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Cognitive Attributes, Attention, and Self-Efficacy of Adequate and Inadequate Responders in a Fourth Grade Reading Intervention

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We examined cognitive attributes, attention, and self-efficacy of fourth grade struggling readers who were identified as adequate responders ($n = 27$), inadequate responders with comprehension only deficits ($n = 46$), and inadequate responders with comprehension and word reading deficits ($n = 52$) after receiving a multicomponent reading intervention. We also included typical readers ($n = 40$). These four groups were compared on measures of nonverbal reasoning, working memory, verbal knowledge, listening comprehension, phonological awareness, and rapid naming as well as on teacher ratings of attention problems and self-reported self-efficacy. The two inadequate responder groups demonstrated difficulties primarily with verbal knowledge and listening comprehension compared to typical readers and adequate responders. Phonological awareness and rapid naming differentiated the two inadequate responder groups. In addition, both inadequate responder groups showed more attention problems and low self-efficacy compared to typical readers.

About one-third of fourth grade students in U.S. public schools performed below a basic reading level on the 2013 NAEP (National Association for Educational Statistics, 2013). This group of "below-basic" or struggling readers includes students who enter fourth grade with reading difficulties. It also includes students with intact basic reading skills at the end of third grade (e.g., adequate word reading and fluency) whose difficulties are manifested in fourth grade as text becomes more demanding (Bulgren, Sampson Graner, & Deshler, 2013; Compton, Fuchs, Fuchs, Elleman, & Gilbert, 2008; Roberts et al., 2014) and as success in school becomes increasingly dependent on higher-level reading and literacy skills (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Reading interventions for struggling readers in fourth grade and older are associated with small- to moderate-sized effects, with comprehension-based multicomponent interventions having the greatest impact on text-level, comprehension-related outcomes (Scammacca, Roberts, Vaughn, & Stuebing, 2013; Wanzek, Wexler, Vaughn, & Cuillo, 2010; Wanzek et al., 2013). Within these interventions there are subgroups of students who are considered high responders particularly when the intervention has been intensive. Also, there is a subset of struggling readers who continue to struggle even after receiving intensive instructional support (e.g., Miciak et al., 2014). This latter group is often described as "inadequate responders." The purpose of this study was to examine the cognitive attributes, attention problems, and self-efficacy of adequate and inadequate responders to intensive reading intervention. In what follows, we present how this study extends the understanding of inadequate responders to reading intervention, describe cognitive attributes, attention problems, and self-efficacy of poor comprehenders, and provide three research hypotheses.

Research suggests that students who adequately respond to intensive intervention and students who do not respond may differ along cognitive and noncognitive dimensions (Fletcher et al., 2011; Miciak et al., 2014). However, for students in upper elementary grades and middle school, only one study, Miciak et al. (2014), has addressed such differences and there is no research on attention or self-efficacy differences between adequate and inadequate responders. Miciak and colleagues compared a group of adequately responding (to a Tier 2 multicomponent reading intervention) middle school students to three groups of inadequate responders sorted by area of response (or inadequate response in this case)—comprehension, fluency, or a combination of decoding, fluency and comprehension. They found that inadequate responders in the combined group (i.e., students who demonstrated lack of adequate response in comprehension, fluency and decoding) had lower levels of cognitive attributes in all areas assessed, including oral language skills, than did adequate responders. By contrast, inadequate responders in the comprehension-only category was mainly associated with

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lower levels of oral language skills including verbal knowledge and listening comprehension. Thus, poor oral language skills were comparably debilitating to responses on measures of comprehension in the group of students who began the year with adequate basic skills (fluency and decoding) and in the group of students who were already struggling in these areas.

In the present study, we contribute to the understanding of inadequate responders in older students by extending Miciak et al.'s (2014) study in three ways. First, the focus on fourth grade is particularly salient given the finding that many fourth graders manifest reading difficulties when text challenges increase (Chall & Jacob, 2003). Second, the present study extends Miciak et al.'s work by including a sample of typical readers, allowing for comparisons beyond those between adequate and inadequate responders. Finally, while Miciak et al. limited their analysis to differences in the cognitive domain, we consider non-cognitive domains such as attention problems and self-efficacy. We use data from a randomized trial of a year-long comprehension-focused, multicomponent reading intervention provided to struggling readers in fourth grade (Vaughn, Solis, Miciak, Taylor, & Fletcher, in review).

Cognitive Attributes Associated with Reading Comprehension

The simple view of reading provides a useful heuristic for thinking about reading comprehension (Hoover & Gough, 1990) and for investigating the cognitive attributes associated with response to comprehension-focused, multicomponent intervention. In the simple view, reading comprehension is the product of decoding and linguistic comprehension, where successful readers decode symbols (letters and words) and create meaning from language. Decoding can be extended to word reading and fluency (Johnston & Kirby, 2006), and phonological awareness and rapid naming have been identified as underlying cognitive processes in the development of these skills. Linguistic comprehension is similarly multidimensional; in a cognitive framework, it can include listening comprehension, vocabulary, and general knowledge (e.g., Florit & Cain, 2011; Kirby & Savage, 2008; Tunmer & Chapman, 2012). In addition, working memory (e.g., Daneman & Merikle, 1996) and nonverbal reasoning (Fuchs et al., 2012) may also be involved in linguistic comprehension process.

Phonological processing refers to the ability to process the phonological features of language. It includes phonological awareness (i.e., the ability to understand sound structures and manipulate the sounds of spoken language) and rapid naming (i.e., the speed at which students can accurately name a series of visual stimuli). Deficits in phonological processing are a core cause of reading difficulties at the word reading level (e.g., Wagner & Torgesen, 1987) and studies have found that students with *specific* comprehension deficits generally do not have impaired phonological skills (Cain, Oakhill, & Bryant, 2000; Catts, Adolf, & Weismer, 2006; Stothard & Hulme, 1995; Nation & Snowling, 1998). Yet, others have found that phonological skills explain reading comprehension when controlling for differences in oral language (Fuchs et al., 2012).

Listening comprehension requires the encoding (as words) of incoming aural stimuli, transforming encoded content to a mental representation, integrating the representation into existing knowledge, and storing it in long-term memory (Anderson, 2005). Listening comprehension shares the same cognitive process with reading comprehension and has shown to facilitate the acquisition of reading comprehension skills (e.g., Adolf, Catts, & Little, 2006; Gough, Hoover, Peterson, 1996). The relationship between listening and reading comprehension becomes increasingly salient as students master basic, word-level reading skills and read increasingly complex text relying more on background knowledge (Diakidoy, Stylianou, Karefillidou, & Papageorgiou, 2005; Tilstra, McMaster, Van den Broek, Kendeou, & Rapp, 2009). Deficits in listening comprehension are associated with poor reading comprehension in older students (Compton, Fuchs, Fuchs, & Lambert, & Hamlett, 2012; Catts et al., 2006) and they are more prevalent among inadequate responders than among adequate responders to reading comprehension interventions (Miciak et al., 2014).

Verbal knowledge, or vocabulary and general knowledge, is central to reading comprehension. Reading comprehension process involves integrating information across sentences and building a situation model, which is a coherent representation of the passage (Kintsch, 1988). The breadth of one's vocabulary is particularly important for comprehension (Tannenbaum, Torgesen, & Wagner, 2006; Ouellette, 2006), with older students who have comprehension difficulties often having more limited vocabulary (Lesaux & Kieffer, 2010). Older students who respond inadequately to intervention have more limited verbal knowledge than adequate responders (Miciak et al., 2014).

Working memory is the ability to retain information in short-term memory and retrieve information from long-term memory while simultaneously processing other incoming stimuli (Baddeley, 1986). It accounts for individual differences in the development of reading comprehension (Cain, Oakhill, & Bryant, 2000, 2004; Cutting, Materek, Cole, Levine, & Mahone, 2009; Seigneuric, Ehrlich, Oakhill, & Yuill, 2000; Swanson & Berninger, 1995). Working memory may be implicated in several processes that influence reading comprehension, including the integration of new information into existing or recalled schema. For students in the upper elementary grades, working memory may also influence word-level reading, as reading complex and novel multisyllabic words requires the reader to hold letter-sounds in short-term memory, decode subsequent sounds, and integrate the sequence(s) of sounds to recognize the word (Compton et al., 2012).

Nonverbal reasoning, or the ability to think logically and solve novel problems, may be associated with differences in reading comprehension given its relationship to the domain-general processes of finding patterns and relations, drawing inferences, and forming concepts. Although studies have found students with and without reading comprehension difficulties do not differ in the level of nonverbal reasoning (Compton et al., 2012), others have found nonverbal

reasoning as a significant predictor of later reading comprehension, controlling for oral language and phonological processing abilities (Fuchs et al., 2012).

Attention and Self-Efficacy Associated with Reading Comprehension

Attention, or the ability to regulate attention, predicts success in school beyond cognitive and language abilities (e.g., Duncan et al., 2007; Spira, Braken, & Fischel, 2005). Conversely, inattention may compromise the time students' engage in reading intervention and inattentive students may not benefit as much from the intervention. Deficits in reading of students with attention problems have shown to be difficult to remediate with reading intervention (e.g., Rabiner, Malone, & Conduct Problems Prevention Research Group, 2004). In addition, attention has been frequently identified as a correlate of inadequate response of students in early grades (Al Otaiba & Fuchs, 2002; Nelson, Benner, & Gonzalez, 2003). As such, attention problems may characterize inadequate responders in fourth grade.

Self-efficacy is a person's belief in his or her capacity to perform at a desired or necessary level (Bandura, 1977; Schunk, 2003). Self-efficacy predicts engagement, effort expenditure, and persistence, especially when confronted with difficulties. Struggling readers who have low self-efficacy tend to doubt their capacity to improve their reading; thus, they may not actively engage in tasks or persist when challenged. As students get older, self-efficacy tends to correlate more strongly with reading skills (Chapman & Tunmer, 1997; Lepola, Vauras, & Maki, 2000). In fourth grade students, self-efficacy is positively related to reading comprehension (Katzir, Lesaux, & Kim, 2009; Shell, Colvin, & Bruning, 1995), even after controlling for verbal ability and word reading skills. Students with learning disabilities tend to possess lower levels of self-efficacy than students without learning disabilities (Chapman, Tunmer, & Prochnow, 2000; Tabassam & Grainger, 2002).

There is a relative lack of intervention research with older students on the inter-relationship of attention and reading outcomes (see Roberts et al., 2014 for an exception) or on the inter-relationship of self-efficacy and reading outcomes. Better understanding of the characteristics of inadequate responders in these non-cognitive areas provides guidance for designing more effective treatments for students with persistent reading difficulties.

Rational for This Study

In the present study, we address two questions: (a) How do adequate and inadequate responders to intervention as well as typical readers differ on key cognitive attributes? And (b) how do these groups differ in teacher-rated attention problems and self-reported self-efficacy? We hypothesized (a) regardless of the presence of word reading difficulties, inadequate responders will have lower levels of verbal abilities (i.e., listening comprehension, verbal knowledge) and working memory than adequate responders or typical readers; (b) inadequate responders with comprehension deficits and with comprehension and word reading deficits will be differentiated by the phonological processing skills (i.e., phonological awareness, rapid naming); and (c) inadequate responders will present greater attention problems and have lower self-efficacy than adequate responders or typical readers.

METHOD

Participants and Procedures

We identified a subsample of students for this study from a larger sample of students participating in a study examining executive functioning and treatment response in third through fifth graders (Vaughn, Solis, Miciak, Taylor, & Fletcher, in review) of an intensive intervention for struggling readers in a randomized control trials. The original study recruited 17 schools from three school districts in the southwestern United States. Following the administration of a reading comprehension screener assessment (Gates MacGinitie Reading Test; GMRT, 2000) to all fourth grade students at the participating schools ($n = 1695$), 298 struggling readers scoring at or below a standard score of 85 on the screener were randomly selected to participate in the intervention. In addition, students who scored at or above the 25th percentile on the GMRT (standard score > 89) were identified as typical readers. One hundred and three students were randomly selected from the pool of typical readers and were administered the same set of pretest and posttest assessments.

Criteria for Identifying Groups

For the present study, we used two groups of students from the original sample - those assigned to treatment and students identified as typical readers. We initially identified three groups of students (typical readers, adequate responders, and inadequate responders) based on posttest scores of the two standardized measures of reading comprehension, the GMRT and the Woodcock Johnson III-Passage Comprehension (WJ III- PC; Woodcock, McGrew, & Mather, 2001). We used *both* standardized assessments as our basis for identifying groups because the use of a single measure yields high false positive and false negative rates (Barth et al., 2008; Fletcher et al., 2014; Waesche, Schatschneider, Maner, Ahmed, & Wagner, 2011). In addition, it is worthy to note that our criteria for responsiveness did not include a direct measure of growth. We used a discrepancy between performance and expectation (expectation operationalized as norm-based cut score) in final status for three reasons: (a) the standardized reading assessments provide a direct measure of comprehension (discrepancy in slope would have required use of the oral reading fluency measure as a proxy for comprehension), (b) national norms allow us to evaluate the extent to which students were 'normalizing' (e.g., Torgesen, 2005) as our goal was to accelerate growth for struggling readers, and (c) slope has shown not to add substantial amounts of explained variance beyond final status (Schatschneider, Wagner, & Crawford, 2008).

From the total 401 students (treatment students and typical readers), students who had missing data on either GMRT or WJ III-PC at posttest ($n = 50$) and students who had

missing data on any of the pretest cognitive measures ($n = 48$) were dropped from this study, resulting in 303 students. Then, we identified students in three groups. First, we selected a subsample of typical readers ($n = 40$) with posttest scores on the two standardized reading comprehension measures at or above a standard score of 96 (40th percentile).The cut point reflects prior research (e.g., Compton et al., 2012) and provided a group that can be described as typical to very good readers. Second, students were identified as adequate responders if they performed at or above a standard score of 90 (25th percentile) on both measures. Third, students were identified as inadequate responders if they performed below a standard score of 90 (25th percentile) on both measures. We selected the 25th percentile as the posttest cut score because a cut-point at the 25th percentile has been used to identify inadequate responders in previous studies (Fletcher et al., 2011; Miciak et al., 2014; Vellutino et al., 2003, 2006). Additionally, because we screened students who scored at or below the 16th percentile on the GMRT in the original intervention study, a cut-point at the 25th percentile required adequate responders to have increased by at least .3 standard deviations (standard score of 5). This procedure resulted in 27 adequate responders (9% of the treated sample) and 137 inadequate responders (46% of the treated sample).

Inadequate responders were further grouped according to their word reading skills. Prior research (Catts, Compton, Tomblin, & Bridges, 2012; Leach, Scarborough, & Rescorla, 2003) has identified distinct subgroups of poor comprehenders with and without deficits in foundational reading skills (word reading). We used the Sight Word Efficiency subtest from the Test of Word Reading Efficiency (TOWRE-2; Torgesen, Wagner, & Rashotte, 2012) and the WJ-III Letter-Word Identification (Woodcock et al., 2001) to identify students with word reading difficulties. As before, students scoring below the 25th percentile on both measures were identified as poor word readers (i.e., inadequate responders with comprehension and word reading deficits). Further, students who scored *above* the 40th percentile on both measures were labeled as inadequate responders with *specific* comprehension deficits (i.e., successful word readers who struggle with comprehension). Word reading skill was not used to identify response status because the intervention targeted reading comprehension. Also, because students were not screened on word reading skills, many students who participated in the intervention did not demonstrate difficulties in word reading at pretest.

This process yielded four groups of students: Typical readers (TR; $n = 40$); adequate responders (AR; $n = 27$); inadequate responders with only comprehension deficits (IR-C; $n = 46$); and inadequate responders with both comprehension and word reading deficits (IR-CW; $n = 52$).

Patterns on demographic variables are described in Table 1. We did not expect differences in the demographic descriptors between the two inadequate responders (IR-C and IR-CW), so comparisons of demographics were made across three groups (TR vs. AR vs. IR). Obtaining extant data records from schools was difficult, increasing the missing data on special education status (48%) and free/reduced lunch status (31%). However, there were no statistically significant associations between the reader group and missingness, thus we excluded missing cases when comparing groups on the demographic variables. There were overall group differences for gender, χ^2 (2, $N = 204$) = 6.59, $p = .037$, special education status, χ^2 (2, $N = 107$) = 7.28, $p = .026$, limited English proficiency status, χ^2 (2, $N = 202$) = 41.00, $p = .000$, and ethnicity, χ^2 (6, $N = 204$) = 17, $p = .009$. We conducted a series of post-hoc analyses using adjusted standardized residuals, which indicate an individual cell's contribution to the omnibus χ^2 value. After adjusting alpha levels for multiple comparisons (using the Sidak method; see Beasley & Schumacker, 1995; Haberman, 1973), we found that inadequate responders were more likely to have an identified learning disability or other health impairment and also more likely to be labeled as limited English proficiency than adequate responders and typical readers.

Intervention

Students in the intervention condition received small group reading instruction targeting vocabulary, word reading, and reading comprehension using social studies content for 35 minutes daily for 16 weeks. Intervention was intensified by providing explicit and systematic instruction, increasing opportunities for student feedback, and, depending on the site, increasing instructional time. The lessons in this intensified intervention consisted of three components: vocabulary and concept development, text-based reading of informational and narrative texts, and word study (see www.texasldcenter.org/).

To enhance vocabulary and concept knowledge, tutors taught pre-identified vocabulary words by presenting simplified definitions, visual representation, and synonyms followed by turn-and-talk questions that students answered with a partner. The text-based reading component included text reading and a "Does It Make Sense?" activity. In approximately half of the lessons, teachers provided students with grade-level texts slightly adapted to improve the ease of readability for struggling readers. As the tutor and students read the grade-level texts, the tutor would stop throughout the activity and ask students to summarize and answer text-based questions, which required students to synthesize information across the texts. In the other half of the lessons, students practiced reading, summarizing, and asking questions about the text. The "Does It Make Sense" activity had students read and evaluate the syntax and semantics of a text section to determine if it made sense, and correct the part that did not make sense. In the word study component of the intervention, phonics skills were addressed. This activity had students read lists of multi-syllabic words, high frequency sight words, and word patterns at their instructional level, while teachers modeled the word reading and provided feedback, as needed. Details on the intervention and implementation fidelity can be found in Vaughn et al. (in review).

MEASURES

Measures for Identifying Groups

Reading comprehension was assessed with the WJ-III Passage Comprehension subtest (Woodcock et al., 2001) and the GMRT-fourth edition (MacGinitie, 2000). The WJ-III

TABLE 1
Demographics and Posttest Reading Comprehension Scores used for Grouping

	Typical Readers ($N = 40$)		Adequate Responders ($N = 27$)		Inadequate Responders ($N = 137$)	
Variables	*N*	%	*N*	%	*N*	%
Gender						
Female	25	62.5	12	44.4	55	40.0
Male	15	37.5	15	55.6	82	60.0
FRL						
Yes	21	52.5	18	66.7	75	54.7
No	2	5.0	3	11.1	9	6.6
Missing	17	42.5	6	22.2	53	38.7
SPED						
Yes	1	2.5	0	0	18	13.1
No	16	40.0	16	59.3	56	40.9
Missing	23	57.5	11	40.7	63	46.0
LEP						
Yes	0	0	9	33.3	78	56.9
No	39	97.5	17	63.0	59	43.1
Missing	1	2.5	1	3.7	0	0
Ethnicity						
African American	13	32.5	10	37.0	31	22.6
Latino/Hispanic	6	15.0	3	11.1	39	28.5
European American	10	25.0	4	14.8	10	7.3
Other/ Multiple	11	27.5	10	37.0	57	41.6
	M (SD)	Min–Max	*M* (SD)	Min–Max	*M* (SD)	Min–Max
Age	9.57 (.33)		9.54 (.47)		9.86 (.58)	
GMRT	111.25 (9.96)	99–135	94.30 (3.28)	91–102	80.29 (5.83)	65–89
WJ III- PC	103.65 (6.54)	97–120	94.30 (3.28)	90–99	79.17 (6.80)	56–89

Notes. GMRT = Gates MacGinite Reading Test; WJ III-PC = Woodcock Johnson III- Passage Comprehension; FRL = Free/Reduced Lunch; SPED = Special Education Service; LEP = Limited English Proficiency.

Passage Comprehension is a cloze-based subtest that requires students to read a passage and answer questions by filling in the missing word. Test-retest reliabilities for children aged 8–13 range from .76 to .86. The GMRT is a timed (35 minutes), group-administered assessment consisting of expository and narrative passages ranging in length from 3 to 15 sentences. Students read each passage silently and answered multiple-choice questions. Internal consistency reliability is above .90. In addition, to subgroup inadequate responders into comprehension only deficits and comprehension and word reading deficits, we used two word reading measures: The Sight Word Efficiency subtest from the TOWRE-2 (Torgesen et al., 2012) and the WJ-III Letter-Word Identification (Woodcock et al., 2001). For the Sight Word Efficiency, students are asked to read a list of words that become increasingly difficult as accurately and quickly as possible for 45 seconds. Test retest reliability coefficients are at or above .90 in the 6 to 12 age range. In the WJ-III Letter-Word Identification subtest, students are asked to read a list of words presented with increasing difficulty until a ceiling is reached.

Nonverbal Reasoning

The Kaufman Brief Intelligence Matrices Subtest – 2 (K-BIT 2; Kaufman & Kaufman, 2004) was used to assess nonverbal reasoning. The Matrices test requires students to select the picture among five or six choices that best fits with the stimulus diagrams or completes an analogy. For students aged 4–12, test-retest reliabilities are above .76.

Working Memory

The Working Memory Test Battery for Children (WMTB-C) Word List Recall subtest was administered (Pickering & Gathercole; 2001). The WMTB-C is a norm-referenced test, designed to measure working memory abilities of children aged between 5 and 15 years. The child's task is to repeat words spoken by the researcher in the order presented. The split-half reliability for the word list recall subtest was found to be .79.

Verbal Knowledge

The K-BIT 2 Verbal Knowledge subtest was used to assess students' receptive vocabulary and general knowledge (e.g., nature, geography). Students are asked to match stimulus picture with a word or phrase. Test-retest reliabilities for aged 4–12 is .88.

Listening Comprehension

The Oral Comprehension subtest of the WJ-III is an individually administered, standardized measure of a student's ability to understand oral passages (Woodcock et al, 2001). Specifically, after a passage is read aloud, students are required to provide the missing word to the end of a sentence. The Oral Comprehension subtest has a median reliability of .80 in the age range of 5 to 19.

Phonological Processing

The Rapid Letter Naming and Elision subtests from the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) were used to assess rapid naming and phonological awareness, respectively. The Rapid Letter Naming subtest requires students to name letters (six sets of six letters, total of 36 letters) that are displayed in a random sequence. The Elision subtest consists of 20 items and requires a student to listen to an audiotape, repeat a real word, and then repeat the word with a specified phoneme deleted, which may appear in the initial, middle, or rime portion of the word; in each case, the result is a real word. Wagner et al. (1999) report test-retest reliability of .88 for the Elision and .8 for Rapid Letter Naming subtest.

Attention

The Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior (SWAN; Swanson et al., 2004) scale was used to assess students' attention and behavior problems. The SWAN is an 18-item teacher rating scale that samples items from the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1994) criteria for attention-deficit/hyperactivity disorder. We used items for inattention (Items 1–9). Teachers were asked to rate the student's attention problems compared to other students of the same age based on the observation over the past months. Items were rated in a 7-point Likert scale ranging from "far below" to "far above. " Internal consistency reliability coefficient for the present sample is .97.

Self-Efficacy

Students were asked to rate their self-efficacy beliefs on a 4-point scale that ranges from 1 (Not true about me, really disagree) to 4 (Almost always true about me, really agree). This measure contains 10 items tapping general academic self-efficacy (e.g., I believe myself when it comes to learning; I am confident that I can success in learning tasks or activities). This measure was part of the Contextual Learning Scale that is currently being developed to assess students' ratings of behaviors and motivational beliefs for students in Grade 3 and older. Internal consistency reliability coefficient is .79 for the present sample.

ANALYSES AND RESULTS

Results are presented according to the two research questions. The first question compared the cognitive profiles of typical readers, adequate responders, and the two groups of inadequate responders. The second question examined how these groups differ in teacher-rated attention problems and self-reported self-efficacy.

Cognitive Profiles

We used Multivariate Analysis of Variance (MANOVA) to evaluate profiles across two domain-general (working memory, nonverbal reasoning) and four language-related (verbal knowledge, listening comprehension, phonological awareness, rapid naming) cognitive attributes. This examination involved four steps. First, we transformed the scale scores ($M = 10$, $SD = 3$) of Elision and Rapid Letter Naming to traditional standard score parameters ($M = 100$, $SD = 15$) so that the measures were on a comparable metric across the six cognitive attributes. Second, we conducted profile analyses. MANOVA tests the hypothesis that there are one or more differences across groups in cognitive attributes and fits the linear combination of cognitive attributes, referred to as a canonical variate, that best differentiates the groups. Profile analysis uses three components of the MANOVA to compare patterns across the groups: shape, elevation, and flatness (Tabachnick & Fidell, 2007). The test of shape examines whether there are differences across groups based on the different cognitive attributes. The test of elevation refers to the main effect of group averaged across the six cognitive attributes. The test of flatness is the main effect of cognitive attribute averaged across the groups. Significant effect for shape makes the tests for elevation and flatness unnecessary. We found statistically significant differences in cognitive attributes across the groups, $F\,(21, 442) = 9.89$, Wilk's $\Lambda = 0.384$, partial $\eta^2 = .273$. The multivariate effect size was estimated at .54, indicating 54% of the variance in the first canonical variate was accounted for by group membership. To examine the shape effect, we removed the elevation effect by subtracting the within-group mean of all measures from each individual's cognitive attribute score, making the elevation score for each group to zero (Bernstein, Garbin, & Teng, 1988). As a result, we found a statistically significant shape effect, $F\,(18, 441) = 3.984$, Wilk's $\Lambda = .653$, partial $\eta^2 = .132$.

As a third step, we conducted four pair-wise comparisons using planned contrasts, separately for each measure: (a) TR versus AR; (b) TR versus IR (IR-C+ IR-CW); (c) AR versus IR (IR-C+ IR-CW); and (d) IR-C versus IR-CW. Because this involved 24 multiple comparisons, we present unadjusted p-values as well as p-values derived from a step-down bootstrapping method to control for the family-wise error rate (Westfall, Young, & Wright, 1993) using SAS PROC MULTTEST (Table 2). The stepdown method has greater power than the Bonferroni correction while maintaining a strong control of familywise error. The bootstrapping method incorporates all correlational and distributional attributes. We calculated effect sizes as the standardized mean difference between each pair of groups using pooled standard deviation from both groups, correcting for small sample size (Hedges' g). Results indicated that inadequate responders (IR-C and IR-CW) scored lower on all six cognitive attributes compared to the group of typical readers (corrected ps $< .001$). Inadequate (IR-C and IR-CW) and adequate responders differed on verbal knowledge, $t\,(123) = 5.15$, corrected $p < .001$, and listening comprehension, $t\,(123) = 4.27$, corrected $p = .001$. Adequate responders differed from typical readers in verbal knowledge, $t\,(65) = 3.52$, corrected

TABLE 2
Descriptive Statistics for Pretest Measures

	TR ($N = 40$)		AR ($N = 27$)		IR- C ($N = 46$)		IR- CW ($N = 52$)	
	M	SD	*M*	SD	*M*	SD	*M*	SD
Reading								
GMRT	105.00	7.63	80.04	3.77	77.02	5.83	74.75	6.56
WJIII- PC	100.78	6.05	89.11	4.93	82.89	5.38	74.88	8.98
SWE	98.28	11.01	83.48	12.30	90.11	6.35	69.40	9.39
WJIII-WID	108.30	10.63	94.04	8.15	95.15	6.43	78.23	8.62
Cognitive Dimensions								
Working Memory	103.13	13.62	91.44	11.88	85.15	12.39	85.79	15.64
Nonverbal Reasoning	108.03	10.07	99.22	15.06	92.04	15.16	92.29	16.07
Verbal Knowledge	104.88	9.15	91.74	13.13	75.67	13.75	76.33	17.53
Listening Comprehension	105.23	9.61	93.63	9.58	81.02	13.15	79.98	19.20
Phonological Awareness	99.25	13.80	87.96	12.35	88.91	13.66	77.31	11.98
Rapid Naming	100.13	11.24	93.70	11.15	91.85	9.51	85.67	10.15
Attention & Self-Efficacy								
Attention Problems (Possible Range: 1–7)	3.10	1.53	4.21	1.32	4.41	1.32	4.95	1.28
Academic Self-Efficacy (Possible Range: 1–4)	2.50	.56	2.28	.62	2.15	.50	1.94	.62

Notes. GMRT = Gates MacGinitie Reading Test; WJ III-PC = Woodcock Johnson III-Passage Comprehension; SWE = Test of Word Reading Efficiency-Sight Word Efficiency; WJIII-WID = Woodcock Johnson III-Word Identification; TR = typical readers; AR = adequate responders; IR-C = inadequate responders with comprehension deficits; IR-CW = inadequate responders with comprehension and word reading deficits; Attention problems was administered at the end of Grade 4.

TABLE 3
Pairwise Comparisons

	TR vs. AR			TR vs. IR			AR vs. IR			IR-C vs IR-CW		
	raw *p*	bootstrap *p*	*g*	raw *p*	bootstrap *p*	*g*	raw *p*	bootstrap *p*	*g*	raw *p*	bootstrap *p*	*g*
Cognitive Dimensions												
Working Memory	.001	.010	.89	<.001	<.001	1.25	.047	.234	.71	.819	.994	–.04
Nonverbal Reasoning	.014	.125	.71	<.001	<.001	1.11	.026	.178	.45	.933	.994	–.02
Verbal Knowledge	.001	.004	1.19	<.001	<.001	2.02	<.001	<.001	1.02	.819	.994	–.04
Listening Comprehension	.002	.015	1.19	<.001	<.001	1.65	<.001	.001	.85	.718	.991	.06
Phonological Awareness	.001	.008	.84	<.001	<.001	1.18	.087	.342	.38	<.001	<.001	.90
Rapid Naming	.016	.125	.57	<.001	<.001	1.09	.031	.186	.49	.004	.040	.62
Attention & Self-Efficacy												
Attention Problems (1–7)	.001	.004	.86	<.001	<.001	1.14	.273	.385	.26	.051	.244	.42
Academic Self-Efficacy (1–4)	.129	.295	.37	<.001	<.001	.80	.063	.243	.41	.075	.244	.36

Notes. TR = typical readers; AR = adequate responders; IR-C = inadequate responders with comprehension deficits; IR-CW = inadequate responders with comprehension and word reading deficits; Attention problems was administered at the end of Grade 4.

$p = .004$, listening comprehension, $t\ (65) = 3.09$, corrected $p = .015$, working memory, $t\ (65) = 3.40$, corrected $p = .01$, and phonological awareness, $t\ (65) = 3.43$, corrected $p = .008$. Inadequate responders with word reading problems (IR-CW) differed from inadequate responders without word reading difficulties (IR-C) on the phonological processing measures - phonological awareness, $t\ (96) = 4.42$, corrected $p < .001$ and rapid naming, $t\ (96) = 2.93$, corrected $p = .04$. Means and standard deviations for each group appear in Table 2.

In the final analytic step, we used discriminant function analyses for each contrast to estimate the relative contribution of each cognitive attribute in discriminating the groups (Table 4). We present canonical structure coefficients and standardized discriminant coefficients. Canonical structure coefficients represent bivariate relationships between each measure and the canonical variate. Coefficients greater than .33 are interpreted (Tabachnick & Fidell, 2007). Standardized discriminant coefficients determine the relative contribution of a particular measure controlling for others. Results indicated that the canonical variates explained 18–55% of the variance in the grouping variable. The canonical variate had greater predictive power when discriminating TR from AR (48%) or IR (55%). Less variance was explained when discriminating AR and IR (18%) and IR-C and IR-CW (27%). For the TR and AR contrast, verbal knowledge was the strongest predictor followed by rapid naming, listening comprehension, and working memory. For the TR and IR contrast, verbal knowledge, nonverbal reasoning, rapid naming, and working memory contributed to the identification of groups. For the AR and IR contrast, verbal knowledge was the most discriminant predictor. Phonological awareness and rapid naming discriminated the IR-C and IR-CW groups.

Attention and Self-Efficacy

We also examined group differences in teacher-rated attention problems and in student-reported self-efficacy related to general learning (Table 3). The measures differed in metric

TABLE 4
Discriminant Function Analyses Results

	TR vs. AR	TR vs. IR	AR vs. IR	IR-C vs. IR-CW
Canonical Structure Coefficients				
Working Memory	.47	.52	.38	–.04
Nonverbal Reasoning	.37	.46	.40	–.01
Verbal Knowledge	.63	.84	.90	–.03
Listening Comprehension	.63	.68	.75	.05
Phonological Awareness	.44	.49	.33	.75
Rapid Naming	.30	.45	.43	.52
Standardized Discriminant Coefficients				
Working Memory	.39	.23	.03	–.20
Nonverbal Reasoning	.12	.30	.27	–.31
Verbal Knowledge	.54	.61	.74	.04
Listening Comprehension	.40	.03	.11	–.39
Phonological Awareness	.09	.17	–.02	.98
Rapid Naming	.48	.29	.33	.53
Eta-squared	.48	.55	.18	.27

Notes. TR = typical readers; AR = adequate responders; IR-C = inadequate responders with comprehension deficits; IR-CW = inadequate responders with comprehension and word reading deficits.

and in occasion (i.e., teacher-rated attention was administered at posttest) thus we compared groups using a series of ANOVAs for each measure instead of running profile analyses. There were significant overall differences on attention problems, $F(3,153) = 13.82$, $p < .001$, and self-efficacy, $F(3,161) = 7.38$, $p < .001$. Pairwise contrasts indicated that inadequate responders showed greater attention problems, $t(130) = 6.33$, corrected $p < .001$, and lower self-efficacy, $t(136) = 4.23$, corrected $p < .001$, compared to typical readers. Adequate responders were more inattentive than typical readers, $t(61) = 3.56$, corrected $p = .004$. Inadequate responders and adequate responders did not differ on attention and self-efficacy. Similarly, there were no significant differences on attention and self-efficacy between inadequate responders with and without word reading difficulties.

DISCUSSION

The present study focused on students in fourth grade, a year in which many students begin to struggle with grade-level text. We examined the cognitive profiles for struggling students who responded to intervention and those who did not respond. We also included a group of typical readers for the purpose of comparison. Additionally, we explored differences in attention problems and self-efficacy across the four groups (i.e., TR vs. AR vs. IR-C vs. IR-CW).

Differences in Cognitive Attributes by Group

Our findings suggest that the four reader groups were characterized by unique cognitive profiles. Inadequate responders (IR-C and IR-CW) showed poor performance on all cognitive measures compared to typical readers and performed poorly on measures of oral language (i.e., verbal knowledge and listening comprehension) compared to adequate responders. The two inadequate responder groups (IR-C and IR-CW) were separated by the measures of phonological processing. Additionally, both typical readers and adequate responders had flatter profiles, while inadequate responders had patterns

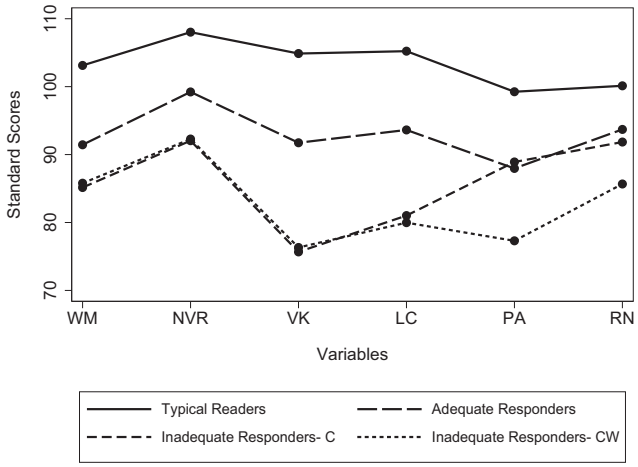

FIGURE 1 Cognitive profiles of typical readers, adequate responders, and inadequate responders.

Note. WM = working memory; NVR = nonverbal reasoning; VK = verbal knowledge; LC = listening comprehension; PA = phonological awareness; RN = rapid naming; Inadequate Responders-C = inadequate responders with comprehension deficits; Inadequate Responders-CW = inadequate responders with comprehension and word reading deficits.

of relative strengths (e.g., nonverbal reasoning) and weaknesses (e.g., verbal knowledge), on average (see Figure 1).

We highlight several findings. First, although significant differences in phonological awareness were found between inadequate responders and the other groups, neither our findings nor do those of Miciak et al. (2014) suggest phonological awareness as a major contributing factor of separating the groups. The role of phonological awareness was not substantial in differentiating inadequate responders to typical readers or adequate responders in a multivariate context as evidenced by the negligent standardized discriminant coefficients (–.02 < coefficients < .17). This pattern of results is different from earlier studies on strengths and weaknesses in students with reading disabilities that implicate phonological awareness as a primary factor of separating adequate and

inadequate responders (Fletcher et al., 2011; Stage, Abbott, Jenkins, & Berninger, 2003; Vellutino et al., 2006). This may be due to the differences in the age range of participating students and criterion used for student selection. The earlier studies focused on beginning readers and used word reading and/or fluency to determine responsiveness. Thus, phonological awareness has shown to be the strongest contributor of the response status in the earlier studies. In contrast, the current study and Miciak et al. (2014) sampled students in fourth grade and older, and reading comprehension was used as the primary indicator of response in both studies, resulting in less substantial effects of phonological awareness on the group separation than in earlier studies.

Second, language-related areas, including listening comprehension and verbal knowledge were significantly lower in inadequate responders (both IR-C and IR-CW) compared with the typical readers and adequate responders. Prior studies have found oral language as a critical precursor of later reading comprehension difficulties (Catts et al., 2006; Catts et al., 2012), and our findings suggest that poorly developed language skills in fourth grade are associated with inadequate response to intervention and poor reading comprehension. As there is limited evidence on the efficacy of language-based intervention (Clarke, Snowling, Truelove, & Hulme, 2010; Fricke, Bowyer-Crane, Hayley, Hulme, & Snowling, 2013) on later comprehension outcomes, the pattern of findings across multiple studies suggests this as an area in need of systematic inquiry.

Finally, we identified two inadequate responder groups with and without word reading difficulties. These two groups (IR-C and IR-CW) were distinguished primarily by the differences in phonological processing, including phonological awareness and rapid naming, an expected outcome given the word reading challenges of the IR-CW group. Consistent with prior findings, our results indicated that older students, as a group, tend to become increasingly diverse in the patterns of cognitive attributes underlying in reading difficulties (Catts et al., 2006; Leach et al., 2003). A subset of struggling readers in upper elementary and middle school has intact phonological processing skills while others may continue to struggle and have comprehension difficulties because of the deficits in phonological processing. This highlights the need for multicomponent intervention targeting both lower level (word reading) and higher level skills (comprehension) for students who has global cognitive deficits.

Differences in Attention and Self-Efficacy by Group

Our second research question addressed attention problems and self-efficacy of inadequate responders. Teachers reported more attention problems among inadequate responders than typical readers. Both inadequate responder (IR-C and IR-CW) groups did not differ from the adequate responder group. The two groups of inadequate responders did not differ from each other in teacher-rated attention problems. Our finding highlights the need for developing intervention that are intensified by incorporating instructional strategies for inattentive students.

Inadequate responders reported lower levels of self-efficacy than typical readers. However, self-efficacy among adequate responders was comparable, on average, to that of typical readers. It is possible that poor comprehenders who began the intervention with elevated levels of self-efficacy showed more persistence, effort, and willingness to try than students with lower levels of self-efficacy, which ultimately led to improved reading outcomes. In addition, as ongoing difficulties of inadequate responders may feed to the negative self-perception, failure to respond to the intervention (and reading difficulties) and poor self-efficacy could become a vicious cycle (Morgan, Fuchs, Compton, Cordray, & Fuchs, 2008; Stanovich, 1986). Our finding suggests that self-efficacy may play a role in how older struggling readers respond to intensive intervention.

Limitations of the Study

The findings should be considered with several caveats in mind. First, the sample sizes for the group of adequate responders and the group of typical readers are relatively small. The adequate responder group accounted for approximately 9 % of the treated students. This represents a considerably lower response rate than that reported in primary grades (e.g., Torgesen, 2000), but it is generally consistent with the research in upper elementary and middle school (Miciak et al., 2014). Second, we recognize that how "responsiveness" to treatment is defined is likely to vary by investigator and influence findings. While other studies have considered fluency as a separate construct that characterize subtypes of adequate and inadequate responders (Fletcher et al., 2011; Miciak et al., 2014), it was not included in the present study for the following reasons. Students were screened on a comprehension measure, the intervention was comprehension-focused, and prior research has shown that fluency does not account for unique variance in reading comprehension beyond word reading and listening comprehension (Adolf et al., 2006).

Implications for Practice

Our findings suggest several implications for practice. First, oral language skills need to be incorporated as an important component of reading intervention for older struggling readers. It seems clear that language deficits characterize inadequate responders compared to the group of responders and it is possible that the likelihood of response increases to the extent that such differences can be addressed as part of intervention. As this research aligns with past research (Miciak et al., 2014) on the importance of both oral language skills and knowledge, it further highlights the need to target these skills at a younger age. By providing at-risk students with intensive early interventions that target problem areas like language and knowledge, it may be possible to increase their chances for success, by mitigating their risk for later difficulties.

It is also important to note that there was a high percentage of English learners in our sample. Students with limited English proficiency were more likely to be identified as inadequate responders and may be at greater risk for

comprehension difficulties than those who are not identified as limited English proficient. This demographic pattern may be due to relatively lower levels of listening comprehension or limited vocabulary in English (Jean & Geva, 2009; Mancilla-Martinez, & Lesaux, 2010). Our finding underscores the need to design intervention that promote English oral proficiency (August & Shanahan, 2006) by providing ongoing oral language support along with reading intervention for these students. Additionally, integrating diverse and complex texts across the curriculum would benefit students with limited English proficiency. Thus, it would be important to intensify the instruction by augmenting such approaches that can build up on reading comprehension.

Non-cognitive factors like inattention and poor self-efficacy beliefs may also have a role in how struggling readers respond to intensive intervention (e.g., Conlon, Zimmer-Gembeck, Creed & Tucker, 2006; Fletcher et al., 2002; Katzir et al. 2009; Sideridis, Mouzaki, Simos, & Protopapas, 2006). Together with the evidence that the relationship of psychosocial factors and reading is bidirectional (e.g., Morgan et al., 2008; Prochnow, Tunmer, & Chapman, 2013), our findings highlight the potential benefit of including strategies that promote positive self-systems including self-efficacy (e.g., Blackwell, Trzesneiwski, & Dwek, 2007; Yeager & Walton, 2011). Finally, the use of multiple measures to identify risk can support instructional decision making about the intensity of intervention, appropriate instructional programming, and necessary levels of ongoing support.

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