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Reading Fluency and Students With Reading Disabilities: How Fast Is Fast Enough to Promote Reading Comprehension?

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Abstract

The goal of improving reading rate and fluency is to positively impact reading comprehension; however, it is unclear how fast students with learning disabilities (LD) need to read to reap this benefit. The purpose of this research was to identify the point of diminishing return for students who were dysfluent readers. Participants included 337 students with reading difficulties in second and fourth grade (61% eligible for special education; 80% with a diagnosis of LD in the area of reading) and 150 typical readers from the same general education classes. LOESS (LOcal regrESSion) plots (logistic regression) were used to determine where linear relations between reading rate and comprehension broke down for these students: the rate at which getting faster no longer contributed clearly to reading comprehension improvement. Although typical readers in this sample showed patterns of oral reading rate and comprehension similar to students in other studies, patterns for students with reading difficulties differed. For dysfluent readers, improving reading rate improved comprehension only in the bands between 35 and 75 words correct per minute in second grade and between 40 and 90 words correct in fourth grade. Reading at faster rates revealed no clear advantage for reading comprehension.

Keywords

reading rate, reading comprehension, fluency, LOESS, learning disabilities, reading disabilities, poor readers, asymptote

Good readers read with sufficient rate to process words effortlessly and think about what they read (LaBerge & Samuels, 1974; Paris, 2005). Effortless word reading enables good readers to draw inferences from text and to link known with new ideas and information (e.g., see reviews by Chard, Vaughn, & Tyler, 2002; Kuhn, Schwanenflugel, Meisinger, Levy, & Rasinski, 2010). By contrast, dysfluent readers tend to read slowly because the process of word recognition has not been consolidated (Ehri, 1995); thus, considerable attention is devoted to "getting words off the page," which makes deep processing of text difficult, if not impossible (Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Perfetti & Stafura, 2014; Thurlow & van den Broek, 1997). For students with a learning disability (LD), reading fluency is often identified as a major hindrance that spirals through many aspects of reading: When students read slowly, they tend also to read less text (Adams, 1990; Allington, 2001; Jenkins et al., 2003), which slows acquisition of vocabulary (Nagy & Townsend, 2012) and the world knowledge that contributes to reading comprehension (Graesser, Singer, & Trabasso, 1994; Kintsch, 1988). Thus, improving students' reading rate may have implications that go beyond the mere acquisition of fluency in students' overall reading development.

Fluency, or the rate and prosody of reading text, has long been considered one of many components of effective reading (National Reading Panel Reports of the Subgroups, 2000). Some reading components, such as phonemic awareness (e.g., the ability to segment spoken words into speech sounds) and recoding printed words as speech (e.g., decoding words by associating printed letters with speech sounds), are considered constrained reading skills because they can be mastered as a complete set in a year or two of instruction (Paris, 2005). Others, such as vocabulary and reading comprehension, are unconstrained and continue to grow over time with sufficient text exposure. Learning in these areas is never complete (Paris, 2005; Perfetti & Stafura, 2014). Fluency, and particularly oral reading fluency, falls in between the constrained and unconstrained components because reading rate grows rapidly over the first several years of instruction (Hasbrouck & Tindal, 2006; Kim, 2015),

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improves gradually through the middle grades (Kim & Wagner, 2015; Silberglitt, Burns, Madyun, & Lail, 2006), and takes several years to attain optimal levels (Silberglitt & Hintze, 2007), which many researchers suggest is the rate of speech (Samuels, Ediger, & Fautsch-Patridge, 2005). Samuels et al. (2005) suggested that "the essential ingredient in fluency is the ability to decode and comprehend at the same time" (p. 2), or reading aloud as if listening to a speaker. Although prosody is clearly part of fluent reading, the measure in the current study refers only to oral reading rate.

Developing sufficient reading rate is thought to be important because studies consistently find strong correlations between reading rate and comprehension throughout the elementary school years (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Roehrig, Petscher, Nettles, Hudson, & Torgesen, 2008). In Grades 1 through 6, Reschly, Busch, Betts, Deno, and Long (2009) found an average correlation of .67 between rate and comprehension across studies. In most studies, correlations between reading rate and comprehension appear to weaken by middle school. For example, Silberglitt et al. (2006) found that correlations between reading rate and comprehension gathered in Grade 7 were smaller than for students in Grade 5. They also hinted at an asymptote for this relationship as reading rates approached 165 words correct per minute (wcpm), which is similar to the rate of speech. For students whose oral reading rate nears this upper desirable level, the influence of fluency becomes constrained, even though reading vocabulary and comprehension continue to grow. For this reason, Silberglitt et al. suggested that schools be wary of setting rate target scores as predictors of reading proficiency beyond the elementary school years.

Along these lines, Garcia and Cain (2014) found evidence that age was a significant predictor of the strength of the relationship between word reading ability and reading comprehension, with younger readers showing stronger relationships between word-level skills, such as decoding and reading rate, and comprehension. In modeling oral reading growth across grades, Silberglitt and Hintze (2007) also found slower rates of growth in Grades 4 through 6 than in Grades 2 through 4. Students with initially slower reading rates also made less growth during the year. Kim and Wagner (2015) also report declines in the strength of the relation between reading rate and comprehension across grades from .93 in first grade to .72 in fourth grade, suggesting that studying the linkage across grades and stages of reading development may be important. In these studies, data for the students with LD were either not included in their sample or not disaggregated.

Garcia and Cain (2014) pointed out that the relationship between reading rate and comprehension may not be not linear (see also Nese et al., 2013) and, like Silberglitt et al. (2006), found a flattening of the relationship for typical readers around age 10. Adding a new dimension to the discussion, Garcia and Cain also found evidence that characteristics of the reading comprehension measure played a role in the strength of correlations between rate and comprehension, a finding that echoes that of Cutting and Scarborough (2006) and Keenan, Betjemann, and Olson (2008).

Students With LD in Reading (RD)

A consistent problem across these studies is that few have considered the rate–comprehension relations specifically for students with RD, who may have the most to gain if reading rate is improved sufficiently. Although some level of reading fluency may be necessary for comprehension, high levels of fluency may not necessarily contribute to the text processing necessary for reading comprehension (Sabatini, O'Reilly, Halderman, & Bruce, 2014). Studies have shown differences in fluency and growth in reading rate between students with and without RD across the elementary grades, and so it becomes important to establish whether reading rates attained by average readers are needed for comprehension of text by students with RD. In a study that compared rates of oral reading fluency growth between students with RD and typical readers in second and third grade, Wanzek, Al Otaiba, and Petscher (2014) found consistently lower reading rates for students with RD coupled with slower rate of growth during each school year. This finding was similar to that of Tindal, Nese, Stevens, and Alonzo (2016), who found that performance on measures of oral reading fluency correlated significantly with special education status. Like Wanzek et al., Tindal et al. also found much less growth on these measures over time for students with RD.

In a study of second and third grade students, Petscher and Kim (2011) demonstrated weaker correlations between reading rate and comprehension for students at the low end of the reading distribution than for students reading in the average and above range. Due to different—and lower—growth trajectories than typical readers, these researchers questioned whether using oral reading rate to measure the reading success of students with RD was appropriate. Tindal et al. also cautioned that students with RD may never reach oral reading fluency that mirrors speech. None of these studies considered whether optimal reading rates for adequate reading comprehension might differ between students with and without RD.

Wolf and Bowers (1999) suggest this slower growth in fluency may be related to the well-documented Rapid Automatized Naming (RAN) deficits of students with LD, which are difficult to treat. In a longitudinal study of LD, Elwer, Keenan, Olson, Byrne, and Samuelsson (2013) found RAN deficits in preschool that persisted through the fourth grade, which was as far as this team followed its sample (see also Johnston & Kirby, 2006; Lyytinen et al., 2006; Swanson & Siegel, 2001). Even when skills such as

decoding accuracy are fully remediated, fluency tends to be more difficult to improve (Torgesen, Alexander, & Wagner, 2001; Vadasy & Sanders, 2008, 2009). Torgesen et al. recommended we fix the subskills of reading and comprehension strategies and worry less about reading rate.

Identifying the levels at which one skill influences another can help interveners to know when one aspect of reading is sufficiently developed and when to turn the focus of intervention toward other aspects of reading. As examples of these shifts in emphasis, plots of phoneme segmentation ability and letter naming in kindergarten or first grade against word reading ability measured concurrently demonstrate that identifying about 30 segments of spoken words or naming 50 letters correctly in 1 minute is strongly related to students' acquisition of decoding printed words (O'Connor & Jenkins, 1999). Thus, improving these skills up to these rates may benefit overall reading development. Nevertheless, identifying more than 30 phonemic segments or more than 50 letters in a minute, as many children are able to do near the end of kindergarten or early in first grade, offers little additional boost to learning to decode (O'Connor & Jenkins). In other words, these levels of skill development are sufficient to generate positive impacts on word recognition.

Understanding points of asymptote among reading components (i.e., the point at which getting better on a lower level reading component fails to improve a higher level component) can inform instructional efficiency by helping teachers understand when to stop teaching a low-level skill in favor of a higher level skill. Several studies have suggested reading rates that appear to offer some protection from comprehension failures (Good, Simmons, & Kame'enui, 2001; Silberglitt et al., 2006); however, these studies did not examine students with RD specifically. Thus, we know little about reading rates that might be sufficient for students with RD, especially during the middle elementary grades (Grades 2 through 4) when building reading fluency is often an instructional priority. Although research provides correlational evidence that faster reading rate is associated with higher levels of reading comprehension for typical-reader samples in the elementary grades, less is known about sufficient reading rate for poor readers and students with RD.

Improving Reading Rate to Improve Comprehension

Researchers have explored the extent to which improving reading rate causes better comprehension. Because accurate oral reading frees up processing resources for text comprehension (Ehri, 1995; Jenkins et al., 2003), fluency should act as a bridge toward comprehension that first helps students to translate printed words to speech, which enables them to use their understanding of oral language to assist with reading comprehension. Perfetti and Stafura (2014) refer to this bridge as word-to-text integration, in which students begin to recognize words and make sense of short sentences in text. With experience, students process printed words faster and gradually shift from oral to silent reading comprehension in the later grades (Rasinski, 2012). Failure to develop sufficient rate to enable silent reading comprehension is one of several "pressure points" in reading development identified by Perfetti and Stafura.

A strong test of the rate–comprehension relationship would require generalized rate improvement that can be demonstrated in new passages students read only once, along with measures of comprehension before and after rate improvement. Markell and Deno (1997) suggested that rate improvement may need to be large (e.g., gains of 20 words per minute or more) to improve comprehension of text, and most experimental studies of the rate–comprehension relations have been too brief to generate rate improvement this high. Studies that have focused on improving generalized reading rate have documented that it takes considerable time—often 6 to 8 weeks or more of practice with feedback (O'Connor, White, & Swanson, 2007; Therrien, Wickstrom, & Jones, 2006)—for this generalized rate improvement to be reliable. Moreover, gains in fluency with intervention tend to be stronger for younger than for older students in the elementary grades (O'Connor et al., 2013; Vadasy & Sanders, 2008, 2009).

With the current focus on rate as a measurement tool to assess reading progress in elementary school, some teachers consider improvement in reading rate as an end goal of instruction (O'Brien, Wallot, Haussmann, & Kloos, 2014), which loses the thread of theory that ties reading rate to reading comprehension (Rasinski, 2012). It seems obvious that recognition of printed words is necessary for comprehension of written sentences and passages; what is less well understood is how *automatic* that recognition must be, especially when students have difficulty across multiple reading components, as do many students with RD. Perseverating on low-level reading skills past the point they facilitate text comprehension denies students opportunities to learn the more advanced skills needed for success in content area learning (Claessens, Engel, & Curran, 2013).

Depending on students' reading ability and history, studies have found distinct differences in relations among components formerly believed to develop concurrently. For example, Shankweiler et al. (1995) found students with adequate comprehension and poor word reading ability and fluency. Ferrer, Shaywitz, Holahan, Marchione, and Shaywitz (2010) used the Connecticut Longitudinal Study (Shaywitz et al., 1995) to measure several aspects of cognition and reading over time in a sample that included typical readers, compensated readers (i.e., students who were poor readers in the primary grades but later became good readers), and persistently poor readers. Although the relations

among measures for typical readers were robust and bidirectional, with reading and cognitive skills sharing mutual facilitation, for students who read poorly cognitive ability and reading skills uncoupled and the relation was both weaker than for typical readers and decreased over time. Compensated readers improved their reading skills such that by ninth grade, their reading comprehension was in the average range; nevertheless, their reading rate—despite adequate reading comprehension—remained significantly below average, calling into question whether rate should be in the average range for adequate comprehension of text. Walczyk et al. (2007) suggested that slow reading rate can provide a compensatory mechanism for students with reading difficulties, in which they read text at a rate that enables their comprehension. They use compensatory-encoding theory to explain how nonfluent skills can combine with compensation to improve reading comprehension. As did Sabatini et al. (2014), they suggest that reading at too fast a rate can interfere with reading comprehension.

The Current Study

Researchers have documented that improving the rate at which students with LD read text can have a positive impact on their reading comprehension (Markell & Deno, 1997; O'Connor et al., 2013; Swanson & O'Connor, 2009; Therrien et al., 2006). Nevertheless, improving reading rate for these students takes considerable supported practice (Kuhn et al., 2010; O'Connor, Swanson, & Geraghty, 2010; Shany & Biemiller, 1995). Given the instructional time it takes to improve reading rate, it becomes important theoretically and practically to understand how fast students need to read to take advantage of the theoretical comprehension boost fluent reading enables. In other words, can we empirically identify reading rates for students with RD that are fast enough to facilitate comprehension of text?

Moving beyond correlations is necessary for exploring this question because the relation might not be linear, even in samples of students in the same grade. Correlations can be misleading if the strength of the correlation is not uniform across the range of scores. Smoothing a line—allowing it to curve empirically—can show where correlations are strongest and the point at which relations weaken. Moreover, exploring these points across grade and reading ability could further our understanding of these relations and inform instructional decisions. To capture these relations, this study employed LOESS (LOcal regrESSion) curves, a nonparametric procedure built on least squares regression that builds a function to describe data point-by-point (Cleveland & Devlin, 1988).

Taking into consideration Garcia and Cain's (2014) finding that the fluency/comprehension connection may differ across comprehension measures, this study also examined how features of comprehension measures affect the perceived relation between rate and comprehension. For example, decoding skill—a major component of reading rate—has been found to be more influential for measures of sentence comprehension than for comprehension of longer passages (Francis, Fletcher, Catts, & Tomblin, 2005; Keenan et al., 2008). Keenan and Meenan (2014) also found that the correlations between measures of sentence- and passage-level comprehension varied for younger and older students, suggesting again that these types of measures require differing demands. Overall, they suggest no one best way to assess comprehension but rather that researchers broaden their approach to measuring comprehension and incorporate more than one type of measure. The design of the current study follows their suggestion by using sentence- and passage-level comprehension measures.

Given grade-level differences in correlations between reading rate and comprehension, we measured rate and comprehension of students with and without RD in second and fourth grade. The overarching goal of this research was to identify the point of diminishing return for students in Grades 2 and 4: the rate at which getting faster was no longer clearly associated with improved reading comprehension. The central issue was to identify likely reading rates that may be "good enough" to enable comprehension of text for younger and older students with RD, using data compiled from four experiments in improving the reading rate of students with RD.

Method

Design

Student data were pooled across four data sets in which the study purpose was to improve reading rate of students who were poor readers in second and fourth grade (O'Connor et al., 2007, 2010, 2013; Swanson & O'Connor, 2009). Five elementary schools in the Southwest United States participated across 4 years, including 4 to 16 classes per year. In the earlier studies from which the data from these participants were drawn, students who were poor readers were randomized to treatment or business as usual. None of the students received researcher-delivered intervention in reading comprehension. In each class, three to six students met criteria (see "Participants" section) for participation, and two thirds of the students received training and practice in reading aloud for 14 to 18 weeks. Data were also collected from two average readers in each of the same classes. Although gains in reading rate were significant for treated students, nearly all of them still read significantly slower than their average-reader classmates following the treatments. For the current study, data were pooled across 4 consecutive years to plot the relations between reading rate and reading comprehension for typical and RD readers in each grade.

Table 1. Means (Standard Deviations) on Reading Measures for Dysfluent (LD) and Typical Readers by Time and Grade.

	Grade 2		Grade 4	
Scores	Dysfluent Readers (*n* = 192)	Typical Readers (*n* = 72)	Dysfluent Readers (*n* = 145)	Typical Readers (*n* = 78)
October				
Oral reading rate	31.49 (14.42)	78.92 (28.23)	65.76 (20.03)	114.15 (26.01)
WRMT passage comprehension–standardized	92.63 (8.30)	106.90 (8.83)	84.45 (9.45)	97.63 (7.47)
GORT-4 comprehension–standardized	76.33 (10.40)	98.76 (16.63)	72.63 (8.71)	97.21 (12.54)
March				
Oral reading rate	62.07 (23.76)	107.54 (25.28)	87.01 (23.29)	140.29 (25.52)
WRMT passage comprehension–raw	21.79 (5.45)	28.98 (5.55)	28.15 (5.56)	33.82 (4.22)
WRMT passage comprehension–standardized	96.32 (7.94)	103.55 (9.89)	90.10 (8.23)	95.48 (7.75)
GORT-4 comprehension–raw	11.82 (4.75)	17.55 (6.15)	14.40 (6.53)	22.60 (9.32)
GORT-4 comprehension–standardized	85.62 (10.52)	102.29 (15.45)	77.99 (12.12)	99.27 (10.43)

Note. Standardized scores have a mean of 100. GORT-4 = *The Gray Oral Reading Test 4*; wcpm = words read correctly per minute; WRMT = *Woodcock Reading Mastery Tests-R*.

Participants

To be eligible for the fluency studies, second graders read below 40 words per minute and fourth graders below 80 words per minute as the median score of three AIMSweb (Academic Improvement Measurement System; Shinn & Shinn, 2002) passages. After securing parent permission (i.e., 93% of those from whom permission was requested), participating students included 337 students with RD. One hundred and ninety-two of these students were in second grade and 145 in fourth grade. Sixty-one percent were eligible for special education services (40% of second-grade and 89% of fourth-grade students), with 80% of students receiving special education services under the category of LD that included RD. Placements for these students included general education and special education resource room for up to 2.5 hours per day. No significant differences were found in reading rate between students with and without formal identification for disabilities; therefore, all of the poor reader sample will be referenced as students with RD.

Eighty-one percent were native English speakers, and 19% were English Learners (ELs) who spoke Spanish as their first language and scored 3, 4, or 5 on a 5-point scale of English Language Development. Thus, none of the EL participants were beginning English speakers and all possessed conversational ability in English. Reading rate did not differ between students with RD with and without identified disabilities or between ELs and native English speakers.

Teachers were asked to identify four average-reader classmates from the general education classes in which the students with RD spent the majority of the school day. Following parent permission, students' average-reader status was verified with measures of word and passage-level reading, described later. Scores from the two students closest to the national norm average were used to compare average readers with students with RD. To describe the sample, Table 1 shows pretest and posttest means and standard deviations (October scores) for reading rate and comprehension; however, only the posttests (March scores) were used for the analyses in the current study.

Measures

Oral reading rate. The dependent variable for reading rate was median score on AIMSweb passages. AIMSweb (Shinn & Shinn, 2002) consists of 30 graded passages for monitoring change in oral reading rate over time. Students read three different passages in October and March, and the median score for words read correctly per minute (wcpm) across passages was recorded as the final score. The reliabilities across passages used for this sample ranged from .84 to .91. Only the March scores were used for generating plots.

Reading comprehension. Due to the differing nature of comprehension tasks, two measures of reading comprehension were collected in March to evaluate their relations with reading rate. *The Gray Oral Reading Test 4* (GORT-4; Wiederholt & Bryant, 2001) was selected to estimate reading comprehension of paragraph- to page-length passages of 50 to 200 words each. Students read increasingly difficult passages orally, while the examiner notes errors and miscues. Following oral reading, the examiner asks passage-dependent comprehension questions that tap a range of comprehension types, from literal to inferential. The reliability of the GORT-4 at ages 8 to 10 ranges from .89 to .91. Regarding validity, the correlation in our sample between the GORT-4 and the *Woodcock Reading Mastery Tests-R* (WRMT) comprehension subtests was .68, and between GORT-4 rate and AimsWeb rate was .88.

The WRMT (Woodcock, 1998) Passage Comprehension subtest requires students to read one or two sentences silently with a missing word signaled by a blank space and to supply a word that makes sense in that space. Split-half reliability estimates for Grades 2 through 5 on this subtest range from .89 to .92. The technical manual reports correlations of the total WRMT reading score with the Iowa Tests of Basic Skills (.83) and Wide Range Achievement Test Reading scale (.88). Descriptive statistics for all of these measures by grade and reader status are shown in Table 1.

Results

Data Analyses

For this study, reading rates and reading comprehension were plotted in March of the school year using both measures of reading comprehension, because one (WRMT passage comprehension) measures sentence-level processing, whereas the other (GORT-4) measures comprehension of longer passages. LOESS (locally weighted scatterplot smoothing) was used to determine whether the linear relationship between reading rate and comprehension was maintained, or broke down, in each set of data using the graphing function of SPSS. LOESS is a nonparametric procedure that is built on linear and nonlinear least squares regression and fits simple models to localized subsets to build a function that describes the data point-by-point (Cleveland, 1981; Cleveland & Devlin, 1988). It is particularly useful for estimating asymptote values in discrete data sets.

Each figure shows scatterplots with oral reading rate along the horizontal axes and sentence (upper plot) or passage comprehension (lower plot), respectively, along the vertical axes. First, plots are shown for the entire data set (Figure 1). Next, to compare asymptotes for students with and without RD, the plots are separated by grade level and reading ability, because expectations for reading rate differ between second and fourth grades, and the central question of this study was to determine whether the relation between rate and comprehension differed between students with and without RD. The logic behind each analysis was to identify bands of reading rate with a direct impact on comprehension at each grade for each student type, and a point at which faster rates had less impact on comprehension, recognizing that treated students were still comparatively slow readers following intervention.

Raw scores on the comprehension measures were used to associate an amount of rate with an amount of comprehension. Figure 2 shows the plots for students with RD in Grade 2, and the typical readers in the same classrooms are shown in Figure 3. Figures 4 and 5 show the comparable relations between reading rate and comprehension for fourth graders.

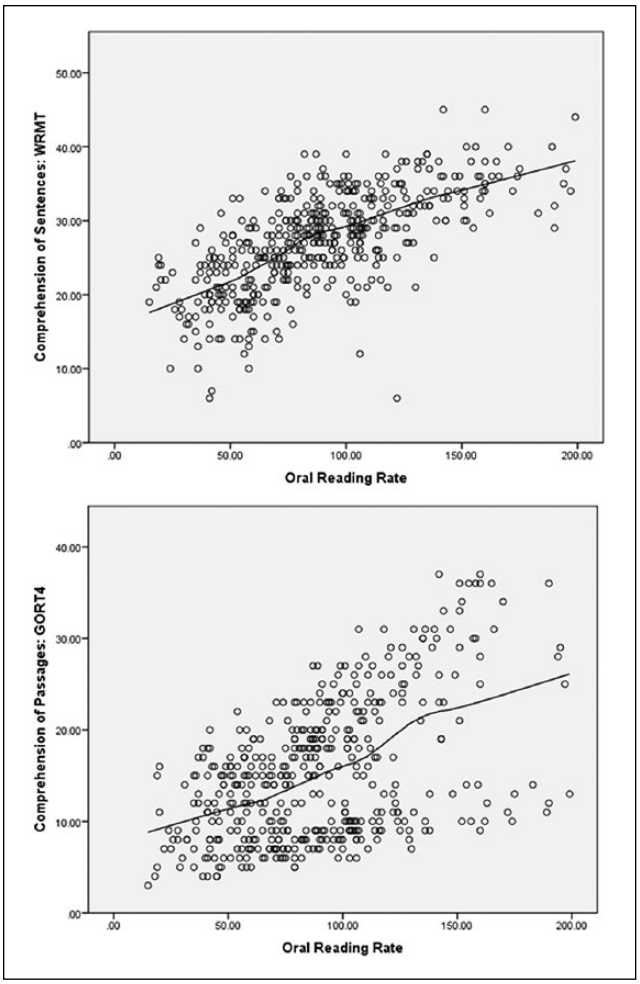

Figure 1. Oral Reading Rate and Comprehension for All Second- and Fourth-Grade Student Participants.

Results for Grade 2

Figure 2 shows the LOESS plots between reading comprehension and rate for the second-grade students with RD on the WRMT and the GORT-4. The upper plot shows the relation between reading rate and sentence-level comprehension (WRMT). The horizontal line at 29 for the WRMT indicates mean comprehension scores for the typical readers in that grade, and the line at 27 marks 0.5 standard deviation below the mean. Most observers would consider scores within half a standard deviation (above 27, equivalent to standard scores above 92.5) to be average comprehension for this grade. A linear trend is shown between about 40 and 75 wcpm, which suggests that improving rate within this band has a positive relation with comprehension of sentences. Note also that by 40 wcpm, several students with RD were achieving average ability to comprehend sentences. At around 75 wcpm, the linear trend reached an asymptote, suggesting that reading faster than 75 wcpm

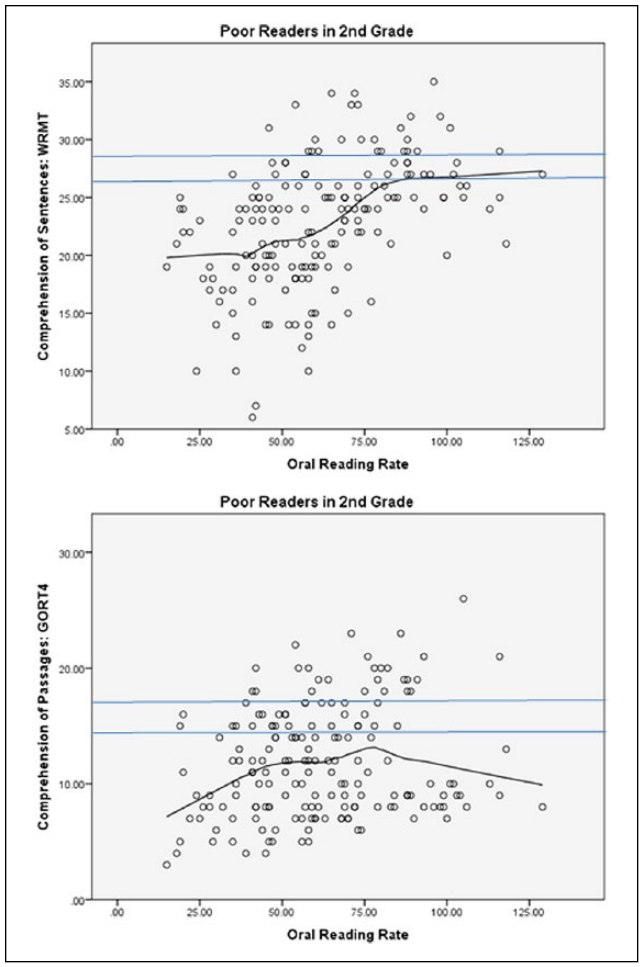

Figure 2. Students With Reading Disability in Second Grade.

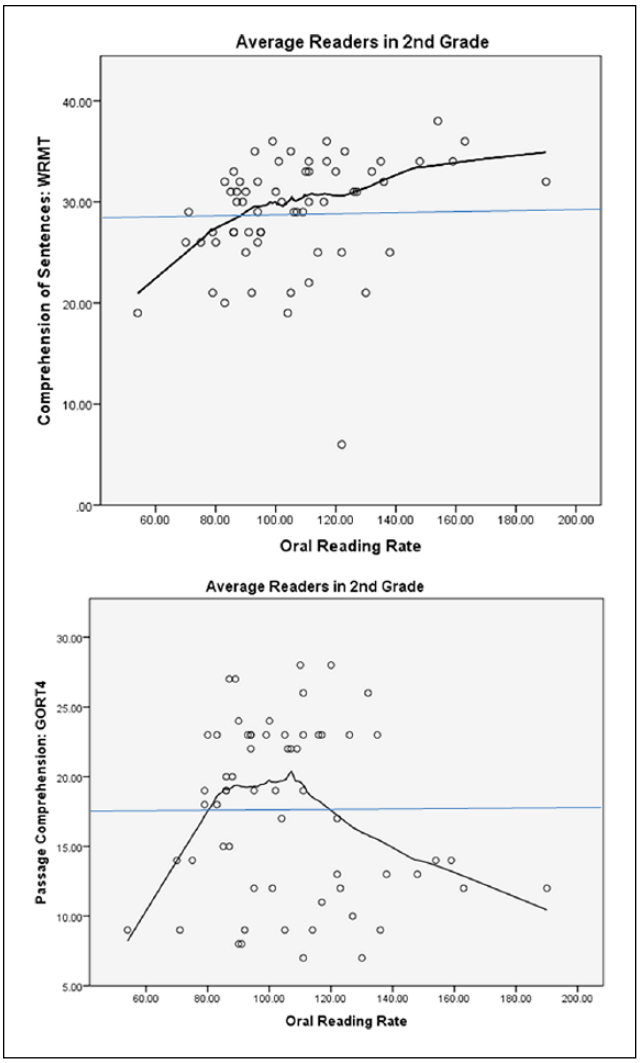

Figure 3. Typical Readers in Second Grade.

showed no distinct advantage for reading comprehension. Moreover, some students with faster rates scored more poorly on sentence comprehension than those who read slowly.

Despite only a moderate correlation (.68) between the comprehension measures, the asymptotes (point at which the linear relationship changes) were remarkably similar across measures for the second graders who were poor readers. The lower plot in Figure 2 shows a linear trend up to about 75 wcpm with comprehension of the longer passages on the GORT-4, with many students reading faster than 75 wcpm scoring more poorly on comprehension. As with the WRMT, many students with RD reading in the 40 to 60 wcpm range reached average levels of comprehension of longer passages.

In Figure 3, these relations are shown for the typical readers in the same second-grade classes. Again, the horizontal lines at 29 for the WRMT and 17.6 for the GORT-4 mark average reader scores on these measures. In both the upper and lower plots, reading faster was associated with comprehending more up to around 110 wcpm, which is a range considered "not at risk" for comprehension difficulties on commonly administered fluency measures such as *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) or AIMSweb. The asymptote for typical readers was considerably higher than for the RD sample of second graders.

Results for Grade 4

Figure 4 shows plots for fourth graders with RD. The linear trend between rate and comprehension of sentences (upper plot) fell between 40 and 85 wcpm, with flattening of the linear trend beginning around 80 wcpm and clear by 90 wcpm. On the lower plot, the linear trend fell between 75 and 90 wcpm, with the asymptote around 90 wcpm. On both plots, many students with RD achieved average levels of comprehension around 70 wcpm.

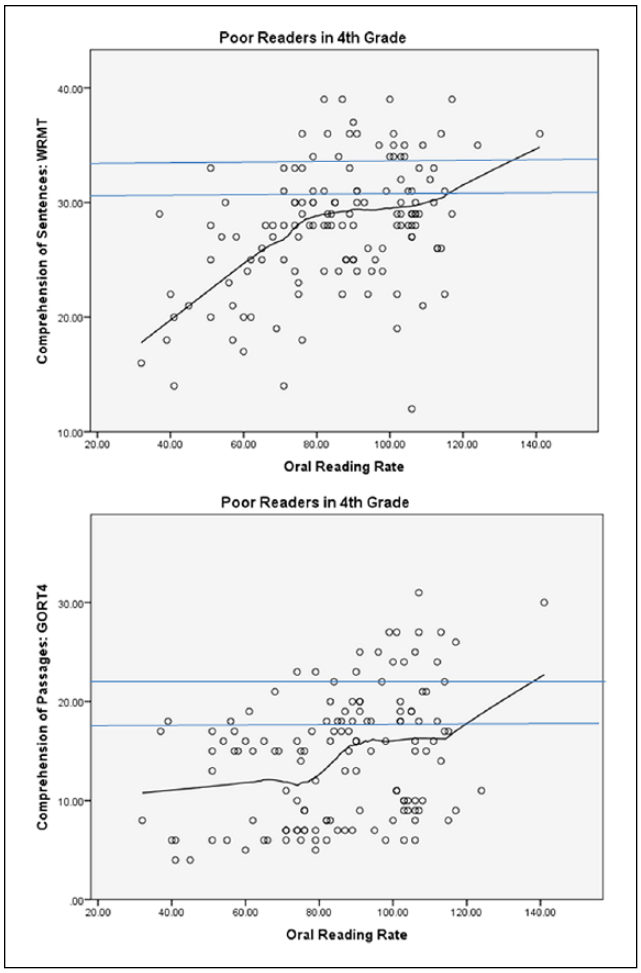

Figure 4. Students With Reading Disability in Fourth Grade.

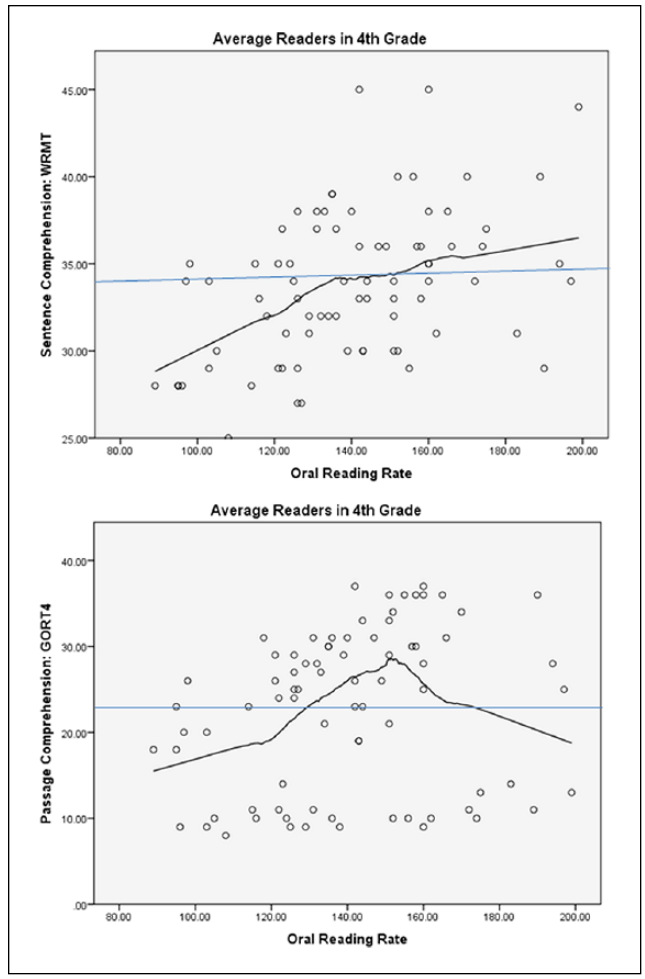

Figure 5. Typical Readers in Fourth Grade.

The plots of typical readers in fourth grade (Figure 5) show asymptotes at much higher reading rates, around 140 wcpm for the WRMT and 150 wcpm for the GORT-4. As with the second graders, several students reading at exceptionally fast rates scored worse on comprehension than those who read more slowly.

Discussion

Reading rate has long been used as a proxy for estimating reading comprehension in the elementary grades (Deno, 1985). Moreover, improving the rate with which students with RD read text can have a positive impact on their reading comprehension (O'Connor et al., 2013; O'Connor et al., 2007; Swanson & O'Connor, 2009). Nevertheless, improving reading rate for these students takes considerable supported practice (O'Connor et al., 2010; Schwanenflugel et al., 2006; Vadasy & Sanders, 2008). The goal of this study was to identify the point of diminishing return for the reading rate of students with RD in Grades 2 and 4: the rates at which getting faster were no longer associated clearly with higher levels of reading comprehension.

The first figure, in which scores are undifferentiated by grade or disability status, shows the approximately linear trend identified in earlier studies by Good et al. (2001) and others. Unfortunately, combining data into a single plot fails to discern differences in the relation between reading rate and comprehension due to grade and disability. Fourth graders (even those with disabilities) are faster readers, on average, than second graders and also generate higher raw scores on reading comprehension. Thus, when all data are combined we cannot determine whether an asymptote exists for poor readers and, if so, whether it falls in different locations for relatively younger or older students with RD. It may be important to consider these differences prior to making recommendations about optimal rate for the purpose of improving reading comprehension, because as Torgesen (2004), Wanzek et al. (2014), and Tindal et al. (2016) suggest, fluency might be less predictive of reading comprehension for students with RD.

Often considered an exploratory graphical tool, LOESS plots have an advantage over other types of analyses by identifying asymptotes among specific sets of data. LOESS can enable insight into the way relations behave at different levels (or in this case, reading rates), which can then be explored in other sets of data on the reading rates and comprehension of students with RD. Cleveland and Devlin (1988) suggest that the name LOESS even "has some semantic substance. A loess … is a deposit of fine clay or silt along river valleys; in a vertical cross-section of earth, a loess would appear as a narrow, curve-like stratum running through the section" (p. 597). In these data, the LOESS plots show how rate supports comprehension at the lower end and where the decoupling of rate and comprehension begins to appear.

As shown by the horizontal lines in Figures 2 and 4, the LOESS plots reveal numerous students with RD at each grade level who scored within the average range on comprehension despite their comparatively low reading rates—a pattern similar to Ferrer et al.'s (2010) compensated readers. Thus, the plots suggest that achieving rates comparable to those of typical readers (Figures 3 and 5) may not be necessary for a substantial portion of students with RD to achieve adequate reading comprehension.

The typical readers at both second and fourth grade showed reading rates similar to those reported in many studies (e.g., see Wanzek et al., 2014). Unlike Keenan and Meenan (2014), the plots shown here suggest that reading rate and comprehension are more tightly linked for typical than for poor readers, with most typical readers who are good sentence comprehenders in fourth grade reading in excess of 120 wcpm. For reading longer passages (i.e., the GORT-4 comprehension task), which require holding more information in memory (recall that students may not look back at the passage while answering questions), fourth-grade typical readers showed an advantage if rates were between 120 and 140 wcpm, which approximates the rate of conversational speech. Reading faster than the rate of speech, which many of these typical fourth graders were able to do, was not associated with higher levels of comprehension and may interfere with comprehension (see also Sabatini et al., 2014; Walczyk et al., 2007).

The plots for both tasks show a trend that rates faster than average were often associated with poor comprehension. Some typical readers read close to 200 wcpm; however, these exceptionally fast readers were not necessarily those with the best comprehension. Others (e.g., Rasinski, 2012; Schwanenflugel et al., 2006) have suggested the importance for comprehension of phrasing and prosody as students read aloud, and many fourth graders reading faster than their rate of speech lacked both prosody and comprehension. Reading aloud faster than speech disrupts the parsing of phrases, which contributes to reading comprehension. Students might read aloud faster than speech because teachers set goals students want to exceed, or students might set high rate goals for themselves; regardless, the result is getting faster for its own sake, rather than reading fluently with expression to better understand what they read.

Within grade, the relation between reading rate and comprehension was not linear (see Figures 2 through 5) for typical readers or students with RD, which has also been suggested by others (Garcia & Cain, 2014; Nese et al., 2013) but not shown graphically. Where other researchers have suggested potential asymptotes for fluency (Silberglitt et al., 2006), these figures show where the asymptotes lie. Each plot reveals a range within which the relation between reading rate and comprehension is linear, and these aspects of reading appear to be mutually supportive. Each plot also shows where this relationship breaks down: the point at which getting faster appears less supportive of comprehension. The horizontal lines representing average levels of reading comprehension reveal reading rates at which students can achieve average reading comprehension scores on the WRMT and the GORT-4. Although many of the students with RD scored in the average range of reading comprehension on these measures, a comparison of the asymptotes across these plots reveals distinctly different patterns between the students with RD and typical readers at both grade levels.

The Influence of the Comprehension Task

Given the differing comprehension task demands and differing relations among decoding, fluency, and comprehension reported in earlier studies (Garcia & Cain, 2014; Keenan & Meenan, 2014), the asymptotes were expected to differ between sentence- and passage-level comprehension. For example, the WRMT comprehension task should rely less on reading rate than the GORT-4 because the task is untimed and students can reread phrases or the entire sentence as they consider logical word choices. The WRMT should also place less stress on the cross-sentence paraphrase effect found by Perfetti and Stafura (2014) to influence comprehension through word-to-text integration. Despite these differences, rates related to comprehension did not differ across comprehension tasks for second graders with RD, nor did they differ across tasks for typical second graders, although typical readers appeared to require faster rates to achieve average comprehension (i.e., rates around 35 wcpm for RD but 70 wcpm for typical readers).

The fourth-grade RD sample revealed a marked difference across comprehension tasks, with much slower rates related to adequate comprehension on sentence-level than on paragraph-level tasks. Surprisingly, typical readers showed no difference across tasks, likely due to a stronger coupling among the reading components by fourth grade.

Implications

Teachers need to understand how fast is fast enough and the rates beyond which improvements in fluency make less difference in what students understand and retain from what they read. Despite apparent differences between the task and memory demands of sentence-level and passage-level reading, these rates were remarkably similar for the struggling readers. Improving fluency for second graders with RD related to improved comprehension in the band between 35 and 75 wcpm. For fourth graders, achieving rates up to 90 wcpm were related to improved comprehension. Beyond these oral reading rates, the two skills uncoupled for the students with RD.

Answering the question "How fast is fast enough for students with RD?" is important in special education instruction because it addresses instructional efficiency. Fluency takes practice over several months to grow significantly for this population (e.g., see O'Connor et al., 2007; Therrien et al., 2006), and it takes instructional time several days per week (O'Connor et al., 2013), which impinges on time to teach other key aspects of reading that also contribute to reading comprehension. On a practical level in classrooms, students with RD and other poor readers often need support and instruction along multiple aspects of the reading task, including word decoding and recognition, word meanings and syntax, and reading comprehension strategies, in addition to building rate of reading. Given the effort it takes to improve reading rate, it becomes important for teachers to understand the points at which improving reading rate may facilitate reading comprehension and the point at which continuing to focus on rate is less likely to have a positive impact. If average rates of fluency are less useful for stimulating comprehension for students with RD than for typical readers, teachers could consider devoting more time to instruction in comprehension and less time to fluency once students reach these asymptotes.

These findings also have implications for tiered models of instruction and Responsiveness to Intervention (RtI) models. Evaluation of reading progress in these models often focuses on measures of reading rate; instruction in these models also focuses on increasing reading rate to meet exit criteria. The findings in this study suggest that overreliance on fluency for poor readers might not be beneficial for the ultimate goal of reading comprehension. Good and Kaminski (2002) report that second graders reading below 60 wcpm in the end of Grade 2 are at high risk for reading failure; however, their study did not include students beyond third grade and so did not consider compensated readers, such as found among the older students in studies of Ferrer et al. (2010) and Torgesen et al. (2001). Of students with RD scoring in the average range on reading comprehension in this study (32% of this sample), half read between 40 and 60 wcpm, which suggests that rate as an indicator of reading comprehension may overestimate risk among slow readers. Moreover, rate as an indicator of comprehension for students with RD may be less accurate than in the general population (Tindal et al., 2016; Wanzek et al., 2014). Clearly these relations should be tested with other samples of students; however, in the meantime, teachers of students with slow reading rates might consider thinking less about "benchmark" rates in Grades 2 through 4 and consider instead the reading rates that appear to facilitate reading comprehension, which for struggling readers may be lower than for typically developing readers.

Limitations

The data in this research were drawn from students across 4 years from five elementary schools in a single district. Over half of the students with RD in this study had participated in intervention to improve reading rate that spanned 14 to 18 weeks, with growth of over 20 words correct per minute, on average, even though their reading rate was still substantially below that of typical-reader classmates. Results could have been influenced by the fluency practice in the earlier studies or the reading instruction provided in this district. Replication of the study in school districts using other instructional procedures and curricula might find different results.

Also, roughly 20% of the student participants were classified as EL. Although all were in the intermediate to advanced English language range, it is likely that aspects of English language other than fluency exerted influences on their reading comprehension. The obvious possibility is that limited English proficiency impacted their vocabulary in English, which is known to affect reading rate and comprehension, as has been found in other studies (e.g., Lesaux & Kieffer, 2010). The current study did not explore differential impacts of these complex language features on EL and native English speaker participants. As mentioned earlier, among the RD sample in this study, students who were EL did not differ from native English speakers statistically on reading rate or comprehension; nevertheless, we lack measures of other aspects of language that support reading comprehension. These possibilities warrant further consideration as they relate to dimensions of fluency and comprehension.

Conclusions

Due to slower growth trajectories in fluency for students with RD, several researchers have suggested that recommended levels of fluency in the elementary grades might be inappropriate and unrealistic for these students (Tindal et al., 2016; Wanzek et al., 2014). The approach in the current study was to explore potential recommendations for oral reading fluency that support comprehension for students with RD.

For average readers, as has been shown in many studies, reading rate was tightly related to reading comprehension up to about 120 words per minute. Facilitative rates for poor readers were much lower: For second-grade students with RD, the points at which reading rate and comprehension decoupled were 75 and 77 words per minute, respectively, for the GORT-4 and WRMT, far lower than the end-of-year recommended rate of 120 wcpm (Good et al., 2001). For fourth-grade poor readers, these rates were 85 and 90 wcpm, respectively. Up to these rates, students with RD showed higher comprehension scores as their reading rate increased. Thereafter, "getting faster" no longer had these clear relations in any of the data sets.

In essence, the results of this study can help teachers to understand both how fast is sufficient and rates beyond which improving rate is less likely to be associated with comprehension growth. At the point where getting faster fails to generate increases in comprehension for struggling readers (i.e., about 75 wcpm and 90 wcpm for second and fourth graders), it makes sense for teachers to stop devoting considerable time to improving rate and instead focus on comprehension strategies, world knowledge, and vocabulary that can make text more accessible to students with RD late in elementary school and through the secondary grades.

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