluency + Vocabulary + Reading comprehension strategies	Std	-	-	-	N
Therrien et al., 2006 (*n* = 30)	4–8	Fluency + Reading comprehension strategy	Std	-	Y	-	N

Vaughn et al., 2016 (n = 483)	4	Fluency + Word reading + Vocabulary + Reading comprehension strategies	Std	N	N	-	N
Wanzek et al., 2016 (n = 221)	4	Fluency + Word reading + Vocabulary + Reading comprehension strategies	Std	N	N	-	N
Wanzek et al., 2017 (n = 451)	4	Fluency + Word reading + Vocabulary + Reading comprehension strategies	Std	N	-	N	Y
Wanzek & Roberts, 2012 (n = 87)	4	Reading comprehension strategies + Word reading	Std	N	N	N	N

Note. WR = Word reading; Fl = Reading fluency; Voc = Vocabulary; RC = Reading comprehension; Std = Standardized reading measure; RD = Researcher developed reading measure. Researcher developed measure is denoted by *.

[a] A yes and no in the same cell indicates mixed results across two different measures of the same reading construct.

[b] Study was conducted with students in Grades 4–10. However, authors report disaggregated data for each grade-level. This table only shows results for students in upper elementary grades.

Table 2

Comparison of Study Elements Between the Original Study and the Current Replication Study

	Wanzek et al. (2017)	Current study
Sample Size	451	128
Grade-level	Fourth	Third and fourth
Selection Criteria	GMRT Standard Score <92	GMRT Standard Score <92
Reading Comprehension Measures	GMRT Reading Comprehension WJ Passage Comprehension	GMRT Reading Comprehension TOSREC KTEA-3
Word Reading Measures	WJ Letter word identification WJ Word attack	TOWRE Sight Word Efficiency WJ Letter word identification WJ Word attack
Intervention	Passport to Literacy	Researcher-developed multicomponent reading intervention
Study Conditions	Passport to Literacy Control	Reading + Math Reading + Anxiety Control
Intervention Components	Phonics and Word Recognition (12%)	Phonics and Word Recognition (13%)

	Vocabulary and Reading Comprehension (62%) Reading fluency and text reading (18%) Spelling and other instruction (8%)	Vocabulary and Reading Comprehension (61%) Reading fluency and text reading (26%)
Latent Variable	Reading Comprehension Word Reading	Reading Comprehension Word Reading
Analytic Approach	Multilevel structural equation modeling	Structural equation modeling

Note. GMRT = Gates MacGinitie Reading Test; KTEA-3 = Kauffman Test of Educational Achievement; TOSREC = Test of Silent Reading Efficiency and Comprehension; TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson III Tests of Achievement.

Table 3

Demographic Information

	Reading + Anxiety		Reading + Math		Control		
	n	Proportion	*n*	Proportion	*n*	Proportion	χ^2
Gender							5.33
Male	18	.41	22	.51	27	. 65	
Female	26	.59	21	.49	14	.35	
Grade							0.11
Three	24	.54	25	.58	23	.56	
Four	20	.46	18	.42	18	.43	
Ethnicity / Race							3.73
African American	07	.16	09	.21	12	.30	
Caucasian	13	.30	12	.28	7	.17	
Hispanic / Latino	22	.50	20	.47	21	.51	
Other	02	.04	02	.04	1	.02	
Home Language							2.08
English	37	.84	34	.79	31	.76	
Spanish	05	.11	08	.19	9	.22	
Not reported	02	.05	01	.02	1	.02	

Table 4

Descriptive Statistics

Measure	Testing time	Treatment			Control		
		n	*M*	*SD*	*n*	*M*	*SD*
WJIII LWID	Fall 2017	87	101.21	9.71	40	101.52	7.77
WJIII WA	Fall 2017	87	101.36	9.36	40	102.02	8.41
TOWRE SWE	Fall 2017	87	87.57	11.45	40	85.62	12.31
GMRT RC	Spring 2018	80	91.16	9.22	36	89.15	9.78
TOSREC	Spring 2018	77	91.25	12.53	35	89.17	9.85
KTEA 3	Spring 2018	77	83.85	5.79	36	83.75	5.11

Note. WJIII = Woodcock Johnson III Tests of Achievement; LWID = Letter–word identification; WA = Word attack; TOWRE = Test of Word Reading Efficiency; SWE = Sight word efficiency; GMRT = Gates MacGinitie Reading Tests; RC = Reading comprehension; TOSREC = Test of Silent Reading Efficiency and Comprehension; KTEA-3 = Kaufman Test of Educational Achievement.

Table 5

Correlations for Reading Measures

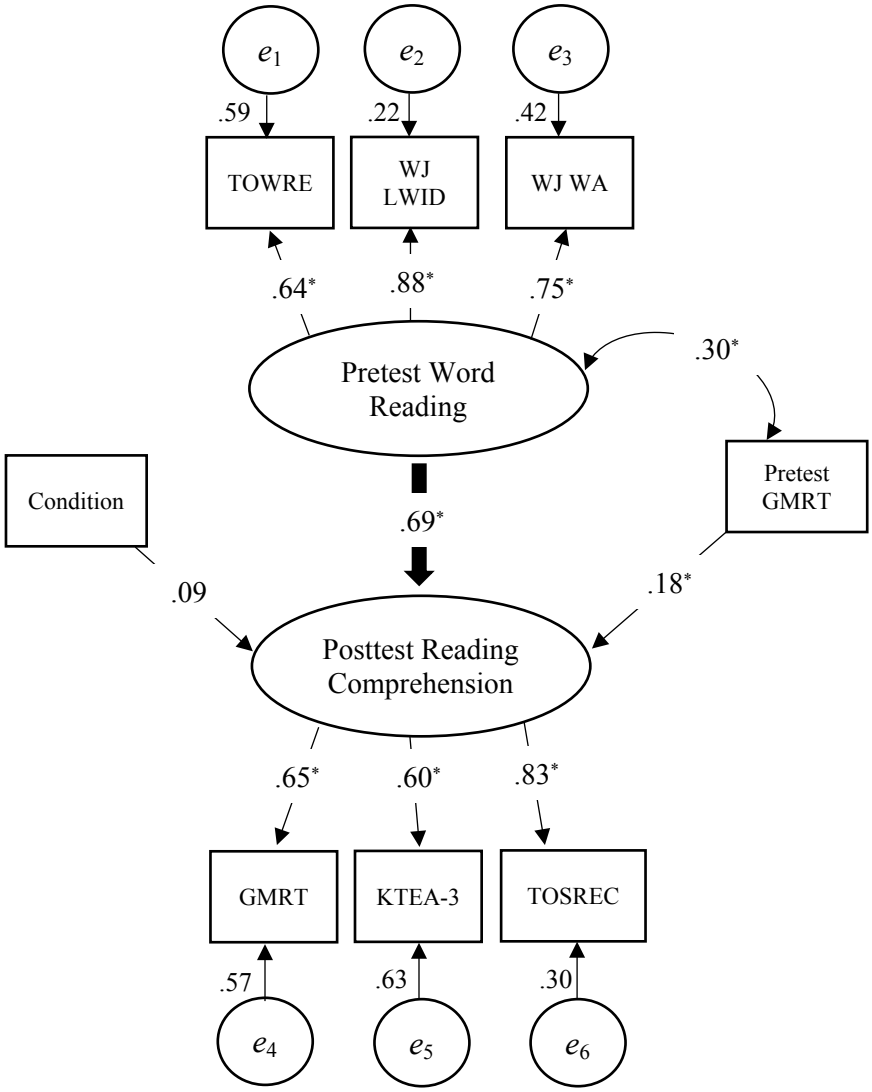
	WJ LWID	WJ WA	TOWRE	GMRT	TOSREC	KTEA 3
WJ LWID	1					
WJ WA	.69	1				
TOWRE	.48	.45	1			
GMRT RC	.31	.36	.33	1		
TOSREC	.52	.38	.45	.54	1	
KTEA 3	.31	.31	.31	.45	.41	1

Note. WJ = Woodcock Johnson III Tests of Achievement; LWID = Letter Word Identification; WA = Word Attack; TOWRE = Test of Word Reading Efficiency-2; GMRT = Gates MacGinitie Reading Tests; RC = Reading comprehension; TOSREC = Test of Silent Reading Efficiency and Comprehension; KTEA3 = Kaufman Test of Educational Achievement.

All correlations statistically significant at least $p < .05$.

Figure 1

Standardized Estimates for the Structural Equation Model



Fit indices: Comparative Fit Index = .997; Tucker-Lewis Index = .995; Root mean square error of approximation (RMSEA) = .023; Standardized root mean square residual (SRMR) = .036; Chi-square = 13.86 (*df* = 13, *p* = .383).

Note. GMRT = Gates MacGinitie Reading Tests; KTEA-3 = Kaufman Test of Educational Achievement-3; TOSREC = Test of Silent Reading Efficiency and Comprehension; TOWRE = Test of Word Reading Efficiency; WJ = Woodcock Johnson III Tests of Achievement; LWID = Letter–word identification; WA = Word attack.

*$p<.05$

IMPORTANCE OF BASELINE WORD READING SKILLS

Supplemental Material

Table A

Parameter Estimates and Significance Levels for Sensitivity Analyses

	B (*SE*)	ß (*SE*)	*p*-value	CFI	TLI	RMSEA	SRMR	Chi-square
GMRT ON								
Condition	2.096 (1.708)	.104 (.085)	.220	1.00	1.00	.00	.02	4.03 (*df* = 5, *p* = .54)
Word reading	0.546 (0.114)	.439 (.079)	.000					
TOSREC ON								
Condition	2.613 (1.827)	.104 (.074)	.153	1.00	1.00	.00	.03	3.99 (*df* = 5, *p* = .55)
Word reading	0.994 (0.140)	.641 (.078)	.000					
KTEA ON								
Condition	0.230 (0.948)	.019 (.080)	.808	1.00	1.00	.00	.02	2.11 (*df* = 5, *p* = .83)
Word reading	0.350 (0.079)	.478 (.102)	.000					

Notes. B = Unstandardized estimate; ß = Standardized estimate; *SE* = Standard error; GMRT = Gates MacGinitie Reading Tests; KTEA = Kaufman Test of Educational Achievement; TOSREC = Test of Silent Reading Efficiency and Comprehension. Word reading = Pretest word reading latent variable; CFI = Comparative fit index; TLI = Tucker Lewis index; RMSEA = Root mean square error of approximation; SRMR = Standardized root mean square residual.