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A written language intervention for at-risk second grade students: a randomized controlled trial of the process assessment of the learner lesson plans in a tier 2 response-to-intervention (RtI) model

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Abstract In a randomized controlled trial, 205 students were followed from grades 1 to 3 with a focus on changes in their writing trajectories following an evidence-based intervention during the spring of second grade. Students were identified as being at-risk (n=138), and then randomized into treatment (n=68) versus business-as-usual conditions (n=70). A typical group also was included (n=67). The writing intervention comprised Lesson Sets 4 and 7 from the Process Assessment of the Learner (PAL), and was conducted via small groups (three to six students) twice a week for 12 weeks in accordance with a response-to-intervention Tier 2 model. The primary outcome was the Wechsler Individual Achievement Test-II Written Expression Scale. Results indicated modest support for the

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PAL lesson plans, with an accelerated rate of growth in writing skills following treatment. There were no significant moderator effects, although there was evidence that the most globally impaired students demonstrated a more rapid rate of growth following treatment. These findings suggest the need for ongoing examination of evidence-based treatments in writing for young elementary students.

Keywords PAL lesson plans · Response-to-intervention in written language · RtI · Writing intervention moderators · Writing subtypes · Written language, written language intervention in elementary school

Introduction

Writing problems for elementary school children in the USA are significant, but they are particularly apparent in this day of high-stakes testing and heightened accountability. Approximately 17 years ago, Hooper et al. (1993) reported significantly higher rates of text generation problems in a large epidemiological sample of middle school students, with rates ranging from 6% to 22% depending on region of the country, gender, and ethnic status. The National Center for Education Statistics (NCES, 2003) reported that only about 28% of fourth graders could write at a proficient level or above, 58% wrote at a basic level, and 14% wrote below the basic level. A more contemporary epidemiological study of the prevalence of written language problems, using a population-based birth cohort of school-age children, found the rate of written language disorders, regardless of definition, to be at least as high as the rate for reading disorders (Katusic, Colligan, Weaver, & Barbaresi, 2009). Depending on the definition, Katusic et al. (2009) revealed a rate of 6.9% to 14.7%, with boys being two to three times more likely to be affected than girls. In this regard, writing challenges appear to be at least as prevalent as reading and math challenges. Despite these findings, the current educational reform policy, No Child Left Behind, gives minimal attention to written expression (Graham & Harris, 2005), and the recent report from the National Center for Learning Disabilities (Cortiella, 2009) on "The State of Learning Disabilities" makes no mention of written language disorders.

Given these concerns, educational changes are needed to improve writing performance. The National Commission on Writing for America's Families, Schools, and Colleges has taken on the challenge of improving the writing skills of students. This organization has begun to examine the overall importance of writing, in addition to increasing public awareness and meeting with educators nationwide (National Writing Project, 2009). Despite these types of efforts, there is still an unmet need for the development and implementation of evidence-based written language instructional practices in the schools before students begin to fail in their writing endeavors (Baker, Chard, Ketterlin-Geller, Apichatabutra, & Doabler, 2009).

In order to assist students in moving through the early developmental stages of written expression, teachers will need to be able to implement a variety of evidence-based instructional strategies, particularly as writing demands change across the school years. While professional development for teachers in "best practices" has been noteworthy (Bradley-Johnson et al., 1989; Kulberg, 1993; Lesiak, 1992), it appears that writing achievement continues to receive less attention by teachers (NCES, 2007). Writing is an inherently challenging task for most children because it requires the coordination of numerous cognitive elements, physical capabilities, and external demands

in an ever-moving recursive process (Hayes, 2000). These challenges demand quality, evidence-based instruction in writing, but it may not be taking place in many of America's classrooms (Graham & Harris, 2009; Troia, 2002). This may be especially true in elementary and middle schools where teachers struggle to integrate writing process instruction with writing skills instruction, while simultaneously attending to the curricular demands of numerous content areas (Troia & Graham, 2002) and related high stakes testing.

Evidence-based approaches to intervention in written language

To date, there have been a number of interventions proposed to address the text generation needs of student who may be at risk for writing problems. Many of these interventions have been devoted to the higher-order aspects of composing, such as planning and revising (Englert, 1990, 1992; MacArthur, Schwartz, & Graham, 1991; Mercer & Mercer, 2001; Wong, Butler, Ficzere, & Kuperis, 1997), organization and self-monitoring (Isaacson, 1995), and metacognition and self-regulation strategies (Englert et al., 2009; Graham, Harris, & Mason, 2005; Harris, Graham, Mason, & Friedlander, 2008; Therrien, Hughes, Kapelski, & Mokharti, 2009; Welch & Jensen, 1991). Other studies have focused on the linguistic aspects of composing such as spelling, capitalization, syntax, and grammar (Berninger et al., 2002; Bos & Vaughn, 1998). Specific teaching practices, such as providing frequent opportunities to write, focusing on the writing process (e.g., the acts of planning and revising), clarifying criteria for successful writing, and taking a balanced approach that includes an emphasis on mechanical correctness and effective rhetoric (Bromley, 1999; Gersten & Baker, 2001; Gleason & Isaacson, 2001; Troia & Graham, 2004), also have been linked to proficient writing achievement.

Further, for students with writing problems, explicit writing instruction is essential (Berninger, 2009; Gleason & Isaacson, 2001; Hooper, Knuth, Yerby, & Anderson, 2009; Troia, 2002). The use of explicit instruction appears to be particularly important to improving planning capabilities that have been shown to improve the length, organization, and quality of students' compositions (Baker et al., 2009; Graham & Harris, 2009; Harris & Graham, 2009). Much less research has been done on explicit teaching of revising a written product, despite the fact that at-risk students engage in little revision. In general, the magnitude of the treatment effects has ranged from small (Berninger et al., 1998, 2002) to large (Englert et al., 2009; Graham & Perin, 2007), depending on the outcome variables used, instructional formats employed, the age of the students, and the specific interventions that were implemented.

Process assessment of the learner lesson plans Berninger and Abbott (2003) have presented a three-tier model of lesson plans devoted to the development of written expression via their Process Assessment of the Learner (PAL). These three tiers are associated with the intensity of the intervention such that Tier 1 is for the entire classroom, Tier 2 is for students who are at risk for learning difficulties in a particular subject area, and Tier 3 is reserved for students with specific learning deficits. Each of these tiers has specific lesson plans to address the level of instructional intensity. The lesson plans associated with these tiers are commercially available, manualized, and developed using controlled instructional experiments (Berninger et al., 1997, 1998, 2000, 2002, 1995). Findings for these lesson plans have been significant, with effect sizes falling within the small to large range for written composition outcomes. Of importance to this study is that none of these lesson plans has been replicated in other randomized

control designs, nor have they been evaluated in conjunction with the intention of examining the possible moderating effects of specific cognitive functions. This type of methodology is critical to determining the effectiveness of these lesson plans for educational instruction in writing and facilitating instructional pedagogy (Wong & Berninger, 2009).

The response-to-intervention approach

Response-to-intervention (RtI) is a prevention oriented approach to learning needs wherein there are direct links from assessment to instruction, particularly with respect to regular, ongoing monitoring of a student's progress. This use of direct assessment strategies can help inform teachers of how to instruct their students across three different Tiers. These include: early intervention for prevention of problems for all learners (Tier 1), curriculum modifications for at-risk learners (Tier 2), and instructional treatment for students with specific disabilities (Tier 3). Typically, Tier 1 interventions are conducted in the regular classroom setting, while Tier 2 interventions should occur in small groups of at-risk learners. Tier 3 is reserved for students with specific learning challenges and interventions typically occur in a one-on-one setting. It is important to note that RtI is not an instructional program but, rather, a framework for developing appropriate supports for a student's learning needs; however, evidence-based interventions are a central part of selecting particular treatments for students with specific learning needs (National Center on Response to Intervention, 2010). Treatment programs that align with this approach will provide linkages to classroom settings where an RtI model is in use.

The current study

This study addresses several key questions with respect to intervention in written language for young, at-risk elementary school students using an RtI Tier 2 format. First, we examined the use of the PAL lesson plans in second grade students at risk for later writing problems, and the subsequent developmental trajectory of overall writing scores across multiple time points from grades 1 through 3. These trajectories were compared to typical and at-risk non-treated comparisons groups, with the expectation that the rate of change in writing skills would be more rapid following exposure to the PAL treatment. Second, we explored the relationship of selected cognitive and reading variables with response to treatment. To date, little data exist that have examined the moderating effects of cognitive or other educational variables on response-to-treatment in written expression. Given the influence of reading, language, and executive functions in written expression, we expected a significant interaction of these variables with the treatment. Finally, we questioned the possibility of the presence of different subgroups in the at-risk group versus the other groups as another strategy for examining moderator effects on response-to-treatment.

Method

Participants

Participants included 205 first grade students from seven elementary schools in a single, suburban–rural school district in the southeastern part of the USA. A single school district

was selected for recruitment in order to minimize potential problems related to basic core curriculum differences and different instructional philosophies that can exist between systems even with a statewide standard course of study. All of the students were in a regular classroom setting as the primary school placement and had attended kindergarten. In addition, all of the students had a functional understanding of English. The total sample was recruited in first grade via two cohorts in successive years: cohort 1 (n=104) and cohort 2 (n=101), and the cohorts were combined for these analyses.

The sample consisted of 88 (42.9%) female and 117 (57.1%) male students. At the first assessment, the students ranged in age from 6.77 to 7.33 years; at the second assessment, the ages ranged from 7.0 to 8.25 years, and at the third assessment 8.0 to 8.33 years. Three fourths (n=154; 75.1%) of the students was European American/white, 38 were African-American/black (18.5%), two were Native American (1%), nine students were multi-racial (4.4%), and two were Asian American (1%). Twenty-five of the students were Hispanic (12.2%). The percentage of students who applied for the free and reduced lunch program in the target school district in the 2007–2008 school year was 31.9% (n=65). For maternal education, 10.1% of the mothers reported not graduating from high school, 10.1% received their high school diploma or GED, 30.2% had some additional college or technical training, 12.2% received an associate's degree, and 37.4% graduated from college. Across the entire sample, 38 (18.5%) students were receiving special education services at the time of the second grade intervention; 19 (9.2%) students were participating in additional tutoring outside of their school programs, and 25 students were taking some type of pharmacological agent largely for attention problems or impulse control. For the treatment group, attrition over the 3 years of the study has been relatively minimal, with only one student exiting the intervention after 13 sessions.

Measures

The primary overall outcome for this study was the *WIAT-II* Written Expression Subtest. At grades 1 and 2, the Written Expression subtest consists of three tasks: timed alphabet writing, written word fluency, and sentence combining. The student is given 15 s to write the lower case letters of the alphabet, in order, and 60 s to write words related to a topic. Finally, the student is asked to combine a series of two simple sentences into one well-written sentence with the same meaning. The Spelling Subtest includes items to demonstrate knowledge of written letters, letter groups, and words. At grade 3, the student is asked to write a paragraph in accordance with a specific writing prompt. The WIAT-II Written Expression Subtest was administered to the entire sample at each yearly assessment, and at the beginning and ending of the treatment trial for the designated at-risk students. Past reported inter-item reliability for the WIAT Written Expression and Spelling subtests scores were strong ranging from .91 to .94 (Wechsler, 2002). The WIAT-II was triple checked (as were all measures in this study) to ensure that the scores were as accurate as possible, and any disagreements in scoring were resolved via consensus.

Cognitive and psychoeducational measures A variety of cognitive and psychoeducational measures were selected based on their empirical or theoretical relationships with written language. The measures were selected to examine the possible moderating effects of cognitive functions on response to intervention in the writing process. Measures also were selected based on their psychometric properties and availability in the school setting in an effort to facilitate translation into the educational setting. These tasks included measures of intellectual functioning (Wechsler Abbreviated Scale of Intelligence Full-2 IQ, internal

consistency~.96), fine-motor speed and control (PAL-2 Finger Succession, internal consistency~.89), language-related functions (Peabody Picture Vocabulary Test-4/Comprehensive Receptive and Expressive Vocabulary Test, internal consistency~.91 to .94; Comprehensive Test of Phonological Processing [CTOPP] Elision Subtest, internal consistency~.89 to .90; PAL-2 Rapid Automatized Naming Letters/Digits, internal consistency~.84 to .92; PAL-2 Word Choice, internal consistency~.66 to .83), and attention/executive functions (CTOPP Nonword Repetition/WISC-IV-PI Digit Span, WISC-IV-PI Spatial Span, internal consistency~.68 to .83; WJ-III Planning, internal consistency~.75; Vigil Continuous Performance Test Omissions and Commissions, temporal stability~.70). In addition, the WIAT-II Word Reading Subtest (internal consistency~.95) was employed as a possible moderator of response to intervention, particularly given findings suggesting a relatively strong reading–writing connection (Bear, Invernizzi, Templeton, & Johnston, 2003; Hooper, Roberts, Nelson, Zeisel, & Kasambira Fannin, 2010). Additional description of these measures and the confirmatory model can be found in Hooper et al. (2011).

Procedures

In accordance with RtI strategies, all children in first grade were screened for their writing skills using the WIAT-II Written Expression Subtest. Of the consented students, grade-based standard scores were used to place students into typical (n=67) versus at-risk groups (n=138). The at-risk group was defined as scores falling at or below the 25th percentile for their grade placement (i.e., a grade-based standard score ≤90). The at-risk students were then randomly assigned into treatment (n=69) versus non-treatment groups (n=70) at the school level. Once these groups were determined, a group of typical students was randomly selected at the school and classroom levels. Writing assessments were conducted in the fall of first, second, and third grade, while interventions were conducted via small groups (i.e., three to six students) between February and May of the second grade.

All students received written language instruction via the regular classroom setting in a business-as-usual (BAU) model. For all participants, classroom instruction in written language followed a statewide standard course of study. For second grade writing skills, this BAU curriculum included ongoing development of the alphabetic principles, using vocabulary effectively in written communication, composing written sentences, planning and composing narrative texts that are descriptive and creative, appropriate use of capitalization, punctuation, syntax, and grammar, and emergent revising of text skills. These skills were embedded in daily classroom activities, with little in the way of direct instruction for written expression. Students assigned to the treatment groups also received the PAL lesson plans in a small group format in accordance with a Tier 2 intervention model.

PAL lesson plans The intervention sequence employed the PAL Reading and Writing Lesson Sets 4 and 7 which comprised three sections: subword level—Talking Letters, word level—Spelling, and text level—Handwriting and Composition. The PAL lessons were designed to be administered on an individual or small group basis in about 35–40 min, but were modified for this study to meet the available time provided by the school system and scripted to ensure fidelity; however, the integrity of the PAL lesson plans was preserved with respect to scope, content, and sequence.

At the subword level, the PAL Talking Letters program has been shown to be effective in teaching the encoding of phonemes to spell words (Berninger & Abbott, 2003). The

children in this study readily participated in this activity, stating the word for each visual cue (picture icon) on their Talking Letters cards, sounding the phoneme it represented, and stating the associated letter or letter group. This task, conducted at the beginning of each lesson, engaged all students in a rapidly paced multi-sensory exercise.

At the word level, students were taught to spell a set of monosyllabic words representing predictable spelling-sound correspondences. Eight words were taught in each session. Students were first asked to spell a word orally. If a response was incorrect or the students did not agree on the correct spelling, the instructor provided a visual model (word card) and three cues while spelling the word orally: (1) whole word- naming all the letters and pronouncing the word, (2) onset-rime-initial phoneme followed by the remaining part of the word, and (3) phoneme-spelling units in left-to-right sequence. The students were instructed to "quietly say the letters" as they wrote each word in their personal dictionaries. Beginning in Lesson 7, by which time the students were familiar with the Talking Letters, they were cued to refer to the phonemic strategies to help them spell the words.

The tasks at the text level included composition (lessons 1–24) and handwriting instruction beginning at Lesson 7. Students were asked to write for 5 min in response to a specific prompt during each lesson. The instructors presented a visual poster of the PAL strategy, "What I think I can say, and what I say I can write," and the students stated the strategy in unison. Each topic included six high frequency words students could use in their compositions. They entered these "target words" in their personal dictionaries. Upon completion of their compositions, the students shared what they had written by reading aloud to the group.

The ability to write legibly and quickly has been shown to be the best predictor of composition length and quality in the elementary grades (Berninger, 2000, Berninger et al., 1997). A feature of the process approach to handwriting instruction is that children practice handwriting before composing, in order to transfer their low-level letter production skills to high-level composing. These students would have received the handwriting instruction had there been a grade one intervention. Beginning in Lesson 7, a modified version of the handwriting lesson was introduced in order to provide the at-risk second grade students participating in the treatment protocol the opportunity to complete the handwriting instruction. Students looked at the model on their papers, consisting of numbered arrow cues for each letter, covered it and wrote the letter, compared their letter to the model, and rewrote as needed.

These lesson plans were utilized via a series of 24 interventions scheduled over 12 weeks, with two 25-min sessions each week. The students were taught in eight groups ranging in size from three to six children. Each project-based interventionist made arrangements with the principal at his/her school regarding when and where the intervention lessons would take place, and parents and teachers were contacted about the arrangements. The 12 weeks of treatment were completed at seven elementary schools between February and May of 2008 (cohort 1) and 2009 (cohort 2).

Treatment fidelity Perhaps one of the biggest contaminants of treatment efficacy relates to how consistently the lesson plans were executed from one session to the next. Therefore, we established procedures to maintain high treatment fidelity. First, training on the PAL lesson plans occurred for all project personnel and they were trained to keep record of reliability for each component of the lesson plans. Second, the lead interventionist for the project discussed each of the individual lesson plans with the project interventionists prior to implementation in the groups. Further, she conducted random observations of sessions and provided follow-up via review of videotapes and audiotapes of the sessions. The lead

interventionist also held weekly discussions regarding treatment strategies and style, and how well the project interventionists (i.e., research associates, graduate students in education and school psychology) were executing the specified treatment plans. During those times, any necessary adjustments were asserted. Third, all of the interventionists blogged after each treatment session in an effort to identify areas of success, difficulty, or concern. The blogging also facilitated establishing specific scripts for prompting students in a more consistent fashion across the different interventionists and treatment sessions. Fourth, each interventionist also completed a lesson checklist regarding the compliance with each treatment component after each session, thus addressing fidelity of each lesson and allowing a comparison to the videotape and audiotape reviews. Taken together, these procedures have contributed to a 94% fidelity rate for the second grade intervention.

We also examined student attendance in the sessions. Across the 24 sessions, 58 (85.3%) attended at least 75% (i.e., 18) of the sessions, with attendance rates ranging from about 30% to 100%. For the data analyses, we examined the data with and without the ten students who did not attend at least 75% of the sessions, and there were no differences in findings in any of the research questions, so these students were included in the analyses.

Data analysis

To address the first question pertaining to the effectiveness of the PAL lesson plans for second grade students at risk for later writing problems, a multilevel growth model or mixed linear model (Raudenbush & Bryk, 2002) was fit to the WIAT-2 raw scores for the three groups: typically developing (TD), at-risk untreated (AR), and at-risk treatment (TX). The multilevel model was selected because it correctly accommodated the repeated-measures structure of the data. Time was conceptualized as a continuous variable indexing grade based on the approximate time of assessment. For example, an assessment occurring approximately at the mid-point of the second grade year would have time coded as 2.5. Non-treatment participants (TD and AR) were measured at three time points (time points 1.5, 2.0, 3.5). Treatment participants were measured at the same three time points with one two additional administrations being conducted during second grade (pre-treatment at time point 2.5, and post-treatment at time point 3.0). Therefore, the growth trajectory of the treated participants was measured more densely over time than either comparison group, but all subjects were measured over approximately the same span.

For the second question, we explored the relationship of selected cognitive variables and reading with response to treatment. Previous research utilizing this sample (Hooper et al., 2010) has uncovered a factor structure to the cognitive measures. A confirmatory factor analysis was fit to the cognitive data measured at the initial time point and included latent variables for language and attention/executive functions, and these latent variables were employed in the analyses. Factor scores for language and attention/executive function were computed via the regression method as implemented in Mplus version 5.21 and saved for further analysis. Reading also was added to this model. These analyses tested the hypothesis that the treatment effect was moderated by reading, attention/executive functions, or language. A multilevel growth model was fit to the data, with the AR group selected as the reference group. The TD was not included in this analysis. The model included intercept, time, time-squared; time-by-language, time-squared-by-language; time-by-attention/executive function, time-squared-by-attention/executive function; and time-by-reading, time-squared-by-reading parameters for the AR group. The main effect for the treatment group and interactions of treatment with all the remaining parameters also were

examined. In this model, the time, attention/executive function, language, and reading variables are grand mean centered in order to reduce the collinearity induced between the product terms and the main effects.

For the third question, we examined the possibility of subgroup differences in the at-risk group versus the other groups on response-to-treatment. In these analyses, we searched for latent groups based on the cognitive data and examined whether the treatment had differential impact within those groups. Here, we examined the baseline cognitive data for evidence of latent classes in the at-risk untreated and treated groups. The model utilized was similar to the confirmatory factor analysis model described in the second analysis, with some additional variables included. In addition to the two latent variables described earlier (Attention/Executive Functions, Language), variables included the WASI IQ, receptive vocabulary (consisting of either the CREVT-2 receptive vocabulary or the PPVT-4 standard score), phonological processing (consisting of the CTOPP Elision Subtest or PAL-2 Letters/Digits standard scores), and fine-motor speed and control as extracted from the latent variable analysis of the assessment model (Hooper et al., 2010). The latent class analysis was performed in Mplus version 5.21. Variances of the latent variables were fixed to one for identification. Once latent classes were determined, we then returned to the model used in the second analysis to test the hypothesis that latent class membership moderates response-to-treatment. Evidence of differential treatment effect within latent classes would indicate moderation of the treatment effect.

Results

Overall treatment effects

Descriptive statistics for the outcomes by group can be seen in Table 1. Using these outcomes, a multilevel growth model or mixed linear model (Raudenbush & Bryk, 2002) was fit to the WIAT-II Written Expression raw scores for the three groups. Non-treatment participants were measured at three time points, while treatment participants were measured at the same three time points with two additional administrations given at the beginning (February) and ending (May) of treatment during the second grade; therefore, the growth trajectory of the treated participants was measured more densely over time than the two comparison groups, but all subjects were measured over the same span. Although the treatment was randomly assigned, we observed statistically significant differences in the scores on the initial round of assessments, which occurred after randomization but before treatment began, t (136)=2.25, p=.03; for this reason, we focused our findings regarding the treatment effects on the slopes. A treatment effect conceptualized in this manner would entail an improvement in the rate of change over time in the acquisition of writing skills in the treated group relative to the untreated at-risk group.

The mixed model regressed the WIAT-II written expression scores on a set of three dummy indicators for each group as well as a set of three group-by-time interactions and a set of three group-by-time-squared interactions. The overall model intercept was suppressed. Suppressing the intercept allowed the model to be identified with indicators for all three groups included. This rendered an inability to retrieve a test of the treatment effect directly from the model parameters; however, this approach did simplify the construction of post-estimation contrasts to provide tests of the treatment effect. Due to evidence that the growth trajectories were non-linear, the squared time parameters were included so that curvilinear trajectories could be modeled. The time index was centered at the grand-mean

Table 1 Descriptive statistics for WIAT-II Written Expression Subtest by group and assessment

Group	Grade	*n*	Mean	Std Dev	Min	Max
Age-based standard score						
Typical	1st	67	103.49	7.73	85.00	132.00
	2nd	65	98.20	10.77	66.00	120.00
	3rd	32	102.22	12.90	80.00	130.00
AR-untreated	1st	70	84.39	9.00	68.00	100.00
	2nd	67	88.30	12.13	68.00	117.00
	3rd	27	91.41	14.39	63.00	121.00
AR-treated	1st	68	81.68	6.61	67.00	94.00
	2nd	68	83.26	8.74	65.00	104.00
	2nd Pre	68	83.84	10.29	65	111
	2nd Post	66	86.70	11.72	63.00	114.00
	3rd	31	81.81	10.01	58.00	103.00
Raw Score						
Typical	1st	67	6.72	1.98	3.00	14.00
	2nd	65	7.46	2.95	0.00	14.00
	3rd	32	17.28	4.91	8.00	28.00
AR-untreated	1st	70	2.51	1.60	0.00	5.00
	2nd	67	4.85	3.02	1.00	13.00
	3rd	27	12.67	6.02	1.00	26.00
AR-treated	1st	68	1.96	1.29	0.00	4.00
	2nd	68	3.74	2.41	0.00	11.00
	2nd Pre	66	4.70	2.88	0.00	12.00
	2nd Post	68	3.51	2.03	0.00	9.00
	3rd	31	8.84	3.83	0.00	16.00

value for all analyses in order to reduce collinearity between the linear and quadratic time variables. The model was initially specified with a random slope and a random intercept, but the random slope was dropped due to estimation problems caused by insufficient slope variance.

As can be seen in Table 2, all three of the groups demonstrated growth in their writing skills over time for both the linear and curvilinear trajectories. When the contrasts between the three groups are examined in Table 3, however, the treatment effect was significant only on the quadratic component of the slope (*B* Estimate=1.18, $p<.006$). The quadratic component represents an acceleration parameter, indicating that the treatment induced acceleration in the rate of writing skill acquisition for treated participants. The plot in Fig. 1 illustrates the rate of growth for each of the groups. As can be seen, the treatment began in the middle of second grade, with the acceleration following at the subsequent two measurement time points. As displayed in the plot, the growth rate for the treated group at that point begins to accelerate such that by the start of third grade, the growth rate for the treated group has significantly exceeded the rate for the untreated at-risk group (*B* Estimate=2.79, $p<.003$).

Estimation of effect sizes for the treatment effect is complicated by the curvilinear shape of the trajectories as well as the initial differences in writing pretest scores after randomization. Contrast analysis of the model-implied means for the treated and untreated at-risk groups at the end of second grade/beginning of third grade indicated that the treated group mean (M_{est}=6.33) was lower than the untreated group mean, (M_{est}=7.19), but this

Table 2 Fixed effects estimates for the PAL treatment effects

Effect	*B* Estimate	Std Err	*p*
AR	4.999	0.389	<.0001
TD	7.412	0.392	<.0001
TX	3.626	0.285	<.0001
AR × time	3.788	0.279	<.0001
TD × time	3.940	0.282	<.0001
TX × time	4.207	0.236	<.0001
AR × time^2	1.123	0.323	.001
TD × time^2	3.013	0.357	<.0001
TX × time^2	2.306	0.277	<.0001

AR at-risk untreated, *TD* typically developing, *TX* at-risk treated

difference was not significant, t (478)=−1.77, p=.08, Cohen's d=−0.19. By the fall of third grade, the treatment group (M_{est}=10.17*)* had caught up with the untreated at-risk group (M_{est}=9.93), but the comparison was not statistically significant, t (478)=0.40, p=.69, Cohen's d=.05. However, these estimates are contaminated by the initial difference in the groups at the beginning of treatment and are therefore not interpretable.

One solution to the problem of post-randomization, pre-treatment differences in scores may be addressed by adding a constant adjustment to the scores of treated students in order to equalize their writing scores with at-risk untreated group at the beginning of treatment at the midway point of second grade. This led to the following adjusted contrasts and effect size estimates for the treatment versus control comparisons. At the end of second grade/beginning of third grade, the adjusted model-implied mean for the treatment group ($M_{est,\ adj}$=7.70) was slightly larger than the mean for the at-risk untreated group (M_{est}=7.19), and the comparison was significant, t_{adj} (478)=2.42, p_{adj}=.02, Cohen's d_{adj}=0.11. In the fall of third grade, the adjusted model-implied mean for the treatment group ($M_{est,\ adj}$=11.54) was larger than the mean for the untreated at-risk group (M_{est}=9.93), and the comparison was statistically significant, t (478)=2.89, p=.004, Cohen's d_{adj}=0.36. Both of these effect sizes would be characterized as small; however, the effect size is increasing over time, consistent with the finding of greater acceleration for the treated group.

Moderators of treatment effects

Specific cognitive variables Previous research utilizing this sample has uncovered a factor structure to the cognitive measures (Hooper et al., 2010). A confirmatory factor analysis

Table 3 Contrast analysis for the three groups

Effect	*B* Estimate	Std Err	*p*
Linear growth rate contrast for AR vs TX	0.419	0.365	0.252
Quadratic growth rate contrast for AR vs TX	1.183	0.426	0.006
Growth rate for AR vs TX at grade=1.5	−1.939	0.930	0.038
Growth rate for AR vs TX at grade=2.5	0.428	0.365	0.242
Growth rate for AR vs TX at grade=3.5	2.794	0.923	0.003

AR at-risk untreated, *TD* typically developing, *TX* at-risk treated

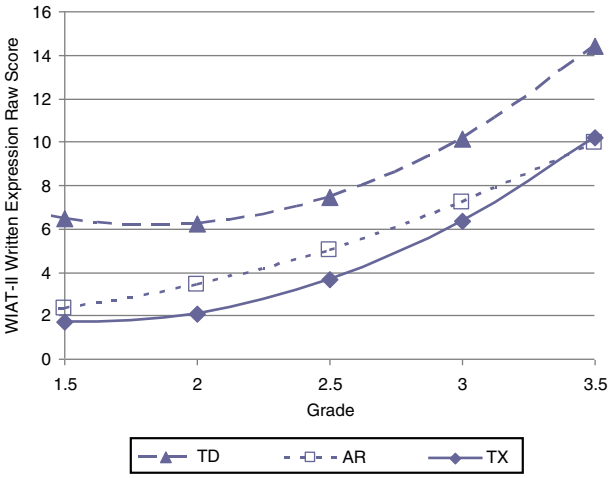

Fig. 1 Model-implied trajectories for WIAT-II Written Expression Raw Score across the typical, at-risk non-treatment, and at-risk treatment groups

was fit to the cognitive data measured at the initial time point. Given the literature on cognitive components to written language (see Hooper et al., 2010), two of those latent variables were extracted for use as moderators in this analysis: attention/executive functions and language. The attention/executive function latent variable had as indicators the following variables: WISC-IV-PI Spatial Span forward and backward scaled scores, WJ-III Retrieval Fluency, WJ-III Planning, and the CTOPP Nonword Repetition standard score (cohort 1) or the WISC-IV-PI Digit Span forward and backward scores (cohort 2). The language-related latent variable was indicated by PAL Letters and PAL Word Choice. For these variables, the model fit was acceptable, χ^2 (36)=43.01, p=.01, CFI=.94, RMSEA= 0.05. Subsequently, factor scores for attention/executive function and language were computed via the regression method as implemented in Mplus version 5.21. Given the suspected reading–writing connection, the WIAT-II Reading Recognition Subtest was included as a third potential moderator. The analysis for this second question tested the hypothesis that the treatment effect was moderated by attention/executive function, language, and/or reading skills.

A multilevel growth model was fit to the data, and Table 4 provides the results of this analysis. Unlike the model used in the first analysis, in this model the parameters are directly meaningful. The four TX-by-time-by-moderator and TX-by-time^2-by-moderator terms provide direct tests of whether the treatment effect is moderated by the designated variables of attention/executive function, language, or reading. As can be seen, none of the interactions between the treatment group and the moderators reached significance.

Cognitive latent classes The latent class analysis produced two latent classes. Of the available 138 participants with complete data sets, 90 second grade students (58%) were assigned to the first latent class and 58 (42%) were assigned to the second latent class. The average probability of class membership for the first group was .93, and .93 for the second group, indicating relative certainty in the assignment of individuals to groups.

Examination of the descriptive information in Table 5, where all scores are presented in standardized z-score format, shows the first group to fall within the average range on the selected cognitive variables, with a relative strength being noted in the attention/executive function latent variable. In contrast, the second group shows relatively lower cognitive

Table 4 Fixed effects estimates for the cognitive and reading moderators

Effect	*B* Estimate	Std Err	*p*
Intercept	4.877	0.323	<.0001
time	1.916	0.365	<.0001
time^2	−0.114	0.347	0.743
Language	0.160	0.803	0.842
Language × time	0.891	0.566	0.117
Language × time^2	0.709	0.660	0.284
Att/Exec	0.898	0.758	0.238
Att/Exec × time	−0.785	0.548	0.154
Att/Exec × time^2	−1.126	0.684	0.101
Reading	0.071	0.023	0.003
Reading × time	0.108	0.018	<.0001
Reading × time^2	0.060	0.020	0.003
TX	−0.961	0.448	0.034
TX × time	0.711	0.547	0.195
TX × time^2	1.073	0.539	0.048
TX × Language	−0.009	1.131	0.994
TX × Language × time	−1.415	0.872	0.107
TX × Language × time^2	−1.948	1.052	0.066
TX × Att/Exec	0.027	0.932	0.977
TX × Att/Exec × time	1.200	0.686	0.082
TX × Att/Exec × time^2	1.242	0.863	0.152
TX × Reading	−0.041	0.033	0.217
TX × Reading × time	−0.018	0.029	0.544
TX × Reading × time^2	0.019	0.030	0.527

TX=treatment, *Att/Exec*=attention/executive function factor

abilities, with relative weaknesses in phonological processing, receptive vocabulary, and overall level of intellectual functioning. In general, the latent class analysis suggested that the first group was characterized by a specific deficit related to writing performance, while the second was characterized by somewhat lower functioning overall (g). Therefore, we

Table 5 Results of latent class analysis (n=138)

Variable	Means	
	Group 1 (n=80)	Group 2 (n=58)
WASI IQ	0.03	−1.06
Receptive Language	0.108	−0.60
CTOPP Elision	0.19	−0.81
Fine Motor (latent)	0.11	0.00
Language (latent)	0.65	0.00
Attention/Executive Function (latent)	2.64	0.00

labeled the first latent class the "Specific Deficit" group and the second latent class the "Low g" group.

In accordance with our data analysis plan, we returned to the model used in the first analysis to test the hypothesis that latent class membership could moderate response-to-treatment. Based on our latent class groupings, the analysis is now based on five groups: TD, Specific-Deficit Untreated, Specific-Deficit Treated, Low-g Untreated, and Low-g Treated. As noted above, evidence of differential treatment effects within latent classes would indicate moderation of the treatment effect. As can be seen in Table 6, the first two contrasts test whether the strength of the treatment effect varies across latent groups. These findings indicated that there was significant change over time on WIAT-II Written Expression for all five of the participant groupings; however, the linear and quadratic components did not vary over the targeted latent classes.

As can be seen in Table 6, the second set of contrasts separately examined evidence of treatment effects within the two latent classes. Significant treatment effects were observed within both the Specific-Deficit and Low-g classes. For the Specific-Deficit Class, the treatment significantly affects only the quadratic component of the trajectory (B=1.28, p<.02), although the linear component of the growth trajectory approached significance in the expected direction (B=0.73, p<.10). In each instance, the students in the treatment groups showed a steeper slope than the untreated students. In the Low-g Class, the treatment positively and significantly affected both the linear component (B=1.54, p<.01) and the quadratic component (B=2.08, p<.002). As with the Specific-Deficit Group, the Low-g treated group showed a faster rate of gain on the WIAT-II Written Expression score following the intervention. The rates of growth in WIAT-II Written Expression for the five classes are illustrated in Figure 2.

Because the overall shape of a polynomial function is difficult to envision from the parameters, the next two sets of contrasts compare the growth rates within strata at the halfway points of grades one, two, and three. By the middle of third grade, the treated

Table 6 Fixed effects estimates for the latent classes (n=205)

Effect	B Estimate	Std Err	p
Specific-deficit untreated	5.694	0.445	<.0001
Low-g untreated	3.395	0.631	<.0001
TD	7.423	0.366	<.0001
Specific-deficit treated	4.404	0.364	<.0001
Low-g treated	2.785	0.361	<.0001
Specific-deficit untreated × time	4.332	0.319	<.0001
Low-g untreated × time	1.888	0.505	0.0002
TD × time	3.953	0.272	<.0001
Specific-deficit treated × time	5.065	0.327	<.0001
Low-g treated × time	3.430	0.319	<.0001
Specific-deficit untreated × time^2	1.493	0.385	0.0001
Low-g untreated × time^2	−0.062	0.548	0.9100
TD × time^2	3.009	0.347	<.0001
Specific-deficit treated × time^2	2.771	0.401	<.0001
Low-g treated × time^2	2.017	0.365	<.0001

TD typically developing (untreated), *TX* treated

groups are increasing significantly more rapidly within both the Low-g (B=5.72, p<.0001) and Specific-Deficit classes (B=3.30, p<.006). Although the rate of increase appears to be more rapid in the Low-g Class than in the Specific-Deficit Class, the difference is not statistically significant (Δ=2.41, p<.20) at this time.

We again performed contrast analysis and estimated effect sizes for treatment versus untreated cases within the latent classes at the end of second grade/beginning of third grade and the mid fall of third grade. Within the specific-deficit latent class, at the end of treatment the treated group mean (M_{est}=7.66) was lower than the untreated group mean (M_{est}=8.26), but the comparison was not statistically significant, t (474)=−0.60, p=.30, Cohen's d=−0.12. By the fall of third grade, the mean score for the treated group within the specific-deficit latent class (M_{est}=12.28) was slightly larger than the mean score for the untreated specific-deficit group, (M_{est}=11.55), but the comparison was not statistically significant, t (474)=0.73, p=.30, Cohen's d=0.15.

As in the initial analysis of the treatment effect, we noted that within the specific-deficit latent class, randomization failed to produce equivalence between the treated (M_{est}=4.42) and untreated groups (M_{est}=5.71) prior to treatment, t (474)=2.24, p=.03. Therefore, the previously presented comparisons are contaminated by initial differences and are therefore uninterpretable. We once again computed adjusted comparisons and effect sizes by adding the difference in means just prior to treatment to the model-estimated outcomes at the end of treatment and the fall of third grade for the treated group. At the end of treatment, the adjusted mean for the treated group ($M_{est,\ adj}$=8.95) was significantly larger than the mean for the untreated group, (M_{est}=7.66), t (474)=2.59, p=.01, Cohen's d_{adj}=0.14. For the last measurement point in third grade, the adjusted mean for the treated group ($M_{est,\ adj}$=13.57) was significantly larger than the mean for the untreated group (M_{est}=11.55) by a larger margin, t (474)=2.82, p=.005, with a small to moderate effect size being present (Cohen's d_{adj}=0.42).

Within the Low-g latent class, the pre-treatment means for treated (M_{est}=2.80) versus untreated groups (M_{est}=3.40) were not significantly different, t (474)=0.83, p=.41, so the adjustment of scores was unnecessary. At the end of treatment, the mean score for the treatment group (M_{est}=5.02) was slightly larger than the mean for the untreated group

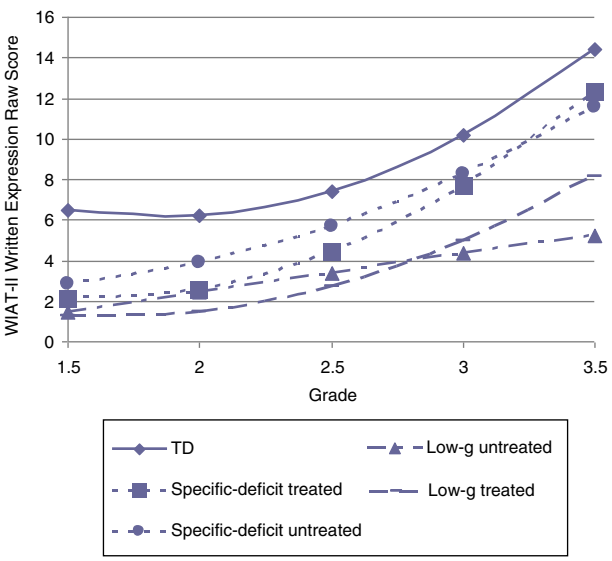

Fig. 2 Change over time for the five latent groups on the WIAT-II Written Expression Raw Score

(M_{est}=4.33), but the comparison was non-significant, t (474)=0.91, p=.36, Cohen's d= 0.19. For the fall of third grade, however, the treated group (M_{est}=8.26) significantly outscored the untreated group (M_{est}=5.23), t (474)=3.11, p=.002, with a large effect size being noted (Cohen's d=0.83).

Discussion

This study examined three critical questions with respect to RtI for young children at risk for writing disorders: (1) Would the selected PAL lesson plans contribute to a more rapid growth rate in written language within the context of an RTI model using a randomized controlled treatment trial? (2) How do selected cognitive and reading variables moderate the treatment effects? (3) Would identifying specific subtypes of writing problems in the at-risk group moderate the treatment effects? As such, this study is one of the few contemporary efforts to address not only the efficacy of evidence-based treatment for at-risk young elementary school writers via a randomized controlled trial, but also to examine the issues of potential cognitive and academic moderators in the treatment process. For our first research question, findings from this study provided modest support for the targeted PAL lesson plans employed, with a more rapid rate of growth being noted in the treated at-risk group immediately following the intervention and at the third grade follow-up time point. Although the level of writing skills did not normalize following this intervention, nor was it necessarily expected to, the effect sizes were slightly higher than the initial effect sizes obtained by Berninger from the instructional experiments documenting the utility of these lesson plans for the improvement of composition skills in poor writers in elementary school (Berninger et al., 1998, 2002)—and the lesson plans were conducted in a shorter amount of instructional time. This rate of growth will continue to be tracked as the sample moves through the third and fourth grades, and it is suspected that larger effect sizes may be possible as the at-risk group continues to receive annual Tier 2 interventions; however, it is unlikely that later effect sizes will approach the magnitude of those achieved by the strategy training efforts in written language with older students (Englert et al., 2009; Graham & Perin, 2007), which have been reported to be in the moderate to large range.

With respect to the overall growth of written language following treatment with the PAL lesson plans, it is not surprising that 10 h of intervention produced only modest effects. The 24 sessions at a length of about 25 min constituted a minimal amount of time to address what appears to be one of the most complex academic functions that confronts students throughout their schooling. What is remarkable is that the rate of growth clearly shifted in a positive direction following intervention, and it continued into the fall of third grade approximately 5 to 6 months later. These findings are consistent with those reported by Berninger et al. (2002) for spelling and composition where efforts to improve both composition and alphabetic skills contributed to the largest gains in writing skills. The current findings also would be consistent with Berninger et al. (1995), who showed newly learned writing skills to be maintained six months post-treatment. Despite the numerous concerns about RtI strategies raised by Reynolds and Shaywitz (2009), these findings also provide modest support for the utility of RTI Tier 2 efforts in working with young elementary school students at risk for problems in written language.

The examination of the effect of specific moderators on treatment response also provided one of the first glimpses of other child variables that could hinder or facilitate treatment. For our second research question, no significant cognitive moderator effects were noted when language and attention/executive function variables were examined. Cognitive variables

clearly have separated good writers from poor writers (e.g., Hooper et al., 2002; Sandler et al., 1992; Wakely et al., 2006), and they also have been deemed important as early kindergarten predictors of slower rates of growth in later elementary school and potential problems in written expression (Hooper et al., 2010); however, in this study, their impact on RtI was not significant. Further, our results would be consistent with the findings by Berninger et al. (1995) who examined the impact of Verbal IQ on treatment effects and reported no effects.

While we had expected that there would be potential moderating effects from the cognitive variables, what was surprising was that reading recognition skills also did not moderate the treatment effects. Given the reading–writing connections (e.g., Bear et al., 2003), and the demonstrated early predictive power of pre-reading skills for later written language growth in the later elementary school grades (Hooper et al., 2010), it would seem that reading skills should have contributed to the treatment outcomes in a major fashion. Indeed, having more intact, or perhaps advanced, reading decoding skills likely would contribute to automatic retrieval of alphabetic principles and rules, spelling rules, vocabulary usage, and content knowledge which, in turn, would positively influence early development of writing skills. In this study, however, this was not the case for our second grade students. Despite potentially inherent reading–writing linkages, these findings support the dissociation of the skills associated with these two academic areas from an intervention perspective, particularly with respect to the impact of reading recognition skills on writing interventions.

Finally, with respect to our third research question, there was support for the most cognitively impaired at-risk latent class subtype (Low-g) to respond positively to treatment, with effect sizes being in the large range. Without additional intervention for writing, our findings would suggest that the trajectory for the untreated at-risk students portends increasing risk for writing problems as they advance into the later grades. More generally, our preliminary findings here demonstrated that students with different cognitive profiles may respond differentially to an evidence-based intervention such as the PAL. While lower functioning students typically struggle in most of their academic endeavors, these students also tend to be the ones who can "fall through the cracks" of the educational system. In fact, they may be the types of students who may not benefit from the early intervention efforts espoused by the response-to-treatment initiatives, and may require immediate referral for in-depth cognitive and academic assessments (Reynolds & Shaywitz, 2009). In fact, our findings would suggest that more in-depth assessment might be useful prior to certain students moving into a Tier 2 intervention in an effort to improve the outcomes from that intervention. These efforts represent novel explorations in the area of written language, but suggest promise for further examination. Indeed, Hooper, Wakely, de Kruif, and Swartz (2006) found modest subtype-by-treatment interactions in their metacognitive intervention with fourth and fifth grades students, although such findings have not been uncovered in the reading literature (Fletcher, Lyon, Fuchs, & Barnes, 2007). This approach to studying response-to-treatment in writing warrants further scientific study.

Study limitations

Within the confines of a randomized controlled trial, this study has a number of strengths that can guide future scientific inquiries into writing interventions; however, there are a number of limitations that could have affected the current results. First, although we identified other major educational interventions that students were receiving, there could have been other educational interventions that were unknown to the investigators. It is possible that some children in the untreated groups did receive added benefits from other

in-class and/or extracurricular activities that were not identified, such as a teacher who placed more emphasis on writing.

Second, we recognize that our typical and untreated at-risk groups did not have corresponding assessments that framed the beginning and ending of treatment. This necessitated our use of corresponding time points at grades 1, 2, and 3 that were similar for all three of the groups. The growth curve methodology provided a strategy for looking at writing progress over time, and we did uncover the expected accelerated rate of growth following the treatment, but the precise mechanisms that facilitated these changes remain unknown at this time.

Third, we acknowledge that additional sources of clustering, such as students nested within classrooms and treatment students clustered within treatment groups, existed and were unmodeled in our analyses. The sample size for this study was simply inadequate to allow for the estimation of three-level or cross-classified random effects models that would accommodate these additional sources of clustering.

Finally, other possible limitations related to the execution of the PAL lesson plans, including the use of project-based interventionists as opposed to classroom teachers. Specifically, for the PAL lesson plans, a limit of 25 min of instructional time was strictly controlled in this study by our participating school system; perhaps, additional time and practice may have facilitated more gains in our groups or in specific students (Berninger et al., 2002). We also provided additional scaffolding for the PAL lessons in order to standardize the execution of the lessons across the different interventionists and to address issues of fidelity; however, these scaffolds may have modified the PAL to an unknown degree (e.g., limiting the number of prompts during treatment). As for our use of project-based interventionists, we acknowledge the potential limitation of ecological validity with this practice; however, this did allow us to monitor and maintain treatment fidelity with a greater degree of control than we may have been able to exert in a classroom setting.

Summary and future research considerations

This study provides some of the first well controlled RtI data addressing young elementary school children at risk for writing disorders. The findings reflected significant, but modest gains in writing skills for second grade students at risk for writing problems using the PAL lesson plans, with indications that students with more pervasive cognitive difficulties responded most positively to the PAL instruction via a Tier 2 RtI format. These findings contribute to the evolving scientific foundation for written language interventions in childhood and suggest a number of considerations for future research endeavors.

It will be important for ongoing efforts to continue to examine various treatments in the area of written language for young children. For example, explicit training in specific strategies has not infiltrated this age range, but given the strong results obtained with older elementary and middle school students, it might prove useful to examine a developmentally appropriate downward extension of such strategies. Also, interventions such as the PAL lesson plans may show differential results if applied to an even younger population. A second consideration relates to our examination of specific moderators. Although we did not find evidence for the effects of specific cognitive functions on treatment in our study, there may be other cognitive variables (e.g., memory) and/or ways to derive such variables that could produce different results. The use of latent class analysis might hold promise here. Finally, any intervention with students presents a moving target with respect to tracking outcomes, and the application of longitudinal methodologies to address treatment efficacy should continue to be examined.

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