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Predictors of Elementary-aged Students' Writing Fluency Growth in Response to a Performance Feedback Writing Intervention

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Abstract

Students at all grade levels in the United States are experiencing significant difficulties in the area of written expression (Salahu-Din, Persky, & Miller, 2008; U.S. Department of Education, 2012). Although performance feedback is an effective evidence-based intervention for improving the writing fluency of elementary-aged students, approximately one-third do not exhibit fluency growth (Eckert et al. 2006, 2008). The transcription skill of handwriting is a prerequisite of skilled writing (Berninger et al., 2002) and interventions to improve handwriting have concurrent positive effects on writing fluency (Berninger et al., 1997; Graham et al., 2000). Transcription skills influence the writing fluency of younger students (Graham et al., 1997; Limpo & Alves, 2013). Additionally gender influences writing fluency, with female students outperforming male students on measures of both handwriting and writing fluency (Malecki & Jewell, 2003; Olinghouse 2008). The goal of the proposed study was to determine whether third-grade students' (n = 74) transcriptional skills and gender predicted their writing fluency growth in response to a performance feedback intervention. As hypothesized, handwriting skill accounted for some variance in writing fluency growth; however, gender did not. Students who did not respond to the intervention exhibited lower baseline writing fluency and were more likely to be male. Considerations for instruction in basic writing skills and improving the effectiveness of writing interventions are discussed.

Keywords: written expression, writing fluency, performance feedback, handwriting, gender, intervention response

PREDICTORS OF ELEMENTARY-AGED STUDENTS' WRITING FLUENCY GROWTH IN RESPONSE TO A PERFORMANCE FEEDBACK WRITING INTERVENTION

by

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Introduction

Writing is a powerful tool for learning and communication, which are essential for success in school and the workforce. Despite its importance, written expression is often an overlooked component in the typical school curriculum. The National Commission on Writing (2003) voiced concerns over writing instruction being "The Neglected 'R'", receiving far less attention than reading or arithmetic instruction. Their report states that 97% of elementary school students spend three hours or less on written assignments per week. This finding was also reflected in high school, where only 49% of twelfth-grade students reported being assigned papers of three pages or more once or twice a month, while 39% reported that they "hardly ever" or "never" received such writing assignments. These instructional inadequacies are evident in the performance of students on national assessments of written expression. Results published in the National Assessment of Educational Progress indicate that American students have been struggling with written expression for the last decade, with 72% of fourth-, 67% of eighth- , and 76% of twelfth-grade students failing to meet standards for Proficient performance (Persky, Daane, & Jin, 2003; Salahu-Din, Persky, & Miller, 2008). More recent results from the 2011 assessment of eighth- and twelfth-grade students using computer-based writing tasks signal a continuing trend, with 73% of students at both grades failing to attain proficiency (U.S. Department of Education, 2012).

The persistence of writing difficulties among students has prompted increased research into the development of effective evidence-based interventions to improve writing performance, particularly that of beginning writers. One such intervention is performance feedback, which is

successful in improving writing fluency among elementary-aged students (Eckert et al. 2006, 2008). Although many students evidence growth in writing fluency in response to performance feedback, Eckert and her colleagues (2008) noted that one third of the students who received the intervention did not show improvement (i.e., were non-responders). These students began the intervention with initial fluency levels that were below that which was expected for their grade level and failed to improve to proficient levels at the close of the intervention (Eckert et al., 2008). These findings suggest that although performance feedback is a powerful means of improving elementary-aged students' writing fluency, it is not universally effective and is subject to individual differences in students' response to intervention.

In this dissertation proposal, I will discuss the importance of writing and students' achievement in writing in the United States as well as theoretical conceptualizations of writing with a particular focus on beginning writers. I will then review the transcription skills of spelling and handwriting as prerequisites for skilled writing and methods for the assessment of handwriting. I will outline interventions to improve writing fluency, including performance feedback. Finally, I will discuss individual differences that may account for student response to performance feedback in written expression, particularly handwriting skill and gender. This review will culminate in a proposed study to examine the influence of the student-level factors of handwriting and gender as predictors of degree of fluency growth in response to performance feedback interventions.

The Significance of Writing

The word "writing" may have many different meanings. Among the most basic definitions are the system of symbols that are a used to represent a language, and the process of reproducing these symbols on a surface (Tolchinsky, 2006). In a larger sense, writing is an

extraordinary tool that transforms our use of language. With the written word we are able to put our “thoughts on paper” (National Commission on Writing, 2003), describe our internal worlds, and share our experiences with others. Writing lends concreteness and permanence to ideas so that information may be gathered, preserved, and transmitted (Graham, Gillespie, & McKeown, 2008).

Writing is an essential tool for learning, allowing students to communicate and comprehend ideas and form connections between pieces of information. Writing about content material has been found to enhance students’ understanding (Graham & Perrin, 2007). It is also the primary means by which teachers evaluate students’ content knowledge (Graham & Perrin, 2007). Written expression has an impact on other language areas and skill in writing confers advantages in other subjects. Meta-analyses conducted by Graham and Herbert (2010, 2011) revealed that writing about material they were learning improved the text comprehension for students in grades 2 to 12. Additionally writing instruction including process writing, sentence construction, and spelling were shown to improve reading comprehension, reading fluency, and word reading skills. These effects appeared to increase with the frequency of writing activities – as students in grades 1to 6 wrote more, they evidenced a corresponding improvement in their reading comprehension skills (Graham & Herbert, 2010; 2011).

Writing continues to be an important skill as students pursue higher education. Written assessment is a component of the Scholastic Aptitude Test (SAT) and students who experience difficulty in writing are ill-equipped for the demands of college (ACT, 2005). Written work products such as reports, briefs, and proposals are common features of the professional world, and the ability to write effectively is endorsed by 90% of midcareer professionals as an important skill for day-to-day work (National Commission on Writing, 2003). Writing skills also affect

career advancement, influencing employer decisions pertaining to hiring and promotions (National Commission on Writing, 2004, 2005).

At the national level, writing is an essential means of evaluating academic achievement. The No Child Left Behind Act (NCLB, 2002; Public Law 107-110) requires states to measure annual progress in reading, mathematics and science by including written assessments. In conjunction with standardized testing, the introduction of Common Core State Standards (CCSS; National Governors Association Center for Best Practices, 2010) stands to dramatically change the expectations for students' written expression (Graham et al., 2013). The CCSS place more emphasis on learning to write and writing to learn than current instructional practices account for. Under CCSS, active instruction in writing continues throughout the grades and students are expected to consume and produce texts from multiple genres (e.g., expository, persuasive, and informational) as well as use technology to collaborate, publish, and share writing (Graham et al., 2013). It is clear that writing is an essential skill in modern society and the future will present even more challenges that will require mastery of this area to ensure student success. As such, it is alarming that so many students continue to underperform in written expression, and critical that we reverse this trend.

Students' Writing Outcomes in the United States

National data on written expression reveal an enduring trend of underachievement in this area throughout grade levels. The majority of students exhibit competency in writing that is discrepant with their level of education. Results published in the 2002 National Assessment of Educational Progress (Persky et al., 2003) reported on the writing achievement of students in the fourth-, eighth- and twelfth-grades. These results were reported in terms of the percentage of students achieving performance at three levels: (1) Basic (i.e., partial mastery of fundamental

skills); (2) Proficient (i.e., grade-appropriate academic performance); and (3) Advanced (i.e., superior performance). In 2002, 72% of fourth-grade students did not attain Proficient performance in written expression. Subsequent assessment in 2007 of students in the eighth- and twelfth-grades indicated underperformance continuing through the grades with 67% and 76% of students failing to attain Proficiency at the respective levels (Salahu-Din et al., 2008). Assessments conducted in 2011 used computer-based writing tasks and reported on the performance of students in the eighth- and twelfth-grades. The results of this assessment showed no remitting of the trend, with 73% of students at both grade levels unable to attain Proficiency (U.S. Department of Education, 2012).

The results of these national assessments concerning beginning writers are particularly distressing. Of the students in the fourth-grade sample, 14% were unable to write at the Basic level and only 1% met the criteria for Advanced performance (Persky et al., 2003). Examination of key demographic variables among fourth-grade students revealed that a disproportionate number of students who were members of ethnic minorities could not write at Proficient levels (86% of Black children, 83% of Hispanic children, and 86% of American Indian/ Alaska Native children). The effects of poverty could also be seen in the results, with 88% of fourth-grade students who were eligible for free or reduced-price lunch failing to meet Proficiency standards (Persky et al., 2003). These findings indicate that American students have been experiencing persistent difficulties in the area of written expression beginning in the early grades that follow them throughout their academic careers. In order to reverse this trend there is a need for thorough understanding of the neurological and cognitive contributors to writing. This knowledge informs theoretical conceptualizations of writing and how writing develops as a means to determine appropriate instructional practices and design effective interventions.

Cognitive Contributors to Written Language

Twenty years ago, Levine et al. (1993) theorized that a number of cognitive functions operate during the writing process. Five possible constructs were proposed: (1) attention, (2) memory, (3) language, (4) neuromotor skill, and (5) higher-order cognition. Findings from more recent empirical efforts have lent support to the role of these cognitive constructs in writing, their interplay, and the degree of influence they exert at different developmental stages of writing. Recently, the significance of these areas among beginning writers has been corroborated by research using structural equation modeling (Hooper et al., 2011).

Attention and executive function have been included in most models of written language. These domains are multi-component systems that work together to sustain focus, divide and shift attention, and integrate information (Repov & Baddeley, 2006). During writing these functions are critical for text generation by contributing to planning, self-monitoring, translating and revision (Hooper et al., 2011). Executive function has been found to predict text generation skills and vocabulary in high school students (Vandenberg & Swanson, 2007) and features of executive dysfunction, such as difficulties initiating and sustaining attention, have been observed in studies of poor writers in the fourth and fifth grades (Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002). Structural equation modeling examining these constructs among young writers revealed that the combination of attention and executive function was one of three latent factors (along with fine motor speed and language) that significantly predicted written expression outcomes among students in the first ($B = 0.53$) and second grade ($B = 0.28$) (Hooper et al., 2011).

Developmental models of writing note that lower-level cognitive functions relating to the motor task of writing are of particular importance for students in the early elementary grades.

Factors relating to graphomotor output such as letter formation and automaticity of handwriting constrain the performance of beginning writers and must be mastered before fluent written expression is possible (Berninger & Winn, 2006). Fine-motor output of letters involves several processes including motor planning, retrieval of letter shapes from memory, and activation of the necessary muscle groups to translate mental representations into physical markings (Hooper et al., 2011). Fine motor speed was found to be a latent factor contributing to early written expression; however, its unique contribution to the overall variance of writing outcomes was not significant (Hooper et al., 2011).

Basic language functions have also been recognized as critical to the writing process. These include phonological processing (knowledge and memory for sounds), orthographic coding (translation of letters and words into graphic representations), vocabulary, syntax, and reading (Hooper et al., 2011). Language skills required for reading are also implicated in writing, with development of the two skills having approximately 50% of their processes in common (Shanahan, 2004, 2006). Early work by Abbott and Berninger (1993) revealed that phonological and orthographic skills contributed to the compositional fluency of students in first to sixth grade, whereas oral language and reading skills were related to compositional quality in early primary grades. Hooper et al. (2011) found that language functions contributed to the development of writing, predicting performance in written expression in among students in the first- ($B = 0.15$), and second-grade ($B = 0.50$), although this finding was only statistically significant for the latter.

Memory has been the subject of extensive study in the area of written expression. It supports the maintenance of ideas, retrieval of grammatical rules and vocabulary, and the self-monitoring processes necessary for review and revision while composing (Hooper, 2009). Long-

term memory is implicated in idea-generation and topic knowledge, whereas short-term memory is critical for management of simultaneous processes such as spelling and error correction (Hooper et al., 2011). Hooper and colleagues (2011) initially attempted to fit a hypothesized model predicting written expression by including the latent factors of working memory and long-term memory. The estimated correlations between these latent factors exceeded 1, which prompted the consolidation of working memory into attention/executive function based on the theoretical association (i.e., central executive functioning; Baddeley, 2007). Long-term memory was also found to be highly correlated with language and attention/executive function. As a result, the indicator variables of long-term memory were consolidated into attention/executive function based on the premise that retrieval of information from long-term stores requires regulatory processes. Therefore, memory functions may be seen as having strong interconnections with executive function and predicting written expression outcomes as part of this latent factor with attention.

These cognitive constructs underpin the various theoretical conceptualizations of writing. Among the early models of writing, Hayes and Flowers (1980) was the most influential, focusing on the cognitive components of writing. More contemporary models, such as the Simple View of Writing (Berninger et al., 2002), reflect growing interest in beginning writers and combine developmental considerations with cognitive components. These theoretical conceptualizations of writing are reviewed in the next section.

Theoretical Conceptualizations of Writing

Writing is a complex multi-component skill that draws on a number of cognitive processes. An early model of writing proposed by Hayes and Flower (1980) reflects this

complexity, consisting of a hierarchical arrangement of three components: (a) planning, (b) translating, and (c) reviewing written work. The first step of planning is divided into three sub-components: generating ideas, organizing ideas, and goal setting. Translating concerns the transformation of ideas into physical text. The final step of reviewing consists of two sub-components: (a) evaluation (appraisal of the written product), and (b) revision (actual changes and error correction). Hayes and Flower (1980) recognized that writing processes, the writer's long term memory, and the task environment are dynamic and interactive, with the components and sub-components engaged in both sequential and recursive relationships.

Although this model lends valuable insight into the cognitive processes of writers, it is based on the think-aloud protocols of adult skilled writers. Hence, Hayes and Flower's (1980) model has been criticized for its failure to account for developmental processes that are significant for beginning writers. Abbott and Berninger (1993) were among those who argued that the Hayes and Flower model was inappropriate for capturing the aspects of writing unique to beginning and developing writers. These researchers built on the work of Juel, Griffith, and Gough (1986) and Juel (1988) in support of what they termed the Simple View of reading and writing. This view conceptualized reading and writing as each consisting of two main sub-components: (a) lower-order skills (e.g. word recognition and a spelling) skills, and (b) higher-order skills (e.g. comprehension and ideation). Poor lower order-skills were hypothesized to impede higher-order skills, and the automaticity of these lower order skills was proposed as a necessary precursor of fluent reading and written expression.

Berninger and her colleagues were proponents of a similar theoretical model, which proposed that varying neurodevelopmental, cognitive, and linguistic constraints affect writing performance at different developmental stages (Berninger, Mizokawa, & Bragg, 1991). Research on 300

students in Grades 1 to 9 revealed that although these constraints occur at all levels of writing development, their relative impact varies across stages. Berninger et al. (1997) report that a 1994 study by Berninger and Swanson revealed that neurodevelopmental constraints were found to be more influential in the lower primary grades, whereas linguistic and cognitive constraints were more influential in the middle-primary and junior-high school grades respectively. Based on these findings it was hypothesized that the efforts of beginning writers are concentrated on the task of translation with the more sophisticated skills of planning and reviewing remaining relatively difficult in the early stages of writing development.

Berninger and Swanson (1994) expanded Hayes and Flower's model to account for developmental differences by dividing the translation component of the model into two sub-components: (a) text-generation, and (b) transcription. Text-generation involves translating ideas into linguistic representations in working memory, whereas transcription refers to the translation of these representations into physical symbols written on a page (Berninger et al., 1992). The resultant model was named The Simple View of Writing (Berninger et al., 2002), and is a three-component system consisting of: (a) transcription (i.e., handwriting, letter production, spelling, and word production; (b) text generation (i.e., at the level of word, sentence and discourse); and (c) executive functions (i.e., planning, monitoring and revising). The components are presented in developmental sequence, with transcription being the sub-component of greatest importance in emerging writers. Research supports the critical importance of mastering the mechanical skills involved in writing – transcription skills are what best differentiate poor and good writers in the elementary grades (Yates, Berninger, & Abbott, 1994). Additionally, based on research that will be explored in more detail later in this review, handwriting fluency is a significant predictor of compositional fluency (Olinghouse, 2008). These findings suggest that the development of

writing in elementary-aged children is dependent on the level of automaticity attained in transcriptional activities and this determines the cognitive resources available for the more effortful and sophisticated tasks of text-generation (Berninger & Winn, 2006).

Writing Development in Elementary-Aged Children

The theoretical conceptualization of writing development presented in the Simple View of Writing and the supporting evidence suggest that the writing of elementary-aged children is best characterized as occurring in two stages. The first stage spans from kindergarten to the second grade, during which the primary focus is developing proficiency in basic transcription skills. The critical task of this stage is the achievement of automaticity in handwriting and the rudiments of spelling. This requires orthographic and motor integration, which allows beginning writers to mentally code, rehearse, and recall the visual patterns of letters shapes, words, and groups of words in order to symbolically reproduce them. The importance of these skills is highlighted by the finding that automatic letter writing is the single best predictor of length and quality of writing in Grades 1 to 6 (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). Proficiency in transcription skills is not sufficient for writing mastery but it is a necessary prerequisite to allow beginning writers to successfully engage in more complex writing tasks.

The second stage of writing development begins in the third grade and continues throughout students' formal education. During this stage, students shift their focus away from the mechanics of producing writing to higher-order processes such as organization of discourse, effective communication of ideas, and consideration of genre and audience. Students in this stage are primarily concerned with mastering the skills required for a fluent text-generation that are supported by executive function and memory. Once transcription has been mastered, more cognitive resources can be devoted to improving compositional quality through active review

and revision. This stage of writing development involves increasing proficiency of syntax, vocabulary, and clarity, as well as the ability to produced extended forms of writing for multiple applications.

As discussed in previous sections, the writing outcomes of fourth-grade students in the United States are poor, which implies that these students are not mastering critical writing skills in the early elementary grades. Empirical investigations (Yates, Berninger, & Abbott, 1994; Berninger & Swanson, 1994; Graham et al., 1997; Berninger et al., 2002; Berninger & Winn, 2006) support the importance of lower level cognitive functions in the development of initial writing skills and the necessity of these initial skills for the production of more sophisticated written expression. These findings suggest that an understanding of how transcription skills are acquired is essential in the development of instructional techniques and interventions designed to improve the written expression of children in the early-elementary grades.

Transcription in Beginning Writers

The role transcription skills play in the performance of beginning writers is considered in the Simple View of Writing (Berninger et al., 2002; Berninger & Amtmann, 2003; Berninger & Winn, 2006). According to this model, transcription is the translation of linguistic representations in working memory into printed symbols. Transcription involves the subset of a processes involved in the mechanics of writing known as production factors, which are specific to the retrieval of orthographic codes representing language structures along with the motor processes required to reproduce them (Abbott & Berninger, 1993). Therefore, transcription underpins the basic writing skills of spelling and handwriting. Deficits in transcription skills impede the development of text-generation by making writing more effortful and decreasing the cognitive resources available for higher-level composing skills (Berninger et al., 2002). The

following sections review spelling and handwriting in beginning writers along with the impact of these skills on subsequent writing outcomes, including writing achievement.

Spelling

Spelling requires the correspondence of letters and groups of letters to the sounds they make, which are called phonemes. Spelling may be seen as phonological to orthographic translation where sounds are processed and the associated letters are retrieved from memory, after which the symbols are written on the page (Berninger et al., 2002). Although spelling and reading share many linguistic and cognitive processes, spelling may be more challenging than reading. During reading, memory cues and possible clues about a word's pronunciation may be drawn from the letters on the page. During spelling, all of the information must be drawn from memory, beginning with the letter forms as well as assembling them in the correct order (Dockrell, 2009). The task of spelling in English is made more difficult by the fact that although there are 26 letters in the English alphabet there are over 40 phonemes (McCutchen, 2006). Spelling is a complex skill involving the coordination of phonological (sounds of letters and letter groups), orthographic (letter forms), and morphological (meaning) information that continues to develop well into formal education (Nagy, Berninger, Abbott, Vaughn, & Vermeulen, 2003).

Fluent and accurate spelling is heavily reliant on working memory. Automaticity in the retrieval of letters and words make production of writing less laborious and allows writers to prioritize tasks such as generating ideas, planning and reviewing (Dockrell, 2009). Lack of automaticity in spelling inhibits the length and quality of writing in beginning writers as the effort required to search for correct spellings overloads the child's working memory (Graham et al., 1997). As part of a practice guide produced by the U.S. Department of Education (Graham et

al., 2012a), a panel of leading writing researchers included instruction in spelling among their recommendations for improving the writing of elementary- aged students. Based on their review of three studies including spelling interventions (Berninger et al., 2000; Berninger et al., 2002; Graham, Harris & Fink-Chorzempa, 2002), they concluded that spelling instruction has generally positive effects on students' basic writing skills which may allow students to produce higher quality and longer texts. These studies are discussed in detail in the following paragraphs.

Berninger et al. (2000) delivered instruction in morphological spelling and phonics to 47 third-grade students judged to be at risk for spelling difficulties after failing to respond to early intervention for spelling in the second grade. Direct instruction was given in alphabetic principle (correspondence between individual letters and sounds) and syllable training (explicit training of word segmentation and syllable types). Students received 24 instructional sessions of 20 min each, delivered twice weekly. None of the students were identified as having a learning disability or being eligible for special education, but 22 of the students were reported has having a history of spelling difficulties. The researchers reported a small but significant effect (d = 0.34) of the spelling intervention on composition length with students in the treatment condition producing more words in 5 min as compared to controls.

In a later study, Berninger and colleagues (2002) compared the effects of four treatments on the writing quality of 96 third-grade students identified as at risk for writing problems. Students were selected if they had verbal IQ scores over 80 and were identified by their teacher as having persistent difficulties in writing across academic domains that was not related to English being their second language. It was not reported whether any of the participants had a diagnosed learning disability or was eligible for special education. The average compositional fluency of the students in the study at pre-test as measured by scores on the Writing Fluency

subtest of the Woodcock-Johnson Psychoeducational Battery – Revised (WJ-R; Woodcock & Johnson, 1990) were one standard deviation below the mean for the normative sample. The treatment conditions included spelling training only composition training only, combined spelling and composition, and contact control. The 24 students who received explicit instruction in phonological awareness and spelling phonics did not improve in overall writing quality on measures of informational or persuasive writing, but showed small gains in spelling mechanics (d = 0.21) and sentence structure (d = 0.21). However, these effects were not statistically significant. All treatment groups showed improvement in post-test scores in writing fluency, as did the control group and an analysis of variance (ANOVA) revealed there was no statistically significant effect of treatment on this outcome measure.

Finally, Graham, Harris and Fink-Chorzempa (2002) conducted an intervention study examining the effects of supplemental spelling instruction on the spelling, reading and writing performance of 60 second-grade students. The participants were at risk for spelling difficulties as indicated by scores two-thirds of a standard deviation or more below the mean on the Spelling subtest of the Wechsler Individual Achievement Test (WIAT; Wechsler, 1992). Half of the students received instruction in phonological awareness, spelling phonics and morphological spelling, while the comparison group received mathematics instruction. Each student received 48 instructional sessions that were delivered three times per week for 20 min a session. Similar to prior studies, moderate to large positive effects were seen in sentence structure at post-test (d = 0.77) and six months after the intervention (d = 0.58), although these results did not meet statistical significance.

Although the results of the aforementioned studies suggest that brief interventions in spelling do have generally positive effects on the performance of emerging writers, there are

various caveats resulting in the panel's determination of moderate evidence in support of their use. The studies reviewed primarily focused on the outcome of writing quality in terms of improved sentence structure. However, the results of these studies suggest that spelling interventions do not have immediate effects on writing quality; although performance generally improved post-intervention, these effects failed to reach statistical significance. Additionally there is limited support for spelling interventions improving writing fluency as indicated by composition length, which would suggest positive contributions to improvement to writing automaticity. It should also be noted that the participants in these studies were selected based on pre-existing difficulties in spelling and received interventions individually or in pairs. The panel cautions that the intervention effects may not generalize if implemented class wide in general education settings. Despite these limitations, the review panel recommends focusing on basic skills is necessary for beginning writers. It is only with the mastery of foundation skills that students later have sufficient resources to benefit from instruction in more sophisticated strategies and techniques to improve the length and meaning of their writing (Graham et al., 2012a). The next section discusses handwriting, which may contribute more directly to automatic letter production and writing fluency in young writers.

Handwriting

The second transcription skill necessary for fluent written expression is handwriting. Handwriting is a complex motor activity requiring the coordination of sensory systems (visual and kinesthetic), motor systems (planning, control, and execution), and muscle systems (proximal, near the writing instrument, and distal, further up the limb and removed from the writing instrument) (Berninger et al., 2006). In addition to the motor programs required to physically produce letters, handwriting requires the acquisition and rehearsal of orthographic

code. Orthographic code is the representation of a letters and words in the long-term memory for retrieval and reproduction (Berninger et al., 2006). Hence, writing letters and words requires integration of both motor and orthographic information (Jones & Christensen, 1999). The combination of cognitive and motor functions required for handwriting makes it an effortful activity for beginning writers.

For adults and skilled writers handwriting is largely unconscious and automatized. In contrast, beginning writers must expend conscious effort on forming letters that makes writing laborious and may hinder beginning writers' development (Berninger, 1999; Graham, 1999). Poor handwriting places a variety of constraints on beginning writers with regards to how their writing is received, the progression of their skills toward mastery such as planning and revision, and their opinions of themselves as writers. First, illegible handwriting reduces the accessibility of children's writing (Graham, 1999), and contributes to devaluation of the content. Adult evaluators of essays that differed only in terms of handwriting legibility assigned lower grades for quality of ideas to samples exhibiting poor handwriting (Chase, 1986; Marshall & Powers, 1969). Second, the effort related to handwriting may interfere with other writing processes that support production of higher quality compositions (Scardamalia, Bereiter, & Goleman, 1982). The diversion of a child's attentional resources away from the composition task to the formation of letters may lead to loss of ideas and plans being maintained in working memory (Graham, 1990). Third, handwriting creates demands for beginning writers that may impede development of more sophisticated writing skills. For instance, young writers with handwriting difficulties may rely on a knowledge-telling approach to composing rather than utilizing planning and revising due to insufficient processing resources (McCutchen, 1996). Finally, in a review of research pertaining to identification and treatment of writing disabilities, Berninger et al. (1991)

state that young students with handwriting difficulties avoid writing and develop the mind-set that they cannot write, which suppresses further writing development.

Based on the aforementioned research it is reasonable to assume that mastery of handwriting is a necessary prerequisite for skilled writing. Upcoming sections consider the components of handwriting as they relate to its measurement, followed by the relationship of handwriting fluency and quality to subsequent writing outcomes.

Measuring Handwriting

Handwriting is an essential skill that must be mastered for skilled writing and effective communication. Children in the elementary school are estimated to spend 31% to 60% of each day engaged in fine motor tasks including handwriting (McHale & Cermak, 1992). Additionally, problems with handwriting is one of the most common reasons for referral to occupational therapy with prevalence rates based on teacher estimates of 11% to12 % for females and 21% to 32% for males (Karlsdottir & Stefansson, 2002). As such, measurement and evaluation of handwriting is needed for early identification of difficulties and intervention. However, handwriting is a challenging construct to measure with considerable debate surrounding what variables are critical components of handwriting quality (Daniel & Froude, 1998). Given this lack of consensus on how handwriting should best be measured the following sections will review the most commonly used instruments for evaluation of children's handwriting. Standardized measures used by occupational therapists will be considered, followed by rating scales and questionnaires for use by teachers.

Standardized, Norm-Referenced Handwriting Measures

As noted in the aforementioned section, there is disagreement among researchers on how best to measure handwriting. As such, there are a number of handwriting evaluation tools

available for different age groups and clinical populations that consider different handwriting product variables. The assessment tools available also vary in terms of their scoring systems and psychometric properties. For the purposes of this review, five evaluation tools will be considered as containing standard elements of handwriting assessment: (1) Diagnosis and Remediation of Handwriting Problems (DRHP; Stott, Moyes, & Henderson, 1985), (2) The Children's Handwriting Evaluation Scale – Manuscript (CHES-M; Phelps & Stempel, 1987), (3) The Minnesota Handwriting Test (MHT; Reisman, 1993), (4) The Evaluation Tool of Children's Handwriting – Manuscript (ETCH-M; Amundson, 1995), and (5) The Test of Handwriting Skills – Revised (THS-R; Milone, 2007). These tools were chosen for their common use among occupational therapists for the assessment of handwriting problems and their research base. The elements under consideration will be dimensions of a legibility and handwriting quality, assessment of handwriting speed or fluency, variety of writing activities used for assessment, scoring procedures and guidelines, target population and standardization, and reliability and validity.

Dimensions of legibility and handwriting quality. Subjective assessments of students' handwriting quality are generally made by visually inspecting writing samples and making a judgment on overall readability (Hammerschmidt & Susawad, 2004). In accordance with this, formalized measures designed to evaluate handwriting focus on assessment of various dimensions contributing to legibility. These variables are thought to provide insight into students' skills in motor planning and execution, memory, and orthographic coding (Reisman, 1993; Stott et al.. 1987). The measures considered for this review have four basic dimensions in common: (a) form, (b) spacing, (c) alignment, and (d) size. Form relates to the degree of similarity between letters in a written sample and an ideal example. This dimension takes into

account whether all the parts of letters are present, whether there are any gaps or overlaps in lines, and whether any shapes are distorted. Spacing evaluates whether there is appropriate amounts of space between letters and words. Alignment involves evaluation of the position of the letters with respect to deviations from the line which is being written on. Assessment of size evaluates whether letters are of the correct size relative to an ideal example and also whether different letters are proportional to each other. The additional variable of slant is included in the DRHP (Stott, Moyes, & Henderson, 1985) and the ETCH-M (Amundson, 1995) and includes an evaluation of case-errors. The most recent measure in this review, the THS-R (Milone, 2007), includes evaluations of all the aforementioned dimensions and goes further with additional considerations for letter and numeral reversal.

Handwriting speed/fluency. In conjunction with handwriting quality, handwriting speed is a primary area of focus in handwriting assessment. Handwriting speed provides insight into the effort relating to the retrieval and production of letter forms (i.e. the extent to which handwriting has become automatized; Reisman, 1993; Amundson, 1995; Milone, 2007). All of the measures considered for this review, with the exception of the DRHP (Stott et al., 1985), include evaluations of handwriting speed. Speed is calculated by counting the number of letters produced in a set time, which may also be converted to the number of letters per minute. The CHES-M (Phelps & Stempel, 1987) and MHT (Reisman, 1993) only include copying speed while the ETCH-M (Amundson, 1995) also evaluates writing speed during free composition. The THS-R (Milone, 2007) assesses handwriting speed during copying and dictation tasks.

Range of writing activities assessed. The extent to which performance on handwriting measures is related to students' written work may depend on the degree of similarity between assessment activities and typical tasks involving handwriting. Comprehensive assessments of

handwriting should include a range of activities representative of the writing demands made on students. The DRHP (Stott et al., 1985), CHES-M (Phelps & Stempel, 1987) and the MHT (Reisman, 1993) make use of copying tasks only for the assessment of handwriting and the writing of letters. The THS-R (Milone, 2007) evaluates handwriting performance with respect to both letters and numerals while copying and in response to dictation. The ETCH-M (Amundson, 1995) boasts the widest range of assessment activities, including copying and dictation of letters and numbers as well as free composition.

Scoring procedures and rubrics. Precise measurement of handwriting is difficult and when scoring, examiners are prone to subjective judgments that diminish the validity and reliability of the assessments (Feder & Majnemer, 2003; Hammerschmidt & Susawad, 2004). Thorough scoring guidelines, included examples, and means to practice scoring procedures can improve the objectivity of handwriting assessments and lead to more accurate measurement of students' skills. The measures considered for this review vary widely with respect to the comprehensiveness of their scoring procedures and rubrics for the evaluation of handwriting quality. The DRHP (Stott et al., 1985) employs physical transparent templates for evaluation of slant, spacing and letters size but does not include any scores or interpretive guidelines (Feder & Majnemer, 2003). The CHES-M (Phelps & Stempel, 1987) yields scores on 10 categories for a maximum score of 100, however the scoring criteria for the categories are not well defined and only general terms are used to describe them (Feder & Majnemer, 2003; Reisman, 1991). The MHT (Reisman, 1993) and the ETCH-M (Amundson, 1995) include clear and detailed manuals with defined scoring criteria. The manual of the MHT includes three sets of 10 handwriting samples scored by the test developer that can be compared against test samples, while the ETCH-M provides scoring tutorials and quizzes to attain the recommended scoring criterion of 90%

accuracy (Feder & Majnemer, 2003). The THS-R (Milone, 2007) is accompanied by an extensive manual outlining the basic scoring procedures and criteria as well as printed exemplars and a training video for examiners to complete.

Target population, standardization, and norming. The intended target population for the various handwriting measures and the standardization procedures used during their development vary widely. These features determine whether a particular measure is appropriate for use with a given subject and will yield an accurate estimate of handwriting skill. As this review focuses on beginning writers, the measures will be discussed with respect to their suitability for use in the lower elementary grades. The DRHP (Stott et al., 1985) was developed for use with adults who had suffered traumatic brain injury. It requires two years of writing instruction, which limits its use to students in the third grade and beyond (Feder & Majnemer, 2003). In addition no demographic information is included for the 150 script samples used to develop the scoring procedures. The CHES-M (Phelps & Stempel, 1987) was standardized using studies carried out on 643 students in the first and second grades in Dallas, Texas. However, the standardization sample is quite old and was selected to reflect demographic characteristics of the 1980 U.S. Census Bureau. The MHT (Reisman, 1993) was republished under the name the Minnesota Handwriting Assessment (Reisman, 1999) and standardization studies were conducted with 2000 children from 11 states in the first and second grades. Although the sample was matched to the 1990 U.S. Census for age, gender, and handedness, ethnicity was not considered and 85% of the sample was Caucasian. The ETCH-M (Amundson, 1995) is a criterion-referenced measure designed for students in Grades 1 through 6 with mild developmental delays and lacks normative data. The THS-R (Milone, 2007) is the most recently published of the handwriting measures and has the widest range of use. It was standardized on a

nationally-stratified sample of 1,467 students between the ages of 6 and 18 years of age. These students were from 34 states and demographic variables were matched to the 2000 U.S. Census.

Reliability and validity. As previously noted, the subjectivity of judgments made in handwriting assessment negatively affects the reliability of its measurement (Feder & Majnemer, 2003). Although all of the measures with the exception of the DRHP were found to have acceptable inter-rater reliability ($r \geq .80$), there is considerable variability reported in the studies of test-retest reliability. The DRHP (Stott et al., 1985) and the CHES-M (Phelps & Stempel, 1987) have not been examined for test-retest reliability. Among the remaining measures, the reliability figures vary between poor and acceptable. Interscorer agreement and test-retest reliability of the MHT was examined with second-grade students ($n = 99$) across a one week period. Substantial variability existed for interscorer agreement ($M = 72\%$ accurate; range, 58% to 96%). Test-retest reliability of rate scores on the MHT was poor ($M = .50$; range, .47 to .67). Diekema, Dietz, and Amundson (1998) conducted a study to assess the test-retest reliability of the ETCH-M using student in the first and second grade ($n = 31$) who were retested after one week. The reliability coefficients ranged from $r = .63$ to .77 with upper case legibility being the most consistent. Test-retest reliability of the THS-R was conducted with students between the ages of 6 and 18 years if age ($n = 46$) over the course of two weeks. The results indicate that overall scores on the THS-R are sufficiently stable over time with a correlation of .82. Reliability coefficients for the individual subtests ranged from $r = .49$ to .82, with those subtests assessing alphabet writing in order from memory, and out of order from dictation emerging as the most stable (Milone, 2007). Interrater reliability was conducted by having five trained raters score 53 protocols. Average agreement was adequate with a range from 72% to 90% across subtests and a mean of 81%.

Similarly, with regards to validity, there is considerable variability across measures, with some measures lacking validity evidence. For example, there are no validity studies to support the use of the DRHP (Stott et al., 1985) and the CHES-M (Phelps & Stempel, 1987). The content validity of the ETCH-M is supported in its development, which involved three pilot editions and revisions by panels of experts to discuss item selection, develop the scoring guidelines, and determine legibility criteria (Amundson, 1995), however there are no data to support its construct or concurrent validity.

There is evidence to support the concurrent validity of the MHT (Reisman, 1993). Cornhill and Case-Smith (1996) tested 48 typical first grade students identified as either having good or poor handwriting on measures of motor accuracy, visual-motor integration, and in-hand manipulation as well as the Minnesota Handwriting Test (MHT). The students identified as having good handwriting had significantly higher scores on all measures. Additionally each performance measure was significantly correlated with scores on the MHT, with translation, visual-motor integration, and rotation scores accounting for 73% of the variance in MHT scores. A later study by Peterson and Nelson (2003) supported the construct validity of the MHT with the finding that first grade students who received a handwriting intervention attained significantly higher scores on the MHT at post-test as compared to those in the control group.

The THS-R is based on the Test of Handwriting Skills (THS; Gardner, 1998) and retains all of the subtests from the earlier measure. The content validity of the THS-R is supported by the expert consensus that was used to develop the THS and a survey of current instructional practices to determine the continued appropriateness of the tasks on the measure. Evidence for the construct validity of the THS-R was found by the developers evaluating score differences among different age groups and clinical populations. The mean standard scores of students with

existing diagnoses of Attention Deficit Hyperactivity Disorder (ADHD) (n = 28, M = 69.0) and Learning Disability (n = 24, M = 69.5) were significantly lower than those of students without diagnoses matched for age, gender and ethnicity (M = 100.5; M = 101.5, respectively). In addition, they conducted Principal Components Analysis using a varimax rotation, followed by a Maximum Likelihood Analysis. This analysis revealed that all 10 subtest scores load on a single factor (Basic Handwriting Skills) while Ancillary Scores (additional scores for handwriting speed, letter reversals, spacing, and case errors) load on another (Ancillary Tasks), supporting convergent validity (Milone, 2007). There are no studies investigating the concurrent validity of the THS-R.

It is evident that there is significant variability in the construction and psychometric properties of handwriting measures. This lack of consensus on how best to measure handwriting necessitates the selection of measures based on their suitability for a particular target population and the precision of the scoring procedures as well as their psychometric properties. Although each of the scales reviewed assesses major dimensions of handwriting, they vary in their suitability for assessing the handwriting performance of beginning writers. The Diagnosis and Remediation of Handwriting Problems (DRHP) is designed for use with adults and the development procedures of the Children's Handwriting Evaluation Scale-Manuscript (CHES-M) limit its use to students in the first and second grades. In addition, they do not include detailed scoring manuals and neither measure has been assessed for test-retest reliability, or validity. The Evaluation Tool of Children's Handwriting-Manuscript (ETCH-M) was designed for use in grades one through six, includes a detailed scoring manual, and has adequate reliability. However, it is a criterion measure targeted at children experiencing developmental delays or diagnosed with learning disability, and does not have published norms, which limits its

suitability for use with typical students. The Minnesota Handwriting Test (MHT) has detailed scoring procedures, adequate interrater reliability and evidence to support its validity. However, it is designed only for students in the first and a second grades and has poor test-retest reliability. Currently the Test of Handwriting Skills-Revised (THS-R) has been developed and normed for the widest age range (6 to 18 years) and has the most detailed and reliable scoring procedures. Although it does not have independent studies to support its validity, it has been assessed by the developers for use with both typical and clinical populations and demonstrates construct validity when subject to factor analysis.

In addition to issues concerning design and selection of handwriting assessments, standardized handwriting instruments are primarily used by occupational therapists and are not commonly available to classroom teachers and other educational professionals (Hammerschmidt & Susawad, 2004). However, teachers are often first to recognize that a student is having difficulty with handwriting and to initiate further investigation of referral for occupational therapy. The following section examines teacher evaluations of student handwriting and the factors they deem important when assessing performance.

Handwriting Rating Scales and Teacher Questionnaires

Primary school teachers play a critical role in recognizing unsatisfactory handwriting among children in their classrooms and placing referrals (Daniel & Froude, 1998; Reisman, 1991). However, very few studies consider teacher ratings of handwriting and there are no commonly used measures specifically intended for use by classroom teachers to evaluate children's handwriting. Despite this, teachers' evaluations of handwriting are a chief determinant of who is eventually given services by occupational therapists for difficulty in this area. Two empirical studies conducted by Daniel and Froude (1998) and Hammerschmidt and Susawad

(2004) examined teachers' subjective ratings of students handwriting, the dimensions they consider when assessing handwriting quality, and how they determine whether student is having difficulty in the area of handwriting.

Daniel and Froude (1998) examined the inter- and intra-rater reliability of handwriting evaluations made by occupational therapists and classroom teachers as well as the dimensions of handwriting each group considered important when rating a student's handwriting sample. Samples of handwriting from students in Grade 5 and Grade 6 (n = 61) were rated by teachers and occupational therapists based on a five point Likert scale (1 – very poor; 2 – poor; 3 – satisfactory; 4 – good; 5 – very good). The teachers were also asked to describe the factors they considered when evaluating the quality of the handwriting samples. Although the percent agreement between teachers and occupational therapists was poor (M = 27%; range, 21% to 36%) their descriptions of which factors they considered when evaluating handwriting were similar. The seven participants in the study described 19 separate variables, two of which were endorsed by all the raters (letter formation and letter size) and three which were endorsed by 6 raters out of seven (letter alignment, word space, and legibility) (Daniel & Froude, 1998). These results suggest that although the judgments of raters are subjective and vary widely, there are common dimensions of handwriting quality that both teachers and occupational therapists deem important.

Hammerschmidt and Susawad (2004) conducted a study to determine what factors lead teachers to refer students to occupational therapy for handwriting problems and the criteria they use to determine whether students' handwriting is acceptable. A questionnaire composed of 31 closed-ended questions was administered to obtain data from 321 teachers in Grades 1 to 4 in 32 states. Of the respondents who completed the questionnaire, 57 (18%) reported referring students

to occupational therapy for handwriting difficulties in the past school year. The most common reason for referral was failure of a student's handwriting to improve with classroom assistance (94.7%), followed by noting that a student had handwriting delays and needed help to catch up (75.4%), and students becoming increasingly frustrated with handwriting (73.7%). Almost half of the teachers who referred students for services endorsed illegible handwriting as the most frequent problem area (49.2%), followed by issues with uniformity of size or case (15.8%) (Hammerschmidt & Susawad, 2004).

Of the respondents who answered all the questions pertaining to criteria for acceptable handwriting (n = 299) the two most important factors endorsed were correct letter formation and directionality, and proper spacing (55.2% of teachers responding that it was very important for both variables). The most important criteria that teachers reported using to determine whether a student is having handwriting difficulties was not being able to read their handwriting (67.8%), followed by failure to perform at age or grade level (14.6%) (Hammerschmidt & Susawad, 2004). These factors echo those described by the raters in the Daniel and Froude's study (1998) indicating that there are components of handwriting that are of particular importance to teachers when making visual assessments of quality, particularly legibility and overall readability of text. Although there is little empirical support for teacher ratings of students handwriting, the two existing studies suggest that there is considerable overlap in the factors teachers and occupational therapists consider when making judgments about students' handwriting and whether they are experiencing difficulty requiring referral for services. Given this phenomenon and the importance of teachers as the individuals most likely to first notice student difficulties in handwriting, it follows that assessment of students' handwriting should include evaluation of aspects of handwriting that influence teachers' judgements of students' performance.

Summary. There is considerable variation in the dimensions of handwriting that are considered to be necessary for its evaluation, the activities that should be used to access these dimensions, and the scoring procedures to quantify performance. However, in surveying the available handwriting measures, a number of features emerge as ideal for the most accurate assessment of handwriting. These features include evaluating: (1) both handwriting quality and fluency, (2) activities representative of typical writing activities, (3) detailed and stringent scoring criteria, and (4) reliability and validity evidence. Teachers are often the first to recognize student difficulty in handwriting and make referrals to occupational therapists (Daniel & Froude, 1998; Hammerschmidt & Susawad, 2004). Therefore, standardized handwriting measures should ideally include those aspects of handwriting which are of interest to educational providers making clinical judgements about students' performance. These areas include correct letter formation, directionality, spacing, size, and overall legibility. Both standardized measures and teacher judgments are of importance for identification of children at risk for handwriting difficulties and assessing the effectiveness of interventions targeting handwriting and other writing outcomes.

Based on the research reviewed in this section, writing intervention studies examining handwriting skill as a variable potentially influencing writing outcomes should include comprehensive assessments of handwriting that take into account both quality and fluency using a standardized measure. To fully understand the impact of handwriting on the development of writing and future writing outcomes among students, it must be accurately assessed. Of the measures reviewed the Test of Handwriting Skills-Revised (THS-R; Milone, 2007) meets the highest number of requirements for the accurate assessment of handwriting. It assesses those dimension of handwriting suggested to be most relevant by clinicians and teachers, takes into

account handwriting speed, has detailed and reliable scoring, and is norm-referenced for a wide age range of students. Based on these criteria, the THS-R has been selected as the measure of choice for the purposes of the proposed study.

The Importance of Handwriting as a Precursor of Skilled Writing

As noted in the previous sections, handwriting requires the coordination of complex motor processes and orthographic coding skills. The level of mastery attained in these areas determines handwriting performance in beginning writers, which goes on to impact the development of skilled writing. This assertion is supported by findings from multivariate analyses of handwriting among students in the primary grades indicating that fine motor skills and orthographic coding of written words account for unique variance in handwriting skill. Intervention studies provide further evidence of the relationship between handwriting and writing fluency with findings that instruction in handwriting leads to improvement of the skill and consequent improvement in other writing outcomes. The next section will review this research illustrating that handwriting is a prerequisite for skilled writing, beginning with multivariate studies followed by an examination of intervention studies.

Multivariate analyses of handwriting. In their first study, Berninger and Rutberg (1992) examined the relationships between fine motor skills and beginning writing among a large sample of students (n = 300) in Grades 1 through 3. Fine motor skills were assessed using six finger function tasks (i.e., finger repetition, finger succession, finger lifting, finger spreading, finger localization, and finger recognition), and the students also completed an alphabet task wherein they were told to print the alphabet letters in lower case. The criterion measure used to assess handwriting was the copying subtest of the Group Diagnostic Reading Aptitude and Achievement Tests (Monroe & Sherman, 1966). This measure required students to copy a

paragraph as quickly as possible. The criterion measure of writing fluency was assessed by asking students to write stories in response to prompts that were expository (e.g. “I like _____ because _____.”) and narrative (e.g. “One day _____ had the best day at school”) and were scored as an index of writing fluency.

Correlations computed between the finger and alphabet tasks and the criterion measures revealed that speed of finger succession (touching the tip of each finger to the thumb in sequence) was significantly negatively correlated (p <0.001) with handwriting accuracy (r = -0.32), and writing fluency (narrative, r = -0.31; expository, r = -0.26). Total finger score, which represented accuracy in the tasks of finger lifting, spreading, localization and recognition, was significantly positively correlated (p <0.001) with handwriting accuracy (r = 0.27) and writing fluency (narrative, r = 0.24; expository, r = 0.22) for the total sample (Berninger & Rutberg, 1992). Although performance on the finger tasks did not correlate with criterion writing measures within the grades, performance on the alphabet task showed significant positive correlation with every criterion measure within each grade (range, r = 0.31 to 0.57) and the total sample (range, r = 0.55 to 0.76). These results suggest that fine motor function is related to handwriting and writing fluency. Further, the results suggest that the alphabet task may be used as a measure of accuracy and speed of orthographic coding which is a necessary component of handwriting and skilled writing (Berninger & Rutberg, 1992).

Berninger et al. (1992) expanded on the work of Berninger and Rutberg (1992). Using the same student sample they explored the relationship between predictor measures assessing lower level developmental skills and writing criterion measures. The battery of predictor measures was broadened to include assessments of orthographic coding (letter, letter cluster, and whole word recognition tasks), word finding, Verbal IQ, syllable and phoneme segmentation, sentence

syntax, and non-word reading (i.e., word attack). The results of this study indicated that the alphabet task correlated most highly with the handwriting criterion (r = .76, p <.00) followed by whole word coding (r = .52, p <.00), letter cluster coding (r = .60, p <.00), finger succession (r = -.32, p <0.00), word attack (r = .32, p <.00), and Verbal IQ (r = .22, p <.01). Regression analysis revealed that the combination of alphabet task (β = .58, p < .001), letter cluster coding (β = .24, p < .001), finger succession (β = -.08, p < .028) and whole word coding (β = .09, p < .056) was statistically significant and accounted for 66% of the variance in handwriting scores (R^2 = .66, F(4,295) = 141.92, p <.001). The predictors that accounted for a large proportion of the variance in handwriting performance were found to also account for scores on measures of writing fluency. The combination of performance on the alphabet task (β = .42, p < .001) , letter cluster (β = .31, p < .001) coding, and finger succession (β = -.12, p < .006) was found to account for 46% of the variance in narrative fluency (R^2 = .46, F(3,296) = 83.57, p <.001), while 33% of the variance in expository fluency (R^2 = .33, F(4,295) = 45.74, p <.001) was accounted for by alphabet task (β = .37, p < .001), letter cluster coding (β = .26, p < .001), word finding (β = .10, p < .057), and finger succession (β = -.08, p < .112).

These results lend further support to the assertion that handwriting is composed of motor and orthographic components as well as providing evidence that these basic skills also contribute to further writing outcomes. However, it should be noted that in both studies handwriting was assessed solely by using a copying task, which considered fluency but did not include factors related to handwriting quality such as legibility. Therefore, they did not explore whether handwriting quality and fluency have similar relationships with orthographic coding and lower level motor skills.

Further studies support the importance of handwriting and its underlying skills, particularly orthographic coding in beginning writers and onward into the upper elementary grades. Abbott and Berninger (1993) examined the contribution of motor skills and orthographic coding to children's handwriting in Grades 1 to 6 (N = 600, 100 from each grade level, 50 males and 50 females). Fine motor function (i.e., finger tasks) orthographic coding (i.e., letter, letter cluster, and whole word recognition tasks), and handwriting was assessed using procedures identical to those described in previous studies (Berninger & Rutberg, 1992; Berninger et al., 1992). Scores on the areas were used to comprise three factors: (a) Fine Motor, (b) Orthographical Coding, and (c) Handwriting. The covariances between the measures were calculated and used to conduct multiple group structural equation modeling, using EQS statistical package developed by Bentler (1991) to fit the model for each grade. According to these conventions, standardized paths between latent variables with z scores exceeding 2.0 are considered statistically significant ($p<.05$). The fit of models was assessed by first constraining the covariances and structural paths between the latent to be equal at each grade, then allowing these parameters to vary freely for each grade.

The researchers found that the relationship between the latent factors was such that although both Fine Motor and Orthographical Coding contributed to model fit, only the path from Orthographic Coding to Handwriting remained significant at all grade levels (range of z-scores = 2.5 to 4.9). The path from the Fine Motor Factor to the Handwriting Factor was not found to be significant at any grade level. The path from the Fine Motor Function to the Orthographic Coding Factor was found to be statistically significant in Grade 1 (z = 3.9) but not at any other grades. This may indicate that the effect of fine motor function on handwriting beyond Grade 1 operates indirectly via orthographic coding. These findings underscore the

importance of orthographic coding as a skill critical to the mastery of handwriting as it concerns the ability to quickly and accurately encode the visual information in written letters and words, and its significance for beginning writers and beyond. Again, it should be noted that handwriting was assessed using a very narrow task and only handwriting fluency was included in the analysis. Inclusion of measures assessing handwriting quality may have yielded differences in model fit.

Intervention studies of handwriting. The connection between handwriting and writing outcomes in beginning writers has been explored in intervention studies addressing handwriting difficulties (Berninger et al., 1997; Graham, Harris, & Fink, 2000). Berninger et al. (1997) conducted a study with 144 first-grade students identified as being at risk for handwriting problems. Of the selected students, 25 received special services in the form of occupational or physical therapy, speech, or reading services. The study compared five teaching strategies designed to improve handwriting: (a) writing letters after seeing a teacher model them; (b) writing letters after looking at a written model with arrows to indicate direction of formation; (c) writing letters while looking at an unmarked copy; (d) writing letters from memory after looking at written copy with arrows; and (e) writing letters from memory after looking at an unmarked copy. There was also a contact control group of children who were trained in phonological awareness. Handwriting accuracy and speed was assessed using the alphabet task and the paragraph copying task as described in previous studies (Abbott & Berninger, 1993; Berninger & Rutberg, 1992; Berninger et al., 1992). In addition, students were given a special copying task using the sentence “The quick brown fox jumps over the lazy dog” which contains all of the letters in the alphabet. This task was scored for the number of correct letter formations produced in one minute. The Writing Fluency subtest of the Woodcock-Johnson Psychoeducational

Battery-Revised (WJ-R; Woodcock & Johnson, 1990) was given at pre- and post-intervention as a criterion writing measure. Using analysis of variance (ANOVA) to examine the difference in performance between treatment groups, the handwriting speed and accuracy of children in all five treatment groups improved more than children in the control group.

Writing fluency was also significantly improved at post-test among children in the treatment groups as opposed to those in the control condition ($F(138,5) = 2.29$, $p<.05$).In addition, post hoc analysis indicated that children who learned to write letters from memory after looking at a written model with directional arrows as cues showed the greatest improvement in their scores both on handwriting and measures of compositional fluency, suggesting that interventions aimed at transcription may transfer to text generation for beginning writers. Similar to prior multivariate research in the area, this intervention study relied on a copying measure to assess handwriting fluency in terms of speed and accuracy (letters correctly copied per minute). No legibility measures or other means of assessing handwriting quality were employed. Therefore it is not known whether the interventions resulted in student writing that was also more fluent but high on measures of overall readability.

Graham, Harris, and Fink (2000) reported similar results in their study examining the contribution of handwriting to compositional fluency. Using first grade students ($n = 38$) identified as having problems with handwriting, students were randomly assigned to a direct instruction in handwriting condition or a control condition for lessons in phonological awareness. Handwriting instruction consisted of 27 lessons of 15 min each focusing on three letters at a time, involving letter identification, tracing letters first with a finger and then with a writing instrument and stencil, and copying words and sentences containing the target letters. Handwriting accuracy and fluency were assessed using the alphabet task and the paragraph

copying task. The Writing Fluency subtest of the WJ-R was administered as a writing fluency measure. Compositional fluency and quality was also assessed by the administration of a story-writing task, asking students to write a story in response to a picture prompt. Examiners recorded the amount of time the students spent writing their stories and fluency was measured in words written per minute. Compositional quality was assessed by two former elementary school teachers using a 9-point scale, where higher scores indicated higher quality. Scorers were given representative stories earning a score of 2, 4, 6, and 8 points as references for their judgments. It should be noted that before being scored for compositional quality, all of the stories were typed and corrected for capitalization, spelling and punctuation to avoid biases in judgment stemming from appearance and surface features of the text.

Analysis of covariance (ANCOVA) was used to analyze the treatment effects on handwriting and writing measures. There was a significant effect of the handwriting intervention on the alphabet task for speed, $F(1,33) = 17.50$, $p < .001$ ($d = 1.39$) and accuracy, $F(1,33) = 16.92$, $p < .001$ ($d = 0.94$), and total letters copied correctly $F(1,33) = 8.25$, $p < .001$ ($d = 1.46$). The handwriting intervention also had a significant effect on compositional fluency as measured by the WJ-R Writing Fluency subtest $F(1,33) = 4.56$, $p < .04$ ($d = 0.76$) and the Story Writing subtest $F(1,33) = 6.79$, $p < .01$ ($d = 1.21$). These results suggest that improvements in handwriting performance led to concurrent improvements in other writing outcomes. Although the handwriting intervention did not have a significant effect on compositional quality, a statistically significant effect of intervention was found at six-month maintenance for performance on the WJ-R Writing Fluency subtest $F(1,27) = 7.06$, $p < .013$ ($d = 0.70$). Again, handwriting was narrowly assessed and measures of quality not considered.

Summary. Taken together, the results of the studies reviewed in this section illustrate the connection between the lower level developmental skills and mastery of handwriting, and further impact on skilled writing outcomes. Handwriting skills are underpinned by fine motor function (Berninger & Rutberg, 1992) and orthographic skills (Berninger et al., 1992). These factors also have predictive value in performance on writing fluency measures (Berninger et al., 1992) and orthographic coding is a significant contributor to handwriting performance from Grades 1 to 6 (Abbott & Berninger, 1993). Handwriting instruction and interventions improve children's performance on measures of handwriting fluency and accuracy while also conferring benefits to their writing fluency (Berninger et al, 1997.; Graham et al., 2000), suggesting a causal relationship between the development of handwriting skill and future skilled writing outcomes (Graham et al., 2000). However, it should also be noted that all of the studies reviewed handwriting measures rely on handwriting fluency measures as assessed by alphabet writing or copying tasks. The lack of tasks to assess handwriting that more closely resemble typical writing activities, the omission of measures to assess handwriting quality, and the failure to comprehensively assess handwriting using a standardized instrument are shortcomings that limit our understanding of the relationship between handwriting skill and writing outcomes. In addition the students in both intervention studies were first-grade students identified as being at risk for handwriting difficulties which limits the generalizability of the findings. The following section will extend the discussion of the causal relationship between handwriting and skilled writing with a focus on individual differences that influence performance in handwriting and consequently impact other writing outcomes.

Individual Differences in Handwriting Skill and Writing Performance

Graham and Harris (2000) propose that the mastery of transcription skills is necessary for fluent and efficient writing and development of writing competence. They reason that if handwriting is an important part of writing development it may assumed that: (1) skilled writers have superior handwriting when compared to less skilled writers; (2) handwriting fluency improves with age and practice; (3) individual differences in handwriting predict writing quality; and (4) teaching handwriting improves the writing performance of developing writers. The following sections consider the existing literature providing evidence to support these assumptions and the assertion that individual differences in handwriting skills predict writing performance.

Age. Graham, Berninger, Abbott, Abbott and Whitaker (1997) produced findings that illustrate the significant contribution of handwriting to written expression throughout the primary grades. In an examination of the relationships between handwriting, spelling and written expression for children in Grades 1 to 6 (N = 600, 100 from each grade level, 50 males, 50 females). Students' handwriting was assessed using the alphabet task and copying subtests of the Group Diagnostic Reading Aptitude and Achievements Tests (Monroe and Sherman, 1966) as utilized in prior studies. Spelling was assessed using the spelling subtest of the Wide Range Achievement Test –Revised (WRAT-R; Jastak & Wilkinson, 1984). Composition was assessed by having the students complete two essays (one narrative, one expository) in response to a sentence prompt. The students were given 5 min to complete each essay. Writing fluency was assessed by counting the number of words the students wrote while writing quality was assessed by ratings given by two experienced teachers according to a five point Likert scale (1 = *considerably below grade expectations*; 5 = *considerably above grade expectations*). The results

of a structural equation modeling analysis indicated that handwriting and spelling accounted for 66% of the variance in students' compositional fluency in Grades 1 to 3, and 41% in Grades 4 to 6. Handwriting and spelling also accounted for 25% of the variance in compositional quality in the early primary grades and 42% in the intermediate primary grades. The unique impact of handwriting fluency was seen in results pertaining to compositional quality. Although both handwriting and spelling contributed to predictions of compositional fluency, only handwriting fluency contributed directly to models predicting compositional quality throughout Grades 1 to 6, suggesting that handwriting has greater influence on the performance of beginning writers than spelling (Graham et al., 1997). The results of this study also suggest that age is a factor influencing handwriting; producing the largest contribution to compositional fluency in the early primary grades.

This finding was corroborated by Jones and Christensen (1999) in a study examining the relationship between orthographic-motor integration, handwriting and written expression for 114 students in the first grade. A writing speed and accuracy measure based on the work of Berninger, Mizokawa, and Bragg (1991) was used to assess handwriting fluency and was operationalized as orthographic-motor integration. This task required students to write the alphabet in order in lower-case. Written expression was assessed by asking children to write about their vacation. The written samples were scored for quality by two professionals (the student's class teacher and an additional trained elementary school teacher) on four dimensions: (1) coherent ideas and sequencing of the text in relation to the topic, (2) accurate or understandable spelling and grammar, (3) syntax skills relating to sentence structure, and (4) fluency. Reading was also assessed using the Southgate Group Reading Test (Southgate, 1962).

After calculating correlations between scores on the measures, orthographic –motor integration was found to account for 67% of the variance in written expression. A partial correlation was also calculated to determine the relationship between orthographic-motor integration and written expression while controlling for reading skill. The results of this analysis indicated that 53% of the variance in written expression scores was accounted for by orthographic motor integration ($r = 0.73$, $p < .001$). These findings highlight the importance of orthographic skills involved in handwriting and their effect on the ability to produce written text in beginning writers. In the tradition of research conducted in this area, both Graham et al. (1997) and Jones and Christensen (1999) used the alphabet task and paragraph copying as measures of handwriting fluency and the sole means of handwriting assessment. Therefore, it is not known what contributions handwriting quality may make to compositional fluency and quality.

More recent work by Limpo and Alves (2013) underscores the continued contribution of handwriting fluency to writing performance among students in higher grades and how the extent of this contribution varies with age. Students were assessed at two developmental points ($N = 376$; $n = 171$ for Grades 4 to 6; $n = 205$ for Grades 7 to 9) using the alphabet task and paragraph copying task as previously described (Berninger et al., 1992). Written expression was assessed by having the students write two essays (one a story, one an opinion) in response to prompts. The students were given 8 min to write each essay. Four scorers rated the essays for quality considering the factors of ideas, organization, sentence structure, and vocabulary.
Structural equation modeling revealed that the path from transcription to text generation was significant in Grades 4 to 6 ($\beta = .60$, $p < .05$) but not in Grades 7 to 9 ($\beta = .26$, *ns*). Whereas earlier studies showed the importance of transcription skills for early elementary school children, these results demonstrate their significance among later elementary school students with reduced

impact in middle school. Although this study also neglects examination of handwriting quality, the results suggest that transcription skills exert more influence on writing performance among younger students than older students who may be assumed to have mastered handwriting.

In 1998, Graham, Berninger, Weintraub, and Schafer conducted the first study examining the development of handwriting speed and legibility. Using students in Grades 1 to 9 (N = 900) they explored the nature of the relationships between speed, legibility and grade. Handwriting speed was assessed using the Copying subtest from the Group Diagnostic Reading Aptitude and Achievement Tests (Monroe & Sherman, 1966). Two additional handwriting samples were used for the assessment of legibility. The students were asked to compose two essays in response to a narrative prompt ("One day ____had the best day at school") and an expository prompt ("I like ____ because ____."). The students were given 5 min to complete each essay. The Test of Legible Handwriting (TOLH; Larsen & Hammill, 1989) was used to score the compositions for legibility. The samples were graded by two trained teachers on a scale of 1 to 9 by considering total legibility according to slant, spacing, size, and letter formation.

The students' scores on handwriting speed were examined using an analysis of variance (ANOVA), which revealed main effects of handedness, gender, and grade ($F(8, 866) = 364.64$, $p<.00$). There was also a significant interaction between grade and gender. Gender-related differences will be fully discussed in a subsequent section of this literature review. Similar findings were found for grade and gender on legibility scores across the copying task (F (8, 866) = 14.34, $p<.00$), narrative essay (F (8, 866) = 12.75, $p<.00$), and the expository essay (F (8, 866) = 12.82, $p<.00$). These results indicate that handwriting speed and legibility generally increase as students mature, and right-handed students write faster writers than left-handed students. However, follow-up analyses indicate that these increases were not linear and differ according to

gender. Handwriting speed increases steadily through the elementary grades with some slowing in the intermediate grades before a plateau in Grade 9 where students begin to approximate adult speed.

Graham et al. (1998) were the first to assess qualitative features of handwriting along with speed across grades, and employed a standardized assessment of handwriting to do so. The inclusion of more thorough measurement procedures and the consideration of student level variables improve the generalizability of the findings. However, although variations in legibility were examined across grades, gender, and tasks, the relationship between legibility and writing fluency was not. Therefore, the results do not provide a complete account of the contributions of handwriting to skilled writing outcomes.

Gender. The phenomenon of boys presenting with more difficulties in written expression than girls is well-documented at all age levels (Persky et al., 2003; Salahu-Din et al., 2008). Girls also outperform boys on standardized measures of writing (Martin & Hoover, 1987) as well on teachers' ratings of handwriting (Ziviani & Watson-Will, 1998). Empirical studies employing multivariate analyses have illustrated group differences in the handwriting and writing fluency of male and female students. The study previously described by Graham et al. (1998) yielded findings supporting gender differences in handwriting speed and legibility in students grades 1 to 9. In this study, a significant main effect of gender was found for handwriting speed with the mean speeds of girls being faster than boys (F (1, 866) = 47.19, p<.00) as well as a significant interaction between grade and gender (F (8, 866) = 2.26, p<.05). Post-hoc analysis using Tukey's HSD revealed that although girls' mean handwriting speed was faster than boys', these differences were only statistically significant in Grades 1, 6, and 7. Additionally, although girls' mean handwriting speed increased through the grades, this improvement was not linear.

Significant increases were observed until Grade 4, followed by another significant increase between Grades 6 and 9. Male students showed a different pattern, with significant increases in handwriting speed through Grade 4, followed by continued increases at a slower pace up to Grade 8, after which speed plateaued. A significant main effect of gender was also found for legibility, with girls being judged has having superior handwriting in copying ($F(1, 866) = 101.43$, $p<.00$), narrative essays ($F(1, 866) = 106.00$, $p<.00$) and expository essays ($F(1, 866) = 96.28$, $p<.00$).

More recent work by Troia, Harbaugh, Shankland, Wolbers, and Lawrence (2013) focusing on older students revealed a similar pattern of results concerning teacher judgments of students writing ability with teachers rating their female students as better writers overall as compared to males in Grade 4 to 10 ($F(12, 1040) = 1.88$, $p < .05$). In addition, compositions written by the students were rated on a scale from 1 (poor) to 6 (outstanding) on five dimensions: conventions, sentence fluency, word choice, organization, and ideas. These ratings were aggregated to produce a narrative quality score and comparative analyses revealed that teachers rated girls as writing papers of higher quality ($d = .32$) than boys.

Hypotheses for the source of these differences in writing performance include gender differences in brain function (Berninger et al., 2008; Shaywitz et al., 1995,) executive function and processing speed (Camarata & Woodcock, 2006) and orthographic skills (Berninger & Fuller, 1992; Berninger et al., 2008). Berninger and Fuller (1992) examined gender differences in the verbal fluency, orthographic fluency and writing fluency of students in grades one through three ($N = 300$, 100 per grade, 50 males and 50 females). The Verbal Fluency subtest of the McCarthy Scales of Children's Abilities (McCarthy, 1972) required students to retrieve as many words as possible from various semantic categories in 20 sec (e.g., name as many animals as you

can) and was used as a measure of verbal fluency. Orthographic fluency was assessed using the alphabet task, while compositional fluency was assessed by having the students write two essays (one narrative, one expository) and counting the number of words written. In addition to these measures, compositional micro-organization was assessed by counting the number of grammatically correct clauses in the students' essays. Analysis of variance (ANOVA) revealed a main effect of gender across grades for verbal fluency ($F(1, 294) = 3.79$, $p < .05$) , orthographic fluency ($F(1, 294) = 10.90$, $p < .001$), compositional fluency ($F(1, 228) = 25.24$, $p < .001$), and compositional micro-organization ($F(2, 228) = 33.41$, $p < .001$). Although boys out performed girls in verbal fluency, girls outperformed boys on both measures of writing fluency. Although boys out performed girls in verbal fluency, girls outperformed boys on both measures of writing fluency in all three grades, producing significantly more words and grammatically correct clauses. The girls also outperformed the boys on measures of basic writing skills as assessed by the speed and accuracy scores on the alphabet task.

In another study, Malecki and Jewell (2003) examined gender differences in performance on writing measures among students in the first through eighth grades (N = 946, 48% male, 51% female, 1% missing data). The students' writing performance was assessed using Curriculum Based Measurement probes in Written Expression (CBM-WE; Shinn, 1989). Each student was required to write a passage in response to a developmentally appropriate story starter. The students were given three min to complete their compositions. The students' compositions were assessed for three primary outcome measures of writing fluency: total words written (TWW), words spelled correctly (WSC), and correct writing sequences (CWS) (Deno, Marsten, & Mirkin, 1982; Espin, 2000) as well as percentage of words spelled correctly, percentage of correct writing sequences and correct minus incorrect writing sequences. For the purposes of their

analyses the researchers divided the students into three grade levels: early elementary (grades one and two), elementary (grades three through five) and middle (grades six through eight). A 2 (gender) by 3 (grade level) multivariate analysis of variance (MANOVA) revealed a main effect of gender, Wilks' lambda = .923, $F(6, 929) = 12.96$, $p < .001$. Follow-up univariate analysis show that there were significant differences with girls outperforming boys on all outcome measures, including TWW, WSC, and CSW ($Fs(1,934) = 49.57, 51.23, 48.68$, $ps < .001$). In addition, an interaction effect was found between gender and grade level (Wilks' lambda = .939, $F(12, 1858) = 4.99$, $p < .001$) indicating that the achievement gap in writing between males and females became more marked as the students progressed through elementary and middle school. It is important to note that in both studies (Berninger &Fuller, 1992; Malecki & Jewell, 2003) the standard deviations were similar for boys and girls, which would suggest that observed differences in performance are due to overall differences in the means of the distributions due gender alone to as opposed to greater variation in the writing scores of one group as compared to another.

More recent work by Olinghouse (2008) examined student and instruction level predictors of writing fluency among 120 third-grade students (53 boys, 67 girls). Handwriting was assessed by the number of legible letters produced in a copying task similar to the Copying subtest of the Group Diagnostic Reading Aptitude and Achievements Test (Monroe &Sherman, 1966) requiring students to copy a sentence containing every letter in the alphabet. Compositional fluency was assessed by asking the students to write a story based on one of six picture prompts and scoring the number of words written in 15 min. Compositional quality was assessed using a holistic 7 point scale where higher scores represented better quality. Additional student level variables included in the study were reading, IQ, and grammatical understanding.

Instructional predictors were the amount of time devoted to teaching basic writing skills and advanced planning skills.

Hierarchical linear modeling was used to determine whether the predictor variables had a significant unique contribution to compositional fluency or quality. Significant predictors of compositional fluency included gender, handwriting fluency, advanced planning ability, and word-reading ability. When all the variables were entered together, gender, handwriting fluency, and advanced planning ability accounted for 28.7% of the variance in compositional fluency. In analyzing the data for compositional quality, gender, compositional fluency, IQ, word reading and grammatical understanding were significant predictors of compositional quality, accounting for 68.6% of the variance in ratings. These results indicate not only that handwriting influences compositional fluency, but that there is a relationship between handwriting fluency and compositional quality via compositional fluency in young writers. In addition, female students achieved higher scores on all writing measures, and this difference was not explained by other variables such as IQ or reading skill.

Summary. Overall, the results of these studies indicate that both age and gender have an effect on students' handwriting performance which influences their writing achievement. Handwriting is most developmentally significant in the early primary grades and those students who have superior handwriting produce longer and higher quality text. The crucial task for beginning writers then is the mastery of transcription skills to attain automaticity, which will reduce the mechanical demands of writing an allow them to attend to more complex writing processes (Graham et al., 2008). It may be reasonably assumed then, that those interventions that would be most effective for beginning writers should focus on lower-level skills such as

handwriting so as to facilitate automaticity. The following section reviews of interventions to improve written expression among beginning writers

Interventions to Improve Written Expression Skills among Elementary-Aged Children

Theoretical models of writing may differ in their structure, but they are alike in their conceptualization of writing as a complex multicomponent skill. Interventions may be designed in alignment with these theoretical models to target one or a combination of components and subcomponents of writing, from the neuromuscular tasks relating to the physical task of writing, to cognitive processes such as reviewing and planning. Although writing interventions may differ in terms of the component skills and processes that are targeted, one outcome measure that is commonly focused on is the improvement of *writing fluency.* Writing fluency is defined as the ability to write quickly and accurately and is typically assessed by the total number of words written or the numbers of correct word sequences written in 3 min in response to a story prompt (Shapiro, 2004).

The ability to write quickly is contingent on the speed with which visual representations of letters, groups of letters, and words can be retrieved and reproduced. Automaticity in these orthographic and motor processes enables effortless and fast retrieval, and production of legible letters required for fluent handwriting (Berninger, Yates, Cartwright, Rutberg, Remy, & Abbott, 1992). This assertion is supported by the significant contribution of orthographic coding to handwriting skills in Grades 1 to 6 (Abbott & Berninger, 1993) and the finding that handwriting automaticity consistently contributes composition length and quality throughout these grades (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). In addition, automatic letter writing

was found to be the single best predictor of length and quality of writing in Grades 1 to 6 (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997).

Achieving automaticity is of critical importance among beginning writers who are still mastering transcription skills. Lack of automaticity in handwriting increases the mechanical demands of text production and reduces the cognitive resources available for higher-order processes such as idea generation (Jones & Christensen, 1999). Therefore, automaticity is positively related to writing fluency in beginning writers and significantly impacts their writing performance and development. The findings of Jones and Christensen (1999) and Olinghouse (2008) lend support to the linkage between automaticity and writing fluency among beginning writers. Jones and Christensen (1999) found that orthographic-motor integration measured using a handwriting task accounted for more than half of the variance in written expression scores among students in the first grade, while Olinghouse (2008) found that the handwriting skills of third grade students was the second strongest predictor of compositional fluency after gender. More recent studies by Kim et al. (2011) and Puranik and Al Otaiba (2012) highlighted the importance of handwriting and its componential skills among Kindergarten studies. These studies found that letter writing fluency was positively and uniquely related to Kindergarten writing ($\gamma = .26$, $p = .003$) (Kim et al., 2011) and handwriting accounts for 4.1% of the unique variance in writing performance in Kindergarten over and above early language, literacy, cognitive skills and student characteristics (Puranik & AlOtaiba, 2012).

The association between handwriting automaticity and writing fluency in beginning writers suggests that writing interventions most appropriate for students in the early elementary grades are those which focus on these areas. The two approaches that have evidence supporting their use in Grades 1 to 4 and target either handwriting or writing fluency are basic skills

instruction and performance feedback. The following sections will review the evidence supporting each approach and their associated strengths and limitations.

Basic skills instruction. Writing interventions involving basic skills instruction attempt to improve children's writing fluency by focusing on difficulties in text production. In keeping with the notion that there are foundational "lower-level" writing skills that are prerequisites for future mastery proposed in the Simple View of Writing (Berninger et al., 2002; Berninger & Amtmann, 2003; Berninger & Winn, 2006) these interventions focus on handwriting and spelling as targets for intervention. The premise, as discussed in previous sections, is that automaticity in these basic transcription skills will reduce the cognitive load associated with the mechanical task of writing, allowing students to attend to more complex skills that will improve text quality such as idea generation and planning. There has been interest the use of word processors as a means to improve text production in children, with the assumption using a keyboard is less effortful than manually forming letters on paper with a writing instrument. Computer-based interventions may be thought of as also targeting basic skills as they attempt to reduce the demands associated with text production, freeing cognitive resources for higher-level composing.

There has been a surge of recent interest in writing interventions involving basic skills instruction. As discussed previously, in a U.S. Department of Education produced practice guide on improving the writing of elementary school students, Graham et al. (2012a) recommend that students be taught to become fluent with handwriting, spelling, sentence construction, typing, and word processing. The panel found moderate evidence in support of this recommendation with interventions in these areas showing generally positive effects on various writing skills and potentially allowing students to construct better sentences and produce longer texts.

Evidence supporting the effectiveness of handwriting interventions on improving the writing performance of young students was provided by three studies as reviewed by Graham et al. (2012b) (Berninger et al., 1997; Denton, Cope, & Moser, 2006; Graham, Harris, & Fink, 2000). The results of two of these studies, Berninger at al. (1997) and Graham, Harris, and Fink (2000), were detailed previously in support of the assertion that handwriting skills form a necessary prerequisite for development of skilled writing (see The Importance of Handwriting as a Precursor of Skilled Writing). Berninger et al. (1997) found that among first grade students at risk for writing difficulties handwriting instruction significantly improved handwriting fluency as compared to a control intervention, and that interventions incorporating visual cues for writing letters were most effective. Evidence of transfer of intervention effects from handwriting skills to writing fluency was seen in post intervention scores on the Writing Fluency subtest of the WJ-R that were significantly improved among students in the treatment groups as compared to controls ($F(138,5) = 2.29$, $p<.05$). Additionally further analysis indicated that those students receiving the intervention that was most effective in improving handwriting skill obtained the greatest gains in writing fluency among the treatment groups.

Similarly, Graham, Harris and Fink (2000) found that first grade students at risk for writing difficulties showed improved performance on handwriting measures after receiving a handwriting intervention as compared to a control condition of phonological awareness. Students who received the handwriting intervention improved on two measures of writing fluency (WJ-R Writing Fluency subtest $F(1,33) = 4.56$, $p < .04$ ($d = 0.76$); story writing task $F(1,33) = 6.79$, $p < .01$, ($d = 1.21$)), with improvements on the WJ-R Writing Fluency subtest maintained after 6 months ($F(1,27) = 7.06$, $p < .013$, ($d = 0.70$)).

Denton, Cope, and Moser (2006) conducted a study comparing the effectiveness of a sensorimotor intervention and a therapeutic practice on handwriting performance among 38 students between the ages of 6 and 11 years identified as having handwriting dysfunction. The sensorimotor intervention consisted of elements such as activities to improve visual perception and visual-motor integration (e.g. visual memory challenges, pattern completion, cutting and tracing). Therapeutic practice included direct instruction in handwriting using workbooks to practice handwriting during copying, dictation, and from memory as well as practice doing "real-life writing" and "writing for fun". These interventions were compared with a control condition of regular in-class instruction. Analysis of variance (ANOVA) revealed a significant main effect of intervention in favor of therapeutic practice ($F(2, 32) = 8.44$, $p = .001$) with an associated effect size of 1.43. This study did not focus on other writing outcome measures but illustrated the statistically and clinically strong effects of a handwriting intervention on handwriting fluency.

Intervention studies focusing on handwriting intervention among students in Grades 1 to 4 suggest that they have positive effects on handwriting performance and possible transfer to writing skills and fluency. However, there are various limitations associated with the studies examining these effects. All of the studies were conducted with students who were identified as being at risk for writing difficulties some of whom had diagnosed learning disabilities and were receiving special education services. Therefore, the generalizability of the findings to typical children in regular education settings is limited. In addition, the intervention procedures examined were implemented individually, in pairs, or in small groups. This may limit the generalizability of the findings and contribute to the results not being replicated if the interventions are attempted with a whole class.

Studies finding support for spelling interventions improving writing outcomes among students in the third and second grades were detailed in a prior section (see Transcription in Beginning Writers) (Berninger at al., 2000, 2002; Graham, Harris, and Fink-Chorzempa ,2002). Of the three studies, only Berninger et al. (2000) found that spelling intervention led to significant improvement in writing fluency. Later studies by Berninger at al. (2002) and Graham et al. (2002) found that spelling interventions chiefly led to improvements in sentence structure – although students showed general improvements in writing fluency post-intervention compared to controls these results did not reach statistical significance when compared to other intervention protocols. These results suggest that although spelling interventions may have positive effects on writing outcomes, these benefits are limited to improved spelling of taught words and sentence structure without marked effects on writing fluency. The relationship between spelling and writing development in beginning writers appears to be related to sentence writing skills as opposed to increased writing output.

Interventions concentrating on explicit instruction in sentence construction also showed promise. Fogel and Ehri (2000) found that two interventions sessions totaling 60 min composed of exposure to text along with traditional grammar lessons improved the writing output of 59 students in Grades 3 and 4, although the effects were non-significant (d = .27). In a study of 44 students in the fourth grade, Saddler and Graham (2005) compared instruction in sentence combining in pairs conducted over 30 sessions for 25 min each with traditional grammar instruction. The sentence combining instruction improved sentence structure for more skilled writers (d= 1.80) and less skilled writers alike (d = 1.45) as compared to traditional grammar lessons. Effects of the intervention on overall writing quality were generally positive but statistically non-significant (d =.52 for more skilled writers; d = .51 for less skilled writers). A

study by Jones (2004) found that use of a word processor among 20 students in the second grade over the course of four weeks improved writing output (d =.48) as compared to regular classroom instruction.

The chief limitation of these studies is that they were primarily carried out with students who had previously been identified as at risk for writing difficulties and implemented individually, in pairs or small groups. This may limit the generalizability of the findings as modification for whole class implementation may not be possible or not yield identical results. Additionally, care must be taken concerning developmental appropriateness. For example, although interventions involving sentence construction yielded strong positive effects, the studies were carried out on students in the third and fourth grade. These results may not be replicated with younger students as their transcriptions skills may still function as a constraint reducing their ability to focus on syntax and sentence structure.

Performance feedback intervention. An additional intervention approach that has been found to improve students' writing fluency and may be particularly suited to the needs of young writers is performance feedback. At its simplest, performance feedback is a mechanism by which people receive information about the effects of their performance on a task (Solomon & Rosenberg, 1964). In the classroom or during academic tasks, it is information provided to students by the teacher or some other agent as a consequence of their performance (Hattie & Timperley, 2007). Early work supporting the use of performance feedback as part of intervention packages to improve writing fluency was conducted by Van Houten and colleagues. In 1974, Van Houten, Morrison, Jarvis and McDonald conducted a writing intervention with second and fifth grade students using the elements of explicit timing and performance feedback. The study design was a single-case reversal where at baseline the students were asked to write as

long of a story as they could in response to a picture. In the performance feedback and timing condition, the students were told that they would have 10 min to complete their writing, and they self-scored their compositions at the end of the session by tallying the total number of words they had written. The students' scores were recorded on a charted and displayed in the classroom. They were instructed that in subsequent sessions they should attempt to beat their score. The students evidenced substantial gains in fluency in response to the intervention, with second grade student improving from 3 to 10 words per min, and fifth grade students improving from 8 to 15 words per min. The results of the study were positive but the experimental design was such that it was not possible to determine the unique effects of performance feedback separated from explicit timing.

In an attempt to explore the individual effects of the various components of an intervention package, Van Houten, Hill and Parsons (1975) conducted a study with fourth-grade students using a writing intervention that included self-scored feedback, public posting of scores, and teacher praise. Intervention elements were introduced and withdrawn individually as part of a reversal design. In addition, the students were divided into groups according to their reading ability (according to teacher rating of their reading the previous year), and performance feedback had positive effects in both groups resulting in an approximately two-fold increase in writing fluency in both cases. In addition, although each intervention component improved writing fluency independently, performance feedback was the single most powerful. It should be noted that along with the limitations in generalization associated with studies conducted using small sample size and single-case design, the results were expressed in terms of a mean increases in writing fluency across groups. The researchers note that there were students who were more and

less responsive to performance feedback but this is not quantified and the underlying reason(s) unknown.

Harris, Graham, Reid, McElroy, and Stern Hamby (1994) examined the individual effects of performance feedback on the writing fluency and on task behavior of four students with learning disabilities in the fifth- and sixth-grades. The procedures were similar to earlier studies with students being given 15 min to write in response to a picture prompt, and self-scoring of total words written which was recorded on a graph and kept in a writing folder. Students were encouraged to write longer stories and to beat their score. In accordance with the results obtained by Van Houten and colleagues (1975), the students attained a two-fold increase in writing fluency from baseline (baseline M = 50.25, intervention M = 109.50) and an almost two point improvement in writing quality as measured on an 8-point rating scale (baseline M = 2.52, intervention M = 4.38). It should be noted that the generalizability of these findings may be limited due to the small sample size, single-case design and the students being diagnosed as learning disabled. Additionally the researchers noted the performance feedback intervention was not acceptable to all the students and increased length of composition was not always accompanied by increases in quality. In particular one student produced no written work during multiple sessions and was consistently negative about both the performance feedback practices and writing in general, and was noted by his teacher as having experienced a great degree of failure and frustration in writing. Based on these observations, the researchers noted that performance feedback may not prove effective if it is not acceptable to the student or targets activities for which they have not mastered the requisite skills (Harris et al., 1994).

Studies by Eckert et al. (2006) explored the effects of performance feedback experimentally with a larger sample size and a control group for comparison. In their first study,

50 third-grade students were randomly assigned to either a performance feedback intervention or a control group. In the performance feedback condition students received individualized writing packets. During baseline they were instructed to write a story in response to an age-appropriate story starter such as*, "I never dreamed the door to my bedroom would lead to…"* The students were given 3 min to write. Their stories were scored in terms of total words written and in the next session they received that score and told to try to beat it. In subsequent sessions, the students' scores were accompanied by a box which either contained an upward pointing arrow, a downward pointing arrow, or an equal sign to indicate whether score had been more than, less than or equal to their score in the preceding week. The study was conducted for eight weeks and daily growth slopes were conducted for each student. Comparison of the growth rate in writing fluency of the students in the intervention group with those in the control condition with a series of analysis of variance calculations (ANOVAs) revealed the performance feedback resulted in significant gains in writing performance (F (1,49) = 10.82, p = .002).

In a subsequent study, Eckert, Truckenmiller, Rheinheimer, Perry, and Koehler (2008) examined the effects of the performance feedback intervention with students in a third-grade general education classroom, including students identified as academically at-risk. Comparing the performance of the students in the intervention condition versus controls revealed that the students who received the performance feedback intervention made significantly greater gains in writing fluency growth (F(1, 27) = 4.57, p = .04), increasing from a mean of 20.33 to 38.55 total words written in 3 min, while those in the control condition increased from a mean of 23.33 to 31.9.

Although the results of these studies suggest performance feedback is a simple and powerful mean of improving students' writing fluency, it is not without caveats. As part of their

2008 study, Eckert et al. determined the baseline instructional levels of the students according to benchmark criteria outlined by Mirkin et al. (1981). At the beginning of the study, the majority of the students, regardless of condition, exhibited Frustrational-level performance (range, 73 to 80%). At the close of the intervention 66.7% of these students in the performance feedback condition had improved to Instructional or Mastery as compared to only 36.4% in the control group. This indicates that although performance feedback can influence students' writing fluency growth, it is by no means universally effective since 33.3% of those students who began the intervention writing at Frustrational levels remained so after six weeks of intervention. Subsequent studies by Hier (2012) and Koenig (2013) found similar results with 34% and 38.5% of students respectively continuing to exhibit Frustrational-level performance at the close of the performance feedback intervention. Such results suggest that other variables may be affecting students' response to performance feedback interventions, thereby requiring investigation.

In an effort to explore student-level factors that may influence response to performance feedback interventions to improve the writing fluency among 122 third-grade students (45 male, 77 female), Alvis (2013) used initial level of writing fluency, handwriting quality, and gender as predictor variables. Initial writing fluency was assessed categorically using the guidelines set by Mirkin et al. (1981). Handwriting quality was assessed during the baseline phase of the intervention using a measure wherein students were asked to write 10 lower-case letters that were dictated. These writing samples were evaluated using a scoring rubric developed by the author considering the dimensions of letter formation, alignment, size, and slant. The students received a performance feedback intervention for a period of 6 weeks using methods as described by Eckert et al. (2006, 2008).

Initial writing fluency, handwriting quality, and gender were entered as predictors in a multiple regression analysis to determine whether they formed a model predicting significant variance in changes in students' writing fluency. Gender was found to have a small but significant positive correlation with slope (r = .20, p = .02) and when entered into the regression model, it was a marginally significant predictor of changes in writing fluency (β = .18, p = .06) accounting for 3.5% of the variance in scores. The regression model was not found to be significant for male (R^2 = .04, F (3,73) = 1.92, p = .13) or female (R^2 = .03, F (3,41) = .47, p = .71) students (Alvis, 2013). This study suffered from various limitations that may explain its failure to yield significant findings. Chief among them was the measure used to assess handwriting quality and the scoring rubric. Letters written out of context in response to dictation constitute a narrow skill and may not be analogous to common writing tasks expected of elementary- aged students, which are more complex. In addition, the scoring rubric was developed by the author and may not have been sensitive enough to distinguish between varying levels of handwriting skill.

Summary. The research reviewed in this section highlights two approaches that can potentially be used to improve writing performance in beginning writers. Based on prior investigations, interventions focused on transcription skills may be most suitable for beginning writers. However, the effectiveness of writing interventions is hindered by the paucity of well-designed experiments in which researchers to fully describe and investigate demographic variables that may affect response to intervention (Rogers & Graham, 2008). Although the existing research has lent considerable support to the assertions that both handwriting interventions and performance feedback improve writing fluency, there have not been any studies considering the effect that deficits in lower-level transcription skills may have on

students' response to interventions targeting skilled writing outcomes. Considering the variability in student response to performance feedback seen in studies by Eckert et al. (2006, 2008) and others (Harris et al., 1994; Hier, 2012; Koenig, 2013), investigations are needed to determine individual differences that may be responsible.

At the time of this review, Alvis (2013) has conducted the only study attempting to identify student-level variables that impact growth in writing fluency in response to performance feedback. Although this inquiry was unsuccessful in finding significant results, its existence as the sole study of its kind underscores the paucity of research in this area and the need for additional investigation to determine how individual differences contribute to writing skill and their consequences in terms of intervention effectiveness. Such knowledge is imperative for the design of writing interventions that are appropriate for beginning writers in an attempt to successfully confront the current trend of student underachievement in writing.

Concluding Summary

It is clear from the extant research in the area that mastery of written expression is a necessary skill for both academic and professional success (National Commission on Writing, 2003, 2004, 2005). Given the critical role writing plays in the lives of students, it is extremely concerning that the majority of students in the U.S. cannot write proficiently according to data collected on writing achievement in grades 4 through 12 (U.S. Department of Education, 2003, 2007, 2012). Despite the importance of writing, instruction in this area is often lacking and little time is spent teaching writing beyond the early primary grades. The recent introduction of the Common Core State Standards (CCSS; National Governors Association Center for Best Practices, 2010) represents a significant change in the expectations for students' writing abilities. These new standards place greater emphasis on both learning to write and writing to learn as well

as the use of writing as a tool for analysis, reflection and research across multiple genres, presenting an instructional challenge for teachers and students.

Difficulties in basic transcription skills of spelling and handwriting are often the harbingers of continued underachievement in writing. Lack of automaticity in transcription makes writing laborious and detracts from compositional quality by increasing cognitive load and siphoning writers' mental resources away from tasks such as planning, idea generation, and revision. Handwriting is of particular importance for writing development as automatic letter writing is the single best predictor of length and quality of writing in the elementary grades (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997) and continues to account for a significant proportion of the variance in narrative writing quality in later grades (Limpo & Alves, 2013; Olinghouse, 2008). Gender is also a significant factor explaining differences in writing performance. Male students are at particular risk for writing problems (Berninger, Nielson, Abbott, Wijsman, & Raskind, 2008; Persky et al., 2003; Salahu-Din et al., 2008) and are consistently outperformed by female students on standardized measures of writing fluency (Martin & Hoover, 1987), as well as subjective judgments of legibility (Graham et al., 1998; Ziviani & Watson-Will, 1998) and writing quality (Troia et al., 2013). Olinghouse (2008) has identified gender has the strongest predictor of both compositional fluency and quality among third grade students.

Early and effective intervention is needed to address problems in written expression (Graham et al., 2012a). Although there are a number of evidence-based interventions designed to improve written expression, few have been extensively studied for use with beginning writers. Performance feedback is an evidence based intervention that has been shown to be effective in improving the writing fluency of young writers. However, student response to performance

feedback interventions is not consistent or universal and some students do not show improvements. Individual differences in handwriting account for unique variance in compositional fluency and quality in elementary-aged children (Graham, Berninger, Abbott, Abbott & Whitaker, 1997) and learner characteristics such as gender have been found to influence academic achievement in writing (Persky et al. 2003). Gender has been shown to have particularly strong impact on writing outcomes, with girls outperforming boys on ratings of legibility (Ziviani & Watson-Will, 1998), overall writing quality (Troia et al., 2013), and writing fluency (Olinghouse, 2008). Learner characteristics that affect writing development may also influence response to interventions designed to improve writing performance. Research on how student-level variables may influence response to writing interventions such as performance feedback is needed to improve our understanding of the needs of developing writers and design effective interventions to address their difficulties.

Purpose of the Current Study

The purpose of the current study was to examine performance feedback interventions to improve writing performance in elementary-aged children and enhance understanding of the factors that determine their effectiveness. Because extant findings indicate that the writing fluency of some students does not improve in response to the performance feedback intervention, there is a need to identify factors that may influence said response. As a result, the aims of the current study were to examine whether student-level variables shown to impact writing fluency predict students' writing fluency growth in response to a performance feedback intervention, and to examine potential differences among students who respond to the intervention (i.e., responders) and students who do not respond to the intervention (i.e., non-responders).

To address the study aims three research questions and corresponding hypotheses were posed:

1) The first research question explored the contribution of multiple student-level predictors to changes in students' writing fluency growth in response to a performance feedback intervention. These variables were predicted to account for differing proportions of variance in changes in students' writing fluency growth in descending order as follows: (a) gender, (b) measures of handwriting, (c) performance on an orthographic fluency measure, and (d) a measure of spelling.

Gender was hypothesized to be most influential predictor of response to the performance feedback intervention based on previously reported findings indicating that female students consistently outperform male students on measures of basic writing skill as well as writing fluency (Malecki & Jewell, 2003; Olinghouse, 2008; Troia et al., 2013). Studies indicate that handwriting is a significant contributor to writing performance in the early primary grades (Abbott & Berninger, 1993; Graham et al., 1997) and findings by Olinghouse (2008) indicate that handwriting fluency accounts for the greatest portion of variance in composition fluency of third grade students after gender. Therefore, handwriting skill was hypothesized to be the strongest predictor of students' response to the performance feedback intervention after gender. It was hypothesized that students' scores on a standardized measure of handwriting would account for a larger proportion of the changes in students' writing fluency than an unstandardized measure because the standardized measure assesses handwriting quality across the entire alphabet.

Two additional skills were also hypothesized as contributing to the changes in students' writing fluency. Because orthographic fluency was shown to a be a significant predictor of writing fluency (Berninger & Rutberg, 1992; Graham et al., 1997; Graham et al., 1998;

Olinghouse, 2008), it was predicted that performance on measures on handwriting skills would account for a significant proportion of variance, second in magnitude to gender, followed by paragraph copying. Furthermore, research suggests that spelling is a necessary skill for the development of skilled writing (Berninger et al., 2002) and improved performance in spelling is associated with improved writing fluency (Berninger et al., 2000; Berninger et al., 2002; Graham, Harris, & Fink-Chorzempa, 2002). It was predicted that student performance in spelling would significantly contribute to the variance in changes in writing fluency growth, and this proportion would be smaller than those contributed by gender and handwriting.

2) The second research question compared the students who responded to the performance feedback intervention (i.e., performance is at Proficient or Mastery level at the close of the intervention) and those students who were non-responders (i.e., those whose performance remained Frustrational at the close of the intervention) on measures of handwriting quality, orthographic fluency, and spelling. Because of the purported impact of basic writing skills on writing fluency (Berninger et al., 1997; Graham, Harris, & Fink, 2000; Olinghouse, 2008), it was predicted that non-responders would demonstrate significantly lower performance on measures of handwriting quality, orthographic fluency, and spelling in comparison to responders.

3) The third research question examined gender differences as they relate to responders and non-responders. As previously noted, prior research indicates there are gender-based differences in writing (Malecki & Jewell, 2003, Olinghouse, 2008, Troia et al., 2013). Additionally, during the elementary grades, male students are outperformed by female students on measures of both handwriting and skilled writing (Martin & Hoover, 1987; Ziviani & Watson-Will, 1998), and overrepresented among students with diagnosed learning disabilities in writing (Berninger, Nielson, Abbott, Wijsman, & Raskind, 2008; Persky et al., 2003; Salahu-Din et al., 2008). Based

on these findings it was predicted that male students would show exhibit less growth in writing fluency in response to the intervention and there would be significantly more male students among the non-responders than female students.

Method

Participants and Setting

Institutional Review Board approval was sought from Syracuse University and the participating school district. Upon approval, third-grade students enrolled in general education classrooms were invited to participate in the study. Third-grade students were targeted because they should have developed their basic handwriting skill and are writing in connected text (Berninger et al., 2006). Additionally, prior studies on the effect of performance feedback invention on writing fluency conducted by Eckert et al. (2006, 2008) were focused on third-grade students and the current study serves as an extension to this work.

Parents were sent a notice to inform them of their child's participation in the study (Appendix A) and student consent was sought (Appendix B). For students whose parents did not object to their participation and gave assent, they were screened for the eligibility criteria and invited to participate in the study. Students were excluded if they were: (a) experiencing severe motor deficits that precluded students from composing written stories; (b) experiencing severe cognitive deficits that resulted in eligibility for special education services; (c) classified as an English Language Learner or student with Limited English Proficiency; (d) classified as Learning Disabled in Writing; (e) not assigned an instructional aide or a Section 504 plan indicating additional instructional modifications; (f) not diagnosed with a significant vision or hearing impairment; (g) unable to demonstrate minimum proficiency writing at least eight letters on a baseline measure; and (h) unable to demonstrate minimum proficiency by writing at least

seven words on a baseline measure. The first six exclusionary criteria were determined by reviewing students' records and conducting interviews with their classroom teachers. The last two criteria were determined during the baseline assessment phase. Ineligible students and those students who did not want to participate in the study completed an instructional activity identified by their teacher.

At the beginning of the study, 141 students were assessed for eligibility. A total of 29 students were excluded due to not meeting the inclusionary criteria (n = 10), being absent for baseline data collection (n = 18), or moving (n = 1). A random number generator was used to randomly assign eligible participants (N = 112) to the performance feedback (n = 36), generalization programming (n = 38), or the practice only conditions (n = 38). The data collected were also used in an accompanying study to compare performance across intervention groups. However for the purposes of the research questions posed in this study the primary researcher sought to examine response to the intervention in relation to student-level variables and baseline measures. Therefore only the students who were assigned to performance feedback and generalization programming conditions were considered, and collapsed into a single intervention group. Prior to collapsing these groups, equivalence across conditions was explored by comparing student demographic data across the three conditions using non-parametric and parametric statistics. The information is displayed in Table 1. The results indicated that there were no significant differences between conditions with regard to gender, χ^2 (2, N = 112) = 1.09, p = .58, race, χ^2 (6, N = 112) = 5.68, p = .45, ethnicity, χ^2 (14, N = 112) = 12.30, p = .58, special education status, χ^2 (2, N = 112) = .78, p = .69 or age, F (3, 111) = 1.14, p = .33 .

Combining of the students in the performance feedback (n = 36), generalization programming conditions (n = 38) yielded a total sample of 74 third-grade students who

participated in this study. Most of the students in this study were female (56.8%) and self-identified their race as Black or African American (64.4%) or White (35.6%). In terms of ethnicity, most students were not Hispanic or Latino (84.9%). There was a smaller portion of students who were identified as Somali (8.2%), Arab (4.1%), Hispanic or Latino (1.4%), and Krgrgyz (1.4%). The average age of the students was 8 years, 3 months (range, 8 years, 3 months to 9 years, 2 months). A small percentage of students (9.5%) were eligible for special education services (i.e., speech or language impairment) but still met the inclusionary criteria (see Table 2).

Between schools, the students were homogeneous with respect to gender (χ^2 [1, n = 74] = .54, p = .49), ethnicity (χ^2 [4, n = 73] = 9.35, p = .53), special education eligibility (χ^2 [1, n = 74] = 0.10, p = 1.00), or age, t (72) = -.71, p = .48. However, statistically significant differences existed between schools with regard to race, χ^2 (1, n = 73) = 14.62, p < .001. Specifically, more than half of the students identified as White (56.7%) in School A, whereas in School B, the majority of students identified as Black or African American (86.1%).

Students attended two urban elementary schools located in a moderate-sized city in central New York. School 1 had 930 students enrolled in Kindergarten to grade 8, while School 2 had 579 students enrolled in Kindergarten to grade 5. The majority of students at both schools qualified for free or reduced-price lunch, with 74% of students at School 1 and 91% of students at School 2 meeting this criterion. All sessions took place in the students' general education classrooms during a 30-min block of time identified by the classroom teachers.

Experimenters

Doctoral students in school psychology served as experimenters. In addition, advanced undergraduate psychology majors were recruited to serve in various capacities as research assistants. Research assistants received training and supervision in the following areas:

administering dependent measures, scoring dependent measures, conducting procedural integrity observations, and completing data entry. All research assistants were required to complete a formal training in research ethics, as required by Syracuse University. This training (i.e., Collaborative Institute Training Initiative) provides online basic courses in the protection of human research subjects. In addition, research assistants were responsible for ensuring correct administration of assessment and intervention materials and scoring of dependent measures with provided procedural scripts for conducting procedural integrity, and a manual detailing the scoring procedures for the dependent measures. They received training on all procedures, followed by opportunities to practice and receive feedback on scoring writing probes and handwriting samples. All research assistants were required to demonstrate 100% proficiency scoring dependent measures and conducting procedural integrity observations.

Materials

Several measures of skill in written expression, writing fluency and handwriting were administered. During the baseline assessment phase, the first 20 items of the Spelling subtest of the Wechsler Individual Achievement Test-Third Edition (Pearson, 2009), and the paragraph-copying task from the Monroe-Sherman Group Diagnostic Reading Aptitude and Achievement Test (Monroe & Sherman, 1966) were administered. Curriculum-Based Measurement probes in Written Expression were used to measure students' writing fluency in both the baseline assessment phase and intervention phase. Handwriting skill was also assessed using two measures administered to the students during the baseline assessment phase: (a) an informal measure of handwriting developed by the author, and (b) the Test of Handwriting Skills – Revised (Milone, 2007).

Wechsler Individual Achievement Test-Third Edition –Spelling. The Wechsler Individual Achievement Test-Third Edition (WIAT-III; Pearson, 2009) is a standardized, norm-referenced measure that was designed to measure academic strengths and weaknesses in listening, speaking, reading, writing, and mathematics for children, aged 4 through 19. The Spelling subtest requires students to spell dictated words. Students were supplied with a lined, numbered sheet for their responses (Appendix C).

The technical adequacy of the Wechsler Individual Achievement Test-Third Edition has been primarily evaluated by the test developers, and the psychometric properties are reported in the test manual (Pearson, 2009). The test-retest reliability of the Spelling subtest for 8- and 9-year-old children is high (r = .95), and interscorer agreement is greater than .90. Scores on the Spelling subtest are significantly lower among students diagnosed with a Specific Learning Disability in Written Expression as compared to their peers.

Orthographic Fluency - Paragraph Copying Task. The paragraph-copying task from the Monroe-Sherman Group Diagnostic Reading Aptitude and Achievement Test (Monroe & Sherman, 1966) was administered as an indicator of orthographic skill (see Appendix D). Students were given 90 s to copy a short paragraph as quickly as possible without making mistakes. Students' responses were scored by counting the number of words copied accurately. These scores were compared to normative data on the measure to yield a standard score. This task was chosen because it is the only paragraph copying task with published normative data for elementary-aged children. Although the psychometric properties and published norming procedures are limited, performance on this measure was shown to be a significant predictor of overall writing ability and writing fluency (Berninger, Hart, Abbott, & Karovsky, 1992; Graham et al., 1997).

Handwriting assessment: Letters from dictation. An informal measure of handwriting was developed by the author (Appendix E). Participants were asked to print a set of 10 lowercase letters from the alphabet (i.e., *a, j, z, u, n, k, t, b, x, d*). These 10 letters were chosen based on research by Graham, Weintraub, and Berninger (2001) indicating that in grades 1 through 3 the letters *q, j, z, u, n,* and *k* account for 48% of omissions, miscues and illegible attempts when writing lowercase letters of the alphabet. If only illegible responses are considered, the letter *a* along with *z, u, q,* and *j* account for 54% of miscues. The letter *t* is among the letters noted by Graham et al. (2001) as contributing to more than 50% of illegibilities in the third grade, and *x* is the lowest ranked letter for legibility in the third grade after accounting for those contributing to the majority of errors. The letters *b* and *d* were included for reversal issues. No psychometric evidence regarding this handwriting assessment measure is available. Students were supplied with a sheet of double-lined guides for recording their responses.

Test of Handwriting Skills – Revised. The Test of Handwriting Skills-Revised (THS-R; Milone, 2007) was used as a standardized measure of handwriting. The THS-R is a norm-referenced measure designed to assess manuscript and cursive handwriting in students aged 6 to 18. It is a revision of the Test of Handwriting Skills (THS) developed by Gardner (1998). This revision represents an expansion of the norming sample and an update of the scoring procedures. The THS-R consists of ten subtests requiring students to write the alphabet in sequence in both upper- and lowercase, write letters dictated out of alphabetical order in upper- and lowercase, copy letters out of alphabetical order in upper- and lowercase, copy words and sentences, and write words from dictation (Milone, 2007).

The scoring system of the THS-R assesses writing speed, letter reversal and case substitution in addition to letter formation. Each letter is scored on a scale of zero to three, where

three indicates a letter accurately written, resembling the ideal. Raw scores on each subtest are converted to scaled scores, which are summed and used to derive a standard overall score on the measure. Ancillary scores are computed for speed, reversals, spacing issues and case errors..

The Test of Handwriting Skills- Revised was standardized on a nationally stratified sample of 1,476 children aged 6 to 18 years. The technical adequacy of the THS-R was evaluated by the test developers and the psychometric properties are reported in the test manual. Internal consistency of the test items was assessed using both Cronbach's alpha and the Spearman-Brown coefficient. For both measures, internal consistency is moderate to high across all subtests and age groups with a range of .60 to .96. The test–retest correlations indicate that the THS-R is sufficiently stable over time with a correlation of .82 for the total test scores, and a range of .49 to .82 for individual subtests. Inter-rater reliability is adequate, with an average of .80.

The items included in the subtests of the THS-R are identical to the previous version. It yields scores on both handwriting quality and speed. Construct validity was assessed by the developers by evaluating developmental differences in scores (reflecting growth in handwriting skill) and performance by exceptional groups (lower scores in clinical populations). Principal Components Analysis revealed that scores on the ten subtests of the THS-R load on a single factor, while ancillary scores load on another, suggesting two underlying factors relating to the basic skills of handwriting (Milone, 2007). There are no concurrent validity studies comparing the THS-R with other instruments for evaluating children's handwriting

Curriculum-Based Measurement probes in Written Expression. Students' writing fluency at baseline and during the course of the intervention were assessed using Curriculum-Based probes in Written Expression (CBM-WE), developed in accordance with procedures outlined by Shapiro (2004). Nine CBM-WE probes were administered: one at baseline

(Appendix F), and one each week for eight weeks during the course of the performance feedback intervention. Each probe began with a story starter designed to prompt ideas for a narrative story (e.g., "I was talking to my friends when all of a sudden…"). The story starters were evaluated for their age appropriateness and use with students in the elementary grades (AIMSweb®, 2004; McMaster & Campbell, 2006).

The CBM-WE outcome measures shown to most accurately and appropriately assess writing fluency among elementary-aged children are total words written, word spelled correctly, and correct writing sequences (Espin et al., 2000). Powell-Smith and Shinn (2004) and McMaster and Espin (2007) have conducted comprehensive reviews of studies exploring the technical adequacy of total words written, words spelled correctly, and correct writing sequences. Their findings support the relationship of these outcome measures with writing fluency and their suitability as measures of student growth in this area. Overall, reliability coefficients (range, r = .51 to .99), as well as interscorer agreement (range, 91% to 99%) for total words written and correctly spelled words were moderate to high, while parallel form reliability (r = .46) and interscorer agreement (range, 86% to 98%) for correct writing sequences was lower than the estimates for the other two metrics. In addition, correct writing sequences were found to be more highly correlated with criterion measures of writing fluency (e.g., holistic and informal teacher ratings, Test of Written Language [Hammill & Larsen, 1996], Minnesota Basic Skills Test [Minnesota Department of Children, Families, and Learning & NCS Pearson, 2002]) than either total words written or words spelled correctly (range, r = 0.18 to 0.85). Additionally, correct writing sequences appear to be more acceptable to teachers than other measures (McMaster & Espin, 2007) and, of the three measures, it is the most accurate and precise for the

measurement of student growth (Hubbard, 1996). These findings suggest that correct writing sequences is the best indicator of writing fluency and writing fluency growth over time.

Procedures

The study was conducted in three phases over the course of 5 weeks. The first three sessions were designated to conduct the eligibility and baseline assessments. Following the eligibility and baseline assessments, students were randomly assigned to one of two treatment conditions: (a) performance feedback condition (n = 36); and (b) generalization programming condition (n = 38). Bi-weekly sessions were conducted in the students' classrooms and lasted approximately 25 minutes. Of this time, 10 to 15 mins was specifically dedicated to administration of the intervention, and the remaining time designated to classroom management and material preparation. After the eligibility and baseline assessment phases, nine intervention sessions were conducted.

Experimenters and trained research assistants were responsible for conducting each session. The primary experimenter read the appropriate procedural script. The research assistant assisted the experimenter in conducting the sessions (i.e., distributing and collecting materials) as well as monitoring the session for procedural integrity using the relevant procedural integrity script. All sessions and procedures were conducted in a group format, and all eligible students participated at the same time.

Eligibility assessment. Students' performance on two of the baseline measures was used to assess their eligibility to participate in the study: the informal handwriting measure and the baseline CBM-WE probe. During the informal handwriting measure, the experimenter read aloud 10 alphabet letters and students were instructed to print each letter in lower-case on response sheets provided by the experimenter. Students were deemed ineligible to participate in

this study if less than 80% of their letters were legible. During the administration of the baseline CBM-WE probe, students were provided with a writing prompt and were given approximately five minutes (including planning time) to write a composition. Results from this probe were used to provide performance feedback during the intervention sessions for those students who met eligibility criteria. Students who wrote less than seven words were deemed ineligible to participate in the study.

Baseline assessment phase. Baseline assessment was conducted in three sessions. All administrations during the baseline assessment were conducted in group format. The first baseline session consisted of the students completing (a) the informal handwriting measure designed by the author (i.e., 10 lowercase letters written from dictation; approximately 2 min); (b) the paragraph copying task (i.e., 90 sec given to copy a paragraph); and (c) (a) the first 20 items of the Spelling subtest of the Wechsler Individual Achievement Test-Third Edition (WIAT-III; Pearson, 2009) (i.e., 20 words dictated in accordance with the administration instructions). The second baseline session consisted of the first five subtests of the Test of Handwriting Skills in the order prescribed by the manual (THS; Milone, 2007;i.e., approximately 2 min per subtest for a total of 10 min). The third baseline session consisted of: (a) the baseline Curriculum-Based Measurement in Written Expression probe (approximately 5 min); and (b) the remaining five subtests of the Test of Handwriting Skills in the order prescribed by the manual (approximately 2 min per subtest for a total of 10 min). For the purposes of this study, all 10 subtests of the THS-R were administered in two sessions, consisting of five subtests per session in the order prescribed by the manual.

Individualized performance feedback condition.

Students assigned to this condition were given a packet (Appendix G) containing a Curriculum-Based Measurement probe in Written Expression. The intervention writing probes

were presented to the students in an individualized writing packet. The first page of each packet contained the student's identifying information. To prevent students from previewing the story-starter, the next page of the packet had a stop sign printed in the middle of it. The next page was an individualized performance feedback sheet. The remaining sheets were CBM-WE probe materials including: (a) one page containing a story starter written across the top of the page and a stop sign at the bottom, (b) one page containing the story starter with compositional lines, and (c) one page containing compositional lines.

The research assistant provided instructions following a procedural script (Appendix H). Individualized performance feedback was provided to each student and was presented in both visual and oral formats. The visual presentation was in the form of a feedback page that was inserted into the writing packet, containing the total number of words the student wrote during the previous session (Appendix I). During intervention sessions, the research assistant explained that the total number of words written was computed by counting all words that each student wrote. From the second intervention session onward, it was explained to the students that the arrows on the performance feedback page indicated whether they had written more or less in the previous session than the one that preceded it. The students were told that if the up arrow was circled they had written more, if the down arrow was circled they had written less, and an equal sign drawn on their sheet indicated that they had written the same number of words in both session. The remainder of the session focused on completing the writing probe. Students were instructed to spend 1 min planning their story based on the prompt, after which they were given 3 min to a spend writing their story.

The procedures for the generalization programming condition included all the elements of the individualized performance feedback condition in addition to tactics to explicitly program

stimulus and response generalization. For three intervention sessions during the course of the study, stimulus generalization probes were administered including CBM-WE story-starters that was presented only visually and read independently by the students, rather than being read by the experimenters. Response generalization was assessed during one intervention session, following assessment of stimulus generalization by administering a CBM-WE probe that required students to write about something that they liked and to explain why they liked it. An additional generalization programming tactic was used in all sessions, in the form a 42 inch, stand-up cardboard pencil. The pencil was placed at the front of the classroom and referred to during the administration of the writing directions as a prompt. The experimenter emphasized the stimuli by pointing to the pencil and saying, "This pencil is going to be here throughout our writing session today to help you to remember to keep writing…"

As previously noted, the stated aims of this study were to examine student level and baseline factors influencing students response to the performance feedback intervention, therefore students in the practice only condition were not considered. No statistically significant differences between students across conditions were found, therefore students receiving both performance feedback and generalization programming were regarded as a single intervention group.

Outcome Measures

Handwriting was evaluated using scores from two measures. The first measure was developed by the author and assessed 10 lower-case letters on the dimensions of letter formation, alignment, size, and slant (scoring manual available upon request). Student scores on this measure consisted of the raw score summated across the four dimensions (range, 0 to 31). The second measure was the Test of Handwriting Skills – Revised (Milone, 2007), and standard

scores were computed. Spelling was assessed on the Spelling subtest of the Wechsler Individual Achievement Test-Third Edition (WIAT-III; Pearson, 2009), and standard scores were derived. Orthographic fluency was assessed using the paragraph-copying task from the Monroe-Sherman Group Diagnostic Reading Aptitude and Achievement Test (Monroe & Sherman, 1966) (see Appendix D). Students' raw scores were converted to standard scores using normative data on the measure.

To measure students' writing fluency over the course of the intervention, the total number of words written (i.e., counting every grouping of letters separated by a space, regardless of spelling or grammatical accuracy) and the number of correct writing sequences (i.e., analysis of each adjacent word for correct punctuation, capitalization, spelling, and syntax) was scored based on procedures outlined by Shapiro (2011). The total number of words written was provided to students as part of the performance feedback intervention. The number of correct writing sequences was used to measure students' growth in writing fluency over the course of the intervention, and the rate of change (i.e., slope) in the number of correct word sequences over the course of the intervention was computed for each student.

Finally, students were categorized as being either 'responders' or 'nonresponders' to the intervention. This was done by using each student's number of words written per three minutes and categorizing their performance into one of three instructional levels: (a) frustrational (i.e., less than 37 words); (b) instructional (i.e., 37 to 40 words), or (c) mastery (i.e., 41 words or more) at the end of the intervention. These classifications were based on normative recommendations developed by Mirkin and colleagues (1981). As noted from prior research, approximately one third of students who receive performance feedback interventions to improve writing fluency continue to demonstrate performance falling in the frustrational range (Eckert et

al., 2006, 2008). Per the purpose of the current study to examine potential differences between these students and their peers performing in the instructional range and above, students whose performance fell in the instructional and mastery categories at the conclusion of the intervention were regarded as 'responders', and those students whose performance remained frustrational were regarded as 'nonresponders'.

Experimental Design

As previously noted this study drew from a larger project examining the effects of performance feedback intervention on writing. As part of this project, students in third-grade classrooms were randomly assigned to the intervention conditions by use of a random number generator. This study used a repeated measures design to examine students' writing growth over the course of 9 intervention sessions. For the purposes of the current study, only those students receiving the performance feedback intervention were included in the analyses as part of a quasi-experimental between-subjects design.

Procedural Integrity

Procedural integrity was assessed in two ways. First, for all sessions, a permanent product measure (i.e., a procedural script) was completed by the primary experimenter responsible for conducting the session. Following the script increased the likelihood that the procedures were implemented accurately. Second, a secondary research assistant observed the primary experimenter conduct 60.09% of the sessions (n = 39) to assess procedural integrity. Using a copy of the script for the corresponding condition, the secondary research assistant determined whether the procedures were correctly implemented by the primary experimenter and noted any errors in administration. Agreements were tallied as instances when the secondary research assistant indicated that the primary experimenter correctly implemented that portion of

the procedure. Adherence to the procedural script was determined by taking the lower total count of agreements divided by the total number of possible procedural steps and multiplying by 100%. Overall, procedural integrity was very high across all sessions (*M* = 99.53%, range, 95.65% to 100%) (see Table 2).

Interscorer Agreement

Following the intervention phase of the study a total of 40% of the writing probes were randomly selected and re-scored for the primary dependent measure, correct writing sequences. The percentage of interscorer agreement was calculated as the number of agreements divided by agreements plus disagreements, multiplied by 100%. The mean percentage of interscorer agreement was 98% (range, 64% to 100%). Kappa coefficients were also calculated to account for errors in agreement due to chance (*M* = .94, range, .45 to 1.00).

Interscorer agreement was also assessed for the students' performance on the Test of Handwriting Skills – Revised (THS-R; Milone, 2007). A total of 40% of the students' response sheets were randomly selected and re-scored. As previously described, the THS-R consists of 10 subtests. Percentage of interscorer agreement was calculated for scores on each subtest as well as overall raw scores. This was calculated as number of agreements plus disagreements, multiplied by 100. The mean percentage of interscorer agreement among the 10 subtests was 92% (range, 71% to 100%), and 94% for overall scores (range, 73% to 98%). Kappa coefficients were also calculated and yielded an average of .89 for scores on the 10 subtests (range, .66 to .94) and an average of .93 for overall scores (range, .69 to 1.00)

Results

Data Preparation

Data input and consistency checks. Raw data were inputted by the primary researcher into a Microsoft Excel file. All data entry was checked for accuracy by another trained research assistant. Data were then transferred and analyzed using IBM SPSS Statistics 20 (IBM Corp, 2011). SPSS was used to generate descriptive statistics, graphs, and to conduct major analyses. Data were complete for all participants with respect to the outcomes being examined, except for two cases, where scores were missing on one measure. This was likely due to the students being absent when the measure was administered. The missing data did not appear to follow any pattern and was assessed to be occurring at random. Given the small amount of missing data and the assumption that the instances were random, listwise deletion was chosen during major analyses.

Data inspection. Baseline data and rate of change in writing fluency as measured by slope were examined for normality, homogeneity of variance, multicollinearity, and autocorrelations to ensure that the assumptions for regression analysis were met. Student scores on the Spelling subtest of the WIAT-III and values calculated for slope were found to have kurtosis values of 3.66 and 8.17 indicating potential departures from normality. The Kolmogorov-Smirnov test of normality was conducted and was not found to be significant, and visual inspection of Q-Q plots revealed a largely normal distribution. Based on these findings, the major analyses were conducted with the assumption that the distribution of the data was sufficiently normal.

In addition to examining the distributions of data, the assumption of homogeneity of variance was examined for all outcome variables and was found to be non-significant. Further,

multicollinearity was assessed by examining the inter-correlations between outcome variables (see Table 5). All correlation coefficients were small (range, -.06 to .38), suggesting low multicollinearity. Collinearity statistics were also calculated, and tolerance values (range, .77 to .92) and variance inflation factor values (range, 1.10 to 1.29) fell within accepted thresholds. Autocorrelation was assessed by running a preliminary multiple regression of slope on the five baseline measures and examining the Durbin-Watson statistic. The Durbin-Watson statistic is a measure of autocorrelation between residuals that may range from 0 to 4, with a value of 2 indicating that there is no autocorrelation in the sample. The value associated with the regression was found to be 1.93 which supports the assumption that there was no significant autocorrelation.

An additional measure of change in each student's writing fluency across the intervention was calculated by subtracting the number of correct writing sequences produced in response to the baseline CBM-WE probe from the number of correct writing sequences produced in response to the final intervention probe. The correlation of these difference scores to the student level variables and slope is presented in Table 5. The differences scores were found to have a strong positive and significant relationship with changes in student writing fluency as measured by slope (r = .96, p <.01), and also to have a small but significant positive relationship to students' performance on the Test of Handwriting Skills (r = .26, p <.05).

Descriptive Analyses

The participants' average performance on baseline measures of writing fluency, orthographic fluency, handwriting, spelling, and their changes in writing fluency over the course of the intervention as measured by slope are reported descriptively in Table 4. Their average overall performance at baseline on the initial Curriculum-Based Measurement in Written

Expression probe was 21.23 correct writing sequences (*SD* = 10.53), which corresponds with the frustrational level of placement based on criterion-referenced standards developed by Mirkin and colleagues (1981). The participants' performance on measures of orthographic fluency and handwriting quality fell in the average range as compared to their peers, as did their spelling. The participants' average score on an informal measure of handwriting developed by the author was 19.91 (*SD* = 6.51) out of a maximum possible score of 31 points. Over the course of the intervention, growth in students' writing fluency as measured by slope, occurred at an average rate of 0.12 correct word sequences per week (*SD* = 0.33). It should be noted that this rate of growth was low in comparison with normative data reported for third-grade students whose performance falls in the 50th percentile, which indicates rates of improvement of 0.33 correct word sequences per week (AIMSweb; 2017). Students' average writing fluency at the close of the intervention remained in the frustrational range (*M* = 28.95 correct word sequences, *SD* = 15.55).

Contribution of Student-Level Predictors to Changes in Students' Writing Fluency

To examine whether gender, handwriting performance, orthographic fluency, and spelling performance accounted for differing proportions of variance in changes to students' writing fluency growth, a standard multiple regression was conducted The results of the regression model for the predictor variables entered as a single block was not statistically significant and did not account for a significant amount of the variance in the slope estimates (R^2 = .10, F (5,71) = 1.50, p = .202 (see Table 6). To test the hypotheses that gender, handwriting skill, orthographic fluency, and spelling each made unique and significant contributions to the prediction of slope, the results of the multiple regression were examined along with the semi-partial correlation of each of the predictor variables with slope. As seen in Table 5, slope was

found to have a negative relationship with gender that was small, not significant (r = -.17, p <.05), and calculation of semi-partial correlations indicated that after controlling for other variables, gender made a unique contribution to 2% of the variance in slope, however this was not statistically significant (sr = -.14, p = .03) (see Table 6).

Slope was found to have a positive relationship with scores on the Test of Handwriting Skills (THS) that was small but statistically significant (r = .24, p <.05), whereas scores on the informal handwriting measure were not found to have a significant association with slope (r = -.06). Examination of the standard multiple regression analysis of all variables hypothesized to predict slope revealed that scores on the THS made a statistically significant unique contribution to the model (β = .29, p = .03), while those on the informal handwriting measure did not (β = -.12, p = .32) (see Table 6). Calculation of semi-partial correlations indicated that controlling for other variables, scores on the THS accounted for 6.25% of the variance in slope, while scores on the informal handwriting measure contributed to 1% of the variance.

Finally, orthographic fluency as measured by scores on the paragraph copying task made a non-significant contribution to changes in writing fluency, accounting for 0.16% of the variance in slope (β = -.04, p = .75). Similarly, scores on the Spelling subtest of the WIAT-III contributed to 0.36% of the variance in slope (β = -.04, p = .75), which was also non-significant (see Table 7).

Comparison of Responders to Non-Responders

Among the 74 students who received the performance feedback intervention, there were 39 students who were classified as responders, while 35 were classified as non-responders. Demographic data for these students is presented in Table 7 and were examined using nonparametric and parametric tests. Statistically significant differences were found to exist

between responders and non-responders with regard to gender, χ^2 (1, n = 74) = 5.23, p < .05, with responders being more likely to be female. A one-tailed z-test was conducted on race, which indicated that the racial proportions in the responder and non-responder groups differed significantly (z = 1.696, p = 0.045). That is, of the 47 students who reported being Black or African American, 26 (55.3%) were among the non-responder students as compared to 9 (34.6%) of the 26 students who reported being White. No significant differences were found between responders and non-responders with respect to age or special education status.

Given the gender and racial differences of responders and non-responders, a multivariate analysis of variance (MANOVA) was conducted to explore the possible interactive effects of three student factors (i.e., responders/non-responders, race, and gender) on their performance. The means and standards deviations for slope, and scores on baseline writing measures as a function of the three factors is presented in Table 8. The results of the MANOVA indicated no significant interaction between student response or non-response to the intervention, race, and gender (Wilks' λ = .98, F (6, 58) = .19, p = .98, partial η^2 = .02). A significant main effect for student response or non-response (Wilks' λ = .56, F (6, 58) = 7.69, p <. 001, partial η^2 = .44) was observed. No multivariate main effects were found for race (Wilks' λ = .91, F (6, 58) = .99, p = .44, partial η^2 = .09) or gender (Wilks' λ = .95, F (6, 58) = .47, p <. 001, partial η^2 = .05). Subsequent examination of univariate main effects revealed higher slope values among students who responded to the intervention compared to those who did not F (1, 71) = 12.39, p <.01 , partial η^2 =.16), and higher scores on the CBM-WE baseline probe (F (1, 71) = 17.12 , p <.001 , partial η^2 = .21). Although students who responded to the intervention also exhibited higher scores on the THS, the paragraph copying task, and the WIAT-III spelling subtest these differences were not found to be statistically significant. Overall, these results of the MANOVA

indicate that students who were categorized as non-responders to the intervention performed at lower levels on the CBM-WE as a baseline measure of writing skill, and subsequently displayed lower growth in their writing fluency as measured by slope.

Students' response to the performance feedback intervention was also examined by comparing their performance on measures of writing fluency in the final intervention session with their performance on these measures at baseline. The performance of the students on the writing fluency measures of correct word sequences and total words written post intervention, and the difference between these scores and their performance at baseline is presented in Table 9 and graphically represented in Figure 1. Results indicated that students classified as a responders wrote an average of 38.79 correct writing sequences at the end of the intervention, which represented an average improvement of 12.46 correct writing sequences from baseline. In contrast, students classified as non-responders produced an average of 18 correct writing sequences at the close of the intervention, representing and average improvement of 2.46 correct writing sequences. These findings were similar with respect to total words written, where responder students produced an average of 50.05 words at the close of the intervention, representing an average improvement of 16.51 words, while non-responder students produced 24.06 words for an average improvement of 3.17 words. As previously noted, the growth in students' writing fluency displayed in their slope values was very low overall. However, students categorized as responding to the intervention exhibited markedly higher slope values that those who were categorized as non-responders.

Discussion

National assessments indicate that the majority of students are not writing at the level expected for their grade. This fact, paired with the changing expectations for students' facility in writing and increased demands on their writing skills through their education, creates a situation for acute and continuing concern. Performance feedback interventions represent a means of quickly and effectively improving the writing fluency of beginning writers. However, these interventions are not universally effective and approximately 30% of students do not achieve gains in writing fluency after intervention. Individual differences known to influence writing fluency may play a part in determining the effectiveness of writing interventions. Exploration of whether these student-level variables predict response to writing interventions and the nature of their influence may improve our selection of what type of intervention is best for a student and enhance precision in identifying those at risk for underachievement in writing.

The primary aim of this study was to examine factors that may influence the effectiveness of performance feedback interventions and determine whether these factors vary between those students who respond to the interventions and those who do not. Overall this study found that handwriting is associated with writing fluency growth, accounting for a small proportion of the variability. Statistically significant gender differences in response to the intervention were not observed, however male students were found to be overrepresented among students who did not respond to the intervention.

Additional variables related to transcription and associated with writing fluency were not found to have a relationship with response to the intervention as measured by changes in students' writing fluency. Students who were classified as non-responders to the intervention based on their instructional level at the close of the study demonstrated lower scores on all

writing measures as compared to responders, however these differences were not statistically significant with the exception of performance in baseline writing fluency.

Handwriting Skill and Response to Performance Feedback Interventions in Writing

Multiple research studies have found a positive relationship between handwriting skill and writing fluency. Skills which predict handwriting skill such as orthographic fluency and coding account also predict performance on writing fluency measures (Berninger & Rutberg, 1992; Berninger et al., 1992). Handwriting skills influence writing outcomes from Grades 1 to 6 (Graham et al., 1997; Limpo & Alves, 2013) and it has been found to be the most important contributor to compositional fluency in the early primary grades (Graham et al., 1997; Jones & Christensen, 1999). Additionally, interventions to improve handwriting lead to concurrent improvements in writing fluency (Berninger et al., 1997; Graham, Harris, & Fink, 2000). Given these findings it was predicted that students' performance on measures of handwriting skill would be a significant predictor of their response to the performance feedback intervention as measured by changes in writing fluency.

This hypothesis was supported by the results. Correlational analysis revealed a small, but statistically significant and positive association between change in writing fluency as measured by students' individual slope values during the intervention, and scores on the Test of Handwriting Skills (THS; Milone, 2007). However, scores on the informal handwriting measure that was designed by the author were not found to have a significant association with changes in writing fluency. There are several potential reasons for this finding. The informal handwriting measure was a restricted handwriting task, which assessed the students' ability to accurately produce 10 dictated lowercase letters in isolation. As noted in the literature review, comprehensive handwriting measures should ideally include tasks analogous to typical writing

demands in classrooms. The informal handwriting task may have lacked the sensitivity to detect variations in handwriting skill that are demonstrated when numbers, whole words, and sentences are assessed, in addition to individual letters. The THS assesses students' handwriting in upper and lowercase and involves tasks requiring production of numbers, letters, words, and sentences from memory, dictation, and copying. This wider range of tasks may have better captured differences in students' performance.

Another factor that is important when considering the observed results is that the average slope values indicating growth in writing fluency demonstrated by the students in this study were very low as compared to previous research employing a similar performance feedback intervention (Eckert et al., 2006, 2008; Hier, 2012; Koenig, 2013). Given the lack of robust response to the intervention, it is difficult to assess the relationship between said response and the hypothesized predictors. Additionally, although students who responded to the intervention demonstrated higher slope values, the average writing fluency performance of the students at baseline was in the frustrational range and remained in this range at the close of the intervention. As a result, the restricted range of slope values may have served to reduce the correlation between them and handwriting as measured by scores on the THS.

Interpretation of the findings must also include the consideration that the students who responded to the intervention demonstrated higher performance on a baseline measure of writing fluency. Recent research by Parker, Burns, McMaster, Al Otaiba, and Medhanie (2017) examining student response to a writing intervention focused on text structure determined that students with lower baseline performance on writing fluency measures demonstrated lower growth rates than students with higher baseline performance. Based on their findings they concluded that those students with higher baseline writing fluency possessed superior

transcription skills and were better able to engage with the text generation skills focused on in the intervention. In contrast, those with lower baseline writing fluency were hypothesized to be constrained by their difficulties in basic writing skill and consequently demonstrated less growth due to the mismatch between their skills and the intervention focus. The majority of the students who participated in the current study demonstrated low writing fluency at baseline. It is possible that despite simplicity of the "beat your score" protocol presented as part of the performance feedback intervention employed the writing task presented demands on the students' transcription skills that outstripped their ability to produce more meaningful text.

Contributions of Other Transcriptional Skills to Writing Fluency

Basic writing skills such as orthographic fluency (as measured by copying speed) and spelling have been shown to also be prerequisites for the development of skilled writing (Berninger et al., 2002). Paragraph copying has been shown to be predictor of writing fluency (Berninger & Rutberg, 1992; Graham et al., 1997; Graham et al, 1998; Olinghouse, 2008) and improved spelling is accompanied by improvements in writing fluency (Berninger et al., 2000; Berninger et al., 2002; Graham, Harris & Fink-Chorzempa, 2002). Given these findings it was hypothesized that students' performance on measures of orthographic fluency and spelling would contribute significantly to changes in writing fluency (slope) and predict response to the performance feedback intervention.

Correlational analysis did not reveal any statistically significant association between slope and students' scores on measures orthographic fluency (the paragraph copying task) or spelling. However, scores on the THS were found to be positively associated with students' performance on the paragraph copying task and spelling measures. Additionally, positive associations were found between students' performance on a baseline measure of writing fluency

(the baseline CBM-WE probe) and their performance on the THS, paragraph copying and spelling. As noted above the student participants in the study demonstrated low baseline performance in writing fluency and very low growth rates. Similar to the case of the association between slope and handwriting, the restricted range of values may have obscured the relationships between orthographic fluency, spelling and writing fluency growth.

Per the findings of Parker et al. (2017), students demonstrating lower baseline writing fluency display lower growth rates in response to writing interventions. The positive associations between students' scores on orthographic fluency and spelling with handwriting, which is in turn a significant predictor of growth, as well as the positive association of all of these with baseline writing fluency suggest an underlying relationship between basic writing skills and writing fluency. Taken together these results may indicated that orthographic skill and spelling affected growth in response to the writing intervention via their contribution to baseline writing fluency as opposed to unique influence.

Comparing the Writing Performance of Responders and Non-Responders

Among the 74 students who received the performance feedback intervention, 35 exhibited post-intervention writing fluency which fell in the frustrational range and were classified as non-responders to the intervention. This represented 47% of those students who received the intervention. It was hypothesized that non-responder students would demonstrate lower performance on writing measures as compared to those students who responded to the performance feedback intervention. Non-responder students demonstrated lower performance than responder students on all baseline and outcomes measures except the informal handwriting measure. However, these differences were only significant with respect to performance on the baseline CBM-WE probe and growth in writing fluency as measured by slope.

Although the average performance of the non-responder students on standardized measures of handwriting, orthographic fluency and spelling at baseline was lower than that of those who responded, in both cases students' scores were well within the range classified as "Average" when compared with same-age peers. In contrast, the average performance of both non-responder and responder students on the baseline writing fluency measure was markedly low (15.56 and 26.33 correct word sequences, respectively). It may be the case that despite not exhibiting markedly lower performance on any one of the component transcriptional skills, students who did not respond to intervention encountered significant difficulty when attempting to employ these skills in concert to compose prose in response to a story prompt. This is also in accordance with the previously noted positive associations between the students' scores on measures of basic writing skill and baseline writing fluency, and growth in response to the intervention.

The means of categorizing students for exploration of the differences between them may also have influenced the results and have implications for their interpretation. As previously noted, the categories of "responder" and "nonresponder" used in the current study were defined based on criteria set by Mirkin et al. (1981), which designates third-grade students who write less than 37 words in three minutes as exhibiting "frustrational" performance. The analyses conducted in the current study considered students writing less than 37 words at the close of the intervention as "non-responders", while any students who wrote 37 words or more were treated as "responders". Although this categorization provides distinction between those students who were writing at grade level and those who were not, it may have been reductive given that small differences in scores may not reflect appreciable differences in proficiency that were amplified by differences in category. Additionally, the categorization method used did not take into

account improvements in the performance of students within the frustrational range (i.e. students whose writing fluency improved over the course of the intervention but did not attain the third-grade standard of 37 words were still categorized as "nonresponders"). Examination of differences in student response that was not based on categorization may have yielded more nuanced findings.

Gender and Racial Differences in Response to Performance Feedback Intervention

Previous studies identified significant differences between the genders on various writing outcomes and measures of writing fluency (Malecki & Jewell, 2003; Olinghouse, 2008; Troia et al, 2013). Gender has been shown to account for the greatest proportion of variance in compositional fluency among young writers (Olinghouse, 2008). Therefore, gender was hypothesized to be the strongest predictor of changes in writing fluency among the students in the study. The results of the study did not support this hypothesis. Although female students demonstrated higher performance on all writing measures as compared to male students these differences were not statistically significant. Gender was not found to be significantly correlated with slope and the results of the regression analysis did not indicate that gender contributed significantly to the model explaining the variance in student change in writing fluency a measured by slope. As previously noted, the growth demonstrated by students in the study was very low throughout the sample and fell within a restricted range which may have impacted the strength of the observed association with gender.

Examination of responder and non-responder students with respect to gender revealed related differences in the composition of each group. There were significantly more male than female students among the non-responders (20 as compared to 15). Among those students who received the intervention, males were underrepresented among those who achieved proficient or

mastery level writing fluency post-intervention (n = 12, 30.8%). These findings suggest consistency with existing data indicating that boys are more likely to display difficulties in written expression (Persky et al., 2003; Salahu-Din et al., 2008). These findings are also in accordance with Parker et al. (2017) who observed that male students were significantly less likely than girls to demonstrate the highest growth pattern relative to the lowest growth pattern in response to a writing intervention.

The racial proportions of the of the responder and non-responder groups were also found to be significantly different, with 55.3% of the students who identified as Black or African-American being classified as non-responders, as compared to 34.6% of the students who identified as White. These findings bear similarity previous findings examining writing performance across racial and ethnic demographics. National data on the performance of beginning writers indicates that students who identify as racial minorities are disproportionately represented among those who underperform in writing; specifically, 86% of Black children in the fourth-grade cannot write at grade level (Persky et al., 2003). There are also intersections with socioeconomic status that should be noted given that the majority of the students who participated in the study were eligible for free and reduced-price lunch. National estimates indicate that 74 percent of black students qualified for free and reduced lunch (Aud, Fox, & KewalRamani, 2010), and 88% of fourth-grade students who were eligible for free or reduced-price lunch fail to meet proficiency standards in writing (Persky et al., 2003).

Despite the differences in racial proportion across groups and lower performance of Black of African-American students on all the writing measures as compared to their White peers, these differences were not found to be significant and no effect of race on writing performance was found. As in prior instances, statistical examination of these differences may

have been adversely affected by the low baseline performance and low growth rates and the impact of this on observed relationships between student level variables and measures of writing were discussed in the sections above.

Therefore, although the present study did not support the hypothesized relationship between basic writing skills and changes in writing fluency in response to performance fluency intervention as measured by slope, there is some evidence to support lower writing outcomes among non-responders as well as an enhanced relationship between the transcriptional skills of these students and their writing fluency. Exploration of performance across the genders did not reveal any significant differences on any of the baseline or outcome measures, but the results did reveal that male students were overrepresented among students who continue to demonstrate writing fluency below what is expected for their grade after exposure to intervention.

Limitations

The current study suffered from several limitations. First, the growth rates displayed by the students in response to the intervention were markedly low as compared to other studies employing a similar performance feedback intervention (Eckert et al., 2006, 2008; Hier, 2012; Koenig, 2013). As noted in previous sections, the study sample contained a disproportionate number of students from racial groups and socioeconomic classes shown to underperform relative to their peers on measures of academic achievement (Persky et al., 2003). This may have contributed to the low overall response of the students to the intervention, which presented challenges to exploring the relationships between the predictive variables and growth.

Secondly, although the sample size was found to be sufficient to detect statistically significant differences in slope values according to a priori power analyses, it was found that significant differences in writing outcomes were primarily between those students who

responded to the intervention and those who did not. The sample of non-responders was small (*n* = 35), and this restricted sample size may have contributed to the lack of robust findings.

Finally, characteristics of the study settings and participants represent a threat to external validity. Although the study aimed to add to the literature pertaining to use of performance feedback interventions among general education students, the students who participated were restricted to the third-grade, attended school in an urban setting, and a large percentage of them were eligible for free or reduced-price lunch. These factors may have served to influence the findings and reduces their generalizability to students from other grades or differing socio-economic backgrounds.

It should also be noted that results of this study may be of limited applicability outside of the United States of America. The data were collected exclusively from American students being instructed in writing in accordance to U.S. standards, and the references for proficient writing performance drawn from national norms. In international educational contexts where practices around writing instruction and assessment may differ, the pattern of results may not concord with those observed in this study.

Directions for Future Research

Previous research has shown that performance feedback interventions are an effective means of improving the writing fluency of elementary school students (Eckert et al., 2006, 2008) However, a substantial proportion of students do not respond to such interventions (Eckert et al., 2006, 2008; Hier, 2012; Koenig, 2013; Alvis, 2013) and little is known about what individual differences between students may influence their response. Additionally, although transcription skills such as handwriting and spelling are known to contribute to the performance of beginning writers (Berninger et al., 2002; Berninger & Amtmann, 2003; Berninger & Winn, 2006) and

recommendations for writing instruction focus suggest explicit focus on these skills (Graham et al., 2012a; Troia, 2014), there is a need for more studies exploring their contributions to skilled writing outcomes.

Although the study found a small relationship between handwriting and slope, other aspects of the results support the premise that basic transcriptional skills contribute to writing fluency which is a feature of skilled writing. It is of interest that the students' performance on a baseline measure of writing fluency was related to their basic writing skills as well as the growth they displayed in response to the writing intervention. The patterns observed in this study echo those found by Parker et al. (2017) who proposed that instructional level data should be used to position students within the instructional hierarchy in order to match interventions with students' needs. Future research may focus on the possibility of combining explicit instruction in basic skills with the performance feedback intervention to improve response and targeting this instruction according to students' baseline writing skills.

The current study indicates that individual differences among students contribute to response to performance feedback interventions in writing. Gender was not found to be an important factor influencing writing fluency in the overall sample, however as detailed above there were significant distinctions between male and female students when considering how many of them whose performance remained frustrational as the close of the intervention. Therefore, gender appeared to moderate response to performance feedback interventions for written expression. Future researchers may wish to more fully explore this relationship and determine whether it changes depending on the ages of the students, their special education eligibility, and their writing fluency at baseline.

The gender differences in response to performance feedback, handwriting quality, and skilled writing fluency are concordant with the results of previous work (Berninger et al., 2008; Olinghouse, 2008; Persky et al., 2003; Salahu-Din et al., 2008, Parker et al., 2017) highlighting the underperformance of a male students on measures of written expression, and their disproportionate risk of being diagnosed with a specific learning disability in this area. More work is needed on the benefits of early identification of males with difficulties in writing, particularly those who exhibit poor mastery of transcription skills.

The current study focuses on production of written expression using pencil and paper and handwritten letters, which may be out of step with the phenomenon that our written communication is increasingly occurring via technology in the form of computers, smart-phones, and other electronic devices. In the 2017 Writing Framework produced by the National Assessment Governing Board, there is an emphasis on "writing for the 21st Century" and proposed changes to the national writing assessments in the fourth-, eighth-, and twelfth grades to be administered on computers (National Assessment Governing Board, 2017). A computer-based writing assessment for fourth-grade students was piloted in 2012 to determine whether young students were able to adequately demonstrate their writing skills using this medium. It was reported that fourth-grade students found the computer-based assessment challenging, with 68% receiving scores in the bottom half of the 6-point scoring scale used in the study. (White, Kim, Chen, & Liu, 2015). Students produced less text than they did on paper assessments and may have been hindered by their typing speed. Additionally, their responses were noted as exhibiting inconsistent grammar and mechanics, insufficient supporting statements, and little or no awareness of audience and purpose.

In addition, prior exposure to computers and access to the internet at home influenced students' facility with producing writing electronically which presents concerns related to demographically linked technology gaps. The percentage of fourth-grade students without access to the internet at home was higher for Black students, Hispanic students, students eligible for free or reduced-price lunch, English language learners, and students with a disability, which is particularly troubling given that these groups are overrepresented among students performing below grade level (White et al., 2015). The 2017 national writing assessment for fourth-grade students was administered on touch screen tablets, with an attached mouse, a stylus pen, and paper and pencil for planning activities. At the time of writing the present study, the results of these assessments have not yet been published. Computer based writing instruction and assessment will likely continue to grow in importance and future research must take this into account, while maintaining awareness of potential shortcomings in measurement accuracy among beginning writers and the problems presented due to uneven proliferation and utilization of technology, particularly among students from marginalized groups.

Conclusion

The disparity between the educational and professional expectations for written expression in the United States and the achievement of students across all grades is a cause for considerable concern (Salahu-Din et al., 2008; U.S. Department of Education, 2012). Difficulties in written expression are evidence from the early elementary grades with the majority of students in grade 4 being unable to write proficiently (U.S. Department of Education, 2003, 2007, 2012). This is distressing given that the fundamental component skills required to become a skilled writer (i.e. handwriting, spelling, and writing fluency) are developing in the early elementary grades. The instructional time devoted to writing is insufficient (The National Commission on

Writing, 2003) and little time is spent teaching writing beyond these grades. Hence, if basic writing skills are not mastered at this level, cumulative dysfluency in written expression is the eventual result. Early intervention using evidence-based methods is an essential aspect of not only treatment, but prevention of writing difficulties (Graham et al., 2012a).

The current study sought to explore student-level factors that may influence students' response to performance feedback interventions, which are known to be effective in improving writing fluency among beginning writers. The findings demonstrated some relationship between transcription skills and changes in writing fluency, with handwriting having unique predictive power. There were no gender-related differences in changes in writing fluency in the overall sample, however male students were overrepresented among students who did not respond to the intervention. Continued research on the differences in performance associated with gender, as well possible use of basic skills instruction as an adjunct to performance feedback intervention will be necessary to further refine and improve the effectiveness of efforts designed to improve writing fluency.

Table 1

Student Demographic Information (*N* = 112)

			Condition							
	Total Sample		Practice-Only		Performance Feedback		Generalization Programming			
Characteristics	%	(n)	%	(n)	%	(n)	%	(n)	X^2	*p*
Gender									1.08	.58
Male	45.70	(50)	46.20	(18)	39.50	(13)	51.30	(19)		
Female	54.30	(62)	53.80	(20)	60.50	(23)	48.70	(19)		
Race									5.68	.45
American Indian or Alaska Native	0.90	(1)	2.60	(1)	0.00	(0)	0.00	(0)		
Asian	0.90	(1)	2.60	(1)	0.00	(0)	0.00	(0)		
Black or African American	67.20	(78)	69.20	(27)	60.50	(23)	71.80	(28)		
White	31.00	(36)	25.60	(10)	39.50	(15)	28.20	(11)		
Ethnicity									12.30	.58
Hispanic or Latino	0.90	(1)	0.00	(0)	2.60	(1)	0.00	(0)		
Not Hispanic or Latino	86.20	(100)	87.20	(34)	84.20	(32)	87.20	(34)		
Somali	6.90	(8)	5.10	(2)	7.90	(3)	7.70	(3)		
Arab	2.60	(3)	0.00	(0)	2.60	(1)	5.10	(2)		
Hutu	0.90	(1)	2.60	(1)	0.00	(0)	0.00	(0)		
Krgrgyz	0.90	(1)	0.00	(0)	2.60	(1)	0.00	(0)		
Maithili	0.90	(1)	2.60	(1)	0.00	(0)	0.00	(0)		
Other	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)		
Special Education Eligibility	7.80	(9)	5.10	(2)	10.50	(4)	7.70	(3)	.78	.67
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	F	*p*
Age	8.33	.05	8.04	.06	8.03	.04	8.02	.04	1.14	.33

Table 2

Student Demographic Information (*N* = 74)

	Total Sample		School 1		School 2			
Characteristics	%	(n)	%	(n)	%	(n)	X^2	*p*
Gender							0.54	.491
Male	43.20	(32)	47.40	(18)	38.90	(14)		
Female	56.80	(42)	52.60	(20)	61.10	(22)		
Race							14.62	.000
Black or African American	64.40	(47)	42.10	(16)	86.10	(31)		
White	35.60	(26)	55.30	(21)	13.90	(5)		
Not specified	0.01	(1)	2.60	(1)	0	(0)		
Ethnicity							9.35	.053
Hispanic or Latino	1.40	(1)	2.60	(1)	0	(0)		
Not Hispanic or Latino	84.90	(62)	92.10	(35)	75.00	(27)		
Somali	8.20	(6)	0	(0)	16.70	(6)		
Arab	4.10	(3)	2.60	(1)	5.60	(2)		
Krgrgyz	0.90	(1)	0	(0)	2.80	(1)		
Special Education Eligibility	9.70	(7)	10.50	4	8.30	(3)	0.10	1.000
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	F	*p*
Age	8.03	.04	8.03	.04	8.04	.04	-.71	.483

Table 3

Descriptive Statistics for Procedural Integrity Assessments

	Sessions Assessed		Total Sessions	Percentage of Steps Completed		
Phase/Condition	%	(n)	(N)	*M*	*(SD)*	Range
Eligibility and baseline	56.25	(18)	(32)	100.00	(0)	N/A
Performance Feedback	34.38	(11)	(32)	99.05	(1.9)	95.65-100
Overall	60.09	(39)	(64)	99.53	(1)	95.65-100

Notes: Baseline procedural integrity assessment contained between 4 and 13 steps. Performance feedback procedural integrity assessment contained 23 steps.

Table 4

Students' Average Scores on Slope and Baseline Measures of Writing Performance

Measures	*M*	*(SD)*
Slope	0.12	0.33
Correct Writing Sequences – Curriculum-Based Measurement in Written Expression Probe	21.23	(10.53)
Test of Handwriting Skills	97.46	(11.32)
Informal Handwriting Measure	19.91	(6.51)
Wechsler Individual Achievement Test -Spelling	93.78	(14.79)
Paragraph Copying Task from the Group Diagnostic Reading and Aptitude Achievement Tests	19.26	(9.19)

Table 5

Correlations between Scores on Baseline Measures, Writing Outcomes, and Gender

Variables	1	2	3	4	5	6	7
1. Slope[a]	--						
2. Gender	-.17	--					
3. Test of Handwriting Skills	.24*	-.23	--				
4. Informal Handwriting	-.06	-.19	.26*	--			
5. Paragraph Copying[b]	.003	-.04	.24*	.01	--		
6. Wechsler Individual Achievement Test – Spelling[c]	.04	-.13	.38**	.11	.27*	--	
7. Baseline Curriculum-Based Measurement in Written Expression Probe	-.16	-.21	.31**	.08	.39**	.35**	--
8. Difference Scores Baseline to Post-Intervention	.96**	-.20	.26*	-.14	.05	.10	-.17

Notes. [a]Change in correct writing sequences per week. [b]Raw score, number of words correctly copied in 90s. [c]Standard score obtained from the Wechsler Individual Achievement Test- Third Edition.*$p < .05$; **$p < .01$.

Table 6

Regression Analysis Summary for Variables Predicting Growth in Students' Writing Fluency Measured by Slope

Variable	B	SE(B)	*β*	*sr*	*t*	Sig.(*p*)
Gender	-.10	.08	-.15	-.14	-1.23	.225
Test of Handwriting Skills	.008	.004	.29	.25	2.18	.033
Informal Handwriting	-.006	.006	-.12	-.12	-1.00	.322
Paragraph Copying	-.001	.003	-.04	-.04	-.33	.746
Spelling	-.001	.002	.01	-.06	-.05	.618

Note: R^2 = .10 (N = 74, p = .20); Adjusted R^2 = .

Table 7

Student Demographic Information Comparing Responders and Non-Responders (*N* = 74)

	Total Sample		Responders		Non-Responders			
Characteristics	%	(n)	%	(n)	%	(n)	X^2	*p*
Gender							5.23	.022
Male	43.20	(32)	30.80	(12)	57.10	(20)		
Female	56.80	(42)	69.20	(27)	42.90	(15)		
Race							2.88	.090
Black or African American	63.50	(47)	53.80	(21)	74.30	(26)		
White	35.10	(26)	43.60	(17)	25.70	(9)		
Not specified	1.40	(1)	2.60	(1)	0	(0)		
Ethnicity							5.55	.235
Hispanic or Latino	1.40	(1)	2.56	(1)	0	(0)		
Not Hispanic or Latino	83.80	(62)	79.49	(31)	88.57	(31)		
Somali	8.10	(6)	5.13	(2)	11.43	(4)		
Arab	4.10	(3)	7.69	(3)	0	(0)		
Krgrgyz	1.40	(1)	2.56	(1)	0	(0)		
Special Education Eligibility	9.50	(7)	5.13	(2)	14.29	(5)	1.81	.179
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	F	*p*
Age	8.03	.04	8.03	.04	8.03	.04	.20	.659

Table 8

Comparison of Performance on Writing Outcomes and Baseline Measures According to Responder Status, Gender, and Race

	Factors											
	Response				Gender				Race			
	Non-Responders (*N* = 35)		Responders (*N* = 39)		Female (*N* = 42)		Male (*N* = 32)		Black (*N* = 47)		White (*N* = 26)	
Measure	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Slope	0.06	(0.22)	0.32	(0.36)	0.25	(0.37)	0.13	(0.23)	0.11	(0.28)	0.24	(0.34)
CBM-WE	15.54	(7.14)	26.33	(10.52)	23.17	(10.19)	18.69	(10.57)	18.66	(9.23)	25.54	(11.49)
THS	94.03	(12.16)	100.54	(9.66)	99.67	(11.12)	94.56	(11.09)	96.89	(11.79)	97.62	(9.88)
Informal Handwriting	19.97	(6.60)	19.85	(6.50)	21.00	(6.11)	18.47	(6.83)	19.68	(6.62)	19.88	(6.16)
Paragraph Copy	96.66	(14.69)	105.00	(15.61)	101.57	(16.56)	100.38	(14.60)	99.26	(14.86)	103.88	(17.02)
WIAT-Spelling	91.68	(16.20)	95.66	(13.34)	95.46	(13.91)	91.55	(15.83)	94.02	(12.37)	92.76	(18.72)

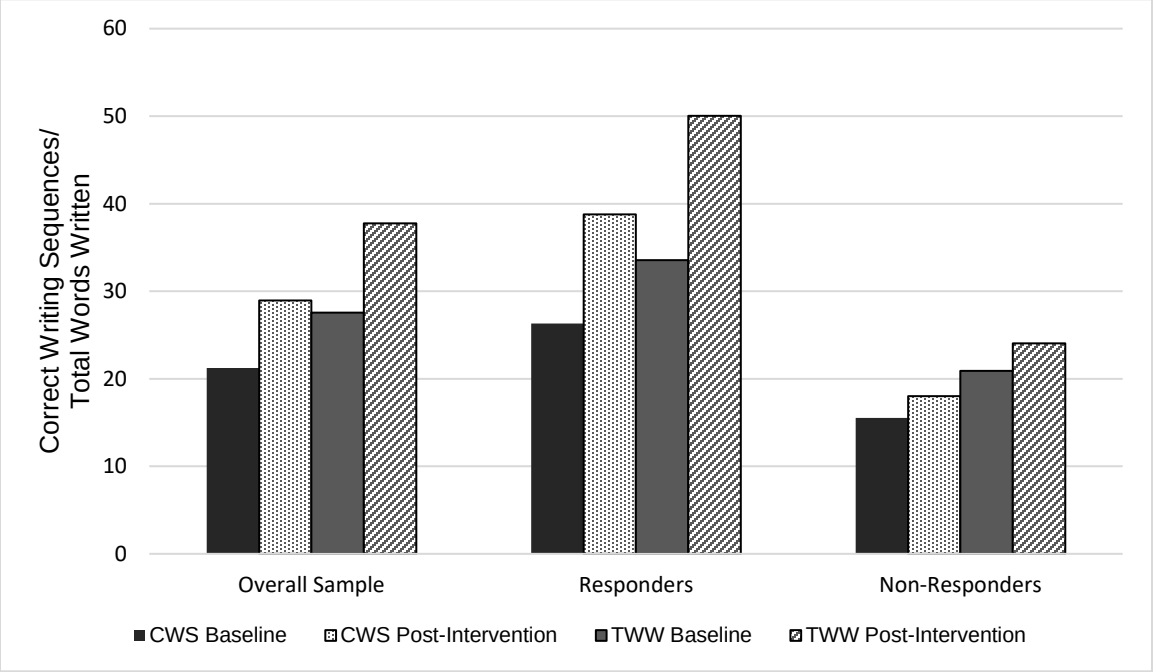
Table 9

Post Intervention Performance and Difference Scores for Overall Sample, Responders and Non-Responders (*N* = 74)

	Whole Sample (*N* = 74)		Responders (*N* = 39)		Non-Responders (*N* = 35)	
Measure	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Post-Intervention CWS[a]	28.96	15.55	38.79	14.37	18.00	7.32
CWS Difference Score	7.73	13.34	12.46	15.04	2.46	8.71
Post-Intervention TWW[b]	37.76	19.08	50.05	17.51	24.06	8.49
TWW Difference Score	10.20	16.81	16.51	19.34	3.17	9.56

Notes. [a]Correct Word Sequences. [b]Total Words Written.

Figure 1. Comparison of Overall, Responder, and Nonresponder Performance at Baseline and Post-Intervention



Appendix A

Parental Consent Form

SYRACUSE UNIVERSITY
COLLEGE OF ARTS AND SCIENCES
Department of Psychology

Improving Third-Grade Children's Academic Competence in Written Expression

Principal Investigator: Dr. Tanya Eckert
Dept. of Psychology, Syracuse University
Phone: (315) 443-3141
Co-Principal Investigators: Alisa Alvis and Rigby Malandrino
Dept. of Psychology, Syracuse University
Phone: (315) 443-1050

Dear Parent or Guardian,

My name is Tanya Eckert and I am a faculty member in the department of Psychology at Syracuse University. I am working on a research study in your child's school in an attempt to better understand how to improve children's writing skills. I am trying to see how much children's writing skills improve over time and across different types of writing tasks.

Taking part in this study is completely voluntary, so you can choose to say 'yes' or 'no' to this invitation. Your decision will **NOT** affect your child's grades or your child's educational program. This consent form will explain the project to you. Please feel free to call me (315-443-3141) if you have any questions. I will be happy to answer any questions you might have.

Purpose of the Study

The purpose of this study is to determine how much children's academic skills change over time when given either: (a) weekly writing practice that involves writing brief stories that are similar; (b) weekly writing practice and feedback that involves writing brief stories that are similar; and (c) weekly writing practice and feedback that involves writing brief stories that are slightly different.

Description of Procedures

First, if you agree to allow your child to participate, we ask that you sign this form and return it to school with your child. If you choose not to have your child participate in the study, please indicate that on the form and return it to school with your child. You should feel free to call me to ask any questions you may have. Beginning in March, myself and other students from Syracuse University will be working with your child's classroom for 15 minutes per week. During those 15 minutes, some students will be practicing writing brief stories that are similar, some students will be told how they are doing in writing in addition to practicing writing brief stories that are similar, and some students will be told how they are doing in writing in addition to practicing writing brief stories that are slightly different.

Benefits of Participation

There are several benefits of your child participating in this study. Your child will get extra practice with writing stories. As a result, your child's writing skills may improve over time. In addition, you child's motivation toward writing may also improve over time.

Risks of Participation

The risks of participating in this study are minimal and are similar to the risks your child may experience on a daily basis at school. For example, your child may experience discomfort, such as becoming mildly frustrated or tired, while participating in the project. We will attempt to reduce these risks by working with you child for a small amount of time (15 minutes), and allowing all children to withdraw from the study without penalty.

Number of Participants

All of the third grade students at your child's school as well as one other elementary schools in the Syracuse City School District are being asked to participate in this study. This will result in a total of approximately 300 third grade students participating in the study.

Duration of Participation

Each week for a period of nine weeks, we will be working with your child in a group setting (20-25 students per group) for about 15 minutes.

Confidentiality of Records

Any information obtained in this study will be kept confidential. That is, the work that your child produces when working with us, will not be shared with anyone. Your child's work will be kept in a locked office at Syracuse University and only our research team will have access to it. Your child's work will not be shared with school staff. Furthermore, your child's school grades will not be based on the work he/she does while working with us. Please note that this promise of

confidentiality does not apply if your child discloses (a) an intention to harm himself/herself or another person, and (b) an incident of child abuse or neglect. In the event of a disclosure, we are mandated by the state of New York to notify the appropriate agencies.

At the completion of this study we will be writing a report about the results. This report will not include any identifiable information about your child. All information in this report and the summary that is presented to your child's school will be in the form of group averages, with each group containing approximately 20-25 students.

Cost and Payment

Participation in this study does not involve any cost to you or your child. At the conclusion of the study, your child will receive a small writing journal and writing instrument for participating in the study.

Contact Persons

If you have any questions, concerns, or complaints about the research, please contact the primary investigator: Dr. Tanya Eckert at Syracuse University, 430 Huntington Hall, Syracuse, NY 13244 by telephone: (315) 443-3141 or email: taeckert@syr.edu. If you have any questions about your rights as a research participant, if you have questions, concerns, or complaints that you wish to address to someone other than the investigator, or if you cannot reach the investigator, please contact the Syracuse University Institutional Review Board at 315-443-3013 or 116 Bowne Hall, Syracuse, NY 13244.

Voluntary Participation

Your child's participation in this study is voluntary. You are free to choose not to have your child's work included in this study. You may also withdraw your child from the study at any time, for whatever reason, without risk to your child's school grades or relationship with the school. In the event that you do not give consent or withdraw consent, your child's work will be kept in a confidential manner. You can also discontinue your child's participation in this study at any time by contacting us or your child's teacher. Furthermore, if you choose not to have your child participate in this study, your child's teacher will choose an educationally relevant activity for your child during the time your child's classmates are participating in our study. By signing this consent form, you give permission to allow your child to participate in the study.

PARENT CONSENT FORM

Improving Third-Grade Children's Academic Competence in Written Expression

I, _____ give my consent for my child, _____

(please print your name) (print child's name)

to participate in this project.

_____ _____

Parent/Guardian signature Date

OR

I, _____do **NOT** give my consent for my child, _____

(please print your name) (print child's name)

to participate in this project.

_____ _____

Parent/Guardian signature Date

Appendix B

Student Assent

Important Question

I would like to work with you each week on a research project that is looking at how different types of story writing improve your writing skills.

I would be working with you for the next two months, twice a week, for about 15 minutes. You will be asked to write stories during this time.

Your parent has said that it would be okay if I worked with you on this project. However, I want to make sure that it is okay with you. If you change your mind it is okay to stop working with me at any time. Your grade at school will not be affected if you choose not to work with me.

Would it be okay if I work with you on writing each week?

Yes **No**

Name:_____

Appendix C

Wechsler Individual Achievement Test- Spelling Response Sheet

1. _____	**11.** _____
2. _____	**12.** _____
3. _____	**13.** _____
4. _____	**14.** _____
5. _____	**15.** _____
6. _____	**16.** _____
7. _____	**17.** _____
8. _____	**18.** _____
9. _____	**19.** _____
10. _____	**20.** _____

Appendix D

Paragraph Copying Task

A little boy lived with his father in a large forest. Every day the father went out to cut wood. One day the boy was walking through the woods with a basket of lunch for his father. Suddenly he met a huge bear. The boy was frightened, but he threw a piece of bread and jelly to the bear.

Appendix E

Informal Handwriting Measure

Please wait for our directions.

Please print each letter that is spoken.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Appendix F

Baseline Curriculum-Based Measurement in Written Expression Probe

I was talking to my friends when all of a sudden _____

Appendix G

Writing Packet: Page 1, Identification Information

Syracuse University

2011-2012 Writing Project

_____Elementary School

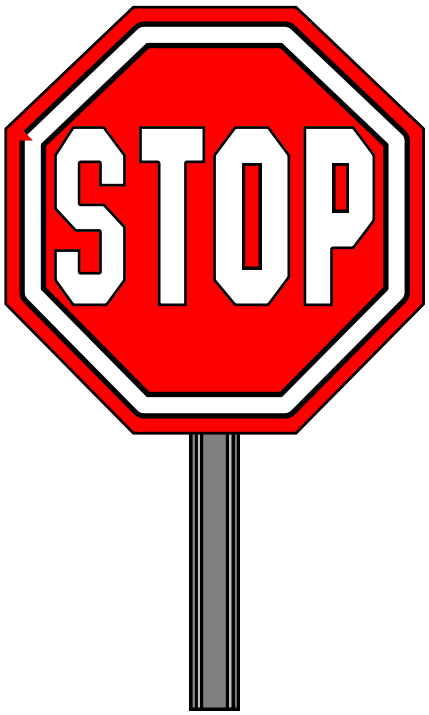
3rd grade

Name: _____

Classroom:

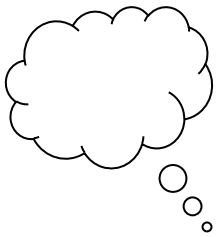
Probe # _____

Writing Packet: Page 2, Stop Sign

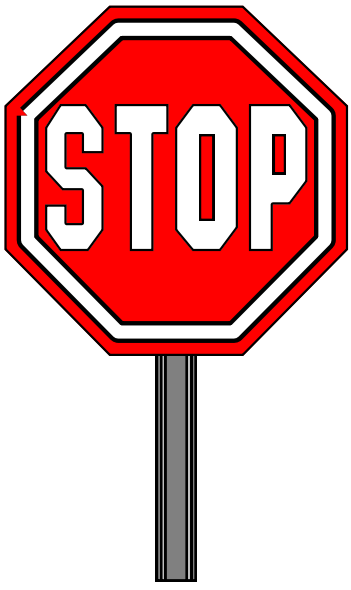


Appendix G

Writing Packet: Story Starter Page with Stop Sign



I was talking to my friends when all of a sudden . . .



Writing Packet: Story Starter with Writing Lines

One day my friend told me the strangest story _____

Appendix H

Procedural Script for Individualized Performance Feedback Condition

Directions: Please fill out each area detailed below. Please make sure that the identifying information (box 1) is complete before you submit the form.

I.	Identifying Information		
Name of primary research assistant:			
Name of secondary research assistant:			or N/A
School/Classroom:			
Date:			
Notes:			
II.	Data Collection – Material Preparation	Circle	
a.	Five (5) sharpened pencils	Yes	No
b.	Assessment packets	Yes	No
c.	Experimenter's copy of packet	Yes	No
d.	Two (2) stopwatches	Yes	No
e.	Insert names	Yes	No
Notes:			
III.	Data Collection Procedures [Please check [✓] each box as you complete each step]✓		
1.	State to the students: "*Hello. If you have not already done so, please clean off the top of your desk, except for a pencil. Please listen for your name as _____ and I hand out the packets. Raise your hand when we call your name.* "		
2	Both research assistants should distribute the packets. (This should be very quick and not take longer than 2-3 minutes.)		
3.	After all of the packets have been distributed, State to the students: "*Today we will be splitting into groups. Please look at your packet; you will see a color listed. Please listen for instructions as I call your group color."*		

	"The _____ group will be staying in this classroom to work with us. Please stay in your seats if you are in the _____ group. *"The _____ group will be going to _____'s classroom. Please line up now and show me how you walk quietly through the halls at _____ .* *"The _____ group will be will be going to _____'s classroom. Please line up now and show me how you walk quietly through the halls at _____ .*	
4.	As students from other classes enter the classroom, the research assistant should direct students to sit down at the nearest desk in a systematic fashion. Do not let students talk you into letting them sit next to friends. Once the desks fill up, place any remaining students at tables in the room. The other research assistant should be standing outside the classroom holding up a sheet of paper that says _____ group. The research assistant should assist students with quickly getting to the appropriate classroom.	
5.	Once you have confirmed that all the students from the other classrooms have arrived, state to the students: "*Welcome to the _____ group. Please turn to the page of your packet that has stop sign in the middle of the page. Today I want you to write a story. Before we do that I want to tell you how you are doing with your writing skills. Last week we took all your stories back to SU and we counted all of the words that each of you wrote in your stories. Please turn to the next page of your packet. This page has a funnel with some numbers going into it at the top of the page.*"	
6.	The research assistant should scan the room to make sure all the students are on the correct page.	
7.	State to the students *"The box in the middle of the page* [The research assistant should point to the box.] *tells you how many words you wrote last week. Next to the box you will see an arrow.* *If the arrow is pointing up towards the sky, you wrote more words since the last time I worked with you.* *If the arrow is pointing down towards the floor, that means you wrote fewer words since the last time I worked with you.* *Every week when I work with you, I will tell you how you are doing with your writing."*	
8	The research assistant should monitor the students for questions.	

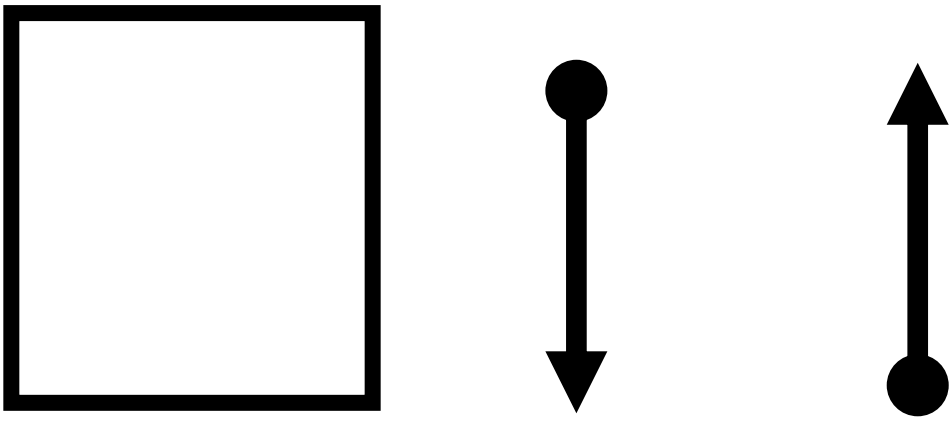
9.	State to the students: "*Now I want you to write another story. I am going to read a sentence to you first, and then I want you to write a story about what happens next. You will have some time to think about the story you will write and then you will have some time to write it."*	
10.	State to the students: "*Please turn to the next page of your packet. This page has a thought bubble at the top of the page.*"	
11.	State to the students: "*For the next minute think about writing a story that begins with this sentence* – <u>One day my friend told me the strangest story. . .</u> *Remember, take time to plan your story. A well-written story usually has a beginning, a middle, and end. It also has characters that have names and perform certain actions. Use paragraphs to help organize your story. Correct punctuation and capitalization will make your story easier to read.* *Please do not write the story. Just think of a story that begins with this sentence* - – <u>One day my friend told me the strangest story. . .</u>"	
12.	The research assistant should begin the stopwatch and time the students for 1 minute.	
13.	At the end of 1 minute, state to the students: "*Okay, stop thinking, turn to the next page of your packet, and raise your pencil in the air."*	
14.	State to the students: *"When I tell you to start, please begin writing your story. Remember, if you don't know how to spell a word, you should try your best and sound it out. It is important that you do your best work. If you fill up the first page, please turn to the next page and keep writing. Do not stop writing until I tell you to. Do your best work."*	
15.	State to the students: "*Okay, you can start writing.*" The research assistant should begin the stopwatch and time the students for 3 minutes.	
16.	The research assistant should monitor the students during the 3-minute period and make sure students are following the directions Also monitor the students to make sure that they are not re-copying the story starter. If a student is re-copying the starter, state to the student *"you do not need to copy the words that have been provided"*	
17.	After 1 minute, 30 seconds has elapsed, state to the students: "*You should be writing about* – <u>One day my friend told me the strangest story</u>"	

18.	After 3 minutes has elapsed, state to the students: "*That is all of the writing that we are going to do today. All of you did a very nice job following my directions.*	
19.	State to the students: "Please hand in your packets. *Thank you for working with us today*."	
20.	The research assistant should collect all of the packets.	
21.	State to the students: *"All of the students in _____'s classroom, please pick up your pencil and line up to the left side of the door. All of the students in _____'s classroom, please pick up your pencil and line up to the right side of the door. All of the students in _____'s classroom, please line up in the middle."*	
22.	The research assistants should then assist the students in getting back to their classrooms quickly and quietly. If the other classrooms are not complete when you get there, please try to keep the students waiting quietly outside of the room.	
Total number of steps completed:		

Appendix I

Feedback Page for Performance Feedback conditions

Here is how you are doing in writing:



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