

Exploring predictors of performance on a curriculum-based measure of written expression

Madison Aitken & Rhonda Martinussen

University of Toronto | Canada

Abstract: This study examined the role of word-level reading proficiency and verbal working memory in grade 4 and 5 students' ($N = 42$; 23 boys) performance on a curriculum-based measure of narrative writing. Two outcomes were measured: correct minus incorrect word sequences (CMIWS; accurate-production of spelling and grammar in-text), and composition quality. CMIWS scores were moderately correlated with the holistic quality score. Word reading proficiency predicted CMIWS above and beyond the variance accounted for by gender, grade, handwriting automaticity, and working memory. Word reading proficiency also predicted composition quality controlling for gender and handwriting automaticity. Working memory, as measured by an updating task, was not a significant unique predictor of CMIWS or composition quality. Grade (5 > 4) and gender differences (girls > boys) were also found for CMIWS scores. Although handwriting automaticity was correlated with CMIWS scores and writing quality, it was not a unique predictor of either measure. The results provide further evidence of the sensitivity of the CMIWS index. They also highlight the importance of considering reading proficiency and handwriting automaticity when assessing children's writing abilities and planning instruction for children with writing difficulties.

Keywords: written expression; curriculum-based measures; reading; handwriting; gender



Aitken, M., & Martinussen, R. (2013). Exploring predictors of performance on a curriculum-based measure of written expression. *Journal of Writing Research*, 4(3), 281-299.
<http://dx.doi.org/10.17239/jowr-2013.04.03.3>

Contact: Madison Aitken, Department of Human Development and Applied Psychology, 9th Floor, Ontario Institute for Studies in Education, University of Toronto, 252 Bloor Street West, Toronto, ON M5S 1V6 | Canada – madison.aitken@mail.utoronto.ca

Copyright: Earli | This article is published under Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported license.

Writing is a multifaceted task that requires the coordination of several sub-skills and processes (Graham & Harris, 2000). Developmental models of writing highlight the contributions of lower-order (e.g., handwriting, spelling) and higher-order skills (e.g., planning, organizing), as well as cognitive factors such as memory (Berninger, Abbott, Whitaker, Sylvester, & Nolen, 1995; Flower & Hayes, 1981). The complexity of written expression means that it is possible for students to struggle with the task due to difficulties with one or several of the sub-skills and processes implicated. This is particularly concerning as writing skills are important to individuals' success in school, in the workplace, and in their daily lives (see Graham & Perin, 2007 for a review). At school, in-class and large-scale assessments often require children to communicate their ideas in writing (e.g., British Columbia Ministry of Education, 2009; Britton, Burgess, Martin, McLeod, & Rosen, 1975; Education Quality and Accountability Office, 2009; Jenkins, Johnson, & Hileman, 2004). Children who struggle with writing may not be able to convey their knowledge and ideas adequately in written form and thus perform poorly on these assessments, resulting in low grades (Graham, 2006). Writing is also often used to facilitate students' learning (Britton et al., 1975; Rivard & Straw, 2000). Students with weak writing skills may not derive the same benefits from learning activities that require writing (e.g., journals) as their peers (Graham & Perin, 2007). Written expression skills are equally important in the workplace, and can impact an individual's ability to secure a job and earn promotions (National Commission on Writing, 2004). Writing difficulties may even impact individuals' social participation in daily life as writing is increasingly required for communication through text messaging and email (Graham & Harris, 2009). Given the importance of written expression skills, reliable, valid, and easy to administer assessment tools are essential in order to identify students at risk for writing difficulties (McMaster & Espin, 2007).

1. Curriculum-Based Measurement of Written Expression

Although standardized measures provide norm-referenced information about achievement, curriculum-based measurement (CBM) may provide more useful information about the development of skills such as writing because it is directly tied to the curriculum in which students are instructed and is more sensitive to small improvements in performance (Deno, 1985; Gansle, Noell, Van Der Heyden, Naquin, & Slider, 2002; Marston, 1989). CBM consists of "a set of standard simple, short-duration fluency measures of reading, spelling, written expression, and mathematics computation" (Shinn & Bamonto, 1988, p. 1). It can be used to monitor students' progress through frequent administration of different probes at the same level of difficulty or as a screening tool to identify children at risk for learning difficulties (Deno, 1985; McMaster & Espin, 2007).

CBM of written expression involves the presentation of a picture, story prompt or topic sentence followed by 1 minute to plan and 3 to 5 minutes to write (McMaster & Espin, 2007). The brevity of these measures facilitates their administration in the school

system, particularly when repeated measurement is to be carried out (Deno, 1985). Students' compositions can be scored for multiple indices to assess various aspects of writing performance. *Total words written* is among the most widely used CBM scores (Gansle et al., 2002). It is a measure of compositional fluency determined by counting the number of words in the child's composition regardless of spelling (Jewell & Malecki, 2005). While total words written is commonly used and easy to score, it measures fluency only, limiting its sensitivity to difficulties with other aspects of writing. As a result, the present study focuses on *correct minus incorrect word sequences* (CMIWS), an additional CBM index that provides richer information about children's writing skills than total words written, particularly in the later elementary grades and beyond (Espin et al., 2000; Malecki & Jewell, 2003). There is also evidence that CMIWS scores are a more valid indicator of writing proficiency than total words written in the later elementary grades (Jewell & Malecki, 2005). CMIWS is an "accurate-production" (Jewell & Malecki, 2005, p. 27) index of spelling and grammar that takes fluency into account as well as the accuracy of basic mechanics of writing (e.g., spelling, capitalization, punctuation; Espin et al., 2000). It is calculated by subtracting the number of incorrect word sequences from the number of correct word sequences. A correct word sequence is defined as "two adjacent writing units (i.e., word-word or word-punctuation) that are acceptable within the context of what is written" (Jewell & Malecki, 2005, p. 32; see Powell-Smith & Shinn, 2004 for training materials for CBM scoring).

The reliability and validity of various CBM indices of written expression have been established across multiple studies (see McMaster & Espin, 2007 for a review). These studies have found high inter-scoring agreement and split-half reliability coefficients, and modest to high test-retest correlations and alternate-form reliability (Marston & Deno, 1981; McMaster & Espin, 2007). In addition, CBM scores are moderately to strongly correlated ($r_s = .67$ to $.88$) with scores on the Test of Written Language (Hammill & Larsen, 1978; see McMaster & Espin, 2007 for a review) and with holistic ratings of composition quality made on a four-point scale ($r_s = .69$ to $.85$; Espin et al., 2000; Espin, De La Paz, Scierka, & Roelofs, 2005). CBM scores also predict academic achievement in high school English and Social Studies, two of the most reading- and writing-intensive courses (Fewster & MacMillan, 2002). However, little research has examined the relationship between children's performance on CBM scoring indices and student characteristics known to be associated with writing performance. The majority of existing studies have explored gender and age differences in CBM scores (Jewell & Malecki, 2005; Malecki & Jewell, 2003). On average, older students earn higher CMIWS scores than younger students (Jewell & Malecki, 2005; Malecki & Jewell, 2003). Gender differences in CBM writing performance have also been reported in elementary school students (e.g., Jewell & Malecki, 2005; Malecki & Jewell, 2003), although evidence is mixed regarding gender differences in CMIWS scores (Jewell & Malecki, 2005; Malecki & Jewell, 2003). Malecki and Jewell (2003) reported that boys performed more poorly than girls on CMIWS and these differences were more apparent

in the later elementary and middle school students than in early elementary students. In a subsequent study by Jewell and Malecki (2005), however, gender differences were limited to those CBM indices that assessed children's fluency (e.g., total words written).

Whereas CMIWS primarily measures the mechanics of writing, quality scores capture higher order aspects of narrative writing, including organization, story development, word choice, and coherence. CMIWS scores are correlated with composition quality (e.g., Jewell & Malecki, 2005), and several existing studies have examined predictors of composition quality (e.g., Olinghouse, 2008; Swanson & Berninger, 1996). However, we did not locate any studies that concurrently examined the factors (aside from age and gender) associated with performance on the CMIWS index and a holistic measure of composition quality. Our goal was to acquire a better understanding of the contribution of reading proficiency and verbal working memory to children's performance on a brief curriculum-based writing task. Although research on CBM has primarily been conducted in the North American context in which there is an emphasis on progress monitoring (the use of performance data gathered through repeated measurement over time to inform instructional decisions; Safer & Fleischman, 2005) using CBM, we believe the findings may also be of interest to international audiences as indices similar to those associated with CBM are often used as indicators of writing ability (e.g., Berninger, Cartwright, Yates, Swanson, & Abbott, 1994; Mäki, Voeten, Vauras, & Poskiparta, 2001; Re, Caeran, & Cornoldi, 2008). Moreover, the results will be useful for those who wish to begin using CBM in research or practice. Below we briefly review the research examining the contribution of reading ability and working memory to objective and holistic measures of written expression.

1.1 Predictors of Writing Performance

Although reading and writing are discrete skills (Berninger, Abbott, Abbott, Graham, & Richards, 2002), their close association is well-established (e.g., Abbott & Berninger, 1993; Abbott, Berninger, & Fayol, 2010). We did not locate any studies that examined the role of reading ability in children's performance on CBM of written expression, but evidence from studies using other writing measures indicates that reading skills (e.g., word reading, passage comprehension) predict the quality of children's narrative compositions (e.g., Berninger et al., 2002; Olinghouse, 2008). In addition, word reading and reading comprehension scores are associated with in-text spelling and grammatical accuracy (Berninger et al. 2002; Mäki et al., 2001; Wakely, Hooper, de Kruif & Swartz, 2006). Therefore, children who are poor readers are likely to score lower than their peers on measures of composition quality and CMIWS.

Working memory has been identified as an important component of cognitive models of writing (Berninger et al., 1995; Hayes, 1996). Children's working memory capacity is often examined with tasks that require simultaneous storing and processing of information (Alloway, Gathercole, Willis, & Adams, 2004). Working memory is important to written expression because writers must simultaneously generate ideas, plan, select and spell appropriate words, form individual letters, monitor their written

output, and revise their work as necessary (McCutchen, 1996; Swanson & Berninger, 1996). Indeed, verbal working memory predicts composition quality even after differences in reading ability have been accounted for (Berninger et al., 1994; Bourke & Adams, 2003; Swanson & Berninger, 1996). Although we did not find any studies that examined the relationship between working memory and CMIWS, prior research has documented an association between verbal working memory and children's single-word spelling (Jongejan, Verhoeven, & Siegel, 2007). In addition, children with poor working memory exhibit weaknesses in monitoring their work for errors (Gathercole et al., 2008). Hence, children with poor working memory may perform more poorly than their peers on the measure of composition quality, and on the CMIWS index because it assesses their accuracy with writing conventions (e.g., punctuation, capitalization).

Given the brief, timed nature of the CBM writing tasks, we also included a measure of handwriting automaticity. We wanted to assess the contribution of reading proficiency and working memory to children's performance on the writing indices controlling for handwriting automaticity. Transcription skills are an important component of written expression (Berninger, 2000a), and handwriting fluency is particularly important in terms of productivity-based outcomes (Graham & Harris, 2000). There is also some evidence that students' ability to write quickly and accurately is associated with their composition quality (Berninger et al., 1994; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997), possibly because more fluent handwriting results in longer compositions (Olinghouse, 2008). In addition, handwriting fluency is related to children's reading proficiency (Berninger et al., 1994) and thus is an important variable to control for when assessing the contribution of reading proficiency to writing outcomes.

1.2 Summary and Research Question

The main objective of the study was to assess the contribution of reading proficiency and verbal working memory to children's scores on the CMIWS index and the measure of composition quality. Given the complexity of written expression and the interrelationships among potential predictors (e.g., working memory, reading proficiency; Gottardo, Stanovich, & Siegel, 1996), it is important to include multiple predictors to identify the variables that make a unique contribution to performance on writing tasks (Olinghouse, 2008).

2. Method

2.1 Participants

Data were collected from two cohorts ($N = 45$) of grade 4 and 5 students as part of a battery of reading, writing, and cognitive measures. Participants were recruited from two schools through a letter sent home with each student in the participating classrooms. Written consent was obtained from parents or guardians, and participants

provided informed assent. Students with a parent-reported diagnosis of a learning disability or Attention-Deficit/ Hyperactivity Disorder (ADHD) were not excluded, and stimulant medication was not discontinued for students with ADHD. Data collection was completed in December and January by trained graduate students in an urban private school (cohort 1; $n = 23$) and a suburban public school (cohort 2; $n = 22$). Cohort 1 was completed one year before cohort 2.

2.2 Measures

2.2.1 Handwriting Automaticity

Participants completed the Alphabet Writing task from the Process Assessment of the Learner Test Battery for Reading and Writing (Berninger, 2000b). They were asked to print the lowercase letters of the alphabet in order as quickly and neatly as possible. In preliminary analyses, total time to write the alphabet was more closely associated with the writing outcomes than was the number of letters written correctly in 15 seconds (the original scores generated for the Alphabet Writing task, based on criteria outlined in the test manual; Berninger, 2000b). For this reason, and because handwriting fluency is more closely related to writing proficiency than is handwriting quality (Graham et al., 1997), we used the total time scores as an independent variable (multiplied by -1 to facilitate interpretation).

2.2.2 Reading Proficiency

The Sight Word Efficiency and Phonetic Decoding Efficiency subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) were administered. Participants read a list of words and a list of pseudowords of increasing difficulty as quickly as possible. The raw score for each subtest is the number of words read correctly in 45 seconds. The test-retest reliability of the TOWRE ranges from .82 to .97 and its validity has been established through correlation with criterion measures (Torgesen et al., 1999). Scores on the TOWRE also correlate highly with performance on reading comprehension tasks (Torgesen et al., 1999), and it has been used as an indicator of reading proficiency in previous studies of writing in elementary students (e.g., Olinghouse & Graham, 2009). Because scores on the Sight Word Efficiency and Phonetic Decoding Efficiency subtests were highly correlated in our sample ($r = .84$), we converted participants' raw scores on these subtests to z scores and averaged them to create a reading proficiency score.

2.2.3 Working Memory

A computerized, object version of the Self-Ordered Pointing Task (Petrides & Milner, 1982) was used to measure verbal working memory. The task is a revised version of that used by Cragg and Nation (2007) to measure working memory in 5 to 11 year old

children. The Self-Ordered Pointing Task measures verbal working memory using common, nameable objects (Joseph, Steele, Meyer, & Tager-Flusberg, 2005) and requires participants to update verbal information and inhibit previous responses (Petrides & Milner, 1982). Prior research suggests that vocabulary does not play a role in performance on this task (Cragg & Nation, 2007); therefore, scores do not appear to be confounded with language ability (Cragg & Nation, 2007).

Participants were seated approximately 40 centimetres from the screen of a laptop computer and completed a practice trial to ensure they understood the task. For each level, an array of pictures was presented on the screen. They completed four levels of 4, 6, 8, and 10 picture stimuli in cohort 1, and four levels of 6, 8, 10, and 12 picture stimuli in cohort 2. Participants completed two trials at each level, beginning with the 4-stimuli level in cohort 1 and with the 6-stimuli level in cohort 2. They were instructed to click on a different picture on each presentation using the computer mouse, and not to click on the same picture twice. The placement of the pictures changed with each presentation, and the number of presentations per level corresponds to the number of pictures. The pictures were not aligned to a grid to eliminate the possibility of receiving a high score by continuously clicking on the same location (Cragg & Nation, 2007). Scores were the total number of errors across all trials at the 6-, 8- and 10-stimuli levels as the total error score has demonstrated high test-retest reliability (Ross, Hanouskova, Giarla, Calhoun & Tucker, 2007), and data for both cohorts were available at these levels. We multiplied these scores by -1 to facilitate interpretation. Accuracy on the practice trial was high, with 76% of children making no errors. Therefore, participants did not appear to have difficulty understanding the task or using the computer mouse. There was no significant difference between cohort 1 ($M = 5.33, SD = 3.51$) and cohort 2 ($M = 5.95, SD = 3.20$) on the total error score, $t(40) = -.60, p > .05$.

2.2.4 CBM of Written Expression

A curriculum-based measure of narrative writing was administered to small groups of students. Participants wrote a composition in response to the writing probe, "I was so surprised when I woke up this morning and looked out my window. I saw..." They were each given a blank sheet of paper and a pencil with an eraser and were told they were going to write a story. The tester read the writing probe to the participants, who were given 2 minutes to think about the writing probe and make notes on the blank paper. Two minutes of planning time were allowed in order to examine differences in planning abilities and how these may predict writing performance. However, preliminary analyses indicated that variability in planning was not correlated with any of the writing outcomes (Spearman's rho, all $r_s < .10, p_s > .50$). Therefore planning scores were not included in subsequent analyses. Following the planning time, participants were asked to begin writing their stories on a lined paper with the writing probe typed at the top. They were told to do their best work and to guess if they were not sure how to spell a word. Participants were allowed 5 minutes to write. This time

limit was chosen as we believed it would be more appropriate than 3 minutes given the age of the students. However, we also wanted to maintain the brevity of the CBM task. Evidence from previous studies suggests that 3 and 5 minute writing samples demonstrate similar reliability and validity (Espin et al., 2000).

The first author scored the narratives for CMIWS. Forty percent of the narratives were randomly selected and independently scored by a trained graduate student to obtain inter-rater agreement, which was acceptably high for both indices (intraclass correlation coefficient = .99 for correct word sequences, which was used to calculate CMIWS scores). Composition quality was scored on a 7-point scale (1 = considerably below grade expectations; 7 = considerably above grade expectations). Before scoring, each narrative was typed and corrected for spelling and grammatical errors (following Graham et al., 1997; Olinghouse, 2008), as handwriting, and spelling and grammatical errors can impact quality ratings (Marshall & Powers, 1969). A graduate student in a pre-service teacher education program with experience in junior grade classrooms completed the quality scoring. The rater selected anchor papers representative of the values of 1 and 7 on the rating scale for each grade, and then scored the remaining writing samples. The first author then independently scored the narratives using the same anchors, and final quality scores were determined by averaging the scores given by the two raters (following Graham et al., 1997; Swanson & Berninger, 1996). Inter-rater agreement (intraclass correlation coefficient = .68) was comparable to that reported in similar studies (e.g., Abbott & Berninger, 1993; Berninger & Fuller, 1992).

2.2.5 Data Analysis

Before analysing data, we examined histograms and skewness and kurtosis statistics. The skewness statistic for handwriting automaticity was elevated ($z = 3.42$). However, we used the raw scores because predictor variables do not need to be normally distributed (Field, 2009). Alpha was set to .05 for all analyses.

To account for potential differences between cohorts, univariate analyses of variance were carried out comparing the two groups on CMIWS and composition quality. Because no significant differences were found (all $ps > .05$), we combined the data from the two cohorts for the remaining analyses.

Next, correlations among dependent variables and predictor variables were examined to provide preliminary information about the relationships between predictor and dependent variables. Finally, hierarchical regression analyses were carried out in order to determine the relative importance of reading proficiency and working memory to the prediction of CMIWS and quality scores. For CMIWS, grade, gender, and handwriting fluency were entered in the first step, followed by reading proficiency in the second step, and working memory in the final step. For composition quality, we entered gender and handwriting fluency in the first step, followed by reading proficiency in the second step, and working memory in the final step. Working memory was added after reading proficiency because there is evidence that it is also implicated

in reading development (Gottardo et al., 1996), and therefore it has been suggested that working memory may not add variance to the prediction of writing beyond that accounted for by reading proficiency (Swanson & Berninger, 1996).

3. Results

3.1 Descriptive Analyses

We restricted the analyses to participants for whom data for all measures were available. One participant was unable to complete the measures, and data for the handwriting task were missing for two participants, resulting in a final sample of 42 ($n = 21$ for each cohort and each grade; cohort 1 = 12 boys; cohort 2 = 11 boys; mean age = 10.05 years). Ninety percent of the participants spoke English at home. Eight participants had one or more parent-reported diagnoses: 6 were diagnosed with ADHD, 6 with a learning disability, and 2 with an emotional behavioural disorder.

Descriptive statistics and correlations are reported in Table 1. Reading proficiency was moderately and positively correlated with CMIWS and composition quality. The correlations between working memory and each writing outcome were weak and not significant. Handwriting automaticity was moderately and positively correlated with both CMIWS and composition quality. Grade also correlated significantly with CMIWS, but its correlation with quality was weak and non-significant, as expected given that quality scores were based on grade level. Gender was significantly correlated with CMIWS, but its correlation with composition quality was weak and did not reach significance. There was a weak correlation between reading proficiency and working memory.

Table 1. Descriptive Statistics and Zero-Order Correlations among Predictors and Writing Indices

	M	SD	3	4	5	6	7
1. Grade	–	–	.08	.04	-.07	.33*	-.18
2. Gender	–	–	.07	.05	.06	.44**	.25
3. Handwriting ^a	48.60	16.82	–	.23	.04	.37*	.33*
4. Reading proficiency	0.00	0.96		–	.26	.51**	.37*
5. Working memory ^b	5.64	3.33			–	.25	.27
6. CMIWS	47.57	24.82				–	.36*
7. Composition quality	3.76	1.44					–

Note. CMIWS = correct minus incorrect word sequences. ^a Descriptive statistics are based on the total time to write the alphabet in seconds. For all analyses the inverse of this value was used to facilitate interpretation; ^b Descriptive statistics are based on an error score. For all analyses the inverse of this value was used to facilitate interpretation. * $p < .05$ ** $p < .01$

3.2 Multiple Regression Analyses

In an initial hierarchical linear regression analysis we entered grade, gender, and handwriting automaticity (Step 1), reading proficiency (Step 2), and working memory (Step 3) as predictors of CMIWS. Handwriting automaticity was a significant predictor in Step 1 ($\beta = .32, p < .05$). However, in the final model, neither handwriting automaticity nor working memory were significant predictors of CMIWS, and grade, gender, and reading proficiency remained significant predictors. We also conducted an additional hierarchical regression analysis with working memory entered in the second step to determine whether it would contribute to CMIWS when reading was not in the regression model. Working memory did not contribute significantly to the prediction of CMIWS beyond the variance accounted for by the control variables ($\Delta R^2 = .06, \beta = .24, p > .05$). As a result, handwriting automaticity and working memory were not included in the final hierarchical regression analysis, which is presented in Table 2. In Step 1 of the regression model, the control variables grade and gender accounted for 28% of the variance in CMIWS scores with each variable contributing significantly to the prediction of CMIWS. When reading proficiency was entered in Step 2, it contributed significantly to the prediction of CMIWS, accounting for an additional 23% of the variance.

Table 2. Results of linear regression analysis predicting correct minus incorrect word sequences scores

Variable	<i>B</i>	SE <i>B</i>	β	ΔR^2
Step 1				.28**
Grade	14.55	6.72	.30*	
Gender	20.11	6.74	.41***	
Step 2				.23***
Grade	13.80	5.64	.28*	
Gender	18.99	5.66	.39***	
Reading proficiency	12.37	2.97	.48***	

* $p < .05$. ** $p < .01$. *** $p < .001$

The results of the regression analysis predicting composition quality are presented in Table 3. Gender and handwriting automaticity, when entered simultaneously in Step 1, accounted for 16% of the variance in composition quality, but only handwriting automaticity was a significant predictor. When reading proficiency was added in Step 2, it predicted an additional 9% of variance in composition quality. Handwriting automaticity was no longer a significant predictor when reading proficiency was included in the regression model. Working memory was not a significant unique

predictor of writing quality when entered in Step 3. As can be seen in Table 3, reading proficiency did not account for unique variance in writing quality in the final model. Together, the four variables accounted for 28% of the variance in composition quality. As a supplementary analysis, we conducted a hierarchical regression in which working memory was entered after handwriting automaticity and gender. It did not account for a significant proportion of variance ($\Delta R^2 = .06$, $\beta = .24$, $p > .05$) in writing quality beyond handwriting automaticity and gender.

Table 3. Results of Linear Regression Analysis Predicting Composition Quality

Variable	<i>B</i>	<i>SE B</i>	β	ΔR^2
Step 1 ^a				.16*
Gender	0.66	0.42	.23	
Handwriting automaticity	0.03	0.01	.31*	
Step 2 ^b				.09*
Gender	0.63	0.40	.22	
Handwriting	0.02	0.01	.24	
Reading proficiency	0.46	0.22	.31*	
Step 3 ^c				.03
Gender	0.60	0.40	.21	
Handwriting automaticity	0.02	0.01	.24	
Reading proficiency	0.39	0.22	.26	
Working memory	0.08	0.06	.17	

* $p < .05$.

4. Discussion

Our results provide preliminary information about the contribution of reading proficiency and verbal working memory to upper elementary school children's performance on objective and holistic measures of written expression. CMIWS scores, which measure spelling and grammatical accurate-production, were predicted by reading proficiency even after grade, gender, handwriting automaticity, and working memory differences had been accounted for. Grade (5 > 4) and gender (girls > boys) differences in CMIWS scores were not explained by differences in handwriting automaticity, reading proficiency, or working memory. Reading proficiency was a significant predictor of composition quality controlling for gender and handwriting automaticity. Working memory did not predict composition quality when entered in the second step after the control variables or in the final step after reading proficiency.

When both reading proficiency and working memory were included in the regression model, neither was a significant predictor of composition quality.

4.1.1 CMIWS

Reading proficiency accounted for 23% of the variance in CMIWS when entered after the control variables. Our results parallel those of previous studies in which reading proficiency has been associated with single-word spelling abilities and in-text spelling and grammatical accuracy (Abbott et al., 2010; Berninger et al., 2002; Mäki et al., 2001). These findings also provide preliminary evidence that the ability to read words quickly and accurately is related to children's accurate production of spelling and grammar while writing. This is in line with Conrad's (2008) experimental research showing that reading practice leads to transfer to spelling ability, possibly by increasing orthographic knowledge.

Verbal working memory was not strongly correlated with CMIWS. The results of the regression analyses revealed that it was not a significant predictor of CMIWS scores when entered in the second step after the control variables, or when entered in the final step after reading proficiency. Our findings are not consistent with those of previous studies in which verbal working memory was a predictor of spelling and grammatical accuracy (e.g., Fayol, Largy, & Lemaire, 1994; Jongejan et al., 2007). These discrepant findings may be due to differences in the demands of the verbal working memory tasks. Our measure of verbal working memory, the Self-Ordered Pointing Task, required participants to update verbal information in memory frequently (Petrides & Milner, 1982), whereas the tasks used in other studies required individuals to maintain and process verbal information concurrently (Berninger et al., 1994; Swanson & Berninger, 1996). Future studies using both processing and updating verbal working memory tasks as well as experimental manipulations of verbal working memory load during writing (see McCutchen, 2000 for a review) are necessary in order to better understand the association between children's verbal working memory and their ability to write compositions with few mechanical, grammatical, or spelling errors.

Consistent with prior research with elementary school children (Malecki & Jewell, 2003), girls scored higher than boys on CMIWS independent of handwriting automaticity, reading proficiency, and working memory. Similar gender differences have been reported for measures of single-word spelling from dictation, proofreading, and in-text spelling and grammar (Allred, 1990; Mäki et al., 2001; Swanson & Berninger, 1996). CMIWS scores were also sensitive to grade level differences of only one year, providing further evidence of their validity as an indicator of writing proficiency for older elementary and middle school students (e.g., Espin et al., 2000; Malecki & Jewell, 2003). These grade level differences remained after accounting for differences in handwriting automaticity, reading proficiency, and working memory.

4.1.2 Composition Quality

In line with previous research (e.g., Berninger et al., 2002; Olinghouse, 2008) reading proficiency was a significant predictor of composition quality when entered after the control variables, accounting for an additional 9% of the variance. This indicates that reading proficiency contributes to the prediction of composition quality on a brief, timed task, even when differences in printing speed have been accounted for.

In contrast, working memory was not a significant predictor of composition quality when entered after the control variables or when entered in the final position after reading proficiency. The lack of association between verbal working memory and composition quality was unexpected given that previous studies have found that verbal working memory plays a role in students' writing quality (e.g., Berninger et al., 1994; Swanson & Berninger, 1996). Again, this lack of consistency in findings may be due to the use of a task that emphasized updating in working memory rather than concurrent storage and processing. Future studies should include multiple measures of working memory to better understand the associations between working memory performance and various writing indices. It would also be helpful to include multiple measures of writing that vary in genre (e.g., narrative, expository) and duration (e.g., 5 vs. 15 minutes).

Although previous studies have reported that girls score higher than boys on measures of composition quality (e.g., Olinghouse, 2008; Swanson & Berninger, 1996), this finding was not replicated in the present study. This may be because the compositions were typed and corrected for spelling and grammar before quality scoring was completed. In our sample, girls earned higher in-text spelling and grammatical accurate production (CMIWS) scores than boys. Given that spelling and grammar influence overall quality ratings of students' compositions (Marshall & Powers, 1969), correcting spelling and grammar before quality scoring may have minimized gender differences. Moreover, when reading proficiency was entered along with working memory, handwriting automaticity, and gender, none of these variables predicted composition quality. In general, the lack of sensitivity of the measure of composition quality to individual differences in these independent variables may also be due to the fact that the compositions were typed and corrected for spelling and grammar before being scored for quality. Therefore, this measure of composition quality may tap other aspects of literacy not measured in the present study such as vocabulary, knowledge of genre, or text organization. It should be noted that Olinghouse (2008) also used typed and corrected passages for quality ratings and found significant associations between composition quality, gender, and reading proficiency, among other variables. However, in this study, the participants were allocated more time (15 minutes) to generate their compositions. Therefore, quality scores based on longer typed and corrected passages may be more sensitive to individual differences in reading and gender.

4.2 Limitations

The findings of the present study must be interpreted in light of some limitations. First, the small sample size may have resulted in reduced power to detect small effects in the regression analyses, particularly for composition quality. Further research using a larger sample of students is needed to confirm and expand upon our results. In addition, participants with diagnoses of ADHD, learning disabilities, or emotional behavioural disorders, or for whom English was a second language were included in the analyses. However, none of the participants had a level of English language proficiency that interfered with their ability to complete the tasks, and diagnostic statistics were examined for all regression analyses and no influential cases were identified.

Participants were given 2 minutes to plan their narratives prior to composing their text. Although it was anticipated that plan quality would be used as an independent variable, preliminary correlations showed that it was not strongly related to any of the writing outcomes, and thus it was not included in subsequent analyses. It is possible that allowing more time for planning (e.g., 5 minutes; Olinghouse, 2008) may have made the quality of participants' plans a more useful measure. In addition, the language of assessment was English, and therefore the results may not generalize to other languages. Finally, the present study assessed writing proficiency using a narrative task, and a different pattern of results may have emerged if an expository writing task were used. However, previous studies have found similar patterns of relationships between predictor variables and performance on narrative and expository tasks (Berninger et al., 1994; Swanson & Berninger, 1996).

4.3 Implications

CBM writing assessments are tools that teachers and school psychologists can use to gain insight into a student's writing proficiency. Our findings provide evidence of the sensitivity of CMIWS scores to individual differences, making them useful as a tool for both cross-sectional and longitudinal research. First, CMIWS scores, an "accurate-production" (Jewell & Malecki, 2005, p. 27) indicator of writing proficiency, were sensitive to differences in reading proficiency after handwriting automaticity had been accounted for, suggesting that even though these scores are drawn from a brief, timed writing task, they index more than just handwriting speed. Second, the CMIWS index was sensitive to individual differences in reading proficiency even in a relatively strong sample of readers (in the present study, only one participant had a standard score below 85 and the mean standard score was 108 on the Total Word Reading Efficiency index of the TOWRE). Therefore, teachers and school psychologists may also need to assess the reading skills of children who perform poorly on this measure (i.e., have negative scores or scores close to zero) or who show little growth in CMIWS scores over time. Moreover, the results are in line with Abbott and colleagues' (2010) suggestion that reading and writing are interrelated skills, and thus students may benefit from teaching that fosters the development of connections across domains of reading and writing.

The presence of gender differences in CMIWS scores builds on existing research (Jewell & Malecki, 2005; Malecki & Jewell, 2003), and suggests that it is important for teachers and school psychologists to recognize that boys may struggle more with writing than girls, particularly on indices that measure productivity and lower-level writing skills such as spelling and grammar (Mäki et al., 2001; Swanson & Berninger, 1996). Therefore, teachers may need to use a range of instructional approaches to promote engagement and interest in writing and to build students' spelling and grammar skills. It is equally important to use assessment tools such as CBM to monitor students' growth in written expression and to adapt instruction when little or no progress is noted. Doing so will help all children to develop appropriate spelling and grammar skills.

As noted earlier, gender, handwriting automaticity, working memory, and reading proficiency were not robust predictors of composition quality. This suggests that knowledge related to higher order aspects of writing, such as genre, text structure, and vocabulary, may be more important to composition quality (Olinghouse & Graham, 2009), and points to a need for instruction in these areas in addition to the mechanical aspects of writing. One example of a method that has been effective in increasing writing quality, particularly for students with learning disabilities, is Self-Regulated Strategy Development (Graham, Harris, & Mason, 2005), which teaches writing strategies including planning and text structure.

Handwriting automaticity, although included primarily as a control variable, was correlated with CMIWS and composition quality scores. This finding is consistent with prior research showing that students with more fluent handwriting tend to score higher on writing outcomes, particularly when the writing assessment is timed (e.g., Graham et al., 1997; Wagner et al., 2011). As a result, handwriting automaticity should be considered as a potential factor in writing performance on both informal and standardized measures of written expression. Students with slow or inefficient handwriting may need additional, explicit instruction in handwriting to increase their automaticity in text production. They may also benefit from using a word processor (Graham & Perin, 2007); however, typing does not always provide an advantage over handwriting in terms of composition length or quality because keyboarding skills are often less fluent than handwriting (Berninger, Abbott, Augsburger, & Garcia, 2009; Connelly, Gee, & Walsh, 2007).

5. Conclusion

Our results demonstrate that word-level reading proficiency adds unique variance to the prediction of spelling and grammatical accurate-production (CMIWS) scores beyond grade, gender, and handwriting fluency. Reading proficiency also accounted for a significant proportion of variance in composition quality controlling for gender and handwriting fluency. Overall, these findings suggest a need for writing evaluations that assess multiple aspects of writing including writing productivity, conventions, and quality, and that take transcription skills and overall reading proficiency into account.

CBM of writing may provide school professionals with additional insight into children's progress in writing – a useful supplement to school-based assessment of writing. Researchers, educators, and school psychologists may find CMIWS scores a useful means of capturing children's performance on lower-order aspects of written expression.

Acknowledgements

This article is based on a poster session presentation made at the Writing Research Across Borders II Conference on February 19, 2011 in Fairfax, Virginia. This research was supported by the Social Sciences and Humanities Research Council through a Canada Graduate Scholarship to the first author, and an Institutional Grant to the second author. Additional funding was provided by the Ontario Graduate Scholarship Program. We thank Dr. Olesya Falenchuk for her guidance regarding the statistical analyses.

References

- Abbott, R. D., & Berninger, V. W. (1993). Structural equation modeling of relationships among developmental skills and writing skills in primary- and intermediate-grade writers. *Journal of Educational Psychology, 85*(3), 478-508. doi: 10.1037/0022-0663.85.3.478
- Abbott, R. D., Berninger, V. W., & Fayol, M. (2010). Longitudinal relationships of levels of language in writing and between writing and reading in grades 1 to 7. *Journal of Educational Psychology, 102*(2), 281-298. doi: 10.1037/a0019318
- Alloway, T. P., Gathercole, S. E., Willis, C., & Adams, A. (2004). A structural analysis of working memory and related cognitive skills in young children. *Journal of Experimental Child Psychology, 87*(2), 85-106. doi: 10.1016/j.jecp.2003.10.002
- Allred, R. A. (1990). Gender differences in spelling achievement in grades 1 through 6. *Educational Research, 83*(4), 187-193.
- Berninger, V. W. (2000a). Development of language by hand and its connections with language by ear, mouth, and eye. *Topics in Language Disorders, 20*(4), 65-84. doi: 10.1097/00011363-200020040-00007
- Berninger, V. W. (2000b). *Process Assessment of the Learner – Test Battery for Reading and Writing*. Pearson: Toronto.
- Berninger, V. W., Abbott, R. D., Abbott, S. P., Graham, S., & Richards, T. (2002). Writing and reading: Connections between language by hand and language by eye. *Journal of Learning Disabilities, 35*(1), 39-55. doi: 10.1177/002221940203500104
- Berninger, V. W., Abbott, R. D., Augsburger, A., & Garcia, N. (2009). Comparison of pen and keyboard transcription modes in children with and without learning disabilities. *Learning Disability Quarterly, 32*, 123-141.
- Berninger, V. W., Abbott, R. D., Whitaker, D., Sylvester, L., & Nolen, S. B. (1995). Integrating low- and high-level skills in instructional protocols for writing disabilities. *Learning Disability Quarterly, 18*(4), 293-309. doi: 10.2307/1511235
- Berninger, V. W., Cartwright, A. C., Yates, C. M., Swanson, H. L., & Abbott, R. D. (1994). Developmental skills related to writing and reading acquisition in the intermediate grades. *Reading and Writing: An Interdisciplinary Journal, 6*, 161-196. doi: 10.1007/BF01026911
- Bourke, L., & Adams, A. (2003). The relationship between working memory and early writing assessed at the word, sentence and text level. *Educational and Child Psychology, 20*(3), 19-36.

- British Columbia Ministry of Education (2009). *Foundation skills assessment (FSA) administration instructions 2009*. Retrieved October 23, 2009 from <http://www.bced.gov.bc.ca/assessment/fsa/>
- Britton, J., Burgess, T., Martin, N., McLeod, A., & Rosen, H. (1975). *The development of writing abilities (11-18)*. London: MacMillan Education Ltd.
- Conrad, N. J. (2008). From reading to spelling and spelling to reading: Transfer goes both ways. *Journal of Educational Psychology, 100*(4), 869-878. doi: 10.1037/a0012544
- Connelly, V., Gee, D., & Walsh, E. (2007). A comparison of keyboarded and handwritten compositions and the relationship with transcription speed. *British Journal of Educational Psychology, 77*, 479-492. doi: 10.1348/000709906X116768
- Cragg, L. & Nation, K. (2007). Self-ordered pointing as a test of working memory in typically developing children. *Memory, 15*(5), 526-535. doi: 10.1080/09658210701390750
- Deno, S. L. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children, 52*(3), 219-232.
- Education Quality and Accountability Office (2008). Ontario student achievement 2007-2008. Retrieved March 20, 2009 from <http://www.eqao.com>
- Espin, C. A., De La Paz, S., Scierka, B. J., & Roelofs, L. (2005). The relationship between curriculum-based measures in written expression and quality and completeness of expository writing for middle school students. *The Journal of Special Education, 38*(4), 208-217. doi: 10.1177/00224669050380040201
- Espin, C., Shin, J., Deno, S. L., Skare, S., Robinson, S., & Benner, B. (2000). Identifying indicators of written expression proficiency for middle school students. *The Journal of Special Education, 34*(3), 140-153. doi: 10.1177/002246690003400303
- Fayol, M., Largy, P., & Lemaire, P. (1994). Cognitive overload and orthographic errors: When cognitive overload enhances subject-verb agreement errors. A study in French written language. *The Quarterly Journal of Experimental Psychology Section A, 47*(2), 437-464. doi: 10.1080/14640749408401119
- Fewster, S., & MacMillan, P. D. (2002). School-based evidence for the validity of curriculum-based measurement of reading and writing. *Remedial and Special Education, 23*(3), 149-156. doi: 10.1177/07419325020230030301
- Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London: SAGE.
- Flower, L., & Hayes, J. R. (1981). A cognitive process theory of writing. *College Composition and Communication, 32*(4), 365-387. doi: 10.2307/356600
- Gansle, K. A., Noell, G. H., Van Der Heyden, A. M., Naquin, G. M., & Slider, N. J. (2002). Moving beyond total words written: The reliability, criterion validity, and time cost of alternate measures for curriculum-based measurement in writing. *School Psychology Review, 31*(4), 477-497.
- Gathercole, S. E., Alloway, T. P., Kirkwood, H. J., Elliott, J. G., Holmes, J., & Hilton, K. A. (2008). Attentional and executive function behaviors in children with poor working memory. *Learning and Individual Differences, 18*, 214 – 223. doi: 10.1016/j.lindif.2007.10.003
- Gottardo, A., Stanovich, K. E., & Siegel, L. S. (1996). The relationships between phonological sensitivity, syntactic processing, and verbal working memory in the reading performance of third-grade children. *Journal of Experimental Child Psychology, 63*, 563-582. doi: 10.1006/jecp.1996.0062
- Graham, S. (2006). Writing. In P. Alexander & P. Winne (Eds.), *Handbook of Educational Psychology*, (pp. 457-477). Mahwah, NJ: Erlbaum.
- Graham, S., Berninger, V. W., Abbott, R. D., Abbott, S. P., & Whitaker, D. (1997). Role of mechanics in composing of elementary school students: A new methodological approach. *Journal of Educational Psychology, 89*(1), 170-182. doi: 10.1037/0022-0663.89.1.170
- Graham, S., & Harris, K. R. (2000). The role of self-regulation and transcription skills in writing and writing development. *Educational Psychologist, 35*, 3-12. doi: 10.1207/S15326985EP3501_2
- Graham, S., & Harris, K. R. (2011). *Writing difficulties*. In R. Allington & A. McGill-Franzen (Eds.), *Handbook of Reading Disability Research* (pp. 232-241). New York: Taylor & Francis.

- Graham, S., Harris, K., & Mason, L. (2005). Improving the writing performance, knowledge, and self-efficacy of struggling young writers: the effects of self-regulated strategy development. *Contemporary educational psychology, 30*, 207-241. doi: 10.1016/j.cedpsych.2004.08.001
- Graham & Perin (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*(3), 445-476. doi: 10.1037/0022-0663.99.3.445
- Hammill, D. D., & Larsen, S. C. (1978). *Test of written language*. Austin, TX: Pro-Ed.
- Hammill, D. D., & Larsen, S. C. (2009). *Test of written language – Intermediate* (4th ed.). Austin, TX: Pro Ed.
- Hayes, J. R. (1996). A new framework for understanding cognition and affect in writing. In C. M. Levy & S. Ransdell (Eds.), *The science of writing: Theories, methods, individual differences, and applications* (pp. 1–27). Mahwah, NJ: Lawrence Erlbaum Associates.
- Jenkins, J. R., Johnson, E., & Hileman, J. (2004). When is reading also writing: Sources of individual differences on the new reading performance assessments. *Scientific Studies of Reading, 8*(2), 125-151. doi: 10.1207/s1532799xssr0802_2
- Jewell, J., & Malecki, C. K. (2005). The utility of CBM written language indices: An investigation of production-dependent, production-independent, and accurate-production scores. *School Psychology Review, 34*(1), 27-44.
- Jongejan, W., Verhoeven, L., & Siegel, L. S. (2007). Predictors of reading and spelling abilities in first- and second-language learners. *Journal of Educational Psychology, 99*, 835. doi: 10.1037/0022-0663.99.4.835
- Joseph, R. M., Steele, S. D., Meyer, E., & Tager-Flusberg, H. (2005). Self-ordered pointing in children with autism: Failure to use verbal mediation in the service of working memory? *Neuropsychologia, 43*, 1400-1411. doi: 10.1016/j.neuropsychologia.2005.01.010
- Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology, 80*(4), 437-447. doi: 10.1037/0022-0663.80.4.437
- Ma, X., & Klinger, D. A. (2000). Hierarchical linear modeling of student and school effects on academic achievement. *Canadian Journal of Education, 25*(1), 41-55. doi: 10.2307/1585867
- Mäki, H. S., Voeten, M. J., Vaurus, M. M., & Poskiparta, E. H. (2001). Predicting writing skill development with word recognition and preschool reading readiness. *Reading and Writing: An Interdisciplinary Journal, 14*, 643-672. doi: 10.1023/A:1012071514719
- Malecki, C. K., & Jewell, J. (2003). Developmental, gender, and practical considerations in scoring curriculum-based measurement writing probes. *Psychology in the Schools, 40*(4), 379-390. doi: 10.1002/pits.10096
- Marshall, J. C., & Powers, J. M. (1969). Writing neatness, composition errors, and essay grades. *Journal of Educational Measurement, 6*(2), 97-101. doi: 10.1111/j.1745-3984.1969.tb00665.x
- Marston, D. B. (1989). A curriculum-based measurement approach to assessing academic performance: What it is and why do it. In M. R. Shinn (Ed.), *Curriculum-based measurement: assessing special children* (pp. 18-78). New York: Guilford Press.
- Marston, D. B., & Deno, S. (1981). *The reliability of simple, direct measures of written expression* (Research Report No. 50). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities.
- McCutchen, D. (1996). A capacity theory of writing: Working memory in composition. *Educational Psychology Review, 8*(3), 299-325. doi: 10.1007/BF01464076
- McCutchen, D. (2000). Knowledge, processing, and working memory: Implications for a theory of writing. *Educational Psychologist, 35*(1), 13-23. doi: 10.1207/S15326985EP3501_3
- McMaster, K., & Espin, C. (2007). Technical features of curriculum-based measurement in writing. *The Journal of Special Education, 41*(2), 68-84. doi: 10.1177/00224669070410020301
- National Commission on Writing (2004). *Writing: A ticket to work...or a ticket out*. New York: The College Board.
- Olinghouse, N. G. (2008). Student- and instruction-level predictors of narrative writing in third-grade students. *Reading and Writing, 21*(1-2), 3-26. doi: 10.1007/s11145-007-9062-1

- Olinghouse, N. G., & Graham, S. (2009). The relationship between the discourse knowledge and the writing performance of elementary-grade students. *Journal of Educational Psychology, 101*(1), 37-50. doi: 10.1037/a0013462
- Petrides, M., & Milner, B. (1982). Deficits on subject-ordered tasks after frontal- and temporal-lobe lesions in man. *Neuropsychologia, 20*(3), 249-262. doi: 10.1016/0028-3932(82)90100-2
- Powell-Smith, K. A., & Shinn, M. R. (2004). *Administration and scoring of written expression curriculum-based measurement (WE-CBM) for use in general outcome measurement*. Retrieved October 5, 2010 from <http://www.aimsweb.com/uploads/files/adminandscoringwebcm.pdf>
- Re, A. M., Caeran, M., & Cornoldi, C. (2008). Improving expressive writing skills of children rated for ADHD symptoms. *Journal of Learning Disabilities, 41*(6), 535-544. doi: 10.1177/0022219408317857
- Rivard, L. P., & Straw, S. B. (2000). The effect of talk and writing on learning science: an exploratory study. *Science Education, 84*(5), 566-593. doi: 10.1002/1098-237X(200009)84:5<566::AID-SCE2>3.0.CO;2-U
- Ross, T. P., Hanouskova, E., Giarla, K., Calhoun, E., & Tucker, M. (2007). The reliability and validity of the self-ordered pointing task. *Archives of Clinical Neuropsychology, 22*, 449-458. doi: 10.1016/j.acn.2007.01.023
- Safer, N., & Fleischman, S. (2005). How student progress monitoring improves instruction. *Educational Leadership, 62*(5), 81-83.
- Shinn, M. R., & Bamonto, S. (1998). Advanced applications of curriculum-based measurement: "Big ideas" and avoiding confusion. In M. R. Shinn (Ed.) *Advanced applications of curriculum-based measurement* (pp. 1-31). New York: Guilford Press.
- Swanson, H. L., & Berninger, V. W. (1996). Individual differences in children's working memory and writing skill. *Journal of Experimental Child Psychology, 63*, 358-385. doi: 10.1006/jecp.1996.0054
- Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1999). *Test of word reading efficiency (TOWRE)*. Austin, TX: PRO-ED.
- Wakely, M. B., Hooper, S. R., de Kruijff, R. E., & Swartz, C. (2006). Subtypes of written expression in elementary school children: A linguistic-based model. *Developmental Neuropsychology, 29*(1), 125-159. doi: 10.1207/s15326942dn2901_7
- Wagner, R. K., Puranik, C. S., Foorman, B., Foster, E., Wilson, L. G., & Tschinkel, E. (2011). Modeling the development of written language. *Reading and Writing, 24*, 203-220. doi: 10.1007/s11145-010-9266-7
- Wechsler, D. (2001). *Wechsler individual achievement test* (2nd ed.). San Antonio, TX: Psychological Corporation.