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The Use of Curriculum-Based Measures in Young At-Risk Writers: Measuring Change Over Time and Potential Moderators of Change

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This study examined gains in written language as assessed by targeted curriculum-based measures (CBMs), and explored how these gains were affected by moderator variables of specific cognitive functions and student subgroups. The sample included 68 second grade students who were at risk for writing disabilities. Handwritten compositions were collected throughout a written language intervention at baseline, sessions 3, 5, 10, 13, 15, 20, 22, and termination. Specific CBM variables

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included Total Number of Words Written, Words Spelled Correctly, Correct Word Sequences, and Percentage of Correct Word Sequences. Using latent growth curve analysis, models were estimated for each of the CBMs, but the data showed poor model fit. Latent class groupings using cognitive variables and student subgroups significantly moderated the growth rate for written language assessed by specific CBMs. Although these latter findings reflected potential moderators of change in written language, the lack of model fit raised questions around the use of these CBM variables in monitoring writing progress for second grade students at risk for writing disabilities. Findings from this investigation revealed the measurement complexities that likely remain hidden from teachers and other professionals engaged in routine progress monitoring using CBM variables.

It has been nearly 10 years since the National Commission on Writing (The College Board, 2003) put forth the notion of the need for a "writing revolution." This group asserted the importance of injecting writing instruction into every class and across all grades, and reinforced the need for states to examine how their respective curriculum standards provided appropriate avenues for a student's growth in written language. More recently, the Common Core State Standards Initiative and National Governors Association (2010) has facilitated the earlier efforts by the National Commission on Writing by providing set targets, by grade, of the writing skills students need to achieve in order to leave high school prepared for college, vocational training, or work-related endeavors.

These policy initiatives are critical to the progress of student writing as, at present, most students do not have proficient writing skills. Specifically, despite small improvements in written language over the past decade, there remains a staggering 67% to 76% of students who either have partial mastery or no mastery of core writing skills for their respective grade levels (Salahu-Din, Persky, & Miller, 2008; U.S. Department of Education, 2003). Given these policy efforts, along with the rather large number of students who are struggling with written language, the need for evidence-based writing instruction and reliable writing assessments to measure progress becomes critical to addressing these issues.

ASSESSMENT OF WRITTEN LANGUAGE

Despite the importance of written language to nearly all school programs, the measurement of written language has lagged behind that of other academic areas, such as reading and math. This was noted more than 20 years ago by Watkinson and Lee (1992) and recently reinforced by Graham, Harris, and Hebert (2011), who provided specific recommendations for how the formative classroom assessment of written language should guide instructional efforts. Using meta-analytic techniques, Graham and colleagues (2012) provided empirical support for nine recommendations that addressed the application of best assessment practices to inform instruction. These assessment recommendations included such directives as collecting multiple samples of a student's writing, randomly ordering students' papers when scoring them, monitoring student's writing on an ongoing basis, and ensuring reliability in the scoring of student writing samples. Such classroom assessment strategies provide teachers with a routine mechanism in which to assess the effectiveness of their instruction and make instructional adjustments. Formative assessments can take any number of forms, but one of these strategies involves curriculum-based measures.

Curriculum-Based Measures (CBM)

More than 25 years ago, Deno (1985) noted the importance of frequent assessment of core academic skills so as to facilitate ongoing progress monitoring of a particular student, and the importance of this assessment approach to written language has been documented (Amato & Watkins, 2011; McMaster & Espin, 2007). In general, the writing measures derived from CBM strategies include such variables as percentage of legible words written, correct letter sequences, percent of words spelled correctly, percent of correct word sequences, mean length of word sequences, and correct minus incorrect word sequences (Amato & Watkins, 2011; Deno, Marston, & Mirkin, 1982; Graham et al., 2011; Jewell & Malecki, 2005; Parker, Tindal, & Hasbrouck, 1991). These types of variables have been correlated with writing outcomes, with some developmental constraints being placed on the utility of selected measures as writing increases in complexity with increasing grade levels (Jewell & Malecki, 2005). For example, Amato and Watkins (2011) noted that there was modest support for the use of selected CBM indices of written language for both elementary (Tindal & Parker, 1991) and middle school samples (Amato & Watkins, 2011), with Jewell and Malecki (2005) noting that different CBMs were predictive of writing skills at different grade levels.

Most recently, Graham and associates (2011) provided evidence suggesting adequate interrater reliability for nine of these variables (i.e., Number of Correct Word Sequences, Percentage of Correct Word Sequences, Correct Minus Incorrect Word Sequences, Mean Length of Correct Word Sequences, Number of Sentences, Total Written Words, Words Spelled Correctly, Percentage of Words Spelled Correctly, and Correct Letter Sequences), with interrater reliability indices of $r = .80$ and above across the various studies, across all nine of the CBM variables; however, few temporal stability estimates have been reported on these CBM variables to date. In one of the only studies to examine the temporal reliability of the slope of various CBM variables in a young first grade sample, McMaster and colleagues (2011) reported that group and individual slopes for each of the CBMs required 8 or 9 data points in order to obtain reliable and stable slopes. In this regard, emergent research efforts with CBMs for written language assessment appear to hold promise for educational diagnosticians and teachers, particularly those engaged in routine progress monitoring.

FACTORS AFFECTING WRITING INTERVENTION OUTCOMES

To date, there have been few data that have provided evidence for potential moderators to growth in writing skills following an intervention to improve written language. In one of the few studies to date, Hooper, Costa, McBee, Anderson, Yerby, Childress, and Knuth (2011) did not find cognitive moderators to affect writing outcomes following an intervention, but they did report that specific types of writing problems responded differentially to intervention. Specifically, using latent cognitive variables in latent class modeling, these investigators reported that the writing latent class defined by general impairment responded significantly better to an evidence-based intervention than a latent class reflecting specific deficits in writing. To our knowledge, there have been no other studies that have examined the importance of specific cognitive factors or cognitive profiles on how a particular student may respond to a specific intervention in written language. Similarly, there are cross-sectional, longitudinal, and instructional studies supporting reading, writing, and spelling as integrated processes and their suspected interlocking development (Bangert-Drowns, Hurley, & Wilkinson, 2004; Bear, Invernizzi, Templeton, & Johnston, 2003; Berninger & Abbott, 2003; Biancarosa & Snow, 2004; Graham & Perin, 2007; Graham & Hebert, 2010; Moats, 2000; Rogers & Graham, 2008). Despite the availability of these studies, there are no empirical data examining reading as a moderator of writing growth as defined by CBMs. How these factors (i.e., cognitive traits, cognitive subtypes, reading level) impact growth in written language, as defined by CBM, remains an unexplored but important research question and perhaps will add to the complexity of measuring change over time following written language instruction or intervention.

THE PRESENT STUDY

The present study was designed to address several key questions related to the use of CBMs for measuring change over time in writing skills following an intervention for young at-risk writers. Even though overall outcomes were reported in a previous publication (Hooper, Costa, McBee, Anderson, Yerby, Childress & Knuth, 2011), this article serves as a follow-up to identify specific changes that occurred over time and to determine whether cognitive or reading factors may have served as moderating factors that may have affected specific writing outcomes as defined by targeted CBM variables. Using a sample of second grade students who were at risk for writing disabilities and whose written language was assessed by CBMs we intend to: (a) Examine gains in written language; (b) Examine the effects of specific cognitive variables included as moderator variables on the growth of students written language; and (c) Explore possible gains in written language with specific subgroups of students with writing problems (i.e., latent class and at-risk reading) included as moderator variables. It is expected that participants will display positive growth over the course of 12 weeks on all of the CBMs, thus contributing to the overall gains in written language. It also is suspected that cognitive abilities and reading problems will have an effect on this growth.

METHOD

Participants

The participants included 68 students who were determined to be at risk for written language by virtue of their performance, falling below the 25th percentile on the *Wechsler Individual Achievement Test–Second Edition* (WIAT-II; Wechsler, 2002) Written Expression Subtest. This subsample was part of a larger study of 205 first grade students who participated in a longitudinal investigation of writing skills development and response-to-intervention using the *Process Assessment of the Learner Research-Based Reading and Writing* (PAL) Lesson Plans (Berninger & Abbott, 2003). All of the participants were drawn from seven public elementary schools in one suburban-rural district in North Carolina. Participant inclusion criteria required previous kindergarten participation by all participants, a functional understanding and use of English, and participation at the time of study enrollment in a regular classroom setting for the bulk of their educational programming. Approximately 18.5% were receiving some form of special education services at the time of the intervention. In spring of their second grade year, the group ranged in age from 7.0 to 8.25 years, was 60% male, approximately 69% Caucasian, and 16% Hispanic. Additionally, 86.3% of their mothers had at least graduated from high school.

Measures

The measures included estimates of written language outcomes using targeted CBM variables, reading level, and cognitive functions. The cognitive tasks were chosen because of their putative alignment with written language (Hooper, Costa, McBee, Anderson, Yerby, & Knuth, 2011) as well as their psychometric properties. The administration and scoring of the measures was done in accordance with the standardized procedures as per available test manuals or scoring guidelines.

Curriculum-based measures for writing. Specific CBMs were used to score the compositions at designated interventions: pretest, sessions 3, 5, 10, 13, 15, 20, 22, and posttest. The CBMs comprised four variables related to the writing product: total number of words written (TWW), words spelled correctly (WSC), correct word sequences (CWS), and percentage of correct word sequences (%CWS). These measures were selected because they have been used frequently by other researchers who examine beginning writing (e.g., McMaster & Espin, 2007; Tindal & Parker, 1991). Many researchers have found adequate interrater agreement and alternate-form reliability coefficients for these measures with early elementary aged students (Graham et al., 2011), although other psychometric properties (e.g., temporal stability coefficients) of these measures need further investigation (McMaster et al., 2011). The compositions were scored using the University of Minnesota Research Institute on Progress Monitoring (RIPM, http://www.progressmonitoring.org) scoring rules and procedures. Each composition was randomly assigned to two of three trained researchers, thus all of the compositions were scored twice. A researcher not involved in the scoring process removed all identifying information and gave each participant a pseudo-identification number; the researchers scored the compositions on copies of the originals, handwritten by the participants. This process resulted in an interrater agreement of 95.1% across all of the CBM variables. After each scorer independently scored the composition, the two researchers assigned to the composition then met to reconcile any differences. If the researchers could not come to agreement on a particular score, the third scorer was consulted before a final decision was made.

Cognitive measures. Cognitive measures were separated into two blocks (Block A and Block B), and the blocks were counterbalanced to address issues of test bias. The tasks in Block A included a measure of intellectual functioning (*Wechsler Abbreviated Scale of Intelligence*; WASI) (Wechsler, 1999), a measure of written language (*Wechsler Individual Achievement Test-Second Edition*; WIAT-II Written Expression & Spelling subtests) (Wechsler, 2002), and a reading measure (WIAT-II Word Reading subtest). The tasks in Block B included subtests from the *Process Assessment of the Learner: Test Battery for Reading and Writing* (PAL-RW) (Berninger, 2001), which were used to measure fine-motor control (i.e., Finger Sense-Succession tasks), orthographic-phonological coordination (i.e., Rapid Automatized Naming

Letters), and orthographic processing (i.e., Word Choice task). Block B also included the *Wechsler Intelligence Scale for Children-Fourth Edition Integrated* (WISC-IV Integrated) (Wechsler et al., 2004) Spatial Span Forward and Backward and Digit Span Forward and Backward subtests, which were administered to assess the students' working memory. For second grade, the Digit Span Subtest replaced the *Comprehensive Test of Phonological Processing* (CTOPP) (Wagner, Torgesen, & Raschotte, 1999) Nonword Repetition subtest, as per school system request, and a combined verbal working memory variable was created via simple summation of the age-based z-scores for Nonword Repetition (grade 1) or Digit Span (grade 2) plus Spatial Span. This combined variable was employed in the confirmatory factor analysis to determine the cognitive latent traits (Hooper, Costa, McBee, Anderson, Yerby, & Knuth, 2011). The *Wide Range Assessment of Memory and Learning-Second Edition* (WRAML-2) (Adams & Sheslow, 2003) subtests of Picture Memory, Picture Memory Recognition, Story Memory, and Story Memory Recognition were administered in Block B to assess visual and verbal short-term memory and delayed recall, respectively. The students' planning and efficiency skills were assessed using the *Woodcock Johnson-III Test of Cognitive Abilities* (WJ-III) (Woodcock, McGrew, & Mather, 2001) Planning and Retrieval Fluency subtests, and attention regulation was assessed with the *Vigil Continuous Performance Test* (Vigil CPT) (Psychological Corporation, 1998).

Cognitive latent traits. Using the previously mentioned tasks, Hooper, Costa, McBee, Anderson, Yerby, and Knuth (2011) produced a model for the neuropsychological underpinnings of early writing skills using confirmatory factor analysis in first grade that was replicated in the sample in second grade. From this analysis, three latent factors were extracted: fine-motor (PAL Finger Succession Dominant Hand and Non-Dominant Hand), attention/executive function (WRAML-2 Picture Memory Recognition, Story Memory Recognition, WISC-IV-Integrated Spatial Span Forward and Backward, WJ-III Planning and Retrieval Fluency subtests, Vigil Commissions and Omissions, combined verbal working memory), and language (PAL Word Choice, PAL Rapid Automatized Naming Letters). The factor score composites from the three latent factors were used as the cognitive latent trait moderators in the data analysis.

Cognitive latent classes. In the Hooper, Costa, McBee, Anderson, Yerby, Childress, and Knuth (2011) study, a latent class analysis using the three latent factors produced two latent classes: Specific-Deficit (i.e., students at risk for writing problems with average cognitive skills) and Low-g (i.e., students at risk for writing problems with relatively lower cognitive abilities). Of the subsample of participants for this study, and in accordance with Hooper, Costa, McBee, Anderson, Yerby, Childress, and Knuth (2011), 28 students fell into the Specific-Deficit group and 40 into the Low-g Group. These latent classes were employed as moderators in the data analyses.

At-risk reading status. The WIAT-II Word Reading Subtest was used to provide an estimate of reading skills in this group. This subtest requires students to read a list of words of increasing difficulty. Age-based standard scores were generated. Reliability and validity of this subtest were deemed strong (Wechsler, 2002). Using the bottom quartile (<25th percentile), 22 of the 68 students were deemed to be at risk for both reading and writing problems. This grouping was used as a moderator variable in subsequent analyses.

Procedures

The students participating in this report were randomly assigned to intervention using the PAL Lesson Plans versus a Business-as-Usual condition. Specifically, PAL Lesson Sets 4 and 7 were utilized for the second grade intervention. These lesson plans were selected for use because of their age-appropriate nature and their focus on writing development. These lesson sets comprised three sections: subword level (i.e., Talking Letters-sounds symbol association development), word level (i.e., Spelling), and text level (i.e., Handwriting and Composition). The students in the intervention group received small group (i.e., 3–6 students) instruction twice a week over a period of 12 weeks (i.e., 24 sessions) in accordance with a Tier 2 Response-to-Intervention model and the PAL manual. Each session lasted approximately 25–30 minutes. Although the PAL intervention was modified for time, as per school system request, the overall structure of the PAL lesson plans was preserved for the intervention. The intervention program occurred between January and May of the school year. For the Business-as-Usual condition, the students received no additional instruction other than what was provided in their regular second grade curriculum. Classroom instruction in written language in second grade followed a statewide standard course of study that included ongoing development of the alphabetic principles, using vocabulary effectively in written communication, composing sentences, composing narrative texts, and using writing conventions (e.g., capitalization, punctuation) appropriately. Please see Hooper, Costa, McBee, Anderson, Yerby, Childress, and Knuth (2011) for a complete description of the intervention details.

With respect to the CBM outcomes, the students were asked to write a composition prior to any intervention; this composition served as a pretest. Students were asked to write for five minutes in response to a written and verbal prompt (e.g., "The Zoo"). During each subsequent intervention session, students were asked to write for 5 minutes in response to a specific written and verbal prompt (e.g., Snow, Mother, The bus, Love, A horse), which was specified in the PAL lesson plan for that session. The interventionist 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. The topic and six high-frequency words that were related to the topic were presented at the top of the preprinted composition sheets. Upon completion of their compositions, the students shared what they had written by reading aloud to the group. For this study, compositions from intervention sessions 3, 5, 10, 13, 15, 20, and 22 were selected for inclusion in the data analyses. If a student was absent or did not produce a composition during those sessions, then the writing sample from the most proximal intervention session was selected. After the last intervention lesson, the students were asked to write one more composition; the prompt that was identical to the one used during the pretest.

Data Analyses

Initial descriptive statistics and box plots for each CBM were generated using PASW Statistics 19, and the results were examined for outliers, influential cases, and normality. Next, we were interested in capturing individual variability across time; thus we conducted latent growth curve analysis in a structural equation model framework to answer our basic research questions. We selected latent growth curve analysis over other traditional repeated measures techniques because these models account for factor mean and variances and allow for individual differences in initial starting point (i.e., intercept) and growth over time (i.e., slope). Model estimations were carried out in all cases by maximum likelihood mean adjusted (MLM) using the Mplus 6.11 program employing listwise deletion for missing data (i.e., effected no more than 2 cases per variable). To address the first research question, unconditional latent growth curve models were estimated to establish the optimal growth function over time for each of the four CBM variables. Here, linear latent growth curve models (i.e., random intercept and slope) were estimated and compared to a nonlinear model (i.e., quadratic models). Overall model fit was evaluated based on the likelihood ratio test (i.e., using the χ^2 test statistic), Tucker-Lewis Index (TLI), the root mean squared error of approximation (RMSEA), and the Akaike Information Criterion (AIC). RMSEA values less than .05 were considered good, less than .08 were adequate, and less than .10 were marginal. Similarly, TLI values greater than .90 were considered adequate and values greater than .95 were considered good. Since AIC is an information-based index, there were no criteria for adequacy of fit. Instead, this index provided a means for comparing models that were not nested, such that the preferred model had the lowest AIC value.

To address the second and third research questions, the models that resulted in the best fit to the data were used to test the moderating effects of the cognitive latent traits, latent classes, and at-risk reading status. For the second question, we determined gains in written language with specific cognitive latent traits (i.e., Fine-Motor, Language, Attention/Executive Functions) included as moderator variables. Finally, for the third research question, we performed similar analyses on possible gains in written language with specific subgroups of students with writing problems included as moderator variables. Specifically, latent class subgroups, as defined by our latent class analysis of the cognitive latent traits (i.e., Writing Specific Deficit, Low-g Deficit) (Hooper, Costa, McBee, Anderson, Yerby, Childress, & Knuth, 2011), were used as the moderator variables. In addition, we examined at-risk reading status by including at-risk writers with (i.e., Writing + Reading Deficits) and without reading deficits (i.e., Writing Deficits-Only) as moderator variables.

RESULTS

Descriptive Statistics

First, the initial descriptive statistics and box plots for each CBM time point were examined. The descriptive statistics for the curriculum-based outcome measures can be seen in Table 1. The results presented in Table 1 show that no variable had more than two missing values. All of the means increased from time point 1 to time point 9, but this increase was not steady. Specifically, for CWS from time point 7 to time point 8 there was a substantial decrease in the mean, and the mean for time point 8 was smaller than the mean for time point 1. Further, the means for %CWS dropped four times between points, with the largest drop from 0.49 to 0.26. The standard deviations are very large and the skewedness values and kurtosis values do not indicate distributions that resemble the normal distribution. Furthermore, the box plots indicated that all the variables had skewed distributions, and several outliers were revealed. Although these violations of normality presented significant challenges for the data analyses, we moved forward with exploratory analyses to further delineate potential change over the course of treatment with the CNB measures and to identify possible moderators.

TABLE 1
Descriptive Statistics of Curriculum-Based Measures

Variable	*Timepoint*	*N*	*Mean (SD)*	*Skewness (SE)*	*Kurtosis (SE)*
TWW	1	68	22.99 (15.82)	1.38 (0.29)	1.83 (0.57)
	2	66	24.85 (16.49)	1.42 (0.30)	2.38 (0.58)
	3	68	29.51 (17.73)	1.45 (0.29)	3.11 (0.57)
	4	68	31.07 (17.95)	1.26 (0.29)	1.58 (0.57)
	5	67	33.28 (24.37)	1.81 (0.29)	4.12 (0.58)
	6	68	32.81 (22.41)	1.35 (0.29)	1.80 (0.57)
	7	67	33.63 (23.19)	1.45 (0.29)	2.23 (0.58)
	8	67	39.42 (22.39)	1.45 (0.29)	2.57 (0.58)
	9	67	40.25 (21.07)	1.27 (0.29)	2.44 (0.58)
WSC	1	68	18.29 (14.16)	1.38 (0.29)	1.94 (0.57)
	2	66	18.44 (14.57)	1.41 (0.30)	2.12 (0.58)
	3	68	25.50 (16.42)	1.41 (0.29)	2.81 (0.57)
	4	68	25.96 (17.42)	1.31 (0.29)	1.48 (0.57)
	5	67	23.40 (18.78)	1.76 (0.29)	3.80 (0.58)
	6	68	27.53 (21.43)	1.52 (0.29)	2.61 (0.57)
	7	67	28.20 (21.20)	1.39 (0.29)	1.94 (0.58)
	8	67	21.43 (15.41)	1.20 (0.29)	1.42 (0.58)
	9	67	33.48 (20.69)	1.46 (0.29)	3.03 (0.58)
CWS	1	68	13.76 (13.00)	1.70 (0.29)	2.93 (0.57)
	2	66	13.41 (12.33)	1.39 (0.30)	1.54 (0.58)
	3	68	18.82 (13.27)	1.24 (0.29)	1.65 (0.57)
	4	68	19.43 (15.73)	1.47 (0.29)	2.02 (0.57)
	5	67	16.87 (13.83)	1.42 (0.29)	1.71 (0.58)
	6	68	19.88 (18.15)	1.70 (0.29)	3.31 (0.57)
	7	67	19.70 (16.90)	1.63 (0.29)	2.96 (0.58)
	8	67	12.18 (11.27)	1.57 (0.29)	2.65 (0.58)
	9	67	23.36 (16.95)	1.99 (0.29)	1.05 (0.58)
%CWS	1	68	0.48 (0.25)	−0.24 (0.29)	−0.74 (0.57)
	2	66	0.43 (0.22)	−0.32 (0.30)	−0.52 (0.58)
	3	68	0.56 (0.22)	−0.23 (0.29)	−0.33 (0.57)
	4	68	0.51 (0.19)	−0.38 (0.29)	−0.12 (0.57)
	5	67	0.44 (0.18)	−0.30 (0.29)	0.11 (0.58)
	6	68	0.49 (0.21)	−0.14 (0.29)	0.55 (0.57)
	7	67	0.49 (0.19)	−0.12 (0.29)	−0.40 (0.58)
	8	67	0.26 (0.19)	0.82 (0.29)	−0.12 (0.58)
	9	67	0.49 (0.20)	−0.16 (0.29)	−0.05 (0.58)

Note. TWW = Total Number of Words Written; WSC = Words Spelled Correctly; CWS = Total Number of Correct Word Sequences; %CWS = Percentage of Correct Word Sequences.

Writing Outcomes Using Curriculum-Based Measures

Initial examination of the linear and quadratic models for the CBM variables showed that violating the assumption of normality had a significant impact on how well the data fit the models. The linear latent growth curve models for WSC, TWW, CWS, and %CWS were estimated, but none of the latent growth curve models fit the data well (see Table 2). Furthermore, we were unable to interpret all of the quadratic models due to a negative variance

TABLE 2
Unconditional Curriculum-Based Measures Model Fit Statistics

Variable	*Model*	*N*	*AIC*	$\chi^2(df)$	*RMSEA*	*TLI*
TWW	Linear	66	4773.93	76.130 (40) $p = 0.0005$	0.117	0.919
	Quadratic	NI				
WSC	Linear	66	4663.32	107.726 (40) $p < 0.001$	0.160	0.843
	Quadratic	NI				
CWS	Linear	66	4480.01	124.763 (40) $p < 0.001$	0.179	0.793
	Quadratic	NI				
%CWS	Linear	66	−323.40	160.049 (40) $p < 0.001$	0.213	0.600
	Quadratic	NI				

Note. TWW = Total Number of Words Written; CWS = Total Number of Correct Word Sequences; WSC = Total Number of Words Spelled Correctly; %CWS = Percentage of Correct Word Sequences; NI = model deemed not interpretable due to negative variance for one of the latent factors.

for one of the latent factors (i.e., %CWS). Plots for six prototypical cases are displayed in Figures 1a–1d to help illuminate the variation in the scores, demonstrating one reason why the models fit the data poorly. Typically, we would not report any of the parameter estimates for models that do not have at least marginal fit with the data; however, given that this is the first publication where latent growth curve analysis has been conducted to analyze written language assessed by CBMs, we felt that the results of this study may provide meaningful information for future research. Therefore, we have reported results for the models that have statistically significant parameter estimates, but all findings should be taken with caution.

Total number of words written (TWW). As can be seen in Table 2, the linear model for TWW fit the data poorly based on our criteria. The latent growth curve conditional models (i.e., those that included the moderator variables) also fit the data poorly; however, all models revealed statistically significant parameter estimates (see Table 3).

When examining change in written language with regards to the TWW, the mean for the intercept ($\alpha_0 = 23.968$, $p < 0.001$) and the slope ($\alpha_1 = 1.977$, $p < 0.001$) were significant. On average, the second graders wrote about 24 words in their compositions during the first time point, and the total number of words written increased at a rate of about two words per time point. Furthermore, the variances for the intercept ($\gamma_{01} = 213.491$, $p < 0.001$) and linear slope ($\gamma_{11} = 4.063$, $p < 0.001$) components of growth were both significant. These results suggested that there was significant variability in the initial number of total words written and in the rates of increase of words written over time.

Next, to understand the difference in variation, we looked at moderating variables. The linear latent growth curve conditional model for TWW that included the latent trait factor scores revealed a significant prediction of the intercept as a function of language and attention/executive function. On average, the initial TWW for students was about 14 units higher per one-unit increase on language ($\gamma_{01} = 14.416$, $p < 0.001$) and about 6 units lower per one-unit increase on attention/executive function ($\gamma_{02} = -6.685$, $p = 0.006$).

When the derived latent classes were entered into the linear latent growth curve model, there was a significant prediction of the slope as a function of latent class ($\gamma_{01} = 1.606$, $p =$

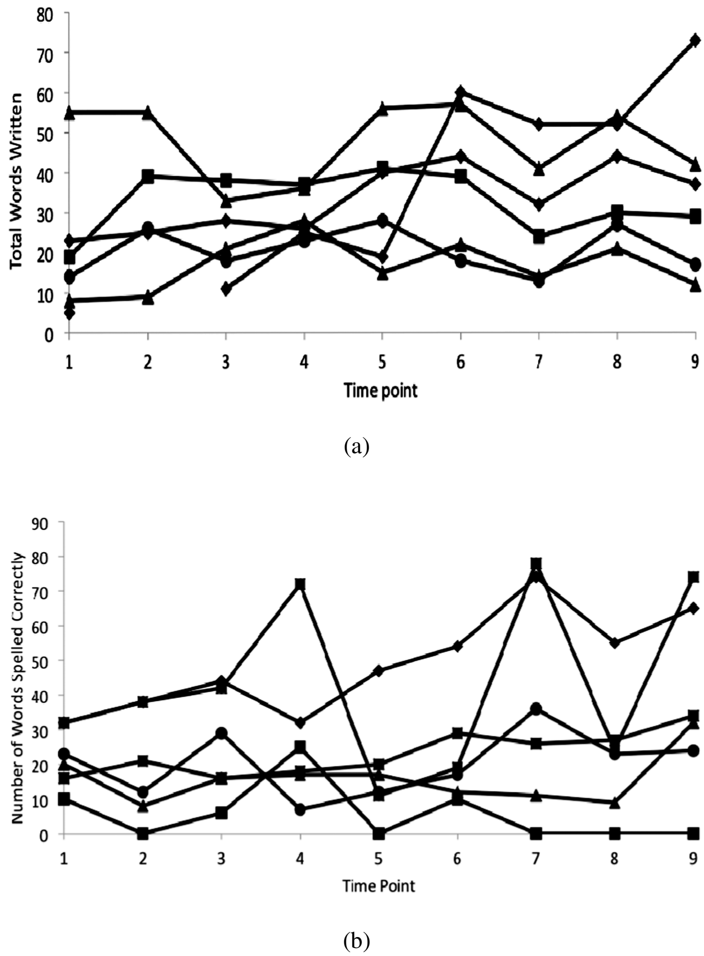
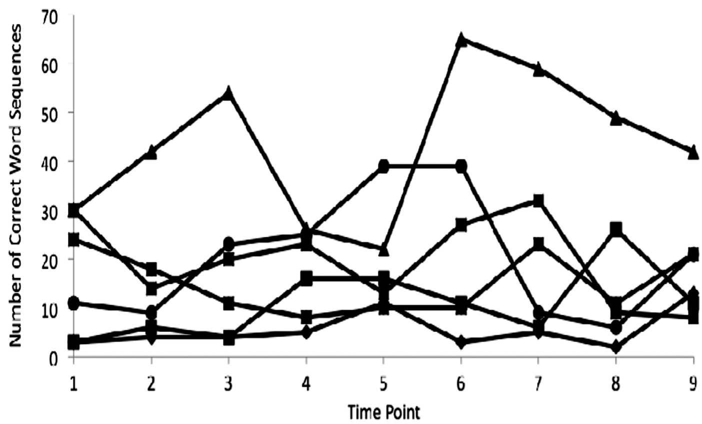


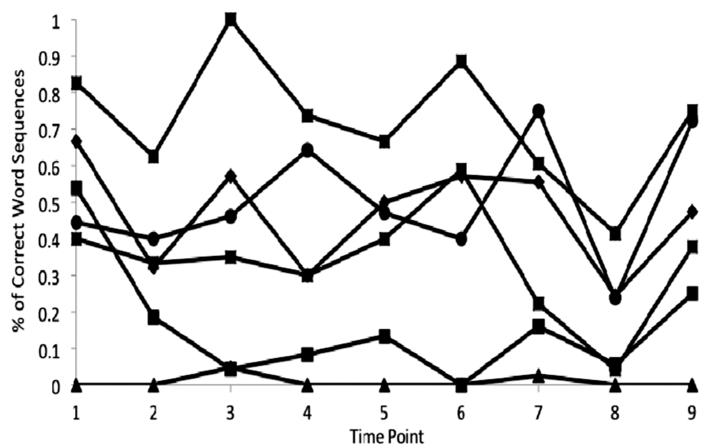
FIGURE 1 Prototypical trajectories for total words written (Fig. 1a), number of words spelled correctly (Fig. 1b), number of correct word sequences (Fig. 1c), and percent of correct word sequences (Fig. 1d) across the 9 assessment time points. (*continued on following page*)

0.001), but not of the intercept ($\gamma_{11} = -0.324$, $p = 0.899$). On average, the groups did not differ initially on the TWW, but the rate of growth for the Specific-Deficit Group was about 1.67 of a word per time point when compared to the Low-g Group, suggesting a moderating effect of latent class group for this variable.

Next, we examined the effects of group status on TWW with regards to students at risk for writing problems and those at risk for writing and reading problems. There was a significant prediction of the intercept as a function of at-risk status ($\gamma_{01} = -6.810$, $p = 0.017$), but not of the slope ($\gamma_{11} = -2.563$ $p = 0.504$). Thus, the groups differed initially on the TWW, but not in the rate of growth. Initially, students who were at risk for both writing and reading problems



(c)



(d)

FIGURE 1 (*Continued*)

spelled about 7 more words incorrectly than the students who were only at risk for writing problems.

Words spelled correctly (WSC). The linear model for WSC did not fit the data well (see Table 2). The conditional models also did not fit the data well (see Table 3), although both the linear unconditional model and the conditional models revealed statistically significant parameter estimates.

When examining change in written language with regards to the WSC, the mean for the intercept ($\alpha_0 = 19.306$, $p < 0.001$) and the slope ($\alpha_1 = 1.507$, $p < 0.001$) were significant. On

TABLE 3
Conditional Curriculum-Based Measures Model Fit Statistics

Variable	*Moderator*	*AIC*	$\chi^2(df)$	*RMSEA*	*TLI*
TWW	Latent Traits	4766.76	140.812 (61) $p < 0.001$	0.141	0.870
	Latent Class	4769.62	87.801 (47) $p = 0.003$	0.115	0.914
	At-Risk Reading Status	4774.56	86.315 (47) $p = 0.0004$	0.113	0.914
WSC	Latent Traits	4650.94	182.522 (61) $p < 0.001$	0.174	0.796
	Latent Class	4658.80	123.960 (47) $p < 0.001$	0.158	0.833
	At-Risk Reading Status	4661.73	122.096 (47) $p < 0.001$	0.156	0.835
CWS	Latent Traits	4460.98	204.556 (61) $p < 0.001$	0.189	0.750
	Latent Class	4476.76	141.044 (47) $p < 0.001$	0.174	0.781
	At-Risk Reading Status	4474.15	138.219 (47) $p < 0.001$	0.171	0.791
%CWS	Latent Traits	NI			
	Latent Class	−324.80	169.134 (47) $p < 0.001$	0.198	0.579
	At-Risk Reading Status	−340.74	168.046 (47) $p < 0.001$	0.198	0.604

Note. TWW = Total Number of Words Written; CWS = Total Number of Correct Word Sequences; WSC = Total Number of Words Spelled Correctly; %CWS = Percentage of Correct Word Sequences; NI = model deemed not interpretable due to negative variance for one of the latent factors.

average, the second graders spelled about 19 words in their compositions correctly during the first time point and the number of words spelled correctly increased at a rate of about 1.5 words per time point. Furthermore, the variances for the intercept ($\gamma_{01} = 168.865$, $p < 0.001$) and linear slope ($\gamma_{11} = 3.078$, $p < 0.001$) components of growth were significant. These results suggested that there was significant variability in the initial number of words spelled correctly and in the rates of increase of words spelled correctly over time.

To better understand the difference in variation, we looked at moderating variables. The linear latent growth curve conditional model for WSC that included the latent trait factor scores revealed a significant prediction of the intercept as a function of language and attention/executive function. On average, the initial number of correctly spelled words for students was about 14 units higher per one-unit increase on language ($\gamma_{01} = 14.041$, $p < 0.001$) and about five units lower per one-unit increase on attention/executive function ($\gamma_{02} = -5.492$, $p = 0.009$). In addition, there was a significant prediction of the slope as a function of language ($\gamma_{11} = 0.884$, $p = 0.041$). These results suggested that the language skills for students who began the intervention with better language skills, also improved more rapidly over time.

When the derived latent classes were entered into the linear latent growth curve model, there was a significant prediction of the slope as a function of latent class ($\gamma_{01} = 1.420$, $p < 0.001$), but not of the intercept ($\gamma_{11} = 0.984$, $p = 0.684$). On average, the groups did not differ initially on the number of words spelled correctly, but the rate of growth for the Specific-Deficit Group was about 1.4 words per time point when compared to the Low-g Group, suggesting a moderating effect of latent class group for this variable.

Next, we examined the effects of group status on WSC with regards to students at risk for writing problems and those at risk for writing and reading problems. There was a significant prediction of the intercept as a function of at-risk status ($\gamma_{01} = -8.028$, $p < 0.001$), but not of the slope ($\gamma_{11} = -0.269$ $p = 0.524$). Thus, the groups differed initially on the number of words spelled correctly, but not in the rate of growth. Initially, students who were at risk for both writing and reading problems incorrectly spelled about 8 more words than the students who were only at risk for writing problems.

Correct words sequenced (CWS). The linear model for CWS, based on our criteria, did not have adequate fit with the data (see Table 2). Additionally, the conditional models did not fit the data well (see Table 3), although the all of the models, unconditional and conditional, revealed statistically significant parameter estimates.

When examining change in written language with regards to the CWS, the mean for the intercept ($\alpha_0 = 14.779$, $p < 0.001$) and the slope ($\alpha_1 = 0.865$, $p < 0.001$) were significant. On average, the second graders demonstrated about 14 correct word sequences in their compositions during the first time point and that increased at a rate of about 0.8 of a correct word sequence per time point. Furthermore, the variance for the intercept ($\gamma_{01} = 124.335$, $p < 0.001$) and linear slope ($\gamma_{11} = 1.609$, $p < 0.001$) components of growth were both significant. These results suggested that there was significant variability in the initial number of correct word sequences and in the rates of increase over time.

The linear latent growth curve conditional model for CWS that included the latent trait factor scores revealed a significant prediction of the intercept and slope as a function of language. On average, the initial CWS for students were about 11 units higher per one-unit increase on language ($\gamma_{01} = 11.131$, $p < 0.001$), and the rate of change for students' CWS ($\gamma_{11} = 0.950$, $p = 0.004$) was about 1 unit higher per one-unit increase on language.

When the derived latent classes were included in the linear latent growth curve model for CWS, there was a significant prediction of the slope as a function of latent class ($\gamma_{01} = 0.896$, $p = 0.005$), but not of the intercept ($\gamma_{11} = 3.083$, $p = 0.140$). Therefore, on average students differed in their rate of growth over time, but not on the initial number of correct word sequences. Specifically, CWS in the compositions of the students in the Specific-deficit group grew at a rate of about three more correct word sequences than CWS for students in the Low-g Group.

When we examined at-risk group status (i.e., Writing-Only and Writing + Reading), the intercept ($\gamma_{01} = -8.996$, $p < 0.001$) was significant, but not the slope ($\gamma_{11} = -0.104$, $p = 0.387$). Thus, the groups differed initially in the number of correct word sequences, but not in the rate of growth. Initially, on average, students who were at risk for only writing problems correctly sequenced about 9% more sequences than the students who were at risk for writing and reading problems.

Percentage of correct word sequences (%CWS). Based on our criteria, the data for %CWS did not have adequate model fit (see Table 2), but revealed statistically significant parameter estimates. Additionally, the conditional models for latent class and at-risk reading status did not fit the data well (see Table 3), and the model that included the latent traits was not interpreted due to negative variance for one of the latent factors.

When examining change in written language with regards to the %CWS, the mean for the intercept ($\alpha_0 = 0.491$, $p < 0.001$) was significant, but not the slope ($\alpha_1 = -0.002$, $p = 0.297$). On average, the second graders demonstrated about 0.5% correct word sequences in their compositions during the first time point but the rate of growth was not significant. Furthermore, the variance for the intercept ($\gamma_{01} = 0.081$, $p = 0.001$) was significant, but the linear slope component of growth was nonsignificant ($\gamma_{11} = 0.001$, $p = 0.477$). These results suggested that there was significant variability in the initial percentage of correct word sequences, but not in the rates of increase over time.

We next examined the results when the derived latent classes were entered into the linear latent growth curve model for %CWS and discovered that there was a significant prediction of the intercept as a function of latent class ($\gamma_{01} = 0.086$; $p = 0.025$), but not of the slope ($\gamma_{11} = 0.001$; $p = 0.966$). This finding suggested that, on average, students differed in the initial percentage of correct word sequences but not in their rate of growth over time. Specifically, students in the Specific-deficit group began with about 0.1 percent more correct word sequences in their compositions than the Low-g Group.

Lastly, we examined the effects of group status on %CWS with regards to students at risk for writing problems and those at risk for writing and reading problems. There was a significant prediction of the intercept as a function of at-risk status ($\gamma_{01} = -0.159$, $p < 0.001$), but not of the slope ($\gamma_{11} = -0.003$; $p = 0.546$). Thus, the groups differed initially in the percentage of correct word sequences, but not in the rate of growth. Initially, on average, students who were at risk for only writing problems had about 0.16% more correct word sequences than the students who were at risk for writing and reading problems.

DISCUSSION

This study provides one of the first examinations of CBM variables over the course of an evidence-based writing intervention for young elementary school students at risk for writing disabilities using latent growth curve methodology. Although an earlier study documented significant, but small, overall effectiveness of the PAL Lesson Plans with this sample of students following the second grade intervention (Hooper, Costa, McBee, Anderson, Yerby, Childress, & Knuth, 2011), we were not able to demonstrate such gains using the CBM variables. Despite a significant, albeit small, positive rate of growth in overall writing in this group in a previous study (Hooper, Costa, McBee, Anderson, Yerby, Childress, & Knuth, 2011), and generally good interrater reliability of the CBM variables selected (Graham et al., 2011), the selected CBM variables did not perform well in the latent growth curve model. Further, contrary to our initial hypotheses, the CBM variables did not show the expected significant change over the course of the intervention. Initial examination of the descriptive statistics for the four targeted CBM variables revealed that the distributions of the scores for each variable at each of the nine time points did not resemble the normal distribution, thus violating the assumption of normality. A robust estimation technique was used to account for the non-normality of the variables, and latent growth curve analysis was conducted to examine change in written language with regards to the four CBM variables. Even with these adjustments, the linear latent growth curve models fit the data poorly. These findings stand in contrast to the work of McMaster and colleagues (2011), in which stable and valid slopes for CBM variables from 8 to 9 writing samples was obtained. Although the samples were slightly different between the studies, students in both studies were receiving their primary instruction from the regular class setting.

Consequently, these results and interpretations should be taken with caution and should not be used to inform decisions about students. Indeed, even with good model fit, CBM variables should be used in combination with other assessment variables to assist with overall assessment and progress monitoring of instruction. Although the results did not support our a priori hypotheses, the findings stand to highlight the complexities of obtaining CBM data in young children at risk for written language disorders. Taken together, these findings raise important questions with respect to the use of CBMs for progress monitoring for second grade students at risk for writing disabilities. If replicated, these findings hold significant implications for teachers using these progress monitoring strategies, who likely will be unaware of the measurement issues and pitfalls inherent in these types of assessments.

Within that context, we did find several statistically significant parameter estimates that might inform future research endeavors with this assessment approach. The unconditional linear latent growth curve models for TWW, WSC, and CWS all revealed statistically significant intercept and slope means and variances. With regards to the conditional models, TWW, WSC, and CWS had several significant moderators of starting point and growth. Specifically, the language latent trait served as a moderator for initial number of TWW, WSC, and CWS, and growth for WSC and CWS. Furthermore, the attention/executive function predicted the initial number of WSC. The intercept for the mean and variance for the %CWS unconditional linear latent growth curve model were statistically significant. The conditional models could explain some of this variability, such that latent class and at-risk status predicted the intercept. Additionally, at-risk status predicted the initial number of TWW, WSC, and CWS. These findings are important and emphasize that other factors, in this instance selected cognitive factors representing language and executive function, cognitively based latent classes, and reading at-risk status, can moderate the effects of growth in written language as measured by CBM variables. Although far from conclusive, it will be important for professionals engaged in routine progress monitoring to take potential moderating variables into consideration when conducting these types of assessments, particularly with young at-risk writers.

It is unclear why the models that included the other CBM variables did not fit the data as it is not unreasonable to expect these assessment strategies to contribute to specific skills analysis (Fuchs, Fuchs, Hamlett, & Allinder, 1991), although overall effects have varied from modest to strong (Amato & Watkins, 2011). One possible contaminant could be related to the performance variability within participants across the course of the intervention. Rather large variability was present in nearly all of the CBM variables, and this may have contributed to the lack of model fit for the linear and quadratic models. Another potential reason was a violation of the assumption of normality. Taken together, these issues might have been remedied with a larger sample size or by using multiple writing samples from the same time point. This latter idea certainly has been employed in other studies (e.g., Hooper et al., 2002), but was not feasible from the perspective of the available time provided by the school system to complete the interventions.

Second, while using CBMs tends to be an objective measurement process (Graham et al., 2011), some subjectivity could come into play. For example, one challenge related to determining the quality of letter formation. In order to be consistent, it was necessary to apply strict rules for determining if a letter was formed properly. The lack of information in previous studies on how correct letter formation was determined, and its effects on the results of the study, have not been clear, thus making it difficult to compare the results of our study to other studies examining writing CBMs. These nuances of measurement may be critical to obtaining stability in the growth curves of specific written language CBMs over the course of instruction or intervention.

A third potential contributor to heightened variability and, perhaps, the poor fit of the CBM models, may be related to the topics selected for writing at the targeted time points over the course of the intervention. Although all of the students were exposed to the same verbal prompt for each of the sessions, the differences in content knowledge from one child to the next on a particular topic, and for a particular child across topics, may have contributed to an inordinate amount of inconsistency in their performance over time. Relatedly, providing preselected words for the writing samples obtained during the intervention but not at the pre- and postintervention time points also may have created undue variance in the CBM variables. Although this strategy (i.e., providing high-frequency words) was used to facilitate written output as part of the PAL Lesson Plans, it is unclear how it may have facilitated or hindered the written product.

A fourth potential contributor to the poor model fit for the CBM variables may have related to having an insufficient number of data points to gain reliable and stable slopes over the course of the intervention. Specifically, we utilized nine data points, which is in line with findings by McMaster and colleagues (2011) (i.e., 8 to 9 data points over a 12-week period) and more than satisfies requirements to construct a latent growth curve model; it is possible that even more data points may be needed for young elementary school students at risk for writing disabilities.

Finally, it is conceivable that reliability and stability of the CBM variables may have improved with more intervention time, either in the form of more sessions or longer sessions. Given the school requirements for the study, we needed to shorten the length of the PAL intervention sessions by about 15 minutes. This may have affected the stability of the growth curves for each of the CBM variables in unknown ways. From a practice perspective, this also begs the question of how much time does a young elementary school child need in a writing intervention so as to stabilize the growth rate of the CBM variables. Most reporting periods are 9 weeks, and students frequently show growth over that time frame. In that regard, we believe that 12 weeks is enough time for students to show growth using certain measures with second grade students, particularly with production dependent measures (e.g., TWW, WSC, CWS). Again, these concerns raise critical issues with respect to teachers and other professionals using CBM variables for day-to-day progress monitoring in the area of writing. At a minimum, from a practice perspective, it is important for teachers to take frequent probes over time and withhold judgment regarding treatment effects until an extended number of probes are given. These types of assessment-treatment linkages undoubtedly will require additional investigation prior to such approaches becoming accepted evidence-based practices for teaching writing skills and reliably monitoring a student's growth over time in the classroom setting.

In summary, this study addressed several key questions related to response-to-intervention using CBM variables and potential moderating factors that could affect the trajectories of CBM performance. Results reflected the measurement complexities of using CBMs to track progress monitoring in second grade students at risk for writing disabilities. Use of interventions, such as the PAL Lesson Plans, clearly provides avenues for positive change in writing at-risk students, but contrary to initial beliefs, the utility of more specific CBM variables for assessing written language were not fruitful in this study. There were several promising moderating factors related to cognitive functions, cognitive subtypes, and at-risk reading skills that were uncovered, but these will require additional investigation, preferably in a model showing stable growth curves with good fit indices. Future studies should continue to examine the effectiveness of evidence-based interventions for young children at risk for writing problems using CBM variables as targeted outcomes, along with potential factors that could moderate their growth trajectories.

The assessment methods used to engage in progress monitoring, however, will require ongoing scientific scrutiny as noted by Graham and colleagues (2011), particularly with respect to their translational application to the classroom setting.

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