Read Writ (2011) 24:151–182
DOI 10.1007/s11145-010-9262-y

Child writers' construction and reconstruction of single sentences and construction of multi-sentence texts: contributions of syntax and transcription to translation

Virginia W. Berninger · William Nagy · Scott Beers

Published online: 30 September 2010

Abstract Children in grades one to four completed two sentence construction tasks: (a) Write one complete sentence about a topic prompt (sentence integrity, Study 1); and (b) Integrate two sentences into one complete sentence without changing meaning (sentence combining, Study 2). Most, but not all, children in first through fourth grade could write just one sentence. The sentence integrity task was not correlated with sentence combining until fourth grade, when in multiple regression, sentence integrity explained unique variance in sentence combining, along with spelling. Word-level skills (morphology in first and spelling in second through fourth grade) consistently explained unique variance in sentence combining. Thus, many beginning writers have syntactic knowledge of what constitutes a complete sentence, but not until fourth grade do both syntax and transcription contribute uniquely to flexible translation of ideas into the syntax of a written sentence. In Study 3, eleven syntactic categories were identified in single- and multi- sentence composing from second to fifth grade. Complex clauses (independent plus subordinate) occurred more often on single-sentence composing, but single independent clauses occurred more often on multi-sentence composing. For multi-sentence text, more single, independent clauses were produced by pen than keyboard in grades 3 to 7. The most frequent category of complex clauses in multi-sentence texts varied with genre (relative for essays and subordinate for narratives). Thus, in addition to syntax-level sentence construction and word-level transcription, amount of translation (number of sentences), mode of transcription, and genre for multiple sentence text also influence translation of ideas into written language of

V. W. Berninger (✉)
University of Washington, 322 Miller, Box 353600, Seattle, WA 98195-3600, USA
e-mail: vwb@u.washington.edu

W. Nagy · S. Beers
Seattle Pacific University, Seattle, WA, USA

child writers. Results of these studies employing descriptive linguistic analyses are discussed in reference to cognitive theory of writing development.

Keywords Sentence construction · Single-sentence composing · Multi-sentence composing · Syntactic level of language · Written syntax

> A sentence is more easily identified in writing than in speech; yet most speakers of a language appear to know what a sentence is, even though grammarians and linguists continue to grapple with its definition. (Harris & Hodges, 1995, p. 231).

Teachers encourage children to write in complete sentences. Yet little is known about developing writers' conceptions of a complete sentence. A sentence is traditionally defined as a group of words that expresses a complete thought, but what is a complete thought? Do beginning writers in first grade and thereafter understand what a complete sentence is? When instructed to write just one sentence, will they write one and only one sentence? When they are asked to combine two sentences into one good sentence without altering the meaning, will they understand how a complete thought can be expressed within one sentence unit? When freely translating their thoughts into written language, what kinds of syntactic constructions will they produce in a sentence unit and in a text unit? Are these syntax structures simple or complex clause constructions and do they vary across genre (narrative or essay), transcription mode (pen or keyboard), and length of writing task (text or single sentence)? Collectively, the three initial, exploratory studies employing descriptive linguistic analyses reported in this article addressed these questions.

The studies did so within a theoretical framework grounded in the cognitive processes of writing, with focus on translation of ideas into the sentences of written language. According to this cognitive theory of the developing writing process (e.g., Fayol, 1991, 199; 2004; Hayes, 1996; Hayes & Flower, 1980), the translation process in child writers draws on transcription processes (handwriting and spelling) (Berninger, Yates, Cartwright, Rutberg, Remy, & Abbott, 1992) and multiple levels of language involved in text generation—word choice, syntax underlying sentence construction, and text composing (Whitaker, Berninger, Johnston, & Swanson, 1994). However, compared to text-level composing, relatively little research has focused on the syntactic level in children's writing and the relationship between syntax construction and transcription in text generation at both the sentence and text level, as the current study did. For a review of studies that have examined oral or written syntax at some time in writing development, ranging from early childhood to adolescence, see Myhill (2009).

Several levels of language are involved in translation of cognitions into writing. Transcription involves the subword level (handwriting) and word level (spelling) of written language, whereas syntax is a level of language that provides structure for organizing multiple words. Although more is probably known about how the multiple levels of language contribute to oral language development than to written language development, progress is being made. Writing research in the cognitive

tradition has generated substantial evidence that internally coded and, subsequently, externally produced letter forms and word spellings play a fundamental role in translating thoughts and ideas into written language (Berninger & Swanson, 1994; Fayol, 1991, 1999, 2004; Hayes, 1996; Hayes & Chenoweth, 2006; Richards, Berninger, & Fayol, 2009). Less is know about whether these processes contribute independently of or jointly with the syntactic level of language for ordering multiple words in child writers. Although word-level phonological, orthographic, and morphological skills emerge early and continue to evolve during writing acquisition (for review of evidence, see Berninger, Abbott, Nagy, & Carlisle, 2010a), less is known about when and how syntactic skills, which are learned during the preschool years for oral language, contribute to the sentence construction of school age writers.

However, the syntactic construction process of writing may not be exactly the same as the syntactic construction process of oral language. Conversation is comprised of utterances during turns-at-talk rather than sentences (e.g., Halliday, 1987). On the one hand, child writers may write the way they often talk—that is, produce many complex clausal constructions that have independent plus dependent clauses rather than only a simple, single independent clause. Because the concept of 'sentence' is defined in terms specific to written language, in which idea units are marked by capitalization and punctuation (Fayol, 1997), and because oral language is organized differently than written language is, T-units have been used to study oral language. Hunt (1970) defined a T-unit as the minimal terminable unit equivalent to "one main clause plus any subordinate clause or nonclausal structure that is attached to or embedded in it" (page 4).

However, T-units may not be the only syntactic measures in either oral or written discourse. Neither oral or written discourse consists of only complex syntactic constructions with both an independent and dependent clause. *Oral discourse* has syntactic (as a minimum, subject and predicate) and non-syntactic units (e.g., contingent queries, which are used for ensuring conversational clarity, and exclamations); these units perform many discourse functions, and occur in conversational turns, which are separated by pauses that regulate the turn-taking process (Garvey & Berninger, 1980). Child writers may also acquire an academic register for *written discourse* that differs from the oral register of conversation (e.g., Beers & Nagy, 2008; Chafe & Danielewicz, 1987; Schleppegrell, 2004; Silliman & Scott, 2009). Alternatively, developing writers may draw on both sources of syntactic knowledge as they sometimes write as they talk, but other times use the new written language register they are learning.

Prior research had shown that young children produce both simple and complex clausal constructions in their writing and that complex clausal constructions equivalent to T-units are common in first graders' written composing (e.g., Traweek, 1993). However, relatively little research has examined the variation in syntactic structures produced by developing writers to express ideas either in single-sentence writing or multi-sentence text writing. Thus, in the current study we examined not only when ability to write just one sentence is first evident, but also the kinds of syntactic constructions observed in both single-sentence and multi-sentence composing and the frequency of occurrence of each kind of syntactic construction. Of interest were changes in the frequency of specific kinds of clausal constructions and the relative mix

of the various kinds of clausal constructions across grade level from second to seventh grade.

The target population for the current research was normally developing writers. The *emergence of syntactic awareness* for written sentence and text construction in normally developing writers from the beginning to middle years of formal schooling is an important research topic because the research results may inform future research on what is and what is not deviation from normal developmental patterns. For example, research on understanding writing skills of children with oral language disabilities is underway (e.g., Dockrell & Connelly, 2009; Nelson, Roth, & Van Meter, 2009).

Two studies were conducted with a longitudinal sample, but analyzed cross-sectionally, to test the hypothesis that the relationship between word-level transcription and syntax-level sentence construction during translation of ideas into written language changes from the primary grades (ages 6 to 8) to the intermediate grades (age 9 and above). The first study used an experimenter-designed measure of sentence construction, referred to as the sentence integrity task, which required the child to write just one complete, syntactically acceptable sentence about a provided topic prompt that was kept constant across children. Successful completion of this task requires knowledge of what constitutes a complete sentence. Lack of this syntactic knowledge results in a fragment, which is less than a complete sentence, or a run-on sentence, which contains more than a complete sentence. The second task was a sentence combining task, which requires the child to rewrite two sentences as one sentence without changing meaning. Sentence combining tasks, which are increasingly used in both instruction and assessment research (e.g. Nelson et al., 2009; Saddler & Graham, 2005; Shanahan, 2009), require child writers to re-construct syntactic structures in a flexible manner to express the same meaning with less words and new syntactic constructions.

Two predictions derived from this hypothesis were tested. First, early in the writing acquisition process many children can construct a single sentence when asked to do so, thus reflecting their syntactic awareness, but the relationship between syntactic awareness and transcription may change across writing development. Second, early in writing development many children may have knowledge of what constitutes a complete sentence, but their syntactic knowledge may not yet contribute uniquely to sentence writing that requires both knowledge of syntactic structure and related transcription processes. Only with writing experience do the transcription processes become automatized (typically during the early grades) and then contribute to sentence-construction independently of the syntactic-level processes underlying sentence re-construction during sentence combining (typically during the later grades). Thus, during the first three grades, the sentence integrity task may not be correlated with the sentence combining task, but beginning in fourth grade the sentence integrity task may explain unique variance in sentence combining, along with sub-word and/or word-level transcription.

To test the first prediction, the percentage of children successfully completing the write-one-sentence task was computed at each grade level one to four. Developmental trends in these percentages were examined across grade levels to evaluate if any beginning writers might have syntactic knowledge for what constitutes a

complete sentence. Then this measure was correlated with sentence combining. To test the second prediction, at each grade level correlations were computed between the sentence integrity task, two measures of transcription, one morphology measure, and one reading comprehension measure, and the sentence combining task; then multiple regressions were performed in which all the measures correlated with sentence combining were used as predictors and the sentence combining task was the outcome. The sentence combining task was scored for acceptable sentence-level sytax, quality of sentence construction, and word-level transcription, punctuation, and capitalization, The other predictors in the multiple regressions were chosen based on past research showing that (a) handwriting automaticity is a unique predictor of composing length and quality during the first four grades (for review, see Berninger & Amtmann, 2003); (b) spelling has the most consistent longitudinal relationships to written composition across grade levels one to seven (Abbott, Berninger, & Fayol, 2010); (c) morphology that marks grammar (derivational suffixes) may contribute to composing (Green, McCutchen, Schwiebert, Quinlan, Eva-Wood, & Juelis, 2003); and (d) silent sentence reading comprehension fluency, which requires integration of word identification and comprehension of sentence syntax (Berninger, Abbott, & Alsdorf, 1996a), may be related to written sentence composing.

The morphological measure provided an interesting control in that derivational suffixes mark word-level grammar (part of speech) but not syntactic-level clausal structures. As such, morphological skill may contribute grammatically at the word-level, which in turn contributes to the syntactic-level skill for constructing a single sentence (sentence integrity) or re-constructing two sentences into a single sentence (sentence combining). The sentence combining task requires transforming two complete clausal constructions into one complete, but newly constructed, clausal construction for translating the same idea(s). The silent sentence-reading fluency task provided another potentially informative control in that it requires sentence-level syntactic processing but in reading rather than writing.

A third study was conducted with two cohorts, one beginning in first grade and one in third grade, in the longitudinal study that provided the sample for the first two studies. The goal was to test the hypothesis that the translation process is influenced by the amount of syntactic construction, transcription mode, and/or genre of extended text. Three predictions, related to the size and nature of constructed written language units and transcription processes, were tested: (a) Single independent clauses are more common in single-sentence constructions, whereas complex clauses (single independent clause plus dependent clause) are more common in multi-sentence constructions (levels-of-language contrast); (b) more clauses are produced by pen than keyboard when writing multi-sentence texts but not single sentences (transcription mode contrast); and (c) the nature of syntax in the written sentences varies by narrative and expository texts (genre contrast). Levels-of-language in composing was of interest because syntactic construction may vary with the job size in writing, that is, whether a single sentence or many sentences have to be constructed. Transcription mode was of interest because past results showed advantages for writing by pen for text-level writing, but advantages for writing by keyboard for letter-level writing (Berninger, Abbott, Augsburger, & Garcia, 2009). Genre was of interest because relatively little research attention has focused on how

syntactic-level construction might interact with genre-specific discourse-level construction (but see Beers & Nagy, 2008, 2009, and this special issue).

General method

Participants

Personnel in a large urban school system in the Pacific Northwest, within driving distance of the university where the study was conducted, mailed letters on district letterhead announcing the opportunity to participate in the research to all parents of all prospective first and third graders who attended one of the district's 51 elementary schools. Interested parents contacted the research coordinator who screened children to make sure they met research inclusion criteria (i.e., no developmental, neurological, or psychiatric disorder prior to or during school age years and no language learning disability LLD, also known as selective language impairment SLI, during the preschool years). After informed consent was obtained, parents completed questionnaires about developmental, medical, family, and educational history, including other languages spoken in the home. Although other languages were spoken in some of the homes, none of the participating children were English-language learners; all had adequate English for completing the administered tasks. The children were diverse in terms of race (more than one-third non-white) and parent's level of education (less than high school to high school to college to postgraduate work). For additional information about the participants in the entire sample across five years, beyond that provided in the text that follows, see Abbott et al. (2010).

Cohort 1

At the start of the study, the 128 first graders had a mean age of 82.72 months (SD = 3.80). Attrition rate was low across years 2 ($n = 124$), 3 ($n = 122$), 4 ($n = 119$), and 5 ($n = 114$) and was due to families moving out of the area or other reasons unrelated to the study. The sample reflected the diversity of the local school population: European American (64.8%), Asian-American (23.4%), African-American (6.3%), Hispanic (1.6%), Native American (1.6%), and other (2.3%). Parental level of education ranged from less than a high school education or graduated from high school (7% mothers and 12.5% fathers) to more than a high school education but less than a college education (11.7% mothers and 7.8% fathers) to an undergraduate education (45.3% mothers and 39.8% fathers) to graduate degrees (33.6% mothers and 32.0% fathers); no information was reported for 2.4% of the mothers and 7.9% of the fathers.

Cohort 2

At the start of the study the 113 third graders had a mean age of 106.01 months (SD = 3.70). Attrition rate was also low across year 2 ($n = 110$), year 3 ($n = 106$), year 4 ($n = 106$), and year 5 ($n = 99$). Self-reported ethnicity and parents' level of

education also exhibited diversity: European American (65.5%), Asian-American (21.2%), African-American (9.7%), Hispanic (0.9%), and other (2.7%). Parental level of education ranged from less than a high school education or graduated from high school (7.1% mothers and 7.1% fathers) to more than a high school education but less than a college education (11.5% mothers and 14.2% fathers), to an undergraduate education (50.4% mothers and 36.3% fathers), to completed graduate degrees (30.1% mothers and 35.4% fathers); no information was reported for 0.9% of the mothers and 7.2% of the fathers.

Enrolled children were tested annually for five years at the university where they completed writing and writing-related tasks in the second, third, or fourth month of the school year. Half began in first grade (Cohort 1) and half began in third grade (Cohort 2).

For Studies 1 and 2, we describe tasks and results for both cohorts only during the first two years of a longitudinal study when measures of sentence integrity and sentence combining were available for both cohorts. Children in cohort 1 were in grade 1 (71 girls and 57 boys) in year 1 and grade 2 (69 girls and 55 boys) in year 2; children in cohort 2 were in grade 3 (57 girls and 56 boys) in year 1 and in grade 4 (57 girls and 53 boys) in year 2.

For Study 3, we report results for measures of narratives (grades 2 or 4, cohort 1, or 4 or 6, cohort 2), essays (grades 3 or 5, cohort 1, or 5 or 7, cohort 2), and single sentences (grades 2 to 5, cohort 1; grades 4 to 7, cohort 2), with the text-level and sentence-level writing both by pen and by keyboard for each cohort and grade level. Across the final four years of the longitudinal study, for which attrition was low, children in cohort 1 were in grades 2 (69 girls and 55 boys), 3 (68 girls and 54 boys), 4 (67 girls and 52 boys), and 5 (62 girls and 52 boys); children in cohort 2 were in grades 4 (57 girls and 53 boys), 5 (54 girls and 52 boys), 6 (53 girls and 53 boys), and 7 (50 girls and 49 boys).

Procedures

All writing tasks and test measures were administered by highly trained and supervised graduate students. Specific writing tasks or writing-related measures, procedures, data analyses, and results are reported for each of the three studies that follow. For additional details about the reliability and validity of these measures and test administration procedures, see Abbott et al. (2010).

Study 1

Writing tasks

In year 1 when Cohort 1 was in first grade and Cohort 2 was in third grade, children were asked to write one good sentence about "My favorite thing at school." In year 2 when Cohort 1 was in second grade and Cohort 2 was in fourth grade, children were asked to write one good sentence about "Writing." Their written productions were coded on two measures: (a) sentence integrity (complete sentences, fragments— less

than a complete sentence, or run-ons—more with than a complete sentence), and (b) number of grammar errors.

Procedures

For sentence integrity, fragments were constructions that were less than a main clause and run-ons were defined as (a) two or more main clauses that were not separated from each other with appropriate punctuation (period, question mark, exclamation point) or a conjunction, or (b) a main clause plus a non-clausal construction. Otherwise, if only a main clause (single independent clause or independent clause plus subordinate clause) was produced, it was coded in Study 1 as a complete sentence even if it was not capitalized at the beginning and punctuated at the end. The rationale was that children had only been instructed to write just one sentence; they had not been asked to capitalize or punctuate it and may have thought that was not important because they did not write any other sentences from which to differentiate it.

Of interest in Study 1 was whether what the child produced was a complete sentence. The sentence integrity measure was thought to reflect the developing writers' syntactic knowledge of what a complete sentence is.

Data analyses

Two research team members were trained by the first author in coding the three possible outcomes on sentence integrity and in identifying grammar errors (e.g., use of singular noun with plural verb or vice versa; tense errors such as he runned). The two coders practiced coding until they achieved 100 percent agreement in scoring both sentence integrity and grammar errors. Then each coded all the sentence writing tasks and compared their results; at weekly research meetings they discussed any discrepancies with the first author until they were resolved.

Chi-square was used to assess whether within each grade level the frequency of occurrence of complete sentences, fragments, or run-ons occurred with comparable frequency or varied in frequency across the three categories. Frequencies were also converted to percentages of each of the three kinds of constructions at each grade level.

In an exploratory analysis, the mean number of grammatical errors and percentage of children who made grammar errors on the sentence writing task were computed for each grade. Then correlations were computed between sentence integrity (rescaled quantitatively with a score of 1 for complete sentences and 0 for either fragments or run-ons) and number of grammatical errors.

Results and discussion

For sentence integrity, of the 127 first graders who completed the year 1 sentence-writing task, 88 wrote a complete sentence, 3 wrote a sentence fragment, and 36 wrote a run-on sentence; $\chi^2(2) = 86.76,\ p < 0.001$. Of the 123 second graders who completed the year 2 sentence writing task, 105 wrote a complete sentence, 9 wrote a fragment, and 9 wrote a run-on sentence; $\chi^2(2) = 149.85, p < 0.001$. Of the 113 third

graders who completed the year 1 sentence writing task, 105 wrote a complete sentence, none wrote a fragment, and 8 wrote a run-on; $\chi^2(2) = 83.27, p < 0.001$. Of the 110 fourth graders who completed the year 2 sentence writing task, 98 wrote a complete sentence, 2 wrote a fragment, and 10 wrote a run-on sentence; $\chi^2(2) = 154.76, p < 0.001$. All chi-square tests confirmed that frequency of the three possible outcomes on the sentence writing task differed significantly from the null distribution in which all categories occur equally often. Thus, the most frequently occurring construction was a complete sentence, which occurred significantly more often than did fragments or run-ons.

For purposes of summarizing and explaining the results of the descriptive statistics, the frequencies were converted to percentages of children at each grade level who produced each of the three kinds of sentence or non-sentence constructions on the sentence integrity task. Children were more likely to write complete sentences (69% first graders, 85% second graders, 92% third graders, and 89% fourth graders) than run-on sentences (28%, first graders, 7% second graders, 7%, third graders, and 9%, fourth graders) or sentence fragments (3%, first graders, 8%, second graders, 0% third graders, and 2% fourth graders).

Inspection of these summary descriptive conclusions supported three conclusions. First, the majority of child writers in first, second, third, and fourth grade could write a complete sentence when instructed to do so. Second, the absolute number of children (frequency) who could do so increased from first to second grade and then to third and fourth grade, when it tended to asymptote on the sentence integrity task. Third, those child writers who could not write a complete sentence accounted for a non-trivial percentage of the first graders (about 30%), second graders (15%), and third and fourth graders (range 8% to 11%); both less than complete sentences (fragments) and more than complete sentences (run-on sentences) occurred.

For grammar usage errors, which are not the same as syntactic structure for the complete clausal or sentence construction (see Chomsky, 1965), two levels of descriptive statistics were computed: (a) total proportion of sentences at each grade level with errors in grammar usage rules; and (b) percent of child writers who made grammar errors. Regarding the first, the proportion of sentences with observed grammatical usage errors was on average 0.52 (SD = 0.72) in first grade and 0.23 (SD = 0.50) in third grade in year 1 and 0.23 (SD = 0.52) in second grade and 0.24 (SD = 0.58) in fourth grade in year 2. However, the majority of the child writers did not make grammar errors. Only 28% of the first graders and 19% of the third graders in year 1 and 17% of the second graders and 19% of the fourth graders in year 2 made grammatical usage errors.

Correlations between sentence integrity (rescaled quantitatively with 1 for complete sentence and 0 for fragment or run-on) and number of grammatical usage errors each child produced were significant: at first grade, $r(1,126) = 0.72$, $p < 0.001$; at second grade, $r(1, 122) = 0.82$, $p < 0.001$; at third grade, $r(1, 112) = 0.52, p < 0.001$; and at fourth grade, $r(1,109) = 0.63, p < 0.001$. Thus, in an unreferred sample in which most normally developing writers in first through fourth grade can write a complete sentence when requested to do so, the percent variance shared between the number of complete sentences and the number of grammar errors

ranged from a low of 27% in third grade to a high of 67% in second grade. Thus, some individuals may lack syntactic awareness for a sentence unit and knowledge of grammar usage but others are impaired in only one or neither of these. Future research might explore whether an impaired language learning mechanism, supported by a working memory architecture (Berninger, Abbott, Swanson, Lovitt, Trivedi, Lin et al., 2010b), may explain both syntactic and grammar usage errors in some individuals. In educational settings, children who make frequent sentence fragments or run-on sentences and grammar usage errors in writing should be referred for screening or diagnostic assessment to identify possible language learning needs across oral and written language; and, if identified, plan language intervention (see Silliman & Scott, 2009). Also, addressing these language learning needs early in writing development may enhance children's motivation and self-efficacy resulting in better writing achievement throughout schooling (Hidi & Boscolo, 2006).

Study 2

Measures

Each of the following measures was administered according to instructions in the test manual. For sentence combining, which is one of three tasks in the *Wechsler Individual Achievement Test, 2nd Edition* (WIAT II) (The Psychological Corporation, 2002) Written Expression subtest, children were given two sentences and asked to combine them into one sentence with the same meaning. Children's written productions were then scored according to criteria in the test manual for awarding points: 2 (preserves the meaning, is syntactically complete and well-written, and makes no transcription errors), 1 (syntactically acceptable but not as well written or makes a transcription error), or 0 (syntactically unacceptable).

Five measures were given to use as predictors in multiple regressions at each grade level in years 1 and 2: automatic alphabet letter writing, dictated spelling, morphology (choosing word whose suffix marks grammar that fits a specific sentence context), silent sentence-reading comprehension fluency, and sentence integrity (1 point for complete sentence and 0 points for fragment or run-on). The first two predictor measures assessed transcription skills (subword-level handwriting and word-level spelling) in cognitive models of writing. For alphabet writing (Berninger, 2001), the child printed from memory the letters of the alphabet in order as accurately (legibly) and quickly as possible. The score was the number of legible, correctly formed letters in alphabetic order in the first 15 s, an index of automatic letter retrieval and production. For spelling, the child spelled in writing the dictated words of increasing difficulty on the WIAT II. Words were pronounced once, then used in a sentence to provide context clues for meaning, and then pronounced a final time.

The last three predictor measures assess different kinds of syntactic skills. For morphological—signals (Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003, an adaptation of Singson, Mahoney, & Mason, 2000; and Tyler & Nagy, 1989,

1990) that assesses awareness of the role of suffixes in marking grammar (tense, plurality, part of speech) at the word-level, the child selected one of four choices (pseudomorphs—pseudowords with a real inflectional or derivational suffix that fits a sentence context). For example, of these choices–*wibbled*, *wibbling*, *wibbler*, *wibbly*—only *wibbler* fits in the sentence context: *The* _____ *really enjoys sharing his sport with others*. Such grammatical awareness at the word-level may serve as a bridge to syntactic awareness at the sentence-level in reading comprehension and written composing. Performance on the Signals test assesses morphological knowledge independent of reading ability because the examiner read each sentence and the choices to the child who could read or look at them silently while the examiner read them orally. For silent sentence-reading comprehension fluency, which assesses dual attention to both word-level word identification and syntax-level reading comprehension (Berninger, Abbott, & Alsdorf, 1997), the child chose the one sentence in a set of three that was meaningful (Berninger, 2001). Although the three sentences contain only real words, two contain one word (a foil) that renders the whole sentence meaningless. Successful performance requires syntactic processing, but not necessarily syntactic knowledge of what constitutes a complete sentence. For administration of sentence integrity, see Study 1 Methods.

Data analyses

Correlations were performed to evaluate whether measures chosen, for theoretical reasons and evidence from past research regarding their relationship to composing, were correlated with the outcome of interest—sentence combining, at each grade level. If they were, measures were entered as predictors into the multiple regression. The purpose of the multiple regression was to identify which predictors in a set, which were shown to be correlated with the outcome, explained unique variance in the outcome over and beyond shared covariance with other predictors.

Results and discussion

The correlations between sentence combining and the other five predictors are reported in Table 1. For the first, second, and third grades, the first four predictors were significantly correlated with sentence combining (see Table 1) and thus were entered into the multiple regression with sentence combining as the outcome. In the fourth grade, when the sentence integrity measure was also correlated significantly with the outcome (Table 1), it was also entered, along with the other predictors, which were still correlated with the outcome, into the multiple regression.

Developmental changes

Results of the multiple regressions are reported in Table 2 by grade. All regressions accounted for significant variance at each grade level. In interpreting results, keep in mind that both syntax and transcription are taken into account in scoring sentence combining. In first grade, only morphological signals, a word-level task, explained

Table 1 Correlations of predictors with WIAT II Sentence combining outcome by grade level

Predictors	Grade 1	Grade 2	Grade 3	Grade 4
PAL Alph 15	0.39***	0.29***	0.43***	0.52***
WIAT II spell	0.48***	0.55***	0.65***	0.49***
Morph signals	0.50***	0.32***	0.55***	0.34***
PAL sentence sense	0.36***	0.45***	0.55***	0.37***
UW sentence integrity	0.05 ns	0.09 ns	0.02 ns	0.27**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

unique variance in sentence combining. Thus, endings on words that mark grammar functions (Nunes, Bryant, & Bindman, 1997, 2006) are related to sentence combining. Morphology serves a unique scaffolding function within and across levels of language, beginning in first-grade writers: It is both (a) a *bridge across spoken and written words at the word-level* where morphemes correspond to both phonology and orthography, and (b) a *bridge across the word- and syntax- levels* for relating word-level suffixes marking grammatical function to sentence syntax. In second grade, only spelling, which shares common variance with morphological knowledge (Carlisle, 1994; Carlisle & Nomanbhoy, 1993; Garcia, 2007; Garcia, Abbott, & Berninger, 2010) and marks parts of speech (grammar) (Nunes & Bryant, 2006; Nunes, et al., 1997, 2006; Tyler & Nagy, 1989, 1990), explained unique variance in sentence combining. In third grade, subword- (handwriting automaticity) and word- (spelling and morphological signals) levels explained unique variance in sentence combining. This result is consistent with prior findings that both transcription skills (letter writing and word spelling) (Berninger & Amtmann, 2003; Berninger & Swanson, 1994) and morphological knowledge, as already explained, are related to writing in grades one to four. In fourth grade, both word-spelling and sentence integrity explained unique variance in sentence combining.

Two findings observed only at the fourth grade level provide converging evidence for the hypothesis that the relationship between syntax knowledge and transcription during translation changes from the first three grades to the fourth grade. First, sentence integrity, which reflects knowledge of what constitutes a complete sentence, was not correlated with sentence combining, which reflects syntactic knowledge enabling flexible transformation of syntactic structures for more concise idea expression, in the first three grades but was in fourth grade (Table 1). Second, in fourth grade both word-level transcription (spelling) and syntactic level (sentence integrity) skills explained unique variance in sentence combining, whereas earlier only word-level skills did. Thus, the first two hypothesis-driven predictions were confirmed.

Differences across reading and writing modes at the syntactic level

That the silent sentence-reading comprehension fluency measure did not explain any unique variance in the sentence-combining measure, even though it was correlated with it, is of some interest, especially because children have to read each of the

Table 2 Multiple regression for constant outcome (WIAT II sentence combining) grades 1–4 and predictors (automatic handwriting, spelling, morphological signals, and silent reading comprehension fluency grades 1–4; plus sentence integrity in grade 4)

Grade	R^2	*df*	*F*	*p*	Predictor variable	*t*	*p*
1	0.53	4,103	10.13	<0.001	PAL Alph 15	0.47	0.64
					WIAT II Spell	1.66	0.10
					Morph signals**	2.82	0.006
					PAL sentence sense	1.57	0.12
2	0.34	4,111	11.56	<0.001	PAL Alph 15	0.36	0.72
					WIAT II spell***	4.07	<0.001
					Morph signals	0.45	0.65
					PAL sentence sense	1.81	0.07
3	0.72	4,106	28.01	<0.001	PAL Alph 15*	1.99	0.05
					WIAT II spell***	3.96	<0.001
					Morph signals***	3.74	<0.001
					PAL sentence sense	0.56	0.58
4	0.58	5,96	9.61	<0.001	PAL Alph 15	1.56	0.12
					WIAT II spell***	3.54	0.001
					Morph signals	1.07	0.29
					PAL sentence sense	0.54	0.59
					Sentence integrity*	2.11	0.04

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

sentences to be combined and the new sentence they are constructing on this task. One explanation for this finding is that reading comprehension and written expression may draw on syntactic knowledge in different ways. Also, the silent reading measure used may have focused readers' attention more on the details within words, whereas the sentence combining task requires (a) focusing attention on word meaning or relationships among words across the syntax unit, (b) omitting or reordering words, and (c) introducing new words or phrases to express the same idea(s) in a more concise way. Thus, multiple kinds of knowledge and processing may contribute to syntactic knowledge underlying sentence re-construction.

Study 3

Writing tasks

In years 2 and 4, when children in cohort 1 were in second or fourth grade and children in cohort 2 were in fourth or sixth grade, they wrote essays, first by pen and then by keyboard. In years 3 and 5, when children in cohort 1 were in third or fifth grade and children in cohort 2 were in fifth or seventh grade, they wrote narratives, first by pen and then by keyboard. For the essay-by-pen task, children were given

this topic, "Explain what a computer is and what it does to someone who has never seen one or used one. "They were instructed to write sentences to complete the essay. For the essay-by-keyboard task, children were given this topic, "Explain what a robot is and can do to someone who has never seen one or used one." They were instructed to add sentences to complete the essay. For the narrative-by-pen task, children were given this topic, "One day at school a funny or surprising thing happened…" and were asked to choose funny or surprising and then add sentences to complete the story. For the narrative-by-keyboard task, they were given this topic, "One weekend at home a funny or surprising thing happened…" and were asked to choose funny or surprising and then add sentences to complete the story. For both the essay and the narrative, children had ten minutes to complete their composition, and, if they stopped writing before the ten minutes had elapsed, they were prompted up to two times to continue their writing with, "What else can you think of?"

Before writing the essays or narratives, children completed a sentence integrity task by pen and then by keyboard. In years 2 and 4, the topic for the sentence-by-pen task was "Writing," and for the sentence-by-keyboard task was "Reading". In Years 3 and 5, for the sentence-by-pen task the topic was to write one sentence about "My favorite thing at school …", and for the sentence-by-keyboard task, the topic was to write one sentence about "My favorite thing at home …" There was no time limit for writing the single good sentence. For additional details about the tasks, administration procedures, and lack of effects due to pen tasks being administered earlier in the session than the keyboard tasks, see Berninger et al. (2009).

Coding syntactic categories

In the first phase of data analyses, a linguistic coding system was developed to account for all observed syntactic constructions in the extended text writing (essays or narratives) and sentence writing of both cohorts from the second to seventh grades. In the second phase of data analyses, the coding scheme, which identified eleven kinds of syntactic structures in the children's writing, was used to code the frequency of occurrence of each of these categories across all writing samples that were codable (the child produced writing that met research criteria established for reliable scoring). Results were used for making comparisons by the three contrasts of interest: different levels of language (text or sentence), transcription mode (pen or keyboard), or genre (essay or narrative).

In the process of reading the writing samples to develop the coding scheme during the first phase, we noted that the child writers generally, but not always, used both an initial capital letter and final punctuation to mark sentence boundaries. Because the goal of the third study was to identify frequency of occurrence of kinds of syntactic constructions in children's writing and not to study their reliable application of capitalization and punctuation, the following coding rules were adopted:

(a) Units of writing were coded for syntax if (a-1) The child had capitalized *and* punctuated (clearly marked the unit as a sentence); or (a-2) The child had

either capitalized at the beginning *or* punctuated at the end and the unit did not seem to be part of either a preceding sentence clearly punctuated or succeeding sentence clearly capitalized. The lack of either a capital letter or punctuation mark was likely due to momentary inattention rather than lack of intention to construct a syntactic unit. Considerable inspection showed that use of one marker (capital letter or punctuation mark), but not both markers, occurred occasionally in protocols in which sentence units were generally marked by capital letters and punctuation marks. Rarely, except in first grade, did a child produce written text without any capital letters or punctuation marks, but in such cases written productions were not coded for kinds of syntax in children's writing, which is why Table 3 indicates the N for the number of writing samples available for coding each level of language, transcription mode, and genre for each cohort and year.

(b) Clauses correctly joined by a semicolon or conjunction were coded for nature of complex clause construction.

(c) Fragments were constructions that were less than a main clause.

The final coding scheme had eleven categories, each of which is illustrated in the "Appendix". The coding scheme differentiates among (a) a single independent main clause, (b) an immature, noncordinate main clause construction, in which a coordinating conjunction (e.g., And) is placed at the beginning of an independent clause (McCutchen, 1987), (c) coordinate main clauses in which two independent clauses are combined with either a coordinating (*and*) or correlative (*either …. or*) conjunction, (d) four kinds of independent clause plus dependent clause construction (relative, complement, subordinate, and adverbial), and (e) other (quotations, non-clausal constructions, and fragments). Of considerable research interest was how often child writers use primarily single independent clauses and how often they use a complex construction with an independent and a dependent clause and, when the latter, what kind of complex construction is used.

To calculate inter-rater reliability for the coding scheme developed in the first phase, a research coordinator and a graduate research assistant randomly selected 20 writing samples for each of four tasks from different years, cohorts, and writing ability levels: narratives by pen, the sentence integrity task by pen, essays by keyboard, and the sentence integrity task by keyboard. One rater served as the anchor for computing percent agreement between coders. The inter-rater reliability was generally very good for each coded category. Except for two categories, initial percent agreement ranged from 84.6% to 100%. For the only two categories of low interrater reliability, subordinate and adverbial clauses, additional training and reliability checks improved inter-rater reliability for these to acceptable levels of over 0.80.

Table 3 reports the frequency of each of the eleven coded syntactic categories for two genre of extended text for each transcription mode—essays in second, fourth, and sixth grade and narratives in third, fifth, and seventh grade, and sentence writing in grades 2 to 7.

Table 3 Frequency of each of 11 coded written syntactic structures for level of language (text or sentence), transcription mode (pen or keyboard), and genre (essay or narrative) by grade level. *N* number of codable writing samples; fewer were available at first grade than other grades because some children did not capitalize or punctuate so that sentences could be differentiated. See "Appendix" for coding criteria with examples

	Essay text—cohort 1				Sentences—cohort 1			
	Gr 2 Pen ($N = 24$)	Gr 2 Keys ($N = 52$)	Gr 4 Pen ($N = 116$)	Gr 4 Keys ($N = 116$)	Gr 2 Pen ($N = 116$)	Gr 2 Keys ($N = 61$)	Gr 4 Pen ($N = 118$)	Gr 4 Keys ($N = 117$)
Single independent main clause	24	39	244	145	87	42	87	64
Noncoordinate main clause	2	1	23	12	0	1	0	0
Coordinate main clause	3	2	53	34	3	2	4	9
Correlative clause	0	0	0	0	0	0	0	9
Relative clause	8	12	149	69	7	2	6	11
Complement clause	1	4	28	24	3	0	5	1
Subordinate clause	2	9	60	37	9	6	16	30
Adverbial clause	0	0	1	3	3	0	0	1
Quotation	0	0	1	3	0	0	0	0
Non-clausal independent units	0	0	1	0	0	0	1	0
Fragment	0	1	10	2	16	2	4	2

Table 3 continued

	Essay text—cohort 2				Sentences—cohort 2			
	Gr 4 Pen ($N = 108$)	Gr 4 Keys ($N = 101$)	Gr 6 Pen ($N = 109$)	Gr 6 Keys ($N = 106$)	Gr 4 Pen ($N = 108$)	Gr 4 Keys ($N = 103$)	Gr 6 Pen ($N = 108$)	Gr 6 Keys ($N = 108$)
Single independent main clause	186	137	275	162	67	52	82	56
Noncoordinate main clause	24	5	29	27	2	1	0	1
Coordinate main clause	47	28	32	49	4	7	2	4
Correlative clause	0	0	0	0	0	0	0	0
Relative clause	167	76	197	137	15	10	11	23
Complement clause	15	25	33	27	3	2	3	2
Subordinate clause	46	25	74	74	29	40	19	22
Adverbial clause	2	0	0	1	0	0	0	0
Quotation	1	0	0	1	0	0	1	1
Non-clausal independent units	2	0	0	1	0	0	0	0
Fragment	8	2	8	8	2	0	0	0
	Narrative text—cohort 1				Sentence writing—cohort 1			
	Gr 3 Pen ($N = 111$)	Gr 3 Keys ($N = 106$)	Gr 5 Pen ($N = 113$)	Gr 5 Keys ($N = 113$)	Gr 3 Pen ($N = 96$)	Gr 3 Keys ($N = 92$)	Gr 5 Pen ($N = 106$)	Gr 5 Keys ($N = 97$)
Single independent main clause	191	114	206	119	28	54	30	31
Noncoordinate main clause	28	7	23	24	2	3	2	1
Coordinate main clause	53	34	90	44	8	8	16	15
Correlative clause	0	0	0	0	0	0	0	0
Relative clause	13	5	22	22	6	5	12	8
Complement clause	34	10	55	40	3	0	4	3
Subordinate clause	50	32	88	69	37	23	64	38

Table 3 continued

	Narrative text—cohort 1				Sentence writing—cohort 1			
	Gr 3 Pen ($N = 111$)	Gr 3 Keys ($N = 106$)	Gr 5 Pen ($N = 113$)	Gr 5 Keys ($N = 113$)	Gr 3 Pen ($N = 96$)	Gr 3 Keys ($N = 92$)	Gr 5 Pen ($N = 106$)	Gr 5 Keys ($N = 97$)
Adverbial clause	4	1	7	6	0	0	0	0
Quotation	20	11	30	18	0	0	0	0
Non-clausal independent units	5	3	6	6	1	0	0	0
Fragment	12	8	4	7	17	7	8	9
	Narrative text—cohort 2				Sentence writing—cohort 2			
	Gr 5 Pen ($N = 106$)	Gr 5 Keys ($N = 106$)	Gr 7 Pen ($N = 100$)	Gr 7 Keys ($N = 97$)	Gr 5 Pen ($N = 100$)	Gr 5 Keys ($N = 98$)	Gr 7 Pen ($N = 96$)	Gr 7 Keys ($N = 89$)
Single independent main clause	192	157	220	128	31	34	27	27
Noncoordinate main clause	18	13	22	27	5	1	6	4
Coordinate main clause	101	77	77	79	14	10	14	13
Correlative clause	30	0	0	0	0	10	0	0
Relative clause	29	20	42	32	16	15	8	10
Complement clause	70	53	89	73	7	6	5	7
Subordinate clause	86	65	102	122	50	43	44	38
Adverbial clause	8	2	8	3	0	0	0	0
Quotation	23	15	28	22	0	0	0	0
Non-clausal independent units	7	2	3	8	1	0	0	0
Fragment	4	6	1	3	10	2	3	1

Data analyses

Descriptive analyses were used to identify the frequency with which various kinds of syntactic structures were observed in children's writing at different levels of language, by different transcription modes, and across genre. Inferential statistical analyses were then used to examine these contrasts from the perspective of drawing conclusions about the syntactic structures that are likely to appear in writing produced by second through seventh graders.

Results and discussion

Descriptive analyses of coded syntactic categories

Observed frequencies for each of the eleven coded syntactic categories are displayed in Table 3, which is organized by writing task (essays or narratives or single sentence), transcription mode (pen or keyboard), and grade levels (second to seventh). The coded categories did account for the variation in syntactic structure observed. Inspection of the frequencies of the coded syntactic structures across levels of written language, transcription mode, and genre, and grade levels identified the following patterns in the data.

For extended text writing (essays or narratives), consistently across genre and transcription modes from grade one to seven, the most frequent syntactic construction was the single independent clause. Single independent clauses introduced with a coordinating conjunction, an immature form of writing, occurred far less often. Constructions involving two independent clauses were connected with coordinating conjunctions far more often than with correlative conjunctions. Of the four kinds of syntactic constructions involving an independent clause and a dependent clause, relative clauses occurred the most often in essays. Although subordinate clauses occurred the most often in narratives, adverbial clauses occurred relatively infrequently, but more often in narratives than in essays. Quotations and nonclausal constructions were more likely to occur in narrative than essay texts. Fragments occurred at a relatively low frequency in both genres.

However, for sentence writing tasks, both single independent clause and independent clause plus dependent clause constructions occurred, but more complex T-units (independent clause with dependent clause) were produced than single independent clauses at grade three for sentence writing by pen (cohort 1 only), and at grade five (both cohorts) and grade seven (cohort 2) for sentence writing by pen and by keyboard.

Thus, whether children were asked to write an extended piece of writing (essay or narrative) or just a single good sentence appears to be related to whether a single independent clause (more likely for multi-sentence construction) or an independent clause plus a dependent clause (more likely for a single-sentence construction) was produced. This finding was contrary to the prediction that single independent clauses would be more likely to occur in single sentences (sentence integrity task), but more complex clausal constructions were more likely in extended text of essays and narratives.

Developmental trends were also evident. Although many single clauses were written across the grades and genre, the number of complex syntactic constructions increased for the older compared to the younger writers (see Table 3). These results are consistent with other reports that the syntactic complexity becomes more advanced over the grades (Hunt, 1965, 1966, 1970). However, the exact trajectory of this development depends on a number of factors, including the specific measure of syntactic complexity used and genre (Beers & Nagy, 2008), as the analyses for genre later in this section also show.

Inferential statistical analyses: contrasts for levels of language and transcription modes

Table 4 summarizes the results of repeated analyses of variance that compared the clausal constructions for extended text by transcription modes at different grade levels. Table 5 summarizes comparable findings for the sentence writing tasks. These analyses were performed only on frequently occurring syntactic categories of theoretical interest: single independent main clauses and three kinds of independent plus dependent clause constructions—relative, complement, and subordinate. For these analyses, extended text writing and single sentence writing were analyzed separately because of differences in their lengths and thus opportunity to use the different kinds of syntactic constructions.

As shown in Table 4, in grades 2 to 7 for one independent clause, the main effect for transcription mode was always significant for text writing. The means showed that more single independent clauses were produced when writing by pen than by keyboard. These findings converge with others showing that for essays children wrote more words and wrote words faster (Berninger et al., 2009) and expressed more ideas (Hayes & Berninger, 2010) by pen than by keyboard.

The findings were mixed for the syntactic constructions involving an independent clause plus a dependent clause. For independent plus relative clause, transcription mode was significant in only three of the eight analyses, for which independent plus relative clause constructions were produced more often by pen. Likewise, the transcription mode was significant for only one of the eight analyses for independent plus complement clause and two of the eight analyses for independent plus subordinate clause. In all these cases more independent plus complement clause constructions were produced by pen than by keyboard.

Length of text written appears to matter for transcription mode effects, as also found by Berninger et al. (2009). Results for single-sentence composing were different from what was found for multi-sentence composing and in general were mixed, as Berninger et al. (2009) had also found. As shown in Table 5, the results for the same eight outcomes on each of the sentence writing tasks given in years 2, 3, 4, and 5 were not clear cut, but were certainly different from those observed for extended text writing of either essays or narratives. For the four significant effects for a single independent clause, three favored more clauses on average when writing by pen than by keyboard. However, the one significant transcription mode effect for independent plus relative clause favored more of these clause constructions by keyboard than by pen. Of the four significant mode effects for independent plus

Table 4 Differences between transcription modes by pen and keyboard for specific clausal productions in extended text (essays and narratives) in grades 2–7

Syntactic structure genre (grade, cohort)	*df*	*F*	*p*	Pen [*M* (SD)]	Keys [*M* (SD)]
One independent clause					
Essay (Gr 2, Coh 1)	1,18	1.90	ns	1.04 (1.19)	0.75 (0.97)
Essay (Gr 4, Coh 1)	1,114	20.86	0.001	2.10 (2.14)	1.25 (1.56)
Essay (Gr 4, Coh 2)	1,98	4.48	0.04	1.72 (1.74)	1.36 (1.38)
Essay (Gr 6, Coh 2)	1,105	18.93	0.001	2.52 (2.25)	1.53 (1.46)
Narrative (Gr 3, Coh 1)	1,100	8.53	0.004	1.72 (1.88)	1.08 (1.43)
Narrative (Gr 5, Coh 1)	1,111	16.01	0.001	1.82 (1.97)	1.11 (1.32)
Narrative (Gr 5, Coh 2)	1,104	3.74	0.06	1.81 (1.87)	1.48 (1.62)
Narrative (Gr 7, Coh 2)	1,95	14.92	0.001	2.10 (1.97)	1.32 (1.67)
Independent plus relative clause					
Essay (Gr 2, Coh 1)	1,18	2.94	0.10	0.35 (0.49)	0.23 (0.55)
Essay (Gr 4, Coh 1)	1,114	28.28	0.001	1.28 (1.38)	0.59 (0.78)
Essay (Gr 4, Coh 2)	1,98	19.36	0.001	1.55 (1.69)	0.75 (0.95)
Essay (Gr 6, Coh 2)	1,105	9.70	0.002	1.81 (1.58)	1.29 (1.24)
Narrative (Gr 3, Coh 1)	1,100	1.59	0.21	0.12 (0.40)	0.05 (0.35)
Narrative (Gr 5, Coh 1)	1,111	0.28	0.60	0.19 (0.53)	0.23 (0.52)
Narrative (Gr 5, Coh 2)	1,104	0.82	0.37	0.27 (0.61)	0.19 (0.62)
Narrative (Gr 7, Coh 2)	1,95	0.98	0.33	0.42 (0.67)	0.33 (0.69)
Independent plus complement clause					
Essay (Gr 2, Coh 1)	1,18	0.00	1.00	0.04 (0.21)	0.08 (0.27)
Essay (Gr 4, Coh 1)	1,114	0.23	0.64	0.24 (0.64)	0.21 (0.49)
Essay (Gr 4, Coh 2)	1,98	3.35	0.07	0.14 (0.42)	0.25 (0.56)
Essay (Gr 6, Coh 2)	1,105	0.56	0.46	0.30 (0.69)	0.25 (0.52)
Narrative (Gr 3, Coh 1)	1,100	10.53	0.002	0.31 (0.60)	0.09 (0.33)
Narrative (Gr 5, Coh 1)	1,111	2.21	0.14	0.49 (0.71)	0.35 (0.65)
Narrative (Gr 5, Coh 2)	1,104	2.16	0.15	0.66 (1.02)	0.50 (0.82)
Narrative (Gr 7, Coh 2)	1,95	0.99	0.32	0.89 (1.08)	0.75 (1.31)
Independent plus subordinate clause					
Essay (Gr 2, Coh 1)	1,18	0.19	0.67	0.09 (0.29)	0.17 (0.51)
Essay (Gr 4, Coh 1)	1,114	6.36	0.01	0.52 (0.83)	0.32 (0.67)
Essay (Gr 4, Coh 2)	1,98	3.24	0.08	0.43 (0.69)	0.25 (0.62)
Essay (Gr 6, Coh 2)	1,105	0.00	1.00	0.68 (0.96)	0.70 (0.99)
Narrative (Gr 3, Coh 1)	1,100	4.80	0.03	0.45 (0.68)	0.30 (0.59)
Narrative (Gr 5, Coh 1)	1,111	2.52	0.12	0.78 (0.98)	0.61 (0.92)
Narrative (Gr 5, Coh 2)	1,104	2.00	0.16	0.81 (1.11)	0.61 (1.00)
Narrative (Gr 7, Coh 2)	1,95	2.30	0.13	1.03 (1.03)	1.26 (1.54)

subordinate clause, three favored more of these clause constructions by keyboard than pen. No transcription mode effects were found for independent plus complement clause constructions.

Table 5 Differences between transcription modes by pen and keyboard for specific clausal productions in sentence writing in grades 2–7

Syntactic structure (grade, cohort)	*df*	*F*	*p*	Pen [*M* (SD)]	*Keys* [*M* (SD)]
One independent clause					
(Gr 2, Coh 1)	1,57	1.96	0.17	0.75 (0.44)	0.69 (0.47)
(Gr 4, Coh 1)	1,116	329.55	0.001	0.74 (0.044)	0.55 (0.50)
(Gr 4, Coh 2)	1,100	4.31	0.04	0.62 (0.49)	0.50 (0.50)
(Gr 6, Coh 2)	1,107	4.36	0.04	0.76 (1.10)	0.52 (0.50)
(Gr 3, Coh 1)	1,81	18.44	0.001	0.29 (0.46)	0.59 (0.50)
(Gr 5, Coh 1)	1,93	0.93	0.34	0.28 (0.45)	0.32 (0.47)
(Gr 5, Coh 2)	1,92	0.57	0.45	0.31 (0.47)	0.35 (0.48)
(Gr 7, Coh 2)	1,86	0.00	1.00	0.28 (0.45)	0.30 (0.46)
Independent plus relative clause					
(Gr 2, Coh 1)	1,57	0.00	1.00	0.06 (0.24)	0.03 (0.18)
(Gr 4, Coh 1)	1,116	1.94	0.17	0.05 (0.22)	0.09 (0.29)
(Gr 4, Coh 2)	1,100	1.82	0.18	0.14 (0.37)	0.10 (0.30)
(Gr 6, Coh 2)	1,107	5,78	0.018	0.10 (0.30)	0.21 (0.43)
(Gr 3, Coh 1)	1,100	1.59	0.21	0.06 (0.24)	0.05 (0.23)
(Gr 5, Coh 1)	1,93	0.47	0.49	0.11 (0.32)	0.08 (0.31)
(Gr 5, Coh 2)	1,104	0.82	0.37	0.16 (0.42)	0.15 (0.39)
(Gr 7, Coh 2)	1,86	0.22	0.64	0.08 (0.28)	0.11 (0.35)
Independent plus complement clause					
(Gr 2, Coh 1)	1,57	3.11	0.08	0.03 (0.16)	0.00 (0.00)
(Gr 4, Coh 1)	1,116	2.71	0.10	0.04 (0.20)	0.01 (0.09)
(Gr 4, Coh 2)	1,100	0.33	0.57	0.03 (0.17)	0.02 (0.14)
(Gr 6, Coh 2)	1,107	0.20	0.66	0.03 (0.17)	0.02 (0.14)
(Gr 3, Coh 1)	1,81	2.03	0.16	0.03 (0.18)	0.00 (0.00)
(Gr 5, Coh 1)	1,93	0.11	0.74	0.04 (0.24)	0.03 (0.17)
(Gr 5, Coh 2)	1,92	0.00	1.00	0.07 (0.26)	0.06 (0.24)
(Gr 7, Coh 2)	1,86	0.08	0.78	0.05 (0.22)	0.08 (0.31)
Independent plus subordinate clause					
(Gr 2, Coh 1)	1,57	2.75	0.10	0.08 (0.30)	0.10 (0.30)
(Gr 4, Coh 1)	1,116	6.41	0.01	0.14 (0.37)	0.26 (0.48)
(Gr 4, Coh 2)	1,100	6.12	0.02	0.27 (0.47)	0.39 (0.56)
(Gr 6, Coh 2)	1,107	0.31	0.58	0.18 (0.41)	0.20 (0.43)
(Gr 3, Coh 1)	1,81	4.34	0.04	0.39 (0.53)	0.25 (0.46)
(Gr 5, Coh 1)	1,93	10.49	0.002	0.28 (0.45)	0.32 (0.47)
(Gr 5, Coh 2)	1,92	0.94	0.34	0.50 (0.56)	0.44 (0.68)
(Gr 7, Coh 2)	1,86	0.41	0.71	0.28 (0.45)	0.30 (0.46)

Thus, converging evidence, based on multiple dependent measures—number of words, rate of word production, and spelling (Berninger et al., 2009), ideas expressed as information (Hayes & Berninger, 2010), and now clausal structure in

Study 3, supports the conclusion that in early and middle childhood the advantages of writing by pen are observed only on writing tasks requiring extended writing to construct multi-sentence texts (essays or narratives). That is, they are most often observed *when the translation process is sustained over time in working memory to construct multiple sentences* rather than executed relatively briefly to construct a single sentence or produce a single letter (Berninger et al., 2009). One possible explanation for this finding, which requires further research to substantiate, is that the act of forming letters by pen rather than selecting them on keyboard is more able to engage the orthographic loop of working memory, that is, the orthographic letter or spelling representations in internal memory linked to sequential finger and hand movements during the act of writing. Consequently, when writers more readily engage the orthographic loop to form letters they can sustain composing in working memory over time longer stretches of time to create extended text. When the task requires only letter- or single-sentence construction, the effects of transcription mode on orthographic loop may not be as robust because the demands on working memory are not as great.

Future research might also address how any benefits found for writing by pen when translating ideas into multiple sentences may (a) enhance efficiency of temporally constrained working memory (e.g., Fayol, 1991, 1999, 2004; Hayes & Chenoweth, 2006) in ways other than engaging orthographic loop, or (b) depend on the complexity of the clausal construction and other cognitive constraints beyond the syntax level. Of some interest, sentence integrity first explained unique variance in sentence combining in fourth grade, which is an important transition time in writing development when writing requirements of the curriculum increase. For example, only word-level working memory contributed uniquely to writing and reading achievement in the first three grades in normally developing students, but both word-level and syntax-level working memory contributed uniquely beginning in fourth grade (Berninger et al., 2010b).

Future research might apply the Eye and Pen device developed by Alamargot and colleagues (e.g., Alamargot, Chesnet, Dansac, & Ros, 2006) to study the timing parameters in language bursts and pauses between them during writing (Hayes & Chenoweth, 2006) for constructing single independent clauses versus independent plus dependent clauses by pen and by keyboard, to determine if the current results replicate and, if so, rule between alternative explanations for them. These initial descriptive studies need to be extended with on-line experiments (see Fayol, in press, for overview) to understand more fully the translation process as it unfolds in real time.

Inferential analyses: genre contrasts

Table 6 summarizes the results showing that, contrary to prediction, the most frequent syntactic category for multi-sentence constructions was the single independent clause. However, complex clause constructions involving an independent clause and dependent clause did occur in multi-sentence text, even if less frequently, but the nature of the complex causal construction varied by genre. For essays in grades two and four (year 2) and grades four and six (year 4), the relative ordering of frequency

Table 6 Relative production of the four most prevalent clause constructions by genre

Genre	Syntactic structure	*df*	*F*	*p*	Grade (cohort)	*M* (SD)
Essays		1,107	93.67	0.001		
	Single				2 (1)	1.04 (1.19)
	Independent clause				4 (2)	1.72 (1.74)
	Independent plus				2 (1)	0.35 (0.49)
	Relative clause				4 (2)	1.55 (1.69)
	Independent plus				2 (1)	0.04 (0.21)
	Complement				4 (2)	0.14 (0.42)
	Clause					
	Independent plus				2 (1)	0.09 (0.29)
	Subordinate clause				4 (2)	0.43 (0.69)
Essays		1,108	92.85	0.001		
	Single				4 (1)	2.10 (2.14)
	Independent clause				6 (2)	2.52 (2.25)
	Independent plus				4 (1)	1.28 (1.38)
	Relative clause				6 (2)	1.81 (1.58)
	Independent plus				4 (1)	0.24 (0.64)
	Complement				6 (2)	0.30 (0.69)
	Clause					
	Independent plus				4 (1)	0.52 (0.83)
	Subordinate				6 (2)	0.68 (0.96)
	Clause					
Narratives		1,105	15.62	0.001		
	Single				3 (1)	1.72 (1.88)
	Independent				5 (2)	1.81 (1.87)
	Clause					
	Independent plus				3 (1)	0.12 (0.40)
	Relative clause				5 (2)	0.27 (0.61)
	independent plus				3 (1)	0.31 (0.60)
	Complement				5 (2)	0.66 (1.02)
	Clause					
	Independent plus				3 (1)	0.45 (0.68)
	Subordinate				5 (2)	0.81 (1.11)
	Clause					
		1,99	21.22	0.001		
	Single				3 (1)	1.82 (1.97)
	Independent				5 (2)	2.10 (1.97)
	Clause					
	Independent plus				3 (1)	0.19 (0.53)
	Relative clause				5 (2)	0.42 (0.67)
	Independent plus				3 (1)	0.49 (0.71)
	Complement clause				5 (2)	0.89 (1.08)
	Independent plus				3 (1)	0.78 (0.98)
	Subordinate clause				5 (2)	1.03 (1.03)

after single independent clause from most to least was (a) independent plus relative clause, (b) independent plus subordinate clause, and (c) independent plus complement clause. For both narratives in grades three and five (year 3) and five and seven (year 5), the relative ordering after single independent clause from most to least was (a) independent plus subordinate clause, (b) independent plus complement clause, and (c) independent plus relative clause. In sum, relative clauses were more prevalent in essay writing than in narrative writing, and subordinate clauses were more prevalent in narrative writing than essay writing.

These results are consistent with research reports showing that early in writing development children (a) differentiate between different genres (Berman & Nir, 2004; Purcell-Gates, 1988), and (b) use genre for different communication purposes (Hudson & Shapiro, 1991). They are also consistent with findings that syntax and genre interactions continue to show interesting relationships in adolescence (Beers & Nagy, 2009).

General discussion

Individual and developmental differences in writing complete sentences

As shown in Study 1, most, but not all, beginning and developing writers could write complete sentences, and the percentage who could increased from grade one to grade three and stayed about the same in grade four. For those who could write a complete sentence, they had probably learned during the preschool and early school years what a sentence is from (a) producing clausal constructions in their oral conversations, (b) looking at the printed text while listening to adults and older children reading books to them, and (c) early experience in translating their ideas into speech and then to writing on paper.

However, two to nine percent of the child writers produced after thoughts (run-ons) and partial thoughts (fragments), showing that thoughts are not always translated into complete syntactic structures during the writing process. These children may require specialized instruction that heightens their syntactic construction abilities across oral and written language.

Developmental changes in combining sentences

Ability to write just one sentence does not mean that child writers have acquired full understanding of what a complete thought or what a well written sentence is. Nevertheless it is encouraging and interesting that complete-sentence construction emerges as early as first grade for many child writers, as reflected on the sentence integrity task—writing a complete thought rather than a partial thought or after thought. Although scoring on the sentence combining task always took into account both syntax (acceptability and quality) and transcription skills, only in fourth grade did both the sentence integrity task and word-level transcription contribute uniquely to it. This developmental pattern in the results suggests that the relationship between syntax and transcription during translation may change from the first three grades to

the fourth grade. Future research might explore via on-line experiments the nature of the syntactic awareness that contributes to emerging sentence construction ability and how syntactic awareness might evolve over writing development. Just as study of linguistic awareness (Mattingly, 1972), including phonological awareness (Liberman, Shankweiler, Fischer, & Carter, 1974) and word awareness (Ehri, 1987), has proved fruitful in reading acquisition research, so might it in writing acquisition research.

Contributions of morphology and syntax to translation

In first grade, the morphological signals test, which assesses knowledge of how suffixes mark grammar information related to sentence syntax, contributed uniquely to sentence combining, even though syntax (sentence integrity task) did not. Thus suffixes which mark tense, number, and part of speech may play an early role in learning how to use grammar to construct syntactic structures.

In the current study, syntax was conceptualized as a structural unit for translating ideas into language. We did not code for part of speech (grammatical roles of certain kinds of words within the syntactic structure), but do not minimize the importance of parts of speech for understanding how ideas are translated into written language via (a) content words (nouns and verbs and the adjectives and adverbs that qualify them, respectively), (b) function words (conjunctions, prepositions, pronouns, and articles that glue content words to each other within the syntactic envelope), and (c) phrases that describe actions, states of being, attributes, and relationships. Rather, we focused on the number and nature of the syntactic structures that may influence how complex ideas are expressed in syntactic units the writer constructs based on language-specific word order. These multi-word, syntactic units contain as a minimum a subject and a predicate, which together are analogous to the topic/comment units observed in children's early language development. The topics become more complex across language development—from simple objects or actions to complex phrases—and so do the comments, which are packaged within the larger syntactic envelope.

We used two kinds of syntactic construction measures to allow for the possibility that developing writers are learning to translate ideas into an ordered series of words with underlying structure (sentence integrity) as well as to re-translate ideas flexibly by altering syntactic structures (sentence combining). Undoubtedly many other aspects of syntax are involved in mastering the translation process whereby ideas are expressed via written language.

Although sentences are believed to represent complete thoughts, much theoretical and empirical work remains to be done to understand fully what thought is, let alone a complete thought. The idea of a complete sentence may be but one way thought can be expressed in language. Moreover, sentence construction draws not only on the word- and syntactic-levels of language during translation, but also in a multi-sentence text on non-linear discourse-level structures for deciding what to write for the next sentence in reference to an earlier topic and in reference to the emergent non-linear discourse schema (Berninger, Fuller, & Whitaker, 1996b).

At the *word level*, written words index the conceptual structures of the cognitive representation system which range from categorical (with prototypical and

non-prototypical features) to non-categorical spreading networks of associations. The challenge for the developing writer is to find a single good word (a single lexical item) to translate what may be a multi-dimensional, underlying cognitive representation. For further discussion of these issues, see Stahl and Nagy (2005).

At the *multi-word, syntactic level*, words are sequenced within the linear syntactic envelope to express ideas via (a) the predicate and its arguments (Kintsch & Van Dijk, 1978), grammatical relationships (e.g., for singular and plural forms of subjects and predicates, Fayol, Totereau, & Barrouillet, 2006), and cohesive ties including but not restricted to pronominal references (Halliday, 1987).

Discourse level

However, at the discourse level of written composition, the syntactic envelope also functions in a non-linear fashion to mark local relevance to a topic in previous text and global relevance to emergent structures that transcend linear structures (Berninger et al., 1996b). Thus, the deep structures may not be in language alone (Chomsky, 1965) or cognition alone, but rather in the complex cognitive-language mappings for translation that brings the unconscious into consciousness. For analogous arguments at the word-level regarding vocabulary instruction, see Stahl and Nagy (2005).

Role of syntax construction in writing instruction

In recent years the importance of teaching sentence grammar in the instructional program in writing has been dismissed based on the meta-analyses showing that intensive diagramming of parts of speech in sentences did not transfer to improved quality of composing (Hillocks, 1986). However, these studies confused levels of cognition-language mapping in their analyses. Instruction focused on the syntactic level, but its effectiveness was assessed for quality of content and organization at the discourse level. The more appropriate questions are whether instruction (a) at the syntactic level transfers to improved sentence construction and awareness, and (b) at the discourse level transfers to improved extended text writing quality.

Sentence diagramming is not the only way to teach syntactic and sentence awareness in first through seventh grade. Evidence-based options include (a) language cueing to find words performing specified sentence functions and sorting games to develop awareness of linguistic cues for guiding children to develop both syntactic and morphological awareness (Berninger & Wolf, 2009); and (b) explicit strategies such as sentence combining (e.g., Graham & Perin, 2007; Nelson et al., 2009; Saddler & Graham, 2005), which is essentially re-translating and may provide a developmental foundation for learning to revise to improve translation. However, additional research on syntactic construction is needed in order to optimize the writing achievement of all students at all levels of language, including word choice, syntax construction, and creation of discourse schema.

In this study we applied the methods of descriptive linguistics to the writing samples of developing children from first through seventh grade. What was learned about early and emerging syntactic construction may hopefully inform future instructional as well as developmental research on writing. Just as the eminent

writer, Mark Twain, complained that reports of his death were premature, so may be the reports of the death of teaching syntax. Developing syntactic awareness in child writers may enhance their ability to translate their thoughts into carefully crafted written sentences, alone or in text.

Acknowledgments The research reported in this article was supported by Grant No. HD25858 from the National Institute of Child Health and Human Development (NICHD). The authors acknowledge the contribution of the research staff in administering and scoring the measures, coding the sentences, and entering data into the computer data base, especially Patricia Stock and Amy Augsburger. They also thank Robert Abbott for creating a data base structure to facilitate ease of data analyses.

Appendix

Types of T-units (independent clauses with or without subordinate clauses) with examples

I. Single Independent Main Clause

I like math class.
Reading is fun.

II. More than One Independent Clause

A. *Noncoordinate* Main Clause beginning with a coordinating conjunction

***And** then we went to the playground.*

B. Coordinate Clause 2 independent clauses with coordinating conjunction

For my birthday, I got a new toy airplane ***and** I got to go to the zoo.*

C. Correlative Clause 2 independent clauses with correlative conjunction

Either we will have a party ***or** we will go to the fair.*

III. T-Units with Dependent Clause in T-Unit Coded

A. Relative Clause

The person *who lives in that house* is nice.

B. Complement Clause

I think *that you are nice.*

C. Subordinate Clause (also known as "dependent clause")

She helped me *because she is nice.*
Even though I'm only in second grade, I know how to write.

D. Adverbial Clause

Sarah ran *as fast as she could.*
Annie practiced *more than Sarah had.*
The boys were so sick *that they threw up.*

IV. Other

A. Quotation

Sarah said, "*I hope I win the race.*"
"Go to your room!" said my mom.

B. Non-Clausal Independent Units

The end.

C. Fragment

Missing or Illegible were not coded.

References

Abbott, R., Berninger, V., & Fayol, M. (2010). Longitudinal relationships of levels of language in writing and between writing and reading in grades 1 to 7. *Journal of Educational Psychology, 102*, 281–298.

Alamargot, D., Chesnet, D., Dansac, C., & Ros, C. (2006). Eye and Pen: A new device for studying reading during writing. *Behavior Research Methods, 38*, 287–299.

Beers, S., & Nagy, W. (2008). The development of syntactic complexity: Grade, genre, ability, and mode of transcription. *Paper presented at Santa Barbara conference on writing research: Writing research across borders*, *Santa Barbara, CA*.

Beers, S., & Nagy, W. (2009). Syntactic complexity as a predictor of adolescent writing quality: Which measures? Which genre? *Reading and Writing: An Interdisciplinary Journal, 22*, 185–200.

Berman, R. A., & Nir, B. (2004). Linguistic indicators of inter-genre differentiation in later language development. *Journal of Child Language, 31*, 339–380.

Berninger, V. (2001). *Process assessment of the learner (PAL) test battery for reading and writing*. San Antonio, TX: The Psychological Corporation.

Berninger, V., Abbott, R., & Alsdorf, B. (1997). Lexical- and sentence-level processes in comprehension of written sentences. *Reading and Writing: An Interdisciplinary Journal, 9*, 135–162.

Berninger, V., Abbott, R., Augsburger, A., & Garcia, N. (2009). Comparison of pen and keyboard transcription modes in children with and without learning disabilities affecting transcription. *Learning Disability Quarterly, 32*, 123–141.

Berninger, V., Abbott, R., Nagy, W., & Carlisle, J. (2010a). Growth in phonological, orthographic, and morphological awareness in grades 1 to 6. *Journal of Psycholinguistic Research, 39*, 141–163. Available on SpringerLink http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s10936-009-9130-6.

Berninger, V., Abbott, R., Swanson, H. L., Lovitt, D., Trivedi, P., Lin, S., et al. (2010b). Relationship of word- and sentence-level working memory to reading and writing in second, fourth, and sixth grade. *Language, Speech, and Hearing Services in Schools, 41*, 179–193.

Berninger, V., & Amtmann, D. (2003). Preventing written expression disabilities through early and continuing assessment and intervention for handwriting and/or spelling problems: Research into practice. In H. L. Swanson, K. Harris, & S. Graham (Eds.), *Handbook of research on learning disabilities* (pp. 345–363). New York: Guilford.

Berninger, V., Fuller, F., & Whitaker, D. (1996). A process approach to writing development across the life span. *Educational Psychology Review, 8*, 193–218.

Berninger, V. W., & Swanson, H. L. (1994). Modifying Hayes and Flower's model of skilled writing to explain beginning and developing writing. In E. Butterfield (Ed.), *Children's writing: Toward a process theory of development of skilled writing* (pp. 57–81). Greenwich, CT: JAI Press.

Berninger, V., & Wolf, B. (2009). *Teaching students with dyslexia and dysgraphia: Lessons from teaching and science*. Baltimore: Paul H. Brookes.

Berninger, V., Yates, C., Cartwright, A., Rutberg, J., Remy, E., & Abbott, R. (1992). Lower-level developmental skills in beginning writing. *Reading and Writing: An Interdisciplinary Journal, 4*, 257–280.

Carlisle, J. (1994). Morphological awareness, spelling, and story writing. Possible relationships for elementary-age children with and without learning disabilities. In N. C. Jordan & J. Goldsmith-Phillips (Eds.), *Learning disabilities. New directions for assessment and intervention* (pp. 123–145). Boston: Allyn Bacon.

Carlisle, J., & Nomanbhoy, D. (1993). Phonological and morphological awareness in first graders. *Applied Psycholinguistics, 14*, 177–195.

Chafe, W., & Danielewicz, J. (1987). Properties of spoken and written language. In R. Horowitz & S. J. Samuels (Eds.), *Comprehending oral and written language* (pp. 83–113). New York: Academic Press.

Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, MA: MIT Press.

Dockrell, J., & Connelly, V. (2009). The impact of oral language skills on the production of written text. *Teaching and learning writing, British Journal of Educational Psychology Series II, 6*, 27–44.

Ehri, L. (1987). Learning to read and spell words. *Journal of Reading Behavior, 19*, 5–31.

Fayol, M. (1991). From sentence production to text production: Investigating fundamental processes. *European Journal of Psychology of Education, VI*, 101–119.

Fayol, M. (1997). On acquiring and using punctuation. A study in written French. In J. Costermans & M. Fayol (Eds.), *Processing interclausal retionships. Studies in the production and comprehension of text*. Mahwah, NJ: Laurence erlbaum Ass. Inc.

Fayol, M. (1999). From on-line management problems to strategies in written composition. In M. Torrance & G. Jeffery (Eds.), *The cognitive demands of writing*. Amsterdam: Amsterdam University Press.

Fayol, M. (2004). Text and cognition. In T. Nunes & P. Bryant (Eds.), *Handbook of children's literacy* (pp. 181–197). Dordrecht, Netherlands: Kluwer.

Fayol, M. (in press). Cognitive processes of children and adults in translating thought into written language in real time: Perspectives from 30 years of programmatic cognitive psychology and linguistics research. In Berninger, V. (Ed.). *Past, present, and future contributions of cognitive writing research to cognitive psychology.* Psychology Press/Taylor Francis Group.

Fayol, M., Totereau, C., & Barrouillet, P. (2006). Disentangling the impact of semantic and formal factors in the acquisition of number inflections. Noun, adjective and verb agreement in written French. *Reading and Writing: An Interdisciplinary Journal, 19*, 717–736.

Garcia, N. (2007). *Comparing the contribution of phonological, orthographic, and morphological processes to the longitudinal spelling development of good, average, and poor spellers*. Unpublished Ph.D. Dissertation, University of Washington, Seattle, WA.

Garcia, N., Abbott, R., & Berninger, V. (2010). Predicting poor, average, and superior spellers in grades 1 to 6 from phonological, orthographic, and morphological, spelling, or reading composites. *Written Language and Literacy, 13*, 61–99.

Garvey, C., & Berninger, G. (1980). Timing and turn-taking in children's conversations. *Discourse Processes, 4*, 27–57.

Graham, S., & Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *Journal of Educational Psychology, 99*, 445–476.

Green, L., McCutchen, D., Schwiebert, C., Quinlan, T., Eva-Wood, A., & Juelis, J. (2003). Morphological development in children's writing. *Journal of Educational Psychology, 95*, 752–761.

Halliday, M. A. K. (1987). Spoken and written modes of meaning. In R. Horowitz & S. J. Samuels (Eds.), *Comprehending oral and written language* (pp. 55–82). San Diego, CA: Academic Press.

Harris, T. L., & Hodges, R. E. (Eds.). (1995). *The literacy dictionary: The vocabulary of reading and writing*. Newark, DE: International Reading Association.

Hayes, J. R. (1996). A new framework for understanding cognition and affect in writing. In M. C. Levy & S. Ransdell (Eds.), *The science of writing* (pp. 1–27). Mahwah, NJ: Erlbaum.

Hayes, J. R., & Berninger, V. (2010). Relationships between idea generation and transcription: How act of writing shapes what children write. In C. Braverman, R. Krut, K. Lunsford, S. McLeod, S. Null, P. Rogers, & A. Stansell (Eds.), *Traditions of writing research* (pp. 166–180). New York: Taylor and Frances/Routledge.

Hayes, J. R., & Chenoweth, N. (2006). Is working memory involved in the transcribing and editing of texts? *Written Communication, 23*, 135–149.

Hayes, J. R., & Flower, L. S. (1980). Identifying the organization of writing processes. In L. W. Gregg & E. R. Steinbert (Eds.), *Cognitive processes in writing* (pp. 3–30). Hillsdale, NJ: Lawrence Erlbaum Associates.

Hidi, S., & Boscolo, P. (Eds.) (2006). *Motivation in writing* (pp. 159–179). Originally Amsterdam: Elsevier; now Emerald: Australia.

Hillocks, G. (1986). *Research on written composition: New directions for teaching*. Urbana, IL: National Conference on Research in English.

Hudson, J. A., & Shapiro, L. R. (1991). From knowing to telling: Children's scripts, stories, and personal narratives. In A. McCabe & C. Peterson (Eds.), *Developing narrative structure* (pp. 89–136). Hillsdale, NJ: Erlbaum.

Hunt, K. W. (1965). *Grammatical structures written and three grade levels (research report no. 3)*. Champaign, IL: National Council of Teachers of English.

Hunt, K. W. (1966). *Sentence structures used by superior students in grade four and twelve and by superior adults*. Tallahassee: Florida State University.

Hunt, K. W. (1970). Syntactic maturity in school children and adults. *Monographs of the Society for Research in Child Development, 35* (1, serial no. 134).

Kintsch, W., & Van Dijk, T. (1978). Toward a model of text comprehension and production. *Psychological Review, 85*, 363–394.

Liberman, I., Shankweiler, D., Fischer, F., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology, 18*, 201–212.

Mattingly, I. (1972). Reading, the linguistic process, and linguistic awareness. In J. Kavanagh & I. Mattingly (Eds.), *Language by ear and by eye: The relationship between speech and reading* (pp. 133–147). Cambridge, MA: MIT Press.

McCutchen, D. (1987). Children's discourse skill: Form and modality requirements of schooled writing. *Discourse Processes, 10*, 267–286.

Myhill, D. (2009). From talking to writing: Linguistic development in writing. *Teaching and learning writing, British Journal of Educational Psychology Series II, 6*, 27–44.

Nagy, W., Berninger, V., Abbott, R., Vaughan, K., & Vermeulen, K. (2003). Relationship of morphology and other language skills to literacy skills in at-risk second graders and at-risk fourth grade writers. *Journal of Educational Psychology, 95*, 730–742.

Nelson, N., Roth, F., & Van Meter, A. (2009). Written composition instruction and intervention for students with language impairment. In G. Troia (Ed.), *Instruction and assessment for struggling writers. Evidence-based practices* (pp. 187–212). New York: Guilford.

Nunes, T., & Bryant, P. (2006). *Improving literacy by teaching morphemes (Improving Learning Series)*. New York: Routledge.

Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology, 33*, 637–649.

Nunes, T., Bryant, P., & Bindman, M. (2006). The effects of learning to spell on children's awareness of morphology. *Reading and Writing: An Interdisciplinary Journal, 19*, 767–787.

Psychological Corporation. (2002). *Wechsler individual achievement test* (2nd ed.). San Antonio, TX: Psychological Corporation.

Purcell-Gates, V. (1988). Lexical and syntactic knowledge of written narrative held by well-read-to kindergartners and second graders. *Research in the Teaching of English, 22*, 128–157.

Richards, T., Berninger, V., & Fayol, M. (2009). FMRI activation differences between 11-year-old good and poor spellers' access in working memory to temporary and long-term orthographic representations. *Journal of Neurolinguistics, 22*, 327–353. doi:10.1016/j.jneuroling.2008.11.002.

Saddler, B., & Graham, S. (2005). The effects of peer-assisted sentence-combining instruction on the writing performance of more and less skilled young writers. *Journal of Educational Psychology, 97*, 43–54.

Schleppegrell, M. J. (2004). *The language of schooling: A functional linguistics perspective*. Mahwah, NJ: Erlbaum.

Shanahan, T. (2009). Connecting reading and writing instruction for struggling learners. In G. Troia (Ed.), *Instruction and assessment for struggling writers. Evidence-based practices* (pp. 113–131). New York: Guilford.

Silliman, E., & Scott, C. (2009). Research-based oral language intervention routes to the academic language of literacy: Finding the right road. In S. Rosenfield & V. Berninger (Eds.), *Handbook on implementing evidence based academic interventions* (pp. 107–145). New York: Oxford University Press.

Singson, M., Mahoney, D., & Mann, V. (2000). The relation between reading ability and morphological skills: Evidence from derivational suffixes. *Reading and Writing: An Interdisciplinary Journal, 12*, 219–252.

Stahl, S., & Nagy, W. (2005). *Teaching word meaning*. Mahwah, NJ: Lawrence Erlbaum.

Traweek, D. (1993). *Teacher and learner variables in early literacy instruction: Treatment, evaluation and ethnographic studies*. Unpublished doctoral dissertation, University of Washington, Seattle, WA.

Tyler, A., & Nagy, W. (1989). The acquisition of English derivational morphology. *Journal of Memory and Language, 28*, 649–667.

Tyler, A., & Nagy, W. (1990). Use of derivational morphology during reading. *Cognition, 36*, 17–34.

Whitaker, D., Berninger, V., Johnston, J., & Swanson, L. (1994). Intraindividual differences in levels of language in intermediate grade writers: Implications for the translating process. *Learning and Individual Differences, 6*, 107–130.