1995

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Abstract. **Twenty-four children with writing problems were given instruction in handwriting automaticity, spelling strategies, and the composing process (plan, write, review, revise) in 14 one-hour individual tutorials during the summer between third and fourth grade. Half the children (8 boys, 4 girls) received extra practice in composing, while half the children (8 boys, 4 girls) received special training in orthographic and phonological coding. Hierarchical linear modeling of growth curves was used to compare the treatment groups to a non-contact control group (10 boys, 5 girls) on a standard battery at pretest, midtest, posttest, and the two treatment groups with each other on probe measures of handwriting, spelling, and composition in each tutorial session. The treatment groups improved at a faster rate than the control group on some measures of handwriting, spelling, and composition (fluency and quality) in the standard battery, but Verbal IQ did not predict rate of improvement. Differences were found between the two treatment groups in some probe measures of writing and a motivation variable (work avoidance). Repeated-measures ANOVA was used to compare treatment groups to a non-contact control group at pretest, midtest, posttest, and follow-up. Differences between the treatment and control groups favoring the treatment groups were maintained at 6-month follow-up on some handwriting, spelling, and composition (quality) measures. Individual differences were found in learner characteristics prior to treatment and in response to the same treatment. The importance of affect and motivation as well as cognitive variables is emphasized.**

Specific Aims

This intervention research addressed seven specific aims.

1. To investigate the heterogeneity among children with a writing disability regarding which component writing skills—handwriting, spelling, or composition—is/are affected and which processing skills related to these component writing skills are affected.

2. To evaluate the effectiveness of an instructional protocol that provided instruction in multiple component writing skills and related processes in remediating writing disabilities.

3. To evaluate the relative effectiveness of two

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contrasting instructional components within the otherwise constant protocol.

4. To evaluate whether individual differences occur in the response to the same multicomponent protocol.

5. To evaluate whether Verbal IQ predicted rate of response to instruction.

6. To investigate noncognitive variables such as affect and motivation that influence writing and response to writing interventions.

7. To evaluate whether gains were maintained at six months following a two-month summer tutorial in writing.

The theoretical rationale, practical significance, and methodological issues related to these specific aims are discussed in the sections that follow.

Theoretical Rationale

Hayes and Flower (1980) proposed a model of the cognitive processes of writing based on think-aloud protocols of adult, skilled writers. This model, which to date is the most influential model of the writing process (Scardamalia & Bereiter, 1986), does not completely capture the writing process from the perspective of the developing writer. Based on research on writing assessment with students in grades 1 through 9, Berninger (1994) and Berninger and Swanson (1994) proposed modifications of the Hayes and Flower model to explain beginning and developing writing. Based on the instructional research reported here, we propose further modifications.

The original Hayes and Flower (1980) model for adult, skilled writing contained three major components: the task environment, the writer's long-term memory, and the writing process. The writing process component was further subdivided into three nonsequential subprocesses—planning, translating, and reviewing—all of which were linked to a monitor, which coordinated the recursive, interacting subprocesses. The planning subprocess was further subdivided into generating, organizing, and goal setting. The reviewing subprocess was further subdivided into evaluating and revising. No subcomponents were specified for the translating subprocesses.

Figure 1 portrays our current working model of the writing process that incorporates a num-

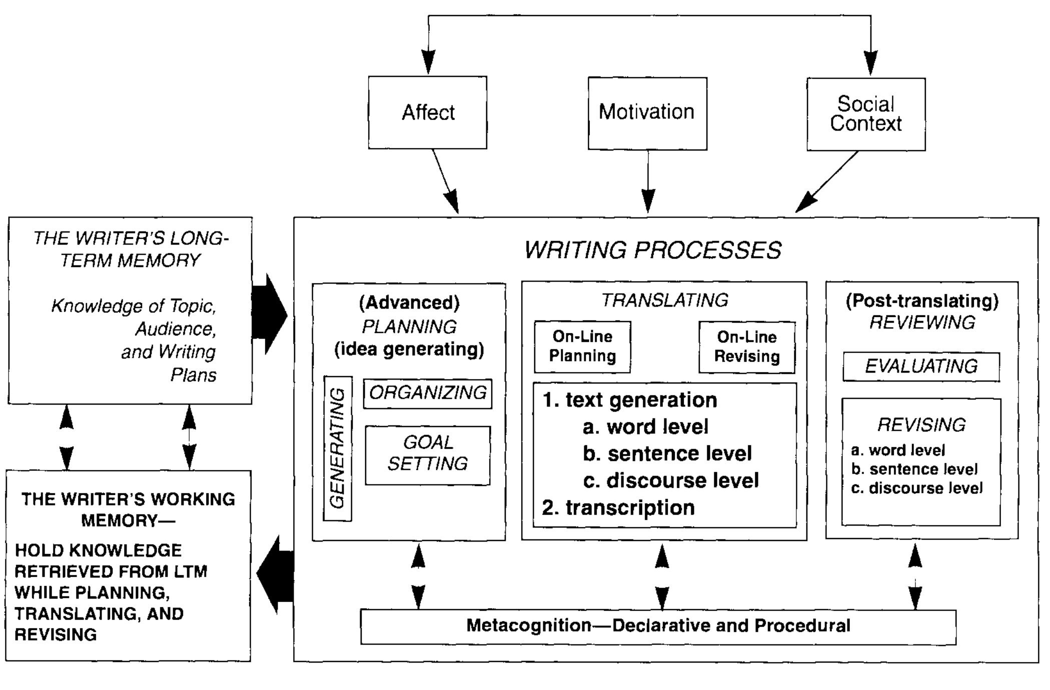

Figure 1. Modification of Hayes and Flower model for beginning and developing writing.

ber of modifications of the original Hayes and Flower model with original components italicized. For the most part the modifications, which are shown in nonitalicized print, are additions. Based on research with writers in grades 1 through 3 (Berninger, Yates, Cartwright, Rutberg, Remy, & Abbott, 1992), two subcomponents were added to the translating subprocess: text generation and transcription. Some primary-grade children were able to generate text (translate ideas in working memory into oral language) far better than they could transcribe (translate those oral language representations into written orthographic symbols); but a smaller number were able to transcribe far better than they could generate text.

We also differentiated between idea generating during the planning process and text generating during the drafting process, thus conceptualizing two kinds of translating: from ideas to internal language representation in working memory and from internal language representations to visible orthography. Based on research with grades 4 through 6 (Berninger, Mizokawa, Bragg, Cartwright, & Yates, 1994; Whitaker, Berninger, Johnston, & Swanson, 1994) showing that skill at one level of language does not predict skill at another, we differentiated among text generating at the word, sentence, and discourse levels and among revising at the word, sentence, and discourse levels.

Based on research with grades 4 through 6 (Whitaker et al., 1994) and grades 7 through 9 (Berninger, Whitaker, Feng, Swanson, & Abbott, in press), we further differentiated between advanced planning and on-line planning, between on-line revising and posttranslating reviewing/revising, and between declarative and procedural metacognition in the monitoring component, and added working memory, which interacts with both long-term memory and the writing processes.

Based on the instructional research reported here, we expanded the task environment, which in the Hayes and Flower (1980) model included writing assignment and text produced so far. We added to the task environment the noncognitive variables that play an important role in writing development—affect, motivation, and social context (which includes audience, communication function of text, etc.).

The instructional protocols used in this intervention study were grounded in the theoretical framework of this modified Hayes and Flower model (Figure 1), in that instruction in handwriting, spelling, and composition was included in each tutorial session for the following reasons. Instruction in handwriting and spelling was provided to develop automatization of the transcription subprocess of translating internal language representations to visible orthography. Automatization of low-level skills is hypothesized to free up attentional resources for higher-level, less automatic (more constructive) aspects of composing (see McCutchen, 1988). However, instruction was not focused only on transcription. During composing tasks the focus was on text generation. Children were encouraged to get their thoughts down on paper without concern about whether the product was perfect. Conventional transcription was emphasized only during reviewing/revising on later drafts.

Tutors modeled advanced and on-line planning, translating, and advanced and on-line revising processes during composition instruction (see Englert, Raphael, Anderson, Anthony, & Stevens, 1991), and offered metacognitive strategies for each of these processes. Children completed activities designed to develop and practice planning, translating, and revising skills. Tutors provided scaffolding or individually tailored assistance. For example, to help children who were having difficulty juggling in their working memory the multiple processes of planning, text generating, transcribing, and revising, they reminded children of plans they had generated but had forgotten. Also, they responded to children's requests for repetition or confirmation and elaborated upon the scripted lesson frames if a child did not understand a task.

Practical Significance

Diversity and developmental issues. Much intervention research for learning disabilities selects children on the basis of a disability in an academic domain, but does not describe the heterogeneity that may be present in the sample regarding which component skill(s) in that domain or related processing skill(s) might be affected. In contrast, we recruited children who were having significant difficulty in writing at the end of third grade and then administered a diagnostic battery to determine which component writing skills and related processing skills were affected for each child. Accordingly, the first specific aim was to characterize heterogeneity in the sample, that is,

the diversity at the beginning of intervention.

We focused on the transition between third and fourth grade because writing task requirements increase in the intermediate grades compared to the primary grades. Primary-grade children who are already struggling in the area of writing are likely to qualify as learning disabled in writing during the intermediate grades unless intervention occurs to prevent more severe writing disabilities. However, such intervention needs to take into account the diversity among these "at risk" individuals. Accordingly, lessons included instruction aimed at multiple skills (handwriting, spelling, and composition) to accommodate this diversity. Therefore, the second specific aim was to evaluate the efficacy of this multicomponent instructional intervention, relative to a non-contact control group.

Integrated systems approach. Teaching approaches vary along a continuum and cannot be categorized as neatly as the controversy over whole language versus basic skills would lead us to believe. Moreover, teachers exhibit as much diversity in their instruction as students do in their learning. Nevertheless, we have observed a disturbing pattern of polarization in the service delivery for students with learning disabilities in local schools. Too often the regular classroom focuses on high-level skills such as reading connected text for meaning and composing for real communication purpose, whereas the special education resource room focuses on drill in decontextualized low-level skills such as phonics, handwriting, and spelling. Seldom is provision made for helping students with learning disabilities integrate the high-level skills acquired in one setting and the low-level skills acquired in another.

In lieu of this fragmented approach, Berninger (1994) advocated an approach in which teaching is directed to and integrated across all levels of language in working mind/brain systems, ranging from high-level discourse skills to low-level word and subword skills. Therefore, we provided instruction in low-level handwriting and spelling skills and high-level composing skills (planning, generating, and revising texts at the sentence and discourse levels) within every lesson and encouraged children to integrate across these low-level and high-level skills.

Typically, intervention research for learning disabilities compares the relative effectiveness of single, contrasting instructional methods. In real classrooms, however, teachers do not deliver unitary, pure methods of instruction. Rather, instruction is a multidimensional process, which is jointly influenced by the teacher's instructional philosophy, specific aims of particular lessons, individual differences in students' abilities, motivation, and prior knowledge, and students' responses to the teacher's instruction. Therefore, we investigated the learning process when all but one of multiple instructional components was kept constant. All treatment protocols included instructional components for handwriting, spelling, and composition. In addition, the More Composing Treatment Group received extra practice in high-level composing. The group who got more practice was expected to improve the most in the text generation component of translating.

The Coding Treatment Group, on the other hand, received extra training in low-level orthographic and phonological coding. Prior research showed that practice in attending to and remembering spelling patterns in written words and sound patterns in spoken words facilitated word recognition (Berninger & Traweek, 1991). We predicted that such training would also facilitate spelling, hence the transcription component of translating. Thus, the third specific aim was to compare the relative effectiveness of this experimental manipulation of two contrasting instructional components added to an otherwise constant, multidimensional instructional protocol.

Methodological Issues

Growth curves over time. For years statisticians argued that difference scores (gains over time) had limited usefulness because they were more unreliable than the scores on which they were based (Lord, 1956). They recommended, instead, that hypotheses be tested in terms of educational *status* at a single point in time rather than *growth* over time (Cronbach & Furby, 1970). Recently, however, statisticians (Collins & Horn, 1991; Francis, Fletcher, Stuebing, Davidson, & Thompson, 1991; Willett, 1988) have shown that these perceived problems can be resolved if one views *change across time as a separate dimension from stability of measures at one point in time*. An emerging perspective in the measurement of change is that data should first be modeled at the individual level before it is analyzed for multiple individuals (e.g., Berninger & Abbott, 1992, 1994a; Bryk & Raudenbush, 1987; Francis et al., 1991; Ro-

gosa, Brandt, & Zimowski, 1992; Willett, 1988).

This approach is exemplified in hierarchical linear modeling in which analyses focus both on describing the individual's observed growth trajectory in terms of individual parameters and on using those parameters as outcome measures to be explained by characteristics of the individual or treatment at the group level of analysis. Bryk and Raudenbush (1987) and Burchinal and Applebaum (1991) are optimistic that change can be measured reliably and validly if (a) change is conceptualized as *individual* growth, and (b) individuals are sampled at multiple time points.

Because we were investigating change over a relatively short period of instruction, we hypothesized that a linear change model would fit the growth curve for an individual. Different individuals were allowed to have different values for the intercept (coded to represent pretest at time 0) and slope (rate of growth). Thus, hierarchical linear modeling (HLM) (Bryk & Raudenbush, 1992) was used first to model rate of growth for each child in the two treatment groups and a control group and then to compare rate of growth (a) between the combined treatment groups and the control group (second specific aim) and (b) between the two treatment groups (third specific aim).

Individual and group levels of analysis. Berninger and Abbott (1992) illustrated how group comparisons may miss important individual differences. Specifically, when reading instruction was kept constant, individual differences in response to instruction occurred, presumably because of the constructive processes of learners who use instructional cues in varying ways. These individual differences, which became apparent only when considered as an explanatory variable in their own right, occurred in response to instruction for word recognition skills, showing that constructive processes operate on low-level as well as high-level skills. (Also see Berninger, 1994, Chapter 1.) Thus, a fourth specific aim was to evaluate whether individual differences occurred in response to instruction (i.e., in individual growth curves within a treatment group) when writing intervention was held constant.

IQ as Predictor of Rate of Learning

Siegel (1989) sparked an ongoing controversy over whether IQ should be used in the diagnosis of learning disability. Thus, our fifth specific aim was to explore whether Verbal IQ is a good predictor of the characteristics of these individual growth curves. We used Verbal IQ because it has been shown to be a better predictor of academic achievement than Performance IQ (e.g., Greenblatt, Mattis, & Trad, 1990).

Noncognitive Variables in Writing

Hayes and Flower (1980) focused on the cognitive processes in writing, but noncognitive variables such as affect and motivation also play a role (see Figure 1). Little is known about how affect (positive or negative) toward writing may affect writing development. Similarly, little is known about the motivation of children with learning disabilities in writing or how their motivation is affected by writing interventions. It seems likely, however, that chronic difficulty with writing and composition leads to decreased motivation to write.

Based on an intentional framework (Nicholls, 1989), our sixth specific aim was to see whether intervention modified the extent to which children with writing disabilities seek to avoid or minimize composition tasks (work avoidance) or seek to increase their writing skill, either for its own sake (task orientation) or to perform well relative to peers (ego involvement).

Follow-Up

The seventh specific aim was to evaluate whether treatment gains at the end of a 2- month summer tutorial were maintained over time. Both treatment and control group children were tested at a 6-month follow-up.

METHOD

Sample

Teachers in two school systems were asked to send home a letter of opportunity to participate in a writing tutorial during summer 1993. The letter was sent to parents of children who at the end of third grade were struggling with writing. From an overwhelming response, we selected the first 39 qualified children who had difficulty with writing and randomly assigned them to one of two treatment groups or a control group. Children in the treatment groups were assigned to one of two tutors who each taught half the children.

The gender ratio in each treatment (8 boys:4 girls) and control group (10 boys:5 girls) was the same as that reported by Hooper, Schwartz, Montgomery, Reed, Brown, Wasileski, and

Table 1a
Standard Battery

	Pretest	Midtest	Posttest	Follow-Up
Prorated Verbal IQ[a]	x			
Phonological Coding[b]	x	x	x	x
Orthographic Coding[b]	x	x[c]	x	x
Fine-Motor Planning[d]	x	x	x	
Alphabet Task[b]	x	x	x	x
Copy Task[b]	x	x	x	x
Compositions[b]	x	x	x	x
WRAT-R Spelling[e]	x	x	x	x
Sentence Memory[f]	x	x	x	
Word Attack and Word Identification[g]	x	x	x	x
Affect Question[h]	x		x	x
Motivation Questionnaire[h]	x		x	x

[a] Based on four subtests (Information, Similarities, Vocabulary, Comprehension) of the WISC-III (Wechsler, 1991).
[b] *University of Washington Clinical Assessment of Writing Skills* (Berninger & Whitaker, 1993).
[c] Letter cluster coding only.
[d] Finger Repetition and Finger Succession (Berninger & Rutberg, 1992).
[e] Jastak & Wilkinson (1984).
[f] *Stanford Binet IV* (Thorndike, Hagen, & Sattler, 1986), which loads on Working Memory (Swanson & Berninger, 1994).
[g] *Woodcock Reading Mastery Test-Revised* (Woodcock, 1987).
[h] See text for assessment of noncognitive variables.

Levine (1993) in a large-scale study of writing disabilities in the middle school grades. The percentage of left handers in the sample, whose mean age at pretest was 113.0 months (*SD*= 5.1), was 12.8%. Many but not all of the children were White. Specifically, 2.6% were African American, 87% White, 7.7% Hispanics, and 2.6% Native American. Socioeconomic status, as indexed by mother's level of education, was diverse: 2.6% less than high school, 20.5% high school, 30.8% community college/vocational, 35.9% college graduate, and 10.3% graduate degree.

According to a parent questionnaire, 46% of the parents (50% in the treatment group) had been told at some time that their child had attention deficit disorder and 33% had been told that their child had a learning disability. However, based on the informal observations of the tutors and the first author, who observed behind a mirror, only 25% of the treatment group showed attentional difficulties in their response during the tutorials; children were rated on distractibility, task persistence, and switching tasks.

Questionnaire responses also indicated that 33% of the children had language delays during the preschool years and all but six children had received some kind of special service (e.g., speech therapy, Chapter 1, or special education) at school. Three of the children had neurological disorders. In the treatment group 79% of parents and in the control group 86% of the parents reported helping their child with writing activities in the home.

Design

All children in the two treatment groups and the control group were given a standard battery at pretest (prior to tutoring), midtest (following seven tutorial sessions), posttest (following seven more tutorial sessions), and follow-up (six months later) (see Table 1a for the schedule). Treatment children participated in two additional sessions after the posttest in which each child selected the favorite composition he/she had written, made final revisions, and created illustrations for publication in a book that included one contribution from each participant in the tutorial. All children in the two treatment groups (More Composing and Coding) generated probe measures for handwrit-

ing, spelling, and composing in each of the 14 tutorial sessions. Thus, growth could be compared between the treatment groups combined and the control group (on standardized measures) and on the probe measures between the two treatment groups. The control group did not receive any treatment from our study during the summer. However, after the posttesting at the end of the summer, consultation to parents and teachers was provided for both the control and treatment children in the form of a written report with extensive and detailed recommendations for writing instruction aimed at best practices in general and tailored to the individual child based on the comprehensive diagnostic information available for each child.

Instructional activities (described later) were the same for each treatment group during the first 45 minutes of each session. During the last 15 minutes, the More Composing Group was given a second topic on which to write another composition but no additional instruction; the Coding Group played "Sound Games" to develop phonological awareness of sound segments in spoken words (syllable and phoneme deletion activities) and "Looking Games" to develop orthographic awareness of letter patterns in written words (spelling whole words or designated spelling units in written words from memory) (see Berninger & Traweek, 1991).

Lesson Frames and Treatment Probes

Each of the tutors was an experienced clinician. The first author wrote lesson frames for the 14 tutorials and trained the tutors in how to implement the scripts in these frames for each writing component—handwriting, spelling, and composition—while still responding to each student's unique needs in a dynamic manner with guided assistance. The goal was to achieve a balance between *instruction* of writing components and *construction* of meaning in teacher-student interaction (see Borkowski, 1992). The first author also monitored fidelity of treatment implementation behind a one-way mirror.

Each of the 14 one-hour individual tutorials began with a 5-minute handwriting *warm-up*. These activities always involved manuscript letters which were familiar to the children, because the goal was to develop automaticity. Most of the children had not yet been taught cursive handwriting. For the first seven sessions, therefore, children were asked to copy each of the 26 alphabet letters in alphabetical order from a model with arrow cues for the direction and order of each stroke and lines for cueing proportional sizing. Prior dissertation work by Rutberg (in preparation) showed that such nonverbal cueing was more effective than verbal mediation in developing automatic letter formation. (See Table 1b for probes.)

Following handwriting warm-up, *spelling* was taught for 15 minutes. The goal was not to teach a specific set of words but rather multiple strategies for learning spelling words. In each session, children were taught three strategies for learning to spell words based on the Multiple Connections Model (Berninger & Abbott, 1994b).

One strategy was orthographic imaging or a whole word strategy. The steps include (a) look at the model word carefully and say its name, (b) close your eyes and "image" the word in your mind's eye, (c) name the letters in left-to-right sequence with your inside voice, (d) open your eyes and write the word, (e) compare your spelling to the model, and (f) repeat steps if your spelling does not match the model. A second strategy involved using letter-sound relationships. These were taught using a systematic spelling program (Rudginsky & Haskell, 1994, 1985), which covers both single letters and letter combinations. Finally, the third strategy was structural analysis of syllable patterns in words. These were taught using the same systematic spelling program, which also covers six syllable patterns in written English. (See Table 1b for probes.)

Following spelling, *composition* was taught for 25 minutes, with topics selected from commercially available materials (Forte, 1983; Tiedt & Ho, 1987; Tiedt & Johnson, 1987). Examples of topics included "Me," "Where I Live," "Best Meal I Ever Ate," "Sillysaurus, etc." In each session, the tutors modeled the PW2R strategy (Plan, Write, Review, Revise) for generating a first and second draft of a composition on the selected topic. Then the child was given 5 minutes to plan out loud what to write, 5 minutes to write, and 5 minutes to review and revise. (See Table 1b for probes.) Although 15 minutes may not seem like a sufficient time to compose, for most of these children, who were referred for lack of productivity, it was the longest sustained writing they had ever done.

Assessment of Composition and Noncognitive Variables

Composition on the standard battery was scored in two ways: fluency (number of words produced in 5-minute interval) and quality. Instead of being based on holistic judgments, quality was rated on the basis of part of a developmental coding scheme for linguistic algorithms (topic selection, comment construction, and cohesive devices) being developed in related work (on a corpus of 1,800 narrative and expository frames in grades 1 through 9). The interrater reliability for the entire coding scheme was 85% agreement between highly trained raters.

The part of that coding scheme which was used here by one of the raters (first author) takes into account the relationship between the encoded clause and the topic sentence of the paragraph, the depth and nature of any elaboration following the encoded clause, and the emerging text structure (story or expository schema). Points were awarded as follows: 0 points: refusal to write, one incomplete clause, or comments totally unrelated to the topic of the topic sentence; 1 point: if topic sentence was repeated; 1.5 points: if the topic sentence was repeated with modification; 1.7 points: one novel comment; 2 points: two or more novel comments strung together in a linear chain (only the first comment clearly selected the topic from the topic of the topic sentence); 2.5 points: if branching comment(s) occurred for one or more of the comments in the string; 3 points: wheel structures in which comments were spokes that clearly selected topic from the topic of the topic sentence; 3.5 points: if branching comment(s) occurred for one or more of the spokes; 4 points: if story structure (e.g., setting, sequence of events, outcome) or expository structure (two or more arguments with supporting evidence and summary statement) was clearly evident.

To assess affect, children were asked whether they liked writing *a lot, some, a little*, or *not at all*. To assess motivation, a questionnaire assessing motivational orientation for writing (Nolen & Valencia, in preparation), based on the work of Nicholls and his colleagues (Nicholls, 1989; Nicholls, Patashnick, & Nolen, 1985), was administered. Children rated their agreement with statements on a 5-point scale (YES!!, yes, ?, no, NO!!). Each statement began with "In writing, I feel most successful if..." *Task Orientation* (7 items) included "I learn an interesting new way to write" and "I can make people really understand what I'm trying to say in my writing." *Ego Orientation* (5 items) included "I show people I'm

Table 1b
Probes in Tutorial Sessions

Handwriting

First 7 sessions

1. Time (in seconds) for copying a random sequence of 26 alphabet letters on lined paper
2. Time (in seconds) for writing the letter that comes after five designated letters and for writing the letter that comes before five designated letters

Last 7 sessions

1. Accuracy in writing 26 random lower-case letters and 26 random-upper case letters from dication
2. Time and accuracy for copying a sentence of a constant number of letters and words

Spelling

First 7 sessions

Orthographic Imaging Strategy—number of words spelled correctly

All 14 sessions

Letter Sound Relationships—percent correct on testing trials

Composition - all 14 sessions

Fluency–number of words written in 5 minutes of first draft, which correlates moderately high with compositional quality in primary-grade children (Berninger, Yates et al., 1992)

Quality—Analysis in progress

Table 2

Diversity of Learner Characteristics at Beginning of Study (Summed over Treatment and Control Groups, N=39)

Component Writing Skill Affected[a]	Percentage of Sample	ADD[b]	Associated Processing Deficits[c]: Phonological	Orthographic	Finger Function	Working Memory	Word Identification	Word Attack	Prorated Verbal IQ
Handwriting Only	7.7								
S6			X						
S16		X	X						
S26					X				
Spelling Only	2.6								
S32		X	X		X				
Compositional Fluency Only	5.1								
S20			X		X	X			
S29					X				
Handwriting + Spelling	23.1								
S2			X		X	X			
S8				X	X				
S9		X	X	X	X			X	
S16		X	X	X	X		X		
S21			X	X	X		X	X	
S23		X	X	X	X		X	X	
S25		X	X	X	X	X	X		X
S27			X	X	X			X	
S38			X	X					
Handwriting + Compositional Fluency	10.3								
S1			X		X		X		
S14		X			X	X			
S18[c]									
S35					X				
Spelling + Compositional Fluency	2.6								
S28		X	X						
Handwriting + Spelling + Compositional Fluency	38.5								
S3		X	X		X			X	
S4		X		X	X			X	
S5		X			X				
S7		X			X				
S11				X	X		X	X	
S12			X	X	X		X	X	X
S13		X							
S19			X		X		X	X	
S22			X	X	X		X	X	
S24		X	X	X	X		X	X	X
S30		X	X	X	X			X	
S31					X				
S34		X		X	X			X	X
S36			X	X	X		X		
S37		X		X	X		X	X	
None on Formal Measures	10.3								
S15					X				
S17					X				
S33		X			X				
S39					X				

[a] At or below -1 standard deviation on at least one measure of skill. [b] According to parent report, child had been diagnosed at some time as having Attention Deficit Disorder. [c] Congenital peripheral neurological disorder impairing hand function but not fine-motor planning tapped in finger function tasks.

a good writer" and "I write a better story than the other students." *Work Avoidance* (6 items) included "I don't have to work hard on my writing" and "I don't have to revise." (See Table 1a.)

Data Analyses

Two kinds of comparisons were made based on growth curve analysis: (a) treatment groups combined versus control group; and (b) Treatment 1 versus Treatment 2. The first comparison was made on the following measures in the standard battery at pretest, midtest, and posttest: phonological coding, orthographic coding (letter cluster), alphabet task, copy task, compositional fluency (total words, narrative and expository combined), compositional quality (combined narrative and expository), WRAT-R spelling, and WRMT-R Word Identification, Word Attack, and the Work-Resistance Scale of the Motivation Questionnaire.

Given the diversity in the sample, these analyses were also done with only the "needy" subjects (i.e., those at or below -1 standard deviation). Results were the same whether all subjects or only the needy were included, except for WRAT-R spelling, on which treatment effects were observed when only the "needy" were included but not when all subjects were included.

The second comparison was made on the following treatment probes at pretest, midtest, and posttest: speed of copying alphabet letters and writing a letter before or after a designated letter (first 7 sessions); speed of copying sentence and accuracy of writing letters from dictation (last 7 sessions); spelling-orthographic imaging (first 7 sessions); spelling-letter-sound knowledge (all 14 sessions); spelling-syllables (all 14 sessions); strategy choice (last 7 sessions); composition fluency (total words) (all 14 sessions).

Repeated-measures ANOVA was used to analyze all measures administered at pretest, midtest, posttest, and follow-up or pretest, posttest and follow-up (see Table 1a) for significant linear trends. It was also used to analyze differences between the two treatments on three subscales of the Motivational Questionnaire.

RESULTS AND DISCUSSION

First Specific Aim: Diversity of Learner Characteristics

As can be seen in Table 2, the sample was diverse in terms of component writing skill deficit. Fifteen percent had a deficit in one component writing skill only—handwriting, spelling, or composition. Thirty-six percent of the sample demonstrated a deficit in two of the component writing skills. Less than half (38.5%) had a deficit in all three component writing skills. Ten percent of the sample did not have deficits in component writing skills, as assessed by formal tests, but did have writing problems in the classroom as reported by their teachers.

Informal observation during the tutoring process also confirmed that children with writing disabilities varied as to whether their problems were specific to one or to a combination of component writing skills. Confirmatory factor analysis on these measures in unreferred samples shows that handwriting, spelling, and composition load on different factors (e.g., Abbott & Berninger, 1993). Thus, the intraindividual differences in component writing skills we see in children referred to our clinic (unpublished data) are not surprising.

The sample was also diverse in terms of the processing deficits associated with the same deficit or combination of deficits in component writing skills (see Table 2). Thus, a different etiology may be related to the same learning outcome, and children with the same kind of writing problem may have different instructional needs related to underlying deficits.

All the processing skills (4th through 10th column headings) in Table 2 had been shown in our prior research to be related to achievement in component writing skills. So we were not surprised to find deficits in these skills in children with writing disabilities. The only surprise was the large number of children (26 of 30) with a handwriting disability who had a deficit on at least one of the finger-function tasks tapping fine-motor planning. Our prior work using structural equation modeling with the entire continuum of writing ability—not just the writing disabled—had shown that the path from fine-motor skills to handwriting was indirect rather than direct (Abbott & Berninger, 1993). Apparently, the relationship between fine motor and handwriting skills is stronger for those at the low end of the handwriting ability distribution. Also, the four children who had not shown deficits in component writing skills on formal tests all had a deficit in finger function. Two of these four had superior or very high Verbal IQs, and their disabilities in component writing skills were evident only in relation to their IQ (relative criteria), not on the basis of the absolute low-functioning crite-

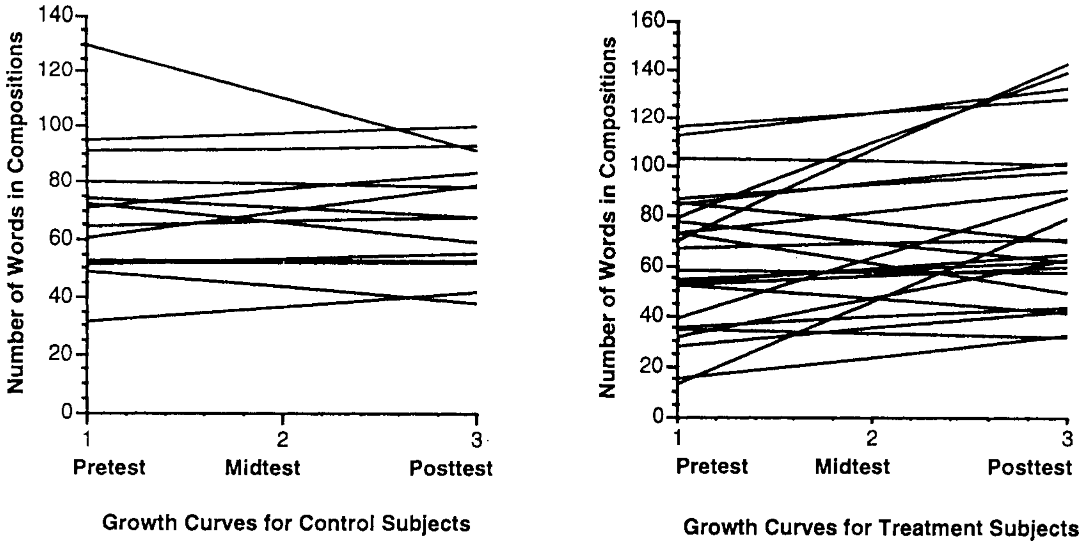

Figure 2. Individual growth curves for control and treatment subjects on length of compositions.

rion used in this study (see Yates, Berninger, & Abbott, in press).

The large number of children reported by parents to have attention deficit disorder (ADD) (see Table 1) is of interest, as little is known about the co-occurrence of ADD and writing disability. However, some attentional problems may have been outgrown in the course of development or are only evident in a large group setting. In the one-to-one tutorial, only Subjects 3, 7, 13, 16, 18, and 24 showed consistent signs of attentional difficulty (based on ratings of distractibility, difficulty in maintaining focus, and difficulty in making transitions between tasks).

Second Specific Aim: Comparison to Control Group

At pretest there was no difference among any of the groups except that the Control Group (M=78.32%) and the More Composing Group (M=76.70%) were significantly higher, $F(2,36) = 4.38$, $p<.02$, than the Coding Group (M= 62.92%) on the phoneme task. The following group comparisons are based on directional hypotheses that treatment would result in improved performance and thus on one-tail tests of probability. The combined treatment groups (slope =.54) showed significantly faster (t[37]= -2.19, $p<.015$) individual growth than the control group (slope = -.40) on the alphabet task, which requires children to write in order the lower-case alphabet from memory. The dependent measure is the number of letters correctly produced in the first 15 seconds. Because this task was not directly trained, it appears that the low-level training in automaticity of retrieval and production of alphabet letters transferred to the alphabet task. This finding is important because the alphabet task was the best predictor of all component writing skills in our primary grade battery (Berninger et al., 1992). When WRAT-R spelling was analyzed for the "needy" group (at or below -1 SD at pretest), the treatment groups (slope .70) showed significantly greater growth (t[14]=1.95, $p<.032$) than did the control group (slope -.10). The combined treatment groups (slope 7.40) showed significantly faster individual growth (t[33]=3.39, $p<.0015$) than the control group (.50) on the phoneme task. Although only one treatment group was given explicit phonological coding training, the spelling training in letter-sound correspondences probably facilitated the phonological awareness of both treatment groups. The combined treatment groups (slope 7.35) showed faster individual growth (t[36]=1.98, $p<.03$) than the control group (slope -.80) on compositional fluency (total number of words produced within a constant time limit on narrative and expository tasks).

Table 3
Positive Treatment Responding of Individual Children (X=Slope of Growth Curve Significantly Different from Zero)

	Battery Measures[a]						Probe Measures[b]	
	Copy Task	WRAT-R Spell	Orthographic Letter Cluster	Phoneme	Composition Length	Composition Quality	Copy Task	Spelling
More Composing Treatment[c]								
S1				X		X		X
S2			X	X		X	X	
S3					X	X		
S4	X							
S5							X	
S6		X		X				
S13				X	X	X	X	X
S14		X				X		
S15		X			X			
S16				X	X			
S17	X	X		X	X			
S18			X	X	X			
Coding Treatment[c]								
S7		X		X		X		
S8	X			X	X		X	
S9	X				X	X	X	
S10				X	X			
S11				X	X		X	
S12			X	X	X		X	
S19	X		X	X	X		X	
S20	X						X	
S21					X		X	
S22			X	X			X	
S23				X			X	
S24			X	X	X			
Control Group								
S25								
S26								
S27					X			
S28				X				
S29					X			
S30					X			
S31								
S32			X	X				
S33								
S34								
S35			X					
S36								
S37			X			X		
S38			X					
S39								

[a] The alphabet task and percent correct spelling on narrative and expository compositions are not included because none of the slopes of the individual growth curves was significantly different from zero on these tasks (except for S11 on expository spelling). [b] Composition length was not included because none of the slopes of individual growth curves was significantly different from zero on these tasks. These probe measures were not available for the control group. [c] The first six subjects in each treatment were taught by Tutor 1, the second six subjects in each treatment by Tutor 2.

As can be seen in Figure 2, the individual growth curves for the Control Group tend to be flat or descending, whereas for the Treatment Groups they tend to be ascending from pretest to posttest. Apparently, practice in planning, generating, and revising compositions improved children's ability to generate longer texts. The combined treatment group (slope=.28) also showed faster individual growth (t[36]=2.748, $p<.006$) than the control group (slope= -.11) on compositional quality (combined narrative and expository).

Third Specific Aim: Comparison of Two Treatments

These group comparisons are also based on directional hypotheses and thus on one-tail tests of probability. The Coding Group (slope=.25) improved at a faster rate (t[22]=2.05, $p<.025$) than the More Composing Group (slope=.06) on the probe measure of Orthographic Imaging Spelling Strategy, which facilitates connections between whole written words and whole spoken words in memory. Presumably, the coding training facilitated students' attention to and memory for spelling patterns and their associated sound patterns. The More Composing Group (slope -3.43) improved at a faster rate (t[22]=1.97 $p<.03$) than the Coding Group (slope = 0.43) on the probes for copying sentence, time. Presumably, the extra practice in producing written text resulted in a speed advantage for written production in general.

Fourth Specific Aim: Diversity in Treatment Responding

As can be seen in Table 3, for the treatment groups, no child was a treatment responder on all dependent measures. Also, all children were treatment responders on at least one dependent measure. Compared to the Control Group (11%), considerably more treatment responding occurred in the Treatment Groups (37.5%) on the standard battery measures. Treatment responding occurred for children taught by both tutors and patterns of treatment responding were not linked to tutor. Although the treatment effects were specific to component writing skills, which were trained, and did not generalize to reading skills, which were not trained, four treatment and two control children were treatment responders on word identification (S2, S3, S7, S24, S26, S30); four treatment children and one control child were treatment responders on word attack (S2, S12, S22, S24, S32).

Fifth Specific Aim: Predictive Validity of Verbal IQ

Verbal IQ did not predict response to *short-term treatment* on low-level skills such as handwriting (alphabet task), spelling (WRAT-R spelling), or compositional fluency or on high-level compositional quality.

Sixth Specific Aim: Noncognitive Variables

In response to the question whether one likes writing *a lot, some, a little,* or *not at all*, a significant linear trend occurred ($F[1,37]=9.717$, $p=.002$) from pretest to posttest to follow-up. At follow-up, children in general were more likely than at pretest to choose *some* or *a lot*. The lack of group differences suggests that participation in the control group (testing only at pretest, midtest, and posttest and evaluation/diagnostic report and consultation with specific recommendations between posttest and follow-up) was as likely as participation in the tutorials to improve affect toward writing.

Assessment and consultation may cause parents and adults to change the way they interact with children regarding writing, and thus change the way children view writing. Although changes in affect cannot be attributed solely to the summer tutorial, tutors who worked with the treatment groups noted changes in affect and not just writing skills. For example, a boy who refused to write any compositions on the pretest (but complied on all other tasks) was oppositional throughout the first half of the tutorial sessions. One day midway he announced, "Remember when I used to say no to writing, well I'm not going to any more." His writing resistance appeared to diminish because the tutor emphasized that the first draft did not have to be perfect *and* because of the scaffolding, which helped him focus attention and plan. At the end of the tutorials, he announced that he wanted to be a writer when he grew up.

Another example is a girl who avoided writing because of spelling problems. She was so delighted to learn about digraphs (no one had ever explained before that letter combinations can be spelling units) that she not only became less writing resistant, but also shared her delight with everyone she came in contact with in the extended family and neighborhood. And she was still telling the world about digraphs when we saw her at follow-up.

Although this study has not isolated the causal

mechanisms in changing affect toward writing, observation of children during the tutorial process suggested that affect be included in the theoretical model and that more systematic investigation of affect be included in future research on writing.

A Time (3) x Group (3) repeated-measures ANOVA was computed for each motivational orientation scale. There were no main effects or interactions for Task or Ego Orientation Scales (all $Fs<1$). However, a significant Time x Group interaction was found for Work Avoidance. The significant interaction of Time and Group (Pretest vs. Posttest) indicated that only the More Composing Group became significantly less work avoidant. Perhaps practice is an effective way of overcoming writing resistance. One-way ANOVAs at each Time showed no differences between groups at pretest or follow-up ($ps>.05$), but a significant Group effect at posttest, $F(2,36)=5.93$, $p<.005$. A correlated-samples t-test confirmed that only the More Composing Group showed a significant change from pretest to posttest, $t(11)=2.55$, $p<.025$; other $ps>.05$. One boy in the More Composing Group summed it up this way: "It's like a whole bunch of dynamite blew up my writer's block." Six of the children in the treatment groups (S5, S9, S10, S11, S23, S24) had growth curve slopes (pretest to midtest to pretest to follow-up) for work avoidance that were significantly different from zero. Four of the children in the control group (S30, S31, S32, S36) had growth curve slopes on work avoidance that were significantly different from zero (pretest to follow-up). Again, assessment and consultation, which may change parent and teacher behavior, may be as effective as the tutorials in changing motivation for individual children. Recall the high percentage of parents in both groups who provided writing activities at home to help their children.

Seventh Specific Aim: 6-Month Follow-Up

After posttest, parents of all children in the treatment and control groups received a comprehensive report with the results of the pretest, midtest, and posttest, behavioral observations of their child during the summer tutorial (if applicable), and practical recommendations for the school to continue to help the child with writing skills. Parents were encouraged to share these reports with the school and all did. In addition, we offered ongoing consultation services, free of charge, to both parents and teachers throughout the year, but less than 20% of the teachers of these children took advantage of this offer. However, many of the parents of children in both groups worked closely with their children to help them with writing. Of the measures analyzed for changes from pretest to midtest to posttest to follow-up (see Table 1a), three showed a significant Group x Sessions (linear trend across pretest, midtest, posttest, follow-up) interaction: alphabet task, $F(1,37)=4.33$, $p<.025$; WRAT-R spelling standard score, $F(1,37)=3.82$, $p=0.25$; and compositional quality rating (narrative only), $F(1,37)=7.51$, $p= .0045$.

For compositional quality, the group effect, $(F1,37)=7.75$, $p=.004$, and the sessions effect, $F(3,111)=4.12$, $p=.004$, were also significant. For the alphabet task, the treatment groups were slightly worse than the control group at pretest (7.8 vs. 8.4) and midtest (7.9 vs. 8.0), but the treatment group was better than the control group at posttest (8.9 vs. 7.6) and follow-up (10.5 vs. 8.7). For the WRAT-R spelling (all subjects), the treatment ($M=87.2$) and control groups ($M=87.7$) were not different at pretest. The treatment group was somewhat better than the control group at midtest (89.1 vs. 87.4) and posttest (89.5 vs. 86.6), but by follow-up the amount of difference between the treatment and control groups had widened (93.6 vs. 89.6). For compositional quality, the treatment and control groups did not differ at pretest ($M=2.04$ vs. 2.08), but they did at midtest ($M=2.63$ vs. 1.98), posttest ($M=2.83$ vs. 2.03), and follow-up ($M=2.91$ vs. 1.69). As a group, these children were producing, on the average, linear strings of comments (chaining) rather than wheel structures. Thus, even though both treatment and control children may have benefitted from diagnosis and consultation provided to parents and teachers and from parental assistance, there was some evidence, on three dependent measures, of the benefits of tutorial assistance persisting over time.

GENERAL DISCUSSION

To summarize the results of this exploratory study, of the measures in the standard battery (see Table 1a), treatment effects relative to the non-contact control group, in rate of growth from pretest to midtest to posttest, were found for phonological coding; the alphabet task;

WRAT-R spelling (only for those at -1 SD or lower at pretest); compositional fluency; and compositional quality. No treatment effects in rate of growth were found for orthographic coding, fine-motor planning, copy task, sentence (working) memory, or reading.

When linear trends in changes in level from pretest to (midtest) to posttest to follow-up were evaluated, rather than rate of growth, the phonological and compositional fluency effects did not appear to maintain whereas the alphabet task, spelling (based on all subjects), and compositional quality did appear to maintain. A linear trend in increased probability of liking writing occurred for both control and treatment children. On the treatment probes, differences between alternative treatments during the tutorial were found only for copying a sentence (favoring the More Composing Group) and orthographic imaging (favoring the Coding Group). Of the measures on the standard battery, treatment effects, relative to the alternative treatments, were found only for the work-avoidance factor on the motivational questionnaire (favoring the More Composing Group). However, this difference did not appear to maintain over time when the extra practice provided by the tutorial was no longer provided. Thus, conclusions about the effectiveness of the tutorial depend on which dependent measures are considered and whether only posttest or follow-up measures are considered.

The research also showed that children with writing disabilities are diverse in terms of their specific writing and processing problems (see Table 1). In selecting participants for research on writing disabilities investigators should, therefore, specify inclusion criteria according to which writing components or related processes are affected. In this research we cast a wide net to determine how much variability might exist. In future research it is important to define the research population more narrowly.

In interpreting research results, generalizations about children with writing disabilities should be avoided as there is heterogeneity in this population just as there is in the population with reading disabilities. That is, generalizations should be restricted to subtypes of writing disabilities. Children with writing disabilities are also diverse in terms of how they respond to instruction (see Table 2). In this study, diversity in responding did not appear to be related to the diversity of learner characteristics prior to intervention. We speculate that diversity in responding to instruction is related to constructive processes of learners who use instructional cues in varying ways.

The goals of science also vary and may include predicting, drawing inferences about causality, or explaining. This exploratory study is limited in that it is relevant only to the first and third goals. Given the multidimensional nature of the treatment protocol, we cannot infer (based on our research design) precise causal influences when treatment effects were found either for comparisons between treatment and control group or between treatment groups. We cannot determine with certainty which component of the multicomponent treatment protocol was responsible for the treatment effect. The trade-off for the reduced ability to draw causal inferences was the opportunity to assess diversity in response to instruction that included multiple components, as classroom instruction does. However, further research is needed to document that such multicomponent protocols can be implemented effectively in groups in regular classrooms. The results of the comparison of the two treatments are interesting in that each treatment exerted a beneficial effect—but on a different aspect of writing. Thus, the most appropriate question is not which treatment is better but which treatment exerts which effect on which component process of writing.

Finally, this study suggests that the effectiveness of writing instruction must be evaluated on the basis of noncognitive variables such as motivation and affect as well as cognitive variables. Assessment and consultation, which affect parent and teacher behavior, may be as effective as individual tutorials, which affect child behavior, in making children like writing. Children who were given more practice in composing did not necessarily write longer compositions, as we predicted, but their responses to a motivation questionnaire suggested that they became less writing avoidant or writing resistant, at least at posttest. The relationship between writing disabilities and motivation is complex. Children may lose motivation because writing is difficult or writing may be difficult because children are not motivated. We saw evidence of both relationships. The results reported here for affective and motivational variables are exploratory and

not conclusive. Future research on writing disabilities should continue to examine the complex relationship between learning and noncognitive variables such as affect and motivation.

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FOOTNOTES

This research was supported by Grant No. 25858-05 from the National Institute of Child Health and Human Development. All authors contributed a necessary and important component to this multidimensional research project. The authors thank the parents and children who participated in this study from whom we learned as much about writing as we were able to teach them about writing. They also acknowledge the helpful assistance of teachers, principals, and district administrators in the Shoreline and Northshore Public Schools in Washington state. They are grateful to Sylvia Mirsepassi for secretarial assistance.

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