

Translation of Thought to Written Text While Composing

Advancing Theory, Knowledge, Research Methods, Tools, and Applications

Edited by
MICHEL FAYOL, DENIS ALAMARGOT,
AND VIRGINIA W. BERNINGER

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Psychology Press
Taylor & Francis Group
New York London

Psychology Press
Taylor & Francis Group
711 Third Avenue
New York, NY 10017

Psychology Press
Taylor & Francis Group
27 Church Road
Hove, East Sussex BN3 2FA

Psychology Press is an imprint of Taylor & Francis Group, an Informa business

Printed in the United States of America on acid-free paper
Version Date: 20111216

International Standard Book Number: 978-1-84872-920-9 (Hardback)

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the Psychology Press Web site at
http://www.psypress.com

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Editors

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Dr. Fayol has held both national and European scientific responsibilities. He created and headed the LEAD (Laboratory for the Study of Learning and Development, CNRS [National Center for Scientific Research]) from 1984 to 1998 and then took over as the director of LAPSCO (Laboratory of Social and Cognitive Psychology, CNRS). He was an elected member of the National Scientific Research Committee and was president of several scientific committees, (among them committees on cognitive sciences, school and cognitive sciences, and learning). He belongs to the Starting Grants Committee of the European Research Council. Dr. Fayol created and co-coordinated with P. Boscolo (Italy) the Special Interest Group (SIG) on Writing for the EARLI European Association. He is now in charge of organizing the funding of cognitive sciences at the French National Research Agency (ANR) in Paris and of establishing collaborations for international research with other research agencies in Europe.

Denis Alamargot has been a senior lecturer (associate professor) in cognitive and developmental psychology at the University of Poitiers in France since 2003. He was originally recruited in 1997 to the Institut Universitaire de Formation des Maîtres Poitou-Charentes, Poitiers, France (Graduate School for Teachers), where he was the director of the "Special Needs Children" training (1999–2002) and of the Department of Human Sciences for Education (2000–2002).

As a statutory member of the laboratory CeRCA-CNRS since 1997, he served three years as a delegate to the CNRS from 2002 to 2005. He conducts research on eye movements during writing with children, students, and professional writers. He has published a variety of articles and experimental syntheses on writing and orthographic processes. He is coinventor, with David Chesnet, of the software "Eye and Pen" and has filed for two software protection patents in this context (APP).

Dr. Alamargot holds both national and European scientific responsibilities; he is the director of the CNRS National Research Group on Written Production (GDR-CNRS 2657) (2003–2010), director of a European COST Action on Writing (ERN-LWE—European Research Network on Learning to Write Effectively) (2008–2012), coleader of a research team (Work Package 6) as part of an ITN (initial training network) EU FP7 Marie Curie People (ELDEL—Enhancing Literacy Development in European Languages) (2008–2012), and co-coordinator of the Special Interest Group (SIG) on Writing for the EARLI European Association (2007–2011). In November, 2011 he earned a second PhD qualifying him for a full professor position.

Virginia Wise Berninger received her PhD in psychology from Johns Hopkins University in 1981, with a specialization in cognitive psychology and developmental psycholinguistics. She has been on faculties at Harvard Medical School, Boston, Massachusetts (1981–1983), Tufts New England School of Medicine, Boston, Massachusetts (1983–1986), and the University of Washington, Seattle, Washington (1986–present), where she is currently professor of educational psychology (learning sciences). She was principal investigator of NICHD-funded research projects on writing—typical writing development and effective writing instruction for at-risk and disabled writers (1989–2008, Literacy Trek and brain imaging of typically developing writers and children with dysgraphia) and specific written language learning disabilities (1995–2006, University of Washington Interdisciplinary Learning Disabilities Center, UW LDC, family genetics, brain imaging, and treatment of writing problems in dyslexia; 2011–2016 Center for Defining and Treating Specific Writing Disabilities). She directs the University Brain Education and Technology (UBET) Center, which is currently investigating computer-assisted instruction in writing with support from the Binational Science Foundation in collaboration with Dr. Zvia Breznitz, director of the Edmond J. Safra Brain Research Center, University of Haifa, Israel. She teaches courses in normal brain development and educational applications, brain disorders in learning and behavior, and writing (as well as reading and math) instruction with the brain in mind. She also advises PhD students in learning sciences. Her research interests include the bidirectional cognitive–linguistic translation processes involving four functional language systems (language by ear, mouth, eye, and hand), each organized by levels (subword, word, syntax, text), and three word forms (phonological, morphological, and/or orthographic) as the human brain interacts with the social and physical environment.

Acknowledgments

Translating an idea for a book into published writing is never a solo activity. It takes a team to write a book.

We would like to acknowledge the important contributions of three members of the team at Psychology Press/Taylor & Francis Group: Paul Dukes helped the editors formulate a plan for the book and then revise it based on input from reviewers; Lee Transue helped them problem-solve issues as needed during the writing process; and Kyle Meyer assisted authors and editors with the editing process.

Finally, we would like to thank Arunkumar Aranganathan of SPi Technologies who oversaw the translation of the manuscript into a published book. All look forward to the contributions of readers who extend knowledge of the translation process through their research, teaching, and other professional activities.

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Part I

Reexamining What Translation Is and Its Role in Writing

1

Introduction to the Book
From Cave Writers to Elite Scribes to Professional Writers to Universal Writers, Translation Is Fundamental to Writing

MICHEL L. FAYOL, DENIS ALAMARGOT,
and VIRGINIA WISE BERNINGER

DEFINING TRANSLATION

According to the *American Heritage Dictionary of the English Language* (Mifflin, 2009), translation is a word of Indo-European origin: *translaten* in Middle English, *translater* in Old French, and *trānslātus* in Latin. This word is used to convey at least nine different concepts, the first of which is the main focus of this book: to change or convert from one form, function, or state to another as in transforming *ideas into written language*. Other meanings include (a) converting to another language, (b) putting into simpler terms or expressing in different words to explain or interpret, (c) transferring from one place or condition to another, (d) forwarding or retransmitting a telegraphic message (communications), (e) transferring a bishop to another assignment or conveying to heaven without death (religion), (f) subjecting a body to translation (physics), (g) subjecting messenger RNA in cell bodies to translation (biology–genetics), and (h) expressing representations in mind in another medium.

Thus, one word can reference multiple concepts, related in some way, yet distinct (Stahl & Nagy, 2005). Indeed, transforming cognitive representations into language may be challenging and even anxiety provoking if the process involves converting from one language to another language to express the same ideas (the second concept).

Moreover, cross-language translation is further complicated in many cases by cross-cultural as well as cross-language differences. Yet the process can also be challenging and anxiety provoking when it involves native speakers of the same language expressing the same ideas in different words to explain or interpret (third concept) or transferring across conditions (fourth concept). Human communication often breaks down among those who speak the same language—both in their oral interactions and in their written productions. The fifth, sixth, seventh, and eighth concepts are domain specific; in fact, when the words used in translation do not reference the appropriate concepts in the minds of those without first-hand knowledge of the specific domain, the words are perceived as jargon. Thus, we provide a glossary at the end of the book, to which readers can refer for conceptual clarification for use of a variety of technical terms in this book, which may have multiple meanings.

Written language is not the only mechanism for translating cognitive representations into another format (ninth concept). Ideas can also be expressed in *gesture* (Goldin-Meadow, 1999; Goldin-Meadow, Alibali, & Church, 1993; Goldin-Meadow, McNeill, & Singleton, 1996; Goldin-Meadow & Singer, 2003), *sign language* (Lubbadeh, 2005), *art* (e.g., Fayol & Barrouillet, 1995), *architecture* (e.g., Chartres cathedral), *dance and bodily motion* (Blakeslee & Blackslee, 2008), *music* (e.g., Mozart), *drama* (e.g., Shakespeare), and *mime* (e.g., Marcel Marceau). These modes of translating ideas into different media are not mutually exclusive. For example, the legendary French maestro, Georges Prêtre, uses bodily motion and gesture both to coordinate the other musicians in real time and to dramatize the musical ideas. Chapter 10 addresses the potential advantages of drawing on both art and written language expression during translation.

GOALS AND ORGANIZATION OF THE BOOK

Translation of cognitive representations into written language is one of the most important processes in writing (Hayes & Flower, 1980). Early studies of translation into written language focused on how children and adults marked cognitive units with capitalization and punctuation (Fayol, 1997; Fayol & Abdi, 1988; Fayol & Lété, 1987; Fayol & Mouchon, 1997) and grammatical conventions in linguistic units (Fayol, Gombert, & Abdi, 1989; Fayol, Hickmann, Bonnotte, & Gombert, 1993; Fayol, Largy, & Lemaire, 1994) and formulated written products (Alamargot & Chanquoy, 2001). Other studies examined the relationship of transcription skills (handwriting and spelling) to composing (Berninger & Swanson, 1994; Fayol & Monteil, 1988) and the intraindividual differences at the *word* (Bonin, Fayol, & Gombert, 1997), *syntax* (Costermans & Fayol, 1997), and *text* (Fayol, 1991) levels of language that contribute to text generation during translation in primary-grade children aged 6–8 years (Berninger, Mizokawa, Bragg, Cartwright, & Yates, 1994) and intermediate-grade children aged 9–12 years (Whitaker, Berninger, Johnston, & Swanson, 1994). In levels-of-language theory, transformation from cognitive to language representations can occur via multiple mapping processes involving different units of expression during the translation process (Berninger, 1994).

The early work grounded in an interdisciplinary levels-of-language theoretical framework introduced methods of linguistics to the cognitive research on writing processes (e.g., see research by Ruth Berman discussed in Chapter 3 and Martin Neef in Chapter 14). However, translation is a complex process, which as a research topic, has received less attention than other writing processes, and deserves further interdisciplinary reflection and investigation, especially about the nature of the cognitive representations and operations accessed, access routes, multiple mechanisms for expression in language (see Chapters 3 through 5) and related formats (see Chapter 10), the role of review of text produced so far (see Chapters 2, 5, 11 through 13), and the timing as translation unfolds in real time (Chapters 11 through 13).

Thus, the goals of this book are to

1. Provide an updated overview, since Hayes and Flower's (1980) initial influential chapter and Butterfield's (1994) and Alamargot and Chanquoy's (2001) subsequent edited volumes, of research on translation—both findings and methodological advances in studying it
2. Discuss each of the commonly used research methods for studying translation including think alouds, qualitative and quantitative descriptive studies, cross-sectional and longitudinal developmental designs, statistical modeling through regression, confirmatory factor analysis, and structural equation modeling, online experiments, and instructional studies
3. Theorize about the nature of the cognitive and language representations and cognitive ←→ linguistic transformation mechanisms involved in translation during writing
4. Make the case that translation is a higher-order executive function that is fundamental to the writing process
5. Consider issues of application of research to practice, that is, the translation of research findings about translation during writing into real-world practices in education and the work world for individuals who interact with others using written language to communicate ideas

Part I includes this introduction (Chapter 1), an update on the theory and recent research about what translation is and its relationship to other writing processes (Chapter 2), and an overview of the methods, measures, and models used to study writing skills for translation and translation-related skills (theoretical frameworks for processes involved in the cognitive ←→ linguistic transformations of translation) (Chapter 3).

Part II examines individual differences and developmental changes in the nature of cognitive and linguistic representations and the cognitive ←→ linguistic transformations involved in translation from the perspective of levels of language. These include subword letter-writing processes (Chapter 5), word-level spelling processes (Chapters 4 and 5), and written text generation (composing) (Chapters 5 and 6). Both Chapters 5 and 6 provide in-depth tracking of individual developing writers, but Chapter 6 provides an important added contribution of focus on children whose first language is not the language of instruction at their school. Also, Chapter 5 findings are based on writing assessments outside the regular classroom, whereas Chapter 6 reports results for teacher–student dialogues about writing instruction and situates writing tasks in the school environment.

Part III contains four chapters with findings relevant to classroom assessment and/or instructional practices related to translation and other related writing skills. The first chapter focuses on professional development of teachers, that is, teaching the teachers to teach automatic handwriting to support the translation process effectively, but reviews research showing the contribution of automatic transcription skills to translation across schooling (Chapter 7). The second chapter focuses on early intervention in teaching children, who have been selected for neuropsychological risk factors, transcription (spelling) and text generation (composing) skills to prevent later writing problems (Chapter 8). The third chapter examines models for classroom assessment of writing in general education classrooms to evaluate response to instruction (Chapter 9). The fourth chapter extends current focus on teaching verbal strategies to include nonverbal art as well, to facilitate idea flow via access to nonverbal imagery and representations during translation (Chapter 10). Chapters in Part III add to Part II in expanding knowledge of the translation process at different levels of language: subword transcription (Chapters 7 through 9), word transcription (Chapters 8 and 9), and text generation (Chapters 7 through 10).

Part IV provides an overview of programmatic research featuring experimental studies of online processing underlying translation during production of written translation products in real time, as introduced by Chanquoy, Foulin, and Fayol (1990). As such, Chapters 11 through 13 offer pioneering extensions of reaction times (to experimenter-controlled stimuli and tasks) to production times for participant-generated written translation products. These online experiments add to the knowledge of the levels of language in the translation process, especially at the level of words (Chapters 11 and 13), sentences (e.g., subject–verb agreements) (Chapters 11 and 12), or text (e.g., review of text produced so far) (Chapters 11 through 13). They also illustrate the growing trend to employ technology in the experimental investigations of online translating. For example, some of the featured studies used both laptops, which record and store translation products and the timing parameters (duration and pauses), *and* eye movement recording to study the writer's visual inspection of text produced so far.

Part V (Chapter 14 and Afterword) serves as a commentary on the volume. Building on the theme that the purpose of the book is to stimulate further research on translation, Chapter 14, which adds to conceptual knowledge of the translation process in writing from the perspective of theoretical linguistics, raises the important issue of what language is. The future of research on cognitive ←→ linguistic translation depends as much on clarifying conceptual understanding of what language is (Chapter 14) as it does on clarifying conceptual understanding of what cognition entails (Chapter 3). Only if it is understood that writing is language, will reference to "language, reading, and writing" and the myth that writing is a motor skill disappear. Writing is ultimately written language and just as much language as is oral language. Motor skills alone do not produce writing.

Chapter 14 raises the important issue, now that online experiments of translation in real time are increasingly employed (see Chapters 2, 3, 11 through 13), of whether the planning and other translation processes unfold sequentially or in interactive and parallel fashion. Note that, in Chapter 2, Hayes presents his updated model of sequential processes in writing but then discusses experimental findings pointing to interactions among these processes in real time, as in his original model coauthored with Flowers (1980). Issues regarding the sequential and parallel processing involved in translation are far from being fully resolved. However, by pursuing research on how translation unfolds in time as it interacts with other writing processes may add to current understanding of what translation is: Translation is not only a process for transforming representations in one domain (cognitive) to another domain (language) but also a process for creating new cross-domain representations (also see Galbraith, 2009).

RELATIONSHIPS OF WRITTEN AND ORAL EXPRESSION MODES FOR TRANSLATION OUTCOMES

Some research reported in this volume calls into question the widely held assumption that in language development the cognitive–linguistic translation process is initially mediated by speech and oral language during the formative years and only later in schooling by writing and written language; rather, both may play a role during the preschool years. For example, see the writing milestones for 20 developing child writers in Chapter 5 (Appendix B). Both writing and speech may emerge early in child development in age-appropriate ways, change across early development, and support acquisition of oral language and written language. Sometimes oral language and written language develop at comparable rates, but sometimes they do not. Which specific skills may develop relatively faster or slower may vary across children and within the same child across time (see Chapter 5). Moreover, it is not the case that reading is first acquired and only later writing. Children benefit from both writing and reading instructional activities at the time formal education commences and thereafter (see Berninger & Chanquoy, in press; Gombert & Fayol, 1992; Rieben, Ntamakiliro, Gonthier, & Fayol, 2005).

The assumption that speech emerged much earlier (about 300,000 years ago) in human evolution than writing (about 5,000 years ago) can probably be refuted, or at least debated, on the basis of recent findings of Von Petzinger, a researcher at the University of Victoria, British Columbia. Based on careful examination of a comprehensive data set she collected and analyzed of early written communication systems in 146 sites in France 35,000–10,000 years ago, she discovered not only drawings but also the marks—semicircles, lines, and zigzags—that expressed a symbolic written code, which was recorded on the walls of the Chauvet Cave in Southern France and elsewhere. She presented her findings at the 2009 Paleoanthropology Society Annual Meeting in Chicago and will also publish them in the *Journal of Antiquity* and *Journal of Human Evolution*. The findings will also be displayed at the Smithsonian Institution's National Museum of Natural History in Washington, DC (see Ravillious, 2010).

In addition, a group of 26 symbols has been found at Stone Age sites throughout the world (e.g., lines, open angles, and dots), which are often paired repeatedly across sites; this pairing suggests that they were used for written communication across groups. In the Les Trois-Frères caves in the French Pyrenees, evidence has been found that prehistoric Europeans used written symbols to express concepts constructed from four signs—thumb stencil, negative hand, dots, and finger fluting—that are frequently grouped (see *Sign of the Times News*, 2010). Thus, prehistoric people had written communication systems that relied on drawings, pictographs, and written symbols.

Von Petzinger's findings show that both writing and speech may have emerged at similar times in human evolution to support the translation of cognitions into language. Humans are wired to use their hands as well as their mouths to express what is in their minds via language (written visual symbols) and other codes (e.g., pictures, gestures, or music). Of relevance, similar circuits support fine motor sequential movement for mouth and hand (Kolb & Whishaw, 2009).

An alternative view (see Corballis, 2002, 2009) is that writing or manual communication may have developed before speech communication through mouth. In support of this view, evidence is cited that, following a creative burst in which humans acquired ability for abstract thinking, language emerged, and then, because of a mutation of the *FOXP2* gene that affects motor skills, this language ability was expressed earlier by hand (writing or manual signs) than by mouth (speech). The manual system uses hand gestures called signs to express concepts underlying language, whereas speech uses articulatory gestures produced by lips, tongue, and vocal tract to express via mouth concepts underlying language.

In contrast to the manual system, an auditory system that processes acoustic signals in received auditory messages through heard speech plays a role in speech acquisition and production. However, the relationships between received auditory messages through ear, analyzed acoustic signals, and higher-level processing of phonological sound representations are complex and do not necessarily relate in one-to-one fashion to the speech produced to send messages via mouth. For example, discrete phonemes, which can be translated into spelling units of written language, do not exist in the acoustic signal. Rather, speech production is based on coarticulated articulatory gestures within a syllable for sending messages, but speech analysis for receiving auditory speech messages translates them to other sound-related signals before abstracting sequential phonemes, which correspond to units in written spelling. These nonsequential and sequential processing mechanisms for spoken and heard words, respectively, draw on different brain regions than do those for written words even when some common brain regions may be involved (Berninger & Richards, 2002). Thus, the aural (heard) and oral (spoken) language forms may have evolved at different phases of human evolution than did manual writing of words because they draw on different brain systems. Likewise, speech and manual writing may emerge at different phases of language development in individual children resulting in individual differences in oral language, reading, and writing development (see Chapter 5).

To summarize, both the Von Petzinger and Corballis hypotheses, each with evidence to support them, call into question the previously widely held view that speech necessarily emerged much earlier in human evolution than did writing or manual communication. Building on the insights of these hypotheses and related evidence, we propose an alternative view: How genetic capability for either human speech or writing expressed itself behaviorally earlier in human history depended, to a large extent, on the current needs of human groups, which depended in turn on current events in their external environment. Such needs have changed over the course of human evolution.

Speech for face-to-face communication emerged to free up hands for tool use among cave dwellers who lived in a hunting-and-gathering society. However, hands were also used to express ideas via drawing pictures and symbols on cave walls (e.g., the Chauvet cave paintings in Southern France studied by Von Petzinger, 2009) to support the cave dwellers' need to record relevant information for the day-to-day operations of hunting and food gathering or resolution of conflicts between human groups via military battles. It does not follow that, of human capabilities for communication, writing capability necessarily evolved the last and long after speech.

Human capabilities may be constrained by genetics but how genetic capabilities are expressed behaviorally often depends on whether the environment presents a need for specific capabilities and nurtures their development, thus increasing probability of their initial or continuing use for survival. Thus, it is not surprising that the human capability for writing has undergone changes as society's needs have evolved.

EVOLUTION OF WRITTEN COMMUNICATION AND RELATED TRANSLATION PROCESSES

Past Evolution

Early in the evolution of modern man, as society's needs evolved beyond a hunting-and-gathering economy, society's needs were better met by a few members of society—an elite class of scribes educated at scribal schools who recorded symbols needed for business records and sacred writings for religious purposes. Later in human history, another elite class emerged, now of professional writers who served various societal functions such as entertaining via play scripts and novels, persuading through written rhetoric delivered orally by orators, government, or religious leaders, and engaging citizens in philosophical inquiry and arguments. Invention of the modern printing press supported the expansion of this class of professional writers. Emergence and spread of free public education created a larger and larger audience for these professional writers. Thus, it is not the case, as often argued, that writing only emerged centuries after reading did, made possible by coding schemes such as alphabets for representing oral language in written language. As Wagner et al. (2011) pointed out convincingly, "Humans have been engaged in writing for as long as they have been able to read. After all, one can only read something that has been written."

Contemporary Evolution

More recently societal needs changed yet again increasing the demand for universal writers who have the necessary writing (as well as reading skills) for the job demands of the work world in the information age and can use technology tools, which are expanding exponentially in the information age, to send written messages as well as to receive them. Thus, educational demands on schools early in the twenty-first century are enormous: Educate *all* normally developing students to write (and read their own and others' writing) using computers and other technology tools as well as conventional tools such as pens and pencils with paper. As Van Waes, Leijten, Wengelin, and Lindgren (2011) remind us, "There has never been a time in which so many people have produced so much written text." Thus, our citizens engage frequently in translation even if researchers are still learning what it entails.

TRANSLATION AS THE FUNDAMENTAL WRITING PROCESS

The common thread underlying the evolution from cave dwellers using written marks to elite scribes to a class of professional writers to universal writers, who are writing readers, is the human capability to translate ideas and thoughts in the mind into written symbols and messages and thus express ideas in written language. Although translation has long been thought to be one of a few key cognitive processes in writing, in this book we boldly propose for consideration the view that *translation is the fundamental cognitive process of writing*. The four cognitive processes in the Hayes and Flower's (1980) model—planning, translating, reviewing, and revising—may be the higher-level executive functions of brain that regulate communication across many mental processes involving different brain systems not only for writing but also for many other functions (Berninger & Richards, 2002; also see Chapter 3). We acknowledge that skilled translation requires ability to plan the content or methods of translation, review what is written so far, and when problems are detected in translation, repair them through retranslation (see Chapter 2). However, sometimes writing may not draw on planning processes and exhibit only flow or knowledge telling (Galbraith, 2009), or may not draw on reviewing and revising (e.g., no knowledge transformation for audience). Writing always requires, as a minimum, some translation (transformation of one or more cognitive representations into written language), whether or not it is planned, reviewed, or revised.

UNDERSTANDING THE COGNITIVE FOUNDATIONS OF TRANSLATION

To understand better what translation is, see Chapter 3 in which we will also examine what cognition is—the variety of cognitive representations (Table 3.1), the cognitive operations for acting on those representations (Table 3.2), mechanisms for accessing cognitive representations or operations during translation (Table 3.3), a conceptual model of cognitive ← → language translation (Table 3.4), and models of lower-order executive functions in working memory and higher-order executive functions supported by working memory that enable the translation process (Table 3.5).

We raise, but do not fully answer, intriguing and hard questions like the following, for which we hope others will also pursue answers:

- What is the nature of cognitions in the unconscious mind?
- What is an idea?
- What is thinking?

- In what different forms are cognitions represented in language? How does syntactic expression of cognitions differ from non-syntactic expression of cognitions (e.g., idiom, poetry, and other formats like art)?
- How are cognitions translated differently as a function of level of language?
- What are nonthinking cognitive operations that may play a role in translation?
- What are the mechanisms (e.g., automatic access versus effortful search) whereby conscious working memory is able to access cognitions in the unconscious mind or implicit memory and translate them into conscious expression in written language?

Thus, it is not surprising to find that more than a single translation mechanism may be operating. Initial longitudinal individual case studies point to multiple translation mechanisms that an individual may use within or across writing bouts (see Chapter 5). Other research also documents that translation is a dynamic process in individual writers (see Chapter 6). Further research is needed on how translation develops in the same individual writers across writing development.

Identifying these multiple mechanisms may be aided by recognition that the challenge the writer faces during translation is gaining access to the cognitive realm, which is in *unconsciousness* or implicit memory. By unconsciousness we mean mental representations that may be created outside conscious awareness and are not easily or previously accessed by the conscious human mind. By implicit memory, which is defined in many ways by cognitive researchers, we mean representations that have previously activated and were consolidated for more permanent storage in long-term memory, and may be accessible to consciousness in the present through automatic activation or effortful search strategies. Unconsciousness and implicit memory are not necessarily mutually exclusive. At times, access may be more like a flow from a rushing waterfall or quiet pool or windy rain storm (see Chapter 3, Table 3.3 and text). At other times, strategic discipline may be imposed on the translation process, through (a) preplanning, (b) online self-regulation, or (c) the revision or retranslation process. Indeed, revision often improves idea expression through plans and strategies for better meeting the needs of the audience or goals of the writer as the writer retranslates.

LIFE SPAN APPROACH: FROM EARLY TO DEVELOPING TO SKILLED WRITING

In addition, a life span approach to translation is adopted. The developmental trajectories by which young children learn to write initially and thereafter at various stages along the journey to skilled writing are examined (Part II). Not only are effective instructional practices for facilitating early writing development considered (Part III), but also attention is devoted to the adult skilled writer and many facets of what being an expert writer entails (Part I, Chapter 2 and Part IV). The contributors recognize that writing development is a journey that may take years to master.

CONTEMPORARY INTEREST AND TRENDS IN TRANSLATION RESEARCH

Reasons for contemporary interest in translation include the following. To begin with, study of the translation process during writing holds promise for learning more about how conscious mental activity gains access in working memory (Chenoweth & Hayes, 2001) to the cognitive representations in the vast unconscious mind (Jung, 1968, 1990) or implicit memory (long-term memory representations) and expresses them in external visual codes via hand, which have links to internal language codes (see Chapter 4). In addition, investigation of translation will add to understanding of the (a) nature of cognitive representations, (b) cognitive operations on them, (c) access to cognitive representations and operations during translation to language, (d) models of mechanisms involved in cognitive ← → linguistic transformations, and (e) role of lower-order and higher-order executive functions in translation (see Chapter 3). Finally, translation may be the fundamental cognitive process in writing: Translation is the goal for planning and provides the product on which the review and revision processes operate.

In Part V, a linguist, who has made substantial contributions to written communication research (Chapter 14), brings the perspective of linguistics to the research on translation. Historically linguistics has been focused on oral language, but an interest in written language is emerging. Oral language and written language are related but not in simple one-to-one ways. The emerging linguistic research on written language will make an important, necessary contribution to advancing understanding of the translation process in writing.

FUTURE OF TRANSLATION RESEARCH

This book, unlike much academic writing directed to an audience of students, faculty, and researchers, is really a narrative with a beginning—characters (researchers who have already begun to think about translation), setting (the world of writing research), and a problem to solve (the nature of translation during writing) with the bare outlines of the plot to date. We encourage readers to contribute, as theorists, empirical researchers, teachers, and clinicians, to continue to participate in the plot introduced in this book. If they contribute to solving the mystery of the cognitive ← → linguistic translation process in writing, then one day the complete story of translation can be written.

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2

Evidence From Language Bursts, Revision, and Transcription for Translation and Its Relation to Other Writing Processes

JOHN R. HAYES

As Fayol, Alamargot, and Berninger point out in Chapter 1, translation—changing one form into another—can happen in many ways. A sketch can be translated into a painting. An idea can be translated into gestures, buildings, equations, or music. In this chapter, I will focus on the process of translating ideas into text and how that process is related to other writing processes.

REVISED WRITING MODEL

The model shown in Figure 2.1 is a graphic aid for thinking about the connections between translation and other aspects of the composing process. This model is generally consistent with earlier models my colleagues and I have published, but is updated to reflect my current thinking about composition.* The model is divided into two major parts: the individual and the task environment. The task environment consists of the social environment (collaborators and audience) and the physical environment (the writing medium and the text-written-so-far). The individual has cognitive processes and motivation. Motivation is assumed to influence planning and transcription and to influence the relations between the task environment and the cognitive processes. The integration of motivation and cognitive processes is treated in Hayes (2011). The individual cognitive processes are described in the next section.

* The new model differs from the model in Hayes (1996) by including transcription as a major process. It also differs from the model in Chenoweth and Hayes (2001, p. 84).

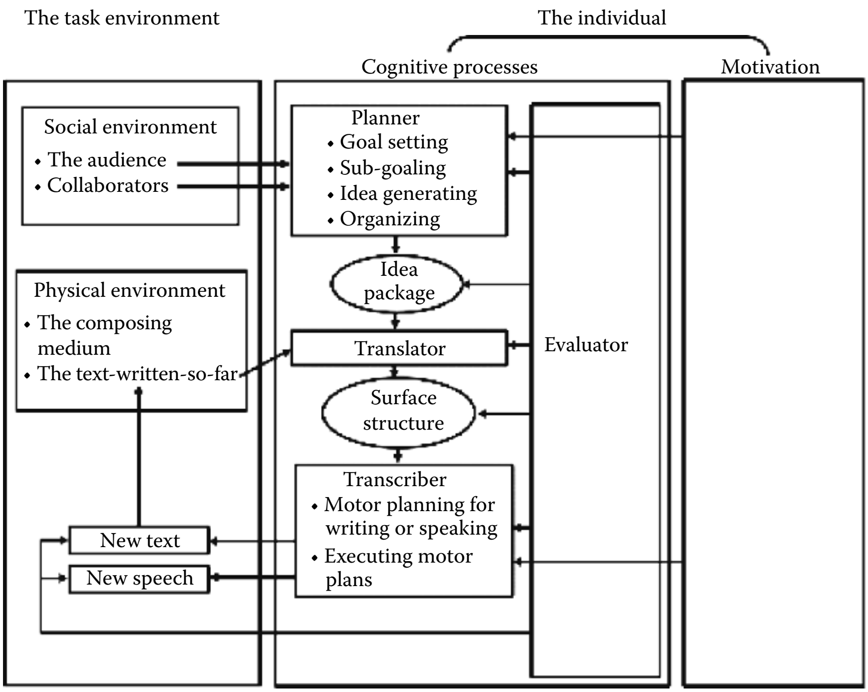

Figure 2.1 A revised model of the writing process.

COGNITIVE PROCESSES

Planner

The planner includes the thinking processes involved in preparing the writer to create text. It includes setting goals, creating subgoals, generating ideas, and organizing them. Inputs may be in nonverbal form (external or internal images) or in verbal form (a writing assignment, written plans that need to be expanded into full text, advice from collaborators, language in the text that needs to be revised, the text-written-so-far, and so on). The output of the planner is an idea package delivered to the translator.

Translator

The translator takes an idea package from the planner and translates it into an unarticulated surface structure.* That is, it selects appropriate lexical items, orders them, and chooses inflections for tense, gender, and number to reflect the ideas from the proposer and to satisfy constraints on tone, register, and so on.

* In his model of speech production, Levelt (1989) proposed that the formulator (corresponding roughly to our translator) has two subprocesses: a grammatical encoder that produces a surface structure and a phonological encoder that produces an articulation plan. I have chosen, for convenience, to include phonological encoding (to produce speech) and orthographic encoding (to produce text) in the transcriber.

Memory Resources

For convenience, I have assumed that each process may have its own buffer to temporarily store its own output until that output can be acted on. The ovals in Figure 2.1 may be thought of as buffers for storing the idea package and the surface structure. Buffers would also be needed to store the motor plans for writing and speaking until they can be executed. Although separate buffers may not be necessary in every case (some processes may share buffers), the outputs of some of the writing processes are different enough so that they probably require different memory resources. For example, it seems unlikely that visual images, verbal material, and motor plans would all be stored in the same memory buffer.

Evaluator

The evaluator assesses whether or not the writing process is meeting the writer's goals. The products of all of the writing processes may be evaluated either while the writing process is acting or after the process has produced an output and stored it in an appropriate buffer.

Transcriber

The transcriber takes the surface structure produced by the translator as input and may take either or both of the following actions:

1. It may encode the surface structure phonologically to produce an articulatory plan and then, if the plan is evaluated positively, it may produce speech corresponding to the articulatory plan.
2. It may encode the surface structure using spelling and orthographic rules to produce an orthographic plan and then, if the plan is evaluated positively, it may produce text corresponding to the orthographic plan.

It is important to include the production of speech in the transcriber because some writers articulate the surface structure before writing it as an evaluation strategy.

The boxes labeled *new text* and *new speech* are part of the task environment. They represent the language that the writer has most recently written or spoken. The new text immediately becomes part of the text-written-so-far described in the following.

Text-Written-So-Far

This is the text that has been completed from the beginning of writing up to the current moment. Adult writers often use the text-written-so-far and especially the sentence currently under construction as input to the translation process to insure consistency in number and tense.

APPLYING THE MODEL TO DIVERSE WRITING TASKS

Generally speaking, writing is an activity designed to create a text for some audience. Within this broad definition, it is useful to identify certain specialized writing activities. What we most commonly think of as writing is the activity of producing text to be read by other people, for example, writing articles or school essays. I will call this formal writing. In formal writing, the author must meet standards for spelling, grammar, and perhaps other rules of good communication. But formal writing is not the only writing activity. For example, journal writing is writing for which the writer is the sole audience. Here, formal rules may be relaxed a bit. Another example is writing reviews, that is writing based on the text of second writer, usually a student or a colleague; the text of the review consists of comments on the second writer's text, and the audience includes the second writer and perhaps an editor.

Creating a written plan should also be considered a specialized writing activity. Although this activity is commonly called planning, it is important to distinguish it from the thinking activity that is included as the first component of the writing model. Creating a written plan involves not only specifying subgoals, generating ideas, and organizing, but also it necessarily involves the translation and transcription to produce a written product: a plan. Thus, creating a written plan involves a complete writing process that produces a text designed to aid the author of the plan in producing another text. As Hayes and Flower (1980, pp. 13–14) noted, plans are often little more than lists of single words or phrases designed to remind the writer of topics to be written about.

Revising written text is also best thought of as a specialized writing activity. Revising is typically initiated in response to a negative evaluation of an existing text.* It involves planning a solution to the problem, translating that solution into language, and transcribing that language into new text to replace the old text. In this view, revision is seen not as a separate writing process parallel to the other writing processes identified in Figure 2.1, but rather as a special application of the writing model.†

SOME EMPIRICAL STUDIES OF TRANSLATION

In the remainder of this chapter, I describe studies that I have carried out in collaboration with colleagues to cast light on the nature of the translation process and its relation to other writing processes.

Translation and Language Bursts

My colleagues and I have identified a phenomenon, "language bursts," that appears to occur whenever the translation process is active. First, I will describe language

* Revision is not always stimulated by a text fault. It may also be initiated when the text suggests a new or a better idea.

† This position is consistent with Hayes, Flower, Schriver, Stratman, and Carey's (1987) model of revision.

Protocol:
. . . ok . . . the summer after tenth grade . . . I and —oh . . . I and . . . no . . . twenty seven students . . . and I . . . from my school district . . . that sounds kind of awkward . . . would it be twenty seven students from my school district and I . . . but then I was part of the school . . . oh but if I said from my school district . . . ah ha . . . the summer after tenth grade . . . twenty seven students from my school district . . . and I . . . went to France . . . for two weeks . . .

Written sentence:
The summer after tenth grade, twenty-seven students from my school district and I went to France for two weeks.

Figure 2.2 A segment of a think-aloud protocol from Chenoweth and Hayes (2001). Periods indicate pauses of 2 s or more.

bursts and then I will describe the series of studies that associates this phenomenon with the translation process.

When we were collecting data in a think-aloud protocol study of essay writing (Kaufer, Hayes, & Flower, 1986), we were struck by how choppy the process of composition was. Writers would produce bursts of words intended for inclusion in their essay—perhaps six or seven words on average—and then stop to think about what to write next or to evaluate or edit what they had just written. Figure 2.2 shows a typical example, from protocols collected by Chenoweth and Hayes (2001), illustrating the discontinuous nature of composing.

As is typical of most writing protocols, the protocol segment in Figure 2.2 consists of bursts of language proposed for inclusion in the text mixed with comments not intended for inclusion in the text. The comments usually reflect planning or criticism.

Language bursts are of two types—*pause bursts* and *revision bursts. Pause bursts* are language bursts that end in a pause of 2 s or more. These pauses appear to reflect the author's uncertainty about what to say next. In many protocols, these pauses are followed by statements such as "I want to say something about …" or "What do I want to say?" Examples of *pause bursts* in Figure 2.2 are "the summer after tenth grade," "twenty-seven students," and "went to France."

Revision bursts are language bursts that are interrupted by revision. For example, in the first line of the protocol segment, the writer says "I and —oh." I hypothesize that the writer was going to say "I and twenty-seven students," doesn't like the sound of it, and stops production in mid-stream to revise. Revision bursts account for 10%–15% of language bursts.

Where Do Language Bursts Originate? In a protocol study, Chenoweth and Hayes (2001) studied American college students writing in both L1 and L2 (French or German). In addition, they compared the writing of students who had three semesters of instruction with students who had five semesters of instruction. This study showed that language bursts were significantly longer when students wrote in L1 than in L2 and were significantly longer for students who had five semesters of instruction than for students who had only three semesters of instruction. Because translation seems the most likely of the writing processes to be influenced by linguistic experience, this result suggested strongly that the translation process is an important source of language bursts.

However, there are other possibilities. Perhaps, language bursts happen when a person is simply transcribing text rather than composing it. Hayes and Chenoweth (2006) addressed this question by asking writers to copy text from one computer window to another. This study found no evidence of language bursts. Thus, it appears that the transcription process by itself does not produce language bursts.

Another possibility is that the planning process is the sole source of bursts or, at least, that it must be involved if bursts are produced. Hayes and Chenoweth (2007) carried out a study to test this possibility. They asked adult writers to revise passive sentences such as "John was robbed by the man who was hit by the Fed-Ex truck" into active form. This task is interesting because it required the translator to produce new language but it did not require the writer to plan new ideas. The ideas to be expressed were already contained in the original passive sentences. The result was very clear. Translating passive sentences into active form produced frequent *pause bursts*. This suggested that whenever the translator is active, that *pause bursts* will accompany it.

Taken together, these experiments strongly implicate the translation process as a prime source of language bursts.

Translation and Working Memory

Chenoweth and Hayes (2003) asked writers to view a sequence of 18 wordless cartoons and to write a sentence describing the point of each one. While participants were composing, the researchers manipulated working memory using articulatory suppression. In some conditions, writers said *tap* in time to a metronome at the rate of 120 beats per second. In the control conditions, participants tapped a foot at this rate, or did nothing. In addition, in half the trials, the texts that participants typed were not visible to them. (Text visibility will be of interest when we discuss the relation between translation and transcription.) The authors found that articulatory suppression significantly decreased writing rate by 20% and *pause burst* length by 34%. Hayes (2009) replicated these results.

In this cartoon-description study, the input from the planner to the translator is nonverbal and unarticulated. The articulatory-suppression technique has its effect by reducing memory for verbal material. Therefore, it seems likely that the reduction of *pause burst* length in this study resulted from interference with the functioning or output of the translator rather than the functioning or output of the planner.

The simplest explanation for this result appears to be that bursts are caused by the limited size of the buffer for storing the output of the translator. This buffer is represented in Figure 2.1 as containing the surface structure. With articulatory suppression, the capacity of this buffer is substantially reduced and the length of *pause bursts* is correspondingly shortened. The cause of the decrease in writing rate is more complex and will be discussed in the section on translation and transcription.

However, although storage capacity of working memory is probably the important factor in pause bursts, other factors may also play a role. We would expect longer bursts when children are dictating essays rather than transcribing them because speech can be produced faster than handwriting. Language factors may also play a role. Bursts tend to end at sentence and clause boundaries more than expected by chance (about 40% end at these places), but they occur in other places as well—for example, in mid phrase or after an initial word.

Translation and Evaluation

We can think of the activities that lead to the proposal of a surface structure (planning and translating) as an attempt to solve a multiple constraints problem.* In a writing task, these constraints include choosing an appropriate topic, satisfying the audience's need for information (satisfying Grice's maxims), making appropriate word choices, maintaining consistency in number, gender, tense, tone, and so on. Presumably the planner is responsible for meeting some of these constraints, such as topic choice, and the translator for others, such as lexical and grammatical selections. As with any complex constraint satisfaction problem, it would not be surprising if some solutions (surface structures) were proposed that did not satisfactorily meet all of the constraints. Protocol studies have found that writers propose substantially more language than they include in the final text (Chenoweth & Hayes, 2001; Hayes & Flower, 1980; Kaufer et al., 1986). Further, whether the protocol method is used or not, many words that are transcribed are revised and fail to make it into the final text (Chenoweth & Hayes, 2003). I provide the following examples from my own writing to illustrate how proposed language may fail to meet constraints of the writing situation:

- *Example 1.* I proposed the words "It includes language bursts that are terminated by" and immediately replaced "terminated by" with "end in" because "terminated by" seemed too formal.
- *Example 2.* I proposed the words "related to other writing processes" and replaced them with "related to *the* other writing processes." I felt that the initially proposed language did not capture my intended meaning of "*all* other writing processes" rather than "*some* other writing processes."
- *Example 3.* I proposed the words "In formal writing, the author must meet standards of good form." I replaced "good form" with "spelling and grammar" because "form" seemed too much like the word "formal" used earlier in the same sentence.
- *Example 4.* I proposed the words "that are not intended to be included in the text" and replaced them with "that the writer does not intend to include in the text" to avoid using passive voice.

These examples show how the proposed language failed to satisfy the writer's standards for tone, meaning, variety in word choice, and voice. Of course, they illustrate just a few of the ways in which proposed language may fail to meet the constraints of the writing problem. Clearly, there are many ways to fail. It may be a surprise then that Kaufer et al. (1986, p. 126) reported that the 12 competent writers in their study accepted 76% of their proposed language for inclusion in their final texts. This figure may reflect great success in meeting the constraints of the

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* This view is consistent with that of Flower and Hayes (1980).

writing situation or it may simply reflect lax standards for meeting those constraints. In the experimental situation, participants may satisfice rather than optimize language choices. Satisfice refers to a decision process in which the decision maker chooses a "good enough" alternative rather than insisting on the best alternative.

The evaluator may detect inadequacies in the proposed language as it is being transcribed, producing revision bursts, or it may detect them after transcription and trigger revisions. Thus, the frequency of revision bursts and the percentage of proposed language that the writer accepts for the final text are both measures of the writer's ability to find solutions that the writer judges to be satisfactory.

As noted earlier, *revision bursts* constitute from 10% to 15% of language bursts for native English speakers writing in English. Chenoweth and Hayes (2001) studied American students writing in English and either French or German as a second language. Some students had studied their second language for three semesters and some for five semesters. The authors found that a larger percentage of writer's total bursts were *revision bursts* for writers writing in L2 (26%) than in L1 (13%). Similarly, they found a larger percentage of *revision bursts* in students writing in L2 with three semesters of study (29%) than students with five semesters of study (24%). Both differences were significant. In addition, Chenoweth and Hayes found that a greater proportion of the language that writers proposed was accepted for the final text in writers writing in L1 (87%) than in L2 (78%). Also, they found that the percentage of proposed language accepted (PPLA) was greater for writers with five semesters of study (87%) than for writers with three semesters (69%). Again, both differences were significant.

Chenoweth and Hayes (2001) interpreted these differences as evidence that translation was interfering with evaluation. The argument was that translation in L2 uses more cognitive resources than in L1 and especially so in writers with few semesters of L2 study. Therefore, relatively fewer cognitive resources would be available for evaluation during translation than after translation was complete. As a result, L2 writers would frequently propose language that they would recognize as unacceptable when more resources became available for evaluation after translation was complete.

This argument is plausible but it has not been supported by more recent evidence. If the cognitive resources argument were correct, one would expect that limiting the availability of verbal working memory would interfere with evaluation and increase the time spent revising and the proportion of *revision bursts*. However, Chenoweth and Hayes (2003) failed to find any evidence for either of these effects. Perhaps, a simpler explanation of Chenoweth and Hayes' (2001) results is that it is harder to meet the constraints of the writing task in L2 than L1. When writing in L2, a person will presumably have fewer lexical choices and fewer grammatical structures available to satisfy the requirements of the writing task than in L1. Thus, the translator will produce more surface structures that need revision in L2 than L1. This situation would lead to a larger proportion of *revision bursts* and smaller percentage of proposed language included in the final text in L2 than in L1, as was observed.

According to the model in Figure 2.1, evaluation of the writing process may take place before the text becomes part of the task environment. Chenoweth and Hayes' (2003) cartoon-description study provided some evidence for this claim.

In this study, writers were sometimes able to see the text that they wrote and sometimes not. An unanticipated consequence of making the writer's text invisible was that writers produced more words per minute than when their texts *were* visible. When the text was visible, writers produced 5.8 wpm and when it was invisible, they produced 7.0 wpm. Chenoweth and Hayes attributed this increase in writing rate to a decrease in revision. In the visible condition, writers averaged 3.01 revisions per sentence and in the invisible condition, 1.34 revisions per sentence. This result clearly indicates that seeing the written text stimulates revision. However, although revision was reduced in the invisible condition by 55%, it was not totally eliminated. The remaining revisions must have been based on evaluation of some precursor of the text such as the idea package, the surface structure, the motor plan, the articulation activity itself, or, perhaps, all four. In any case, it is clear that in adult writers a substantial amount of evaluation can occur before the text is transcribed.

Translation and Transcription

Chenoweth and Hayes (2003) and Hayes and Chenoweth (2007) found that articulatory suppression slowed the rate of writing in tasks that involved both translation and transcription. In addition, Hayes and Chenoweth (2006) found that articulatory suppression slowed writing rate in a task that involved only transcription. This finding raised the question, "Could the reductions in writing rate observed in Chenoweth and Hayes (2003) and Hayes and Chenoweth (2007) be attributed entirely to the effect of articulatory suppression on the transcriber?" To answer this question, Hayes (2009) replicated Chenoweth and Hayes (2003) and Hayes and Chenoweth (2006) with the same group of participants. This method allowed a within-group comparison of writing rates when the participants were writing to describe cartoons and when they were simply transcribing text. The time to perform these tasks was divided into time occupied by typing, time devoted to pausing (of more than 2 s), and time involved in revising.

In the cartoon-description task, articulatory suppression significantly increased typing time and pause time but had no effect on revision time. Fifty-five percent of the total increase in writing time was due to the increase in typing time and 45% due to the increase in pause time. I interpreted these results to mean that there were two memory-sensitive "bottlenecks" in the composing process—one in the transcriber and one in the translator. I attributed the increase in pause time to the translator because earlier studies had found no effect of articulatory suppression on planning (start time) or revision (Chenoweth & Hayes, 2003; Hayes & Chenoweth, 2007), and those findings were replicated in this study.

Comparison of typing rates across tasks showed that rates were significantly slowed by articulatory suppression in both tasks, and typing rates in the cartoon-description task were significantly slower than in the transcription task, with or without articulatory suppression. These results are consistent with the notion that the translator can use up cognitive resources, which in turn can slow transcription.

These results and those of Chanquoy, Foulin, and Fayol (1990) are also consistent with the possibility that the cognitive resources involved are verbal working memory resources.

SUMMARY AND CONCLUSIONS

In this chapter, I have summarized evidence from a variety of empirical studies designed to reveal properties of the process by which ideas are transformed into language. The results of these studies suggest the following conclusions:

1. *Translation and language bursts.* Writers create texts by proposing short bursts of language. These bursts occur whenever the translator is active. We have called bursts that end in pauses "*pause bursts*" and bursts that end in revision "*revision bursts*." Pause bursts occur because writers have limited capacity for storing the output of the translation process, that is, for storing unarticulated surface structures. The length of pause bursts increases with the writer's linguistic experience and decreases when the writer's working memory resources are reduced.
2. *Translation and evaluation.* Translation may be viewed as a constraint satisfaction task that produces surface structures intended to meet a variety of constraints imposed by the writing situation. Sometimes, this process produces surface structures that the writer judges inadequate. Evaluation may identify faulty structures as they are being transcribed, producing *revision bursts*, or after transcription is completed, triggering revisions. Thus, the efficiency of translation process is reflected in a decreased percentage of *revision bursts* and an increased percentage of the proposed language that is accepted in the final text. Efficiency of the translation process increases with linguistic experience.
3. *Translation and transcription.* Both translation and transcription are "bottlenecks" that can slow writing rate when verbal working memory is limited. Transcription is slowed when the other writing processes are active.

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3

Mapping Research Questions About Translation to Methods, Measures, and Models

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The first goal of this chapter is to situate translation research within the historical context of writing research. The second goal is to remind readers of an established, but often overlooked, principle in scientific research that the most appropriate methods, measures, and models depend on the research question. One research method is not intrinsically superior to another, even though many mistakenly believe that certain methods are superior to others. The third goal is to discuss alternative, interdisciplinary approaches and encourage future research on translation that draws on multiple approaches. The fourth goal is to explain why (a) researchers should be more careful in describing the population studied and research question addressed and (b) reviews and meta-analyses of the research findings should be clearly linked to both population characteristics and research design and questions.

To accomplish the first and second goals, we set the record straight that, despite the false belief of some researchers that hardly any writing research exists, writing research has indeed been done for over a century. We provide contemporary access to this cross-disciplinary, cross-country research through publication lists, which are organized by conceptual frameworks guiding past writing research. To accomplish the third and fourth goals, we review widely used methods of research, consider how multiple methods may be applied to writing research, and emphasize how important theory and conceptual frameworks are in applying these methods to research on translation (and other cognitive processes, see Chapter 2). For example, what is the nature of the representations, operations, and cross-domain mapping and transformation processes involved in cognitive ← → linguistic translation?

We emphasize the importance of (a) defining the research inclusion criteria for selecting a research sample because these participant characteristics restrict the population to which the findings can be generalized and (b) taking sample characteristics, research design, and methods into account in meta-analyses, evidence-based reviews, and peer feedback.

HISTORICAL CONTEXT FOR TRANSLATION RESEARCH

Many researchers or practitioners are unaware of either the rich history of writing research around the world conducted by researchers in many different disciplines or the variety of methods, measures, and models already employed in writing research (e.g., Bazerman et al., 2010; Berman & Verhoeven, 2002; Grigorenko, Mambrino, & Preiss, In press; Le Ha & Baurain, 2011; Rogers, 2011). A brief overview of the early scientific research on writing over a century ago shows that it initially focused on transcription skills.

Writing research commenced as early as the end of the nineteenth century. Joseph Mayer Rice (born 1857, died 1934), an American pediatrician, spent 2 years in Europe near the end of the ninth decade of the nineteenth century observing school systems and visiting the first experimental psychology lab established in 1879 by Wundt at the University of Leipzig. He then returned to the United States to introduce comparative research methods to education and studied how research could improve education in his home country. In 1891, Rice proposed in the *Forum* essentials for improving education: proper training of the teacher, a curriculum based on sound psychological principles, and educational systems managed by trained educators. He then conducted what may have been the first scientific research in education. During a 16 month study beginning in 1895, he toured the country visiting many states and schools during which he gave the first educational test of spelling to nearly 33,300 students in grades 4–8. Carefully noting age, nationality, environment, and type of school system, Rice found no relationship between amount of time children were drilled in spelling and their performance on spelling tasks. He discovered that *less was more*: Short practice periods a few times a week resulted in better test scores than long practice periods every day. His findings, which were reported in *Scientific Management in Education* (Rice, 1897, 1898, 1913), may be explained by subsequent research showing that humans habituate to repetitive practice or learn more from distributed short periods of instruction and practice widely spaced over time than massed practice within a short interval (e.g., Mayer, 2003).

Subsequently, Montessori (1912), who was both the first Italian woman to become a physician and an innovator in early childhood education, introduced application of the scientific method to education in Europe. She designed and implemented multisensory and motor activities for teaching letter formation using slanted letters (cursive writing) and for generating words in composing. Her methods, which support translation early in writing development, are still used today in Europe and North America.

Despite this pioneering research by Rice and Montessori, which stimulated additional writing research, there are three possible reasons why many researchers in reading are unaware of the sizable body of existing writing research. First, researchers in different writing traditions use terminology, concepts, and methods often unfamiliar to those in other traditions; or the research in one writing tradition is not always easily accessible or interpretable by those in other writing traditions who receive different kinds of professional training and participate in different kinds of organizations and social networks. Second, even within the same disciplines (e.g., education, psychology, neuropsychology, neuroscience, linguistics, and psycholinguistics), different streams of research, perspectives, belief systems, and paradigms exist. Third, writers are studied at different time points within the life span and writing changes across these time points.

Thus, to tell or write the whole writing story one needs to synthesize research findings across writing development as well as disciplines and traditions within them. In fact, existing writing research covers a variety of writing skills: transcription (*handwriting* and/or *spelling*); composition (*text generation at different levels of language*—word, sentence, and discourse genre); *cognitive processes*—planning, translating, reviewing, revising; *neuropsychological processes*—internal language and nonlanguage codes, working memory storage and processing (capacity, efficiency, timing), and motor processes related to hand function; and *social pragmatic acts in historical, cultural, social, and linguistic contexts*.

Translation as a research topic has been primarily of interest to writing researchers in the cognitive tradition. It traces its origins to a conference (see Chapter 8) and an influential chapter by Hayes and Flower (1980) that followed the conference in which they proposed a model of the cognitive processes of writing, one of which is translation. To help contemporary and future writing researchers and practitioners learn more about the story of the sizable body of writing research across disciplines and traditions, we provide at the end of this chapter both a reference list for the text and an appendix with supplementary references that serve as an introduction to the field of writing research.

The appendix contains (a) recent publications that enable access to the contemporary research with references to earlier research in the past and (b) possible schemata for organizing existing research according to current topics or research questions and developmental level of writers (early childhood to adulthood). We hope that current researchers will become aware of this sizable body of writing research since the nineteenth century. The field would benefit from someone writing a complete history of writing research that accurately and carefully represents the whole body of research-based knowledge of writing.

METHODS, MEASURES, AND MODELS FOR TRANSLATION RESEARCH QUESTIONS

Early pioneers in the cognitive writing research tradition, Bereiter and Scardamalia (1987, p. 34), who envisioned a field in which multiple methods were used to investigate writing processes, identified six methods for studying composing: reflective inquiry, empirical variable testing, text analysis, process description, theory embedded experimentation, and simulation (see Rogers, 2011). In the broader scientific community, a distinction is often made among descriptive, correlational, or experimental research. Some (e.g., Shadish, Cook, & Campbell, 2002, which is the current version of Campbell & Stanley, 1966) believe that experimental studies that assign participants randomly to experimenter-manipulated treatments and include control conditions are superior because they support conclusions about cause–effect relationships. Thus, randomized control experiments have become for many psychologists and educators the gold standard all researchers should strive to achieve. However, as explained next, other methods have also contributed valuable knowledge.

Descriptive Studies

In descriptive studies, investigators observe, interview, or assess humans or animals and may employ methods of ethology, anthropology, or ethnography. They may use quantitative and/or qualitative methods. An example of a descriptive study that has had scientific impact is Darwin's (1859) careful documentation of the normal variation among and within species in a natural, relatively undisturbed environment. Often descriptive studies lead to the future quantitative and/or experimental studies. For example, the descriptive, analytical analyses based on adult think-aloud protocols (see Costa et al., Chapter 8, for application to children as well) generated a theoretical model (Hayes & Flower, 1980; also see Chapter 2) that has influenced over three decades of experimental research on the cognitive processes in writing including translation (e.g., see Chapters 11 through 13; also Whitaker's study in Berninger, Fuller, & Whitaker, 1996, Study 3). A review of descriptive, correlational, and experimental research across disciplines contributed to the summary in this chapter of the diverse nature of cognitions (Table 3.1), thought processes (see Table 3.2), mechanisms supporting access to cognitions (Table 3.3), and cognitive ← → linguistic translation processes (Tables 3.4 and 3.5).

Descriptive qualitative and mixed qualitative and quantitative studies can yield insights not likely to surface with other research methods, such as describing specific populations, for example, middle school student writers whose families immigrated to a country less than 5 years ago and whose first language (L1) is not the language of the school they attend and learn as a second language (L2). In Europe, the Middle East, North America, South America, Asia, and Pacific Islands, an increasing number of students are faced with the challenges of translation across languages (L1 and L2) and cultures to succeed on academic writing tasks required for school success and graduation.

Correlational Studies

Observation of a correlation in the natural world can lead to scientific advances. For example, Fleming unexpectedly observed a correlation between nearness to a biological culture with a fungus contamination *and* the absence or presence of staphylococci; he then conducted a planned study in which he grew the fungus in a pure culture that produced a substance (from the *Penicillium* genus) that killed a number of disease-causing bacteria (Fleming, 1980). This design experiment to bring about a desired outcome (Brown, 1992) led to experiments conducted by other scientists, which resulted in wide scale use of penicillin in the population to treat infection (Diggins, 1999). Examples of *correlational studies* currently having scientific impact are the statistical genetics and molecular biology DNA studies, which employ complex multivariate correlational methods. DNA studies have identified genetic variations in at least 10 gene loci reported to be associated with dyslexia, which is both a writing and reading disorder (reviewed in Berninger & Richards, 2010).

Writing researchers have applied a variety of correlational methods to study unidirectional or bidirectional relationships among writing variables: bivariate, partial, or canonical correlational analyses; multiple regression; confirmatory factor analyses; structural equation modeling; or multilevel hierarchical linear modeling. Often the multivariate models are data driven rather than theory driven, especially in the early research on a particular question, but can make important contributions if (a) research design, measures, and results interpretation are grounded in theory or conceptual frameworks and/or (b) alternative models are evaluated to determine if they fit the data and is so which model is the best fit to the data (e.g., see Abbott, Berninger, & Fayol, 2010). Data may be measures of individual differences on experimenter-designed or standardized measures, which are then evaluated for their potential statistical relationships. Multivariate correlational studies have been used to study writing-related processes from a variety of disciplines: cognitive (Chapters 2 through 13), neuropsychological (Chapter 8; Berninger, 2009), affective and motivational (e.g., Boscolo, 2009; Boscolo & Gelati, 2007; Boscolo & Hidi, 2006; Chapter 5), and linguistic (e.g., Berman, 2009; Berman & Nir, 2004).

Multiple methods for analyzing statistical relationships can be applied to the same data set (for review, see Berninger, 2009). For example, in one cross-sectional study of grades 1–6 (50 girls and 50 boys representative of U.S. population in ethnicity and mother's level of education), initially *bivariate correlations* were computed between each measure of a *writing skill* (e.g., transcription, handwriting or spelling, and translation outcome—written composition) and *writing-related skill* (e.g., oral vocabulary knowledge, orthographic and phonological coding in working memory, and finger skills such as finger repetition and finger succession). Then *multiple regression* was used to test theoretical models of which writing-related process measures in a set of predictors, chosen for significant correlations of highest magnitude with writing skill outcomes, explained significant variance in outcomes; results had significance for which measures validly identify impaired processes related to poor transcription skills or text generation at different levels of language during translating. Remediating transcription or text generation or related skills may render child writers better able to translate during composing. Then, *canonical correlations* were used to identify two underlying dimensions in the multiple correlations between multiple writing-related processes and multiple writing skill outcomes—automatic processing and nonautomatic, reflective cognition.

Next, after showing in *confirmatory factor analyses* that handwriting, spelling, and composing are separable factors, Abbott and Berninger (1993) used *structural equation modeling* to evaluate which writing-related process factors explained unique variance in each of handwriting, spelling, and composing outcome factors; results had instructional utility for which writing-related process skills to teach to students in grades 1 to 6 who struggle with transcription (e.g., orthographic coding or fine motor skills) or text generation (e.g., levels of language). Finally, Graham, Berninger, Abbott, Abbott, and Whitaker (1997) used structural equation modeling to evaluate which transcription factors (independent measures of handwriting or spelling) explained unique variance in composition factors (length and quality ratings); note the quality ratings were based on inter-rater judgments of typed transcripts that retained words, sentence structure, and content, but did not reflect children's actual handwriting or spelling that can bias judgments of composing quality. Results showed a consistent unique contribution across grades 1–6 of the independent measure of handwriting to length and quality ratings of compositions (one narrative and one expository), but the contribution of the independent measure of spelling to the same composition outcomes was unique only at some grade levels.

More recently, in a longitudinal study, with a new sample of overlapping cohorts grades 1–5 or 3–7, Abbott et al. (2010) used *longitudinal structural equation modeling* to address a similar question about the relationship between transcription and text generation requiring translation, but used only independent standardized, norm-referenced measures of transcription and text generation. In this new study, spelling had the most stable relationship with itself and composing across adjacent grade levels. Again, transcription was shown to play a role in the outcome of translation during writing, but clearly the relationship between handwriting or spelling and text generation during translation may depend on the nature of the measures used to assess each transcription or composing skill and design for collecting observations (cross-sectional or longitudinal). Although correlational relationships do not support conclusions about cause–effect relationships, they can validate assessment measures and models for purposes of identifying students with specific kinds of writing problems and designing multicomponent instructional studies to overcome those writing problems.

All these examples of multivariate analyses of interrelationships among transcription and text generation skills were theory driven and based on unreferred samples of typically developing students. Other recent multivariate correlational analyses informed by theory and relevant to translation and related processes are featured in this volume. Wagner and colleagues (Wagner et al., 2011; Chapter 9) used confirmatory factor analyses to identify the best fitting model for a set of measures selected for classroom assessment of the range of writing skills in general education classes. Of interest, their factors can be interpreted as modeling two levels of language in translation—word level and metalevel (beyond single words)—and transcription (handwriting, spelling, punctuation, and capitalization). Hooper and colleagues (Hooper et al., 2011; Chapter 8), in contrast, studied normal writers and at-risk writers in a longitudinal design across the first three grades and identified factors underlying their neuropsychological assessment measures, which can be interpreted as corresponding to the motor, language, and executive function systems of brain (see Berninger & Richards, 2011). Hooper et al. documented the longitudinal stability of these factors from first to second grade in children who were and were not at risk for writing disabilities. Berninger, Abbott, Nagy, and Carlisle (2010) tested the stability of growth curves for phonological, orthographic, and morphological word-form storage and processing over the first four grades. Berninger, Fayol, and Alamargot (Chapter 4) evaluated whether growth curves across the first three grades for these three word-form units and for finger sequencing (comparable to the measure Hooper and colleagues validated in their model) predicted writing outcomes in fourth grade. See Chapter 4 for interesting findings including those about the unique relationship of growth curves for orthography and fourth grade writing outcomes, which validate Fayol's construct of the silent orthography (e.g., Fayol, 2011).

Findings from correlational research could inform further writing research which then is conducted using randomized, controlled experiments to test initial observations. For example, longitudinal case studies described in Chapter 5 showed interindividual differences in typically developing writers' ability to sustain self-regulated translation bouts; planned experiments will evaluate whether these self-regulated bouts generally last longer than language bursts (see Chapter 2) and are related to sustaining working memory over time during translation. Multivariate correlational studies have advanced knowledge of statistical validity of various measures of individual differences in transcription and text generation skills and related processes, which can be used to identify students needing further instructional assistance (e.g., Chapters 4 through 9) and plan instructional intervention (Chapters 6 through 10). However, studies of online processing in which written translation products are produced in real time are needed to draw conclusions about functional (causal) relationships between processing and production. The online experiments, which Fayol, students, and colleagues introduced and conducted for nearly two decades (e.g., see next section and Chapters 11 through 13; Fayol, 2011), are featured in the section that follows.

Experimental Studies

Experimental studies examine the effect of a treatment or experimental manipulation (independent variable) that typically includes a control condition (receive no treatment or business as usual) or contrast condition (receive an alternative treatment). Two kinds of experiments have supported causal inferences related to writing and writing-related processes: (a) *online production of translation outcomes in real time* (Bourdin & Fayol, 1994, 2000; Chanquoy, Foulin, & Fayol, 1990; Fayol, Largy, & Lemaire, 1994; Largy & Fayol, 2001; Chapter 11) in which between writing pauses (BWPs) and writer's writing rate (WWR) are used to infer online processing from temporal parameters of written production of written translation outcomes (Fayol, Foulin, Maggio, & Lété, in press) and (b) *instructional experiments that evaluate treatments for specific writing skills* (Berninger, 2009; Boscolo, Gelati, & Galvan, in press; Fayol, Thévenin, Jarousse, & Totereau, 1999; Graham, MacArthur, & Fitzgerald, 2007; Rijlaarsdam et al., in press; Rijlaarsdam, van den Bergh, & Couzijn, 1996; Troia, 2009; see Chapters 8 through 10).

Online Studies Online studies of translation production in real time were an important methodological innovation in psychology at a time when cognitive psychology used primarily (and often exclusively) reaction time (RT) experimental methodology in which the researcher manipulated stimulus and task parameters and investigated participants' response as a function of those experimenter manipulations. RT methods did not lend themselves to writing research because writing (a) is a self-generated process, even if writer is using strategies taught by a teacher or feedback provided by a reviewer and (b) results in variable written productions in content, structure, and timing across participants. Fayol and his collaborators have generated programmatic research findings for nearly two decades using online experimental methodology, which remains cutting edge and is expected to increase in use and influence in the future given the advancements in technology (for review, see Alamargot, Chesnet, Dansac, & Ros, 2006; Alamargot et al., 2011; Van Waes, Leijten, Wengelin, & Lindgren, 2011; Chapters 12 and 13).

Current findings based on online methods and technologies (also see Chapter 2 for language bursts—pause bursts and revision bursts) will undoubtedly spawn increasingly sophisticated future studies of the timing of cognitive and written language processes during translation. However, online methods are most likely to be fruitful when grounded in theory, for example, about cognitive processes, as in study by van den Bergh and Rijlaarsdam (2001). They showed that students who delayed translation production and engaged in planning time produced higher-quality persuasive writing texts (arguments) than those who immediately began translating. Likewise, language processes such as subject–verb agreement during translation can be studied in reference to working memory constraints (Chapters 11 through 13; Alamargot et al., 2011; Fayol, 2011) or domain knowledge (Kellogg, 2001).

Instructional Experiments In another line of experimental research, children are randomly assigned to one or more treatment groups for teaching specific transcription or text generation skills or to a control group (no treatment or business as usual) or a treated control group (to rule out Hawthorne effects due to novelty or special treatment). Performance across the groups (treatment conditions) is compared to identify the most effective treatment on behavioral and/or brain outcomes. For review of such instructional studies with low achieving writers or children at genetic risk for writing problems, see Berninger (2009) and Berninger and Richards (2010). For overview of representative instructional research in writing including translation, see Graham et al. (2007), Graham and Perrin (2007), Rijlaarsdam et al. (in press), Rijlaarsdam, van den Bergh, and Couzijn (1996, 2004), and Troia (2009). For representative instructional studies related to affective and motivational issues, see Boscolo and Gelati (2007), Boscolo et al. (in press), and Hidi and Boscolo (2006). Although most experimental studies employ group designs, the design features of experiments can be adapted for single subject studies (Chapter 10). Alternatively, multiple components designed to achieve the outcome can be kept constant except for one that is systematically varied across treatment and control groups (e.g., Berninger et al., 1997, 1998; for review, Berninger, 2009).

Validity Criteria for Experimental and Quasi-Experimental Methods Campbell and Stanley (1966) defined design features for experimental and quasi-experimental research to ward off *threats to internal validity* (drawing conclusions from results), *external validity* (generalizing findings to specific populations), *construct validity* (measuring constructs in reliable and valid way), and *statistical validity* (analyzing data with appropriate methods). However, these criteria could and should be applied in relevant ways to descriptive and correlational as well as experimental methods.

New Research Methods

Hybrid Designs: Learner Variables and Experimental Instructional Treatments

A scheme of basic variables for designing instructional studies is shown in Figure 3.1. Such studies search for effects of variations in instruction (for instance, peer review versus teacher review) or variation in planning conditions (brainstorming versus planning sheets, etc.) on outcomes, in most instances "text quality" or production measures (fluency or text length). In other studies in which writing is the learning activity, outcome measures can be knowledge change or attitude (writing to learn studies). However, such hybrid studies can also take into account individual differences in learner processes (characteristics) (see Figure 3.1).

When all relevant design features are validly implemented using randomization, balanced pretest and posttest measures, and controls during implementation, these hybrid studies inform us about which relevant variations in instruction covary with outcome variables. Adding learner variables in the research design provides opportunities to study nuances in instructional theories about the effect of certain instructional variables. Differentiated instruction and feedback are major issues in classrooms that become more and more heterogeneous in social and linguistic background. Writing research must theoretically accommodate for these situations, as shown in Figure 3.1, which provides a scheme of basic variables for designing instructional studies.

One relevant variable for translation is "writing style." Kieft and colleagues (Kieft, Rijlaarsdam, Galbraith, & van den Bergh, 2007) designed two learning arrangements, varying in the planning component (draft versus planning schemes) that guided students in writing about literary texts. Writing style (varying on the

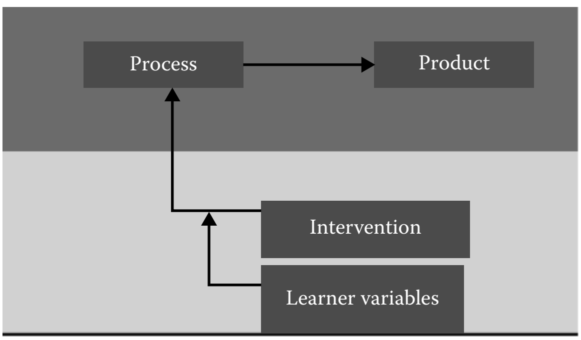

Figure 3.1 Which variations in writing instruction covary with outcomes (process and product), and which learners' variables modify this covariation? (Reproduced with permission from Rijlaarsdam, G. and van den Bergh, H., *Past, Present, and Future Contributions of Cognitive Writing Research to Cognitive Psychology*, Psychology Press/Taylor & Francis Group, New York, 2011.)

dimensions "planning" and "revising") did indeed interact with the learning arrangement when it concerned the effect of writing on learning (quality of literary interpretation) (Kieft, Rijlaarsdam, & van den Bergh, 2008). This effect was partly confirmed for the effect of the instruction on the quality of writing (Kieft et al., 2007).

Another relevant variable, given the reality of mixed ability classrooms, is academic aptitude or intelligence. Couzijn and Rijlaarsdam (2004) studied the effect of two learning activities on argumentative text quality: observing (students observe and evaluate on video how other students perform learning tasks) versus performing (students perform the learning task themselves). They found that observing resulted in better argumentative texts as outcome than did performing. This effect is replicated with other writing tasks and other age groups (Van Steendam, Rijlaarsdam, Sercu, & van den Bergh, 2010) for revising letters of application with first year business students, and for composing synthesis text with first year students of economics (Raedts, Rijlaarsdam, Van Waes, & Daems, 2006). Similar findings were found for visual arts in higher forms of secondary education (Groenendijk, Janssen, van den Bergh, & Rijlaarsdam, submitted).

A replication study with somewhat refined conditions revealed that the effect was moderated by academic aptitude. The observation condition had two versions: In one version, participants had to decide and explain which of the observed students of a pair did best; in the other version, students had to decide and explain which student did worst. Results showed that students with a weak aptitude profited most from deciding which student did worst, whereas students with a relatively high aptitude learned most by deciding which student did best (Braaksma, Rijlaarsdam, & van den Bergh, 2002). Van Steendam (2008) and Raedts (2008) also found clear interactions between learner variables (aptitude, writing proficiency) with the learning conditions of observation versus performing.

In Figure 3.1, Rijlaarsdam and colleagues also included "process" in the outcome box, mediating the effect of the intervention on the resulting text. Effects of interventions on processes are often assumed but seldom measured. Rijlaarsdam and colleagues proposed two reasons for including process measures when designing experiments: (1) theory building and (2) generalizing. For theory building, we still need more insight about writing processes and the relation between these processes and resulting text. In instructional experiments, researchers assume effects of the instruction on processes and therefore on products, but whether the processes were changed as a consequence of the instruction is seldom studied and is an especially critical issue for studies of translation. Adding process measures as outcome variable also strengthens the external validity (generalization) of the study. In most cases, the outcome variable text quality is measured by one writing task per individual. If the result is positive, it is based on thin ice, with very limited generalizability. As soon as other related variables are included in the design, and the results are in the same direction, the basis of the study outcome is much stronger (also see Chapter 6) because of converging evidence (Shadish et al., 2002).

Torrance, Fidalgo, and Garcia (2007) showed that planning was improved by the strategy instruction, but revision was not. Braaksma, Rijlaarsdam, van den Bergh, and Van Hout-Wolters (2004), who included process measures, showed that the observation condition affected the planning and analyzing activities of the writing process, whereas the control condition did not. These last two studies illustrate the importance of discriminant validity (Shadish et al., 2002) in designing and interpreting experiments on the translation process, namely that the effect is observed for one but not another treatment or condition.

When we define the writing process in a broader sense, other variables come to mind, contributing to theory and generalization. Rijlaarsdam, Couzijn, Janssen, Braaksma, and Kieft (2006), for instance, added a generalization task as delayed measurement: Not only the effect of the intervention on text quality (instructional text) but also on the procedural knowledge students acquired about how to write an instructional text was measured (see also Raedts et al., 2006). To test the transfer effect of observation as an effective learning activity, Couzijn and Rijlaarsdam (2004) included the reading tasks next to the writing tasks and proved that the effect of observing learning to write transferred to reading tasks, with an even larger effect than performing or observing this kind of reading task in a control condition.

Linguistics and Psycholinguistics Linguistics and psycholinguistics have traditionally focused for the most part more on oral language than written language, but that is changing. Many research teams, often inspired by the pioneering work of Berman and colleagues in the last decade, are showing the value of linguistic analyses of written communication (e.g., Beers & Nagy, 2008, 2009, 2011; Berman, 2009; Berman & Nir, 2004; Berman & Nir-Sagiv, 2007; Berman, Ragnarsdóttir, & Strömqvist, 2002; Berman & Slobin, 1994; Berman & Verhoeven, 2002; Stahl & Nagy, 2005; Venezky, 1970, 1999; also see Chapter 14). For example, the online studies discussed earlier were clearly inspired by psycholinguistics (e.g., study of subject–verb agreement during online translation). Also, linguistic analyses employing a levels-of-language theoretical framework guided all the text generation assessment and instructional studies conducted by Berninger and colleagues for two decades (reviewed in Berninger, 2009); see Chapter 5 for recent application and Beers and Nagy (2008, 2009, 2011) and Berninger, Nagy, and Beers (2011) for interactions among level of language (e.g., syntax and discourse genre). As research moves forward on translation, we expect to see more psycholinguistic methods and models applied to both online experiments (Chapter 11) and analyses of the written products of the translation process in instructional studies (e.g., see research by Rijlaarsdam and colleagues, Chapters 7, 9, and 10) and longitudinal and cross-sectional assessment studies (Chapters 5 through 9).

Combining Design Experiments, Randomized Controlled Designs, Learner Processes, and Transfer at Different Levels of Language The instructional studies of Berninger and colleagues (reviewed in Berninger, 2009) combined

- *Design experiments*—keeping constant a set of instructional components shown in prior research to be effective in bringing about a desired student learning outcome in handwriting, spelling, or composing
- *Theory-driven, randomized experiments* systematically varying one instructional component in a set of instructional components

- *Learner processes* (a common research inclusion criteria used to identify all participants by screening all classrooms at a grade level in participating schools, for example for lowest handwriting skill in first graders, lowest spelling skill in second graders, or lowest compositional fluency in third graders)
- *Outcomes at multiple levels of language* related to treatment effects of skill directly trained in a particular instructional experiment (e.g., handwriting, spelling, or composing strategy), a transfer effect for skill not directly taught but at same level of language as instructed skill (e.g., spelling words not directly practiced), a transfer effect for a trained skill used spontaneously at another level of language (e.g., spelled words in independent composing), and a transfer effect to a nonwriting domain (e.g., reading)

Meta-Analyses Separate treatment effects are calculated for different kinds of instruction, but investigators who do meta-analyses are not always paying careful attention to these design features: (a) conceptual and measurement differences in instructional treatments sharing a common verbal label and (b) the other treatments to which a treatment is compared within a design. Consequently, treatment effects may be misanalyzed and misinterpreted. We note this inattention to design features in many meta-analyses regarding effective instruction in many domains and encourage researchers conducting meta-analyses or using the reported results of meta-analyses to address the following questions and make sure that the meta-analyses are not comparing apples and oranges:

1. Who were the participants? What was their age? Were they in a convenience sample? Or were they in a sample that was recruited on the basis of the same research inclusion criteria for all participants (learner processes in Figure 3.1)?

   If the participants had not met the same research inclusion criteria across all the studies included in a meta-analysis or their characteristics are not clearly defined on relevant variables, there is a high probability that the results of the meta-analyses are confounded in ways that cannot be unconfounded without knowing how the participants may have differed on variables relevant to the independent and/or dependent variables.
2. Was one treatment compared to one control condition? Were multiple treatments compared? If the latter, then the results of this study cannot be meaningfully compared to those from a study that did not include the same set of treatment conditions. Also, what kind of control was employed (treated or no-contact business as usual)? Unless the whole set of conditions is identical across studies, the effects and effect sizes cannot be meaningfully interpreted.
3. On what outcome measure(s) was effectiveness evaluated? If measures are not identical, the comparison may be meaningless. What is the treatment effect for the directly manipulated variable? Are some treatments or outcomes included as indicator(s) of transfer effects? If so, direct effects and transfer effects should be analyzed separately and interpreted separately.

Using treatments or outcomes, which were included to capture transfer effects, as indicators of direct treatment effects would be misleading in a meta-analysis.

4. On which theory-guided instructional components were the instructional treatments contrasted? For example, if the purpose of the meta-analysis is to analyze the effects of phonological treatment on spelling (i.e., instruction based on analysis of spoken words) versus a no-treated control, then any study that included both phonological instruction and phonological–orthographic correspondences instruction (contrasting, alternative treatments) is not comparable and should not be included in the meta-analysis of the effects of phonological instruction versus no phonological instruction on spelling. Separate meta-analyses should be conducted for studies that compare phonological instruction only versus phonological–orthographic instruction or that compare each of those to a third alternative treatment (phonology, orthography, and morphology) (e.g., in English, a morphophonemic language, all three are likely relevant to instruction, see Chapter 4 and Nunes & Bryant, 2006).

Longitudinal Single Case Studies Following Emig's (1971) and Rogers' (2011) recommendations for longitudinal individual case studies of the same students in a sample, we report in Chapter 5 case studies for 10 girls and 10 boys assessed annually for the first five grades to characterize each of their longitudinal developmental trajectories for translation (Hayes & Flower, 1980). Multiple measures provide converging evidence for inferring writing development within and across grades: (a) psychometric test scores for each child in each grade 1, 2, 3, 4, and 5 for verbal reasoning, writing achievement (handwriting, spelling, and composing), and components of the verbal working memory system that supports writing (summarized in 20 individual profiles in Appendix B in Chapter 5); (b) parent questionnaire and rating data; (c) other test results; (d) analyses of individual children's translation outcomes on multiple researcher-designed writing tasks (handwriting, spelling, and composing), and oral think-aloud protocols (idea generation, plan for organization, and plan for revision) (Appendix A in Chapter 5); (e) child's ratings on scales for attitude toward writing (grades 1–3) and approach-avoidance orientation to writing in motivation scale (grades 4 and 5); and (f) child explanations about what writing is (one index of metacognitive understanding of writing). Such longitudinal studies of individual cases on multiple measures are time consuming, but results can inform hypotheses and research design for future online experiments and instructional experiments. See discussion at end of Chapter 5.

Brain Research Although research on acquired brain disorders affecting writing has been available for over a century, research on the writing brain in developing children is a relatively new, but growing, topic of research (for a review, see Berninger & Richards, 2011; Richards, Berninger, & Fayol, in press). Some of this research employs experimental designs with contrasts between an on (target) task and off (control) task chosen to identify how the two tasks, which share common as well as unique processing requirements, may vary in brain activation.

Other research compares brain activation during other-guided processing (experimenter task) and self-guided processing (resting condition or open-ended task). Existing research on children's writing brains relevant to translation include studies on idea generation (Berninger et al., 2009) and updating working memory over time (Richards et al., 2009). Both studies provided evidence for working memory differences in child writers who do and do not have a specific writing disability (dysgraphia). Working memory enables the writing brain to engage sensory and motor, language, and cognitive systems to support translation (Table 4.1) via loops that connect the sensory or motor and language systems (Table 4.2), which in turn are able to communicate with internal cognitive systems (Table 3.1), and executive functions that supervise activities to coordinate all working memory components in time (Table 3.5). Working memory also allows the developing writer's brain, which is a complex, multilevel organ, as explained next, to gain access to thoughts and thinking and enrich these in turn through writing.

The human brain is organized *hierarchically with different levels of neural activity, transmission, and computational mechanisms* (see Berninger & Richards, 2002, 2009, 2011). These levels range from (a) chemically mediated computations in the nucleus of single cells (neurons) to (b) activation of distributed neural pathways of large collections of single neurons, each with functional connections from the cell body to axon of one neuron and then across the synaptic gap to the dendrites and then cell body of another neuron to (c) computational networks in cerebral cortex, which is a thin region comprised of six layers and a variable number of columns that integrate the distributed processes across space and time in the brain in real time. Cerebral cortex surrounds the cerebrum, which on both the right and left sides of the brain has four cortical lobes, each with voluminous folds that rise or fall creating boundaries among regions specializing in different kinds of computations. For the most part, the cell bodies are bundled together in specific layers of the cerebral cortex (gray matter) and axons are bundled together in paths that transmit in a single direction throughout the brain (white matter) but may be coupled with a separate feedback pathway that operates in a different direction. White matter tracts are organized along axes that transmit in multiple directions in the brain—top-down, down-up, back-front, front-back, right-left, and left-right.

At any one moment in time, all these loci of neural activity, which are on different time scales, are active but for the most part are not consciously aware of each other (Minsky, 1986). However, periodically, monitoring mechanisms reconcile in real time the widespread activity that is co-occurring throughout the brain at many levels. The resulting observed "brain waves" vary with level of consciousness, for example, whether the individual is sleeping, wide awake but resting, semiawake and daydreaming, or engaged in a goal-driven task. Subcortical cerebellar computations and other computations may also play a role in the integration of brain processes across space and time in the human brain. See Kolb and Whishaw (2009) for further discussion.

The relevance to a theory of translation is that most brain activity occurs outside conscious awareness (Berninger & Richards, 2011). At any moment in time, the writer can gain only limited conscious access to what is happening throughout the brain at many different levels of processing and organization that may be relevant for the writing task at hand. Working memory is a brain mechanism that supports temporary conscious access to a fraction of what exists in the vast unconscious internal mind in which all these neural activities are taking place (e.g., Goldman-Rakic, 1992). Consciousness and unconsciousness may not be dichotomous variables but rather lie along a continuum of levels of consciousness; both the reticular activation system and neurochemical mechanisms underlying the circadian rhythms and sleep–wake cycles may play a role in regulating where an individual may be at any moment in time in level of consciousness. All four ways Jung (1968) proposed that consciousness may be oriented to experience—*perception through the senses*, *feelings* experienced during living (positive or negative affect), *intuition* (sensed but not easily articulated), and *thinking* (active and concerted effort to understand)—may contribute in some way to the cognitive ← → linguistic translation process for writing.

Working memory may be the brain mechanism that enables humans to access unconsciousness, momentarily and partially, for purposes of conscious processing in the present. Working memory enables the individual, while in the present, to engage in mental time travel from the present to the past and from the present to the future (Berninger & Richards, 2002; Suddendorf, Addis, & Corballis, 2009; Suddendorf & Corballis, 1997). Access to the past through conscious working memory may involve (a) accessing what exists, but heretofore has been unknown, until it comes spontaneously, creatively, or strategically into explicit memory, (b) reexperiencing in explicit, conscious memory, through active search or other mechanisms, what has been experienced in past but stored in implicit, unconscious memory, or (c) reactivating declarative or procedural knowledge stored in implicit memory that is quickly accessible in explicit memory through a direct, automatic retrieval route. Setting goals, making plans, and imagining (envisioning what does not exist) are all future-oriented activities enabled by conscious working memory to bring together the past, present, and future during active translation. Executive functions play a critical role in managing these processes because the representations in the two communicating cognitive and linguistic systems, which contribute to the mapping and transformation during translation, have to be coactivated at least momentarily at the same time.

To bring clarity to the relationship between executive functions and working memory, a distinction is proposed between the lower-order executive functions, which provide the supervisory attention mechanisms for self-regulating working memory, and the higher-order executive functions that are supported, in turn, by the whole working memory system. The relevance to writing is that the lower-order executive functions (supervisory attention) in working memory support transcription (handwriting and spelling); but the higher-order executive functions, which are supported by the working memory architecture (storage and processing units, loops, and lower-order supervisory attention executive functions) (see Table 5.4), enable the thinking processes of writing including translation and related idea generating, planning, reviewing, and revising (see Figure 2.1 and Table 5.1). The lower-level executive functions that regulate working memory include *inhibiting*, *switching*, and *sustaining* (e.g., Altemeier, Abbott, & Berninger, 2008; Berninger et al., 2006; Berninger et al., 2008a,b). Inhibition is focusing on what is relevant and ignoring or suppressing what is irrelevant. It is assessed with a color-naming task in which the color of ink to be named (e.g., red) differs from word meaning of the printed color word (e.g., green) (the Stroop task named for the scientist who introduced this task to psychology). Switching attention is changing attention focus from one relevant target to a new one. It is assessed with a rapid automatic switching (RAS) task, which was introduced by psychologist Mary Ann Wolf, in which the category of stimuli to be named (e.g., letters and numerals) alternates, requiring flexible switching attention. Sustained attention is ability to maintain focus over time and thus stay on task. How long focal attention is sustained can be assessed by noting the time elapsed at end of each row of a serial rapid automatic naming task (one category) or switching (two categories) task and then analyzing whether the row times are initially slow and stay steady slow or become steadily slower. If one or more lower-order executive function for supervisory attention is impaired, so is working memory efficiency because all its components cannot function in concert like the instruments in the orchestra. Efficiency of working memory is relevant to supporting the higher-order executive functions—planning, translating, monitoring, and revising (MacArthur, 2011)—that are needed for self-regulated (controlled) translation during composing (Berninger & Richards, 2002). See Chapter 8 for the contributions over the years of Hooper and colleagues to the role of executive functions in writing.

THEORY AND MULTIPLE MODELS FOR GUIDING FUTURE WRITING RESEARCH ON TRANSLATION

To accomplish our goal of stimulating more research on the translation process, which is the transformation of ideas into written language (Berninger et al., 1996; Chapter 1), we now consider the value of grounding such research in theoretical frameworks. It is unlikely that one theory alone will ever explain nature, but basic research in cognitive, developmental, and linguistic science has benefited from articulating many small theories or hypotheses before testing them empirically and then interpreting findings in reference to the conceptual or theoretical framework guiding the research.

Thus, we turn to cognitive psychology for insights into what conceptual frameworks might serve to guide future research on translation during writing. We begin by considering what might be represented in the inner cognitive world of the mind. Table 3.1 summarizes what some of these might be based on published research in cognitive psychology during the twentieth and twenty-first centuries. We encourage readers to consider these in selecting conceptual frameworks relevant to the research questions they might address in research on translation, a *higher-order, bidirectional executive function for transforming cognitive representations into written language and of written language into cognitive representations*. Translation thus requires communication across mental systems that differ in the nature of their underlying representations, which are not related in a simple one-to-one fashion.

One way systems are thought to communicate with each other is mapping, that is, creating cross-system (or subsystem) relationships, which both linguists and cognitive psychologists have studied. A general principle in linguistics is that

TABLE 3.1 Kinds of Cognitions Represented in the Internal Mind

I. **Associations**
   A. Free associations (Freud, 1920)
   B. Paired associations (Skinner, 1938)
   C. Spreading activation across networks of associations (Anderson, 1983) and across interconnected nodes in human-associative memory (HAM) (Anderson & Bower, 1973, 1980)

II. **Categories** (Rosch, 1975, 1978, 2002; Rosch & Mervis, 1975)
   A. *Grouping schemes* for organizing cases based on defining and differentiating features
      1. Can be *leveled* within hierarchies (living organisms, animals, mammals, cats)
      2. *Flexible grouping*—The same case or exemplar can belong to alternate categories, depending on grouping scheme at hand (e.g., a female might be undergraduate, mother, or wife but does not necessarily belong to each category).
   B. *Individual exemplars* (cases) *within categories vary in how prototypical or representative they are of their categories* (e.g., female teacher versus female carpenter).

III. **Schemata**. Noncategorical structures for organizing knowledge (Bartlett, 1932)

IV. **Concepts**. Abstractions that exist independently of language, but are involved in language learning (Stahl & Nagy, 2005) as children learn to use oral vocabulary to express concepts in early development (Waxman, 1999; Waxman & Gelman, 2009; Zheng & Goldin-Meadow, 2002) or school age years (Stahl & Nagy, 2005).

V. **Thought forms in the mind** (Plato & Jowett, 1941[a]) or archetypes (39 image forms) in the species-specific inherited collective unconscious (Jung, 1990) may, compared to perceptions through sensation (the shadows on the wall of the cave, Plato & Jowett, 1941[a]), be fundamentally more or as real, but probably interact with experience and change in some ways over cognitive development through nature–nurture interactions. (Waxman, 1999; Waxman & Gelman, 2009; Zheng & Goldin-Meadow, 2002).

VI. **Dimensions** are variables for specific domains, each of which varies along a continuous, quantitative scale; the dimensions may exist alone or within or among mutually exclusive categories.

VII. **Declarative knowledge**. *Knowing that*, based on representations of facts or other kinds of information. Chunks in Adaptive Character of Thought (ACT) theory (Anderson, 1992, 1996). For application to art, see Fayol and Barrouillet (1995).

VIII. **Procedural knowledge**. Knowing *how*, based on representations of how to perform acts. Production rules in ACT theory (Anderson, 1992, 1996). For application to art, see Fayol and Barrouillet (1995).

IX. **Episodic events**. *Life experiences that occur over time* (Tulving, 1972, 1983, 2002)

X. **Nonverbal representations**
   A. Imagery (concrete ties to sensory world; or abstract without ties to sensory world)
   B. Visual–spatial: scenes or other visual input that can be viewed or photographed, videotaped, or televised; visual diagrams, tables, graphs, figures, maps (two- and three-dimensional), and models (*n*-dimensional), and geometry.
   C. Auditory—nonlanguage including but not restricted to music
   D. Arts (visual, graphic, music, dance) with and without associated language or motoric or sensory (vestibular and tactile) representations
   E. Movement including but not restricted to athletics, motoric, or sensory (vestibular and tactile) representations
   F. Tactile (touch) and kinesthetic (sequential touch sensation from movement)

XI. **Linked to language** and may through feedback modify or create cognitive representations (Galbraith, 2009) and play a role in verbal learning including writing
   A. *Subword* sound, spelling, or morpheme units
   B. *Word meaning, pronunciation, spelling, and morphology (mental lexicon or dictionary)*

(*continued*)

TABLE 3.1 (continued) Kinds of Cognitions Represented in the Internal Mind

- C. *Propositions*—predicates and their arguments (Anderson, 1974; Kintsch, 1998)
- D. *Syntactic*
- E. *Discourse structures* (connected text)
- F. *Idiom*

XII. **Affective—emotions about cognitions** (Jung, 1968; Mishkin & Appenzeller, 1987; Zajonc, 1980; Zajonc & Markus, 1984). Supported by uni- and bidirectional brain pathways through limbic system below cerebral cortex to the cerebral cortex) (see Berninger & Richards, 2002)

XIII. **Formal logic** including syllogisms (sequential logic, given A and then B, does C follow?)

XIV. **Self as organizing principle**

- A. *For personality, sense of self-awareness* that arises from and organizes life experiences (Markus, 1977)
- B. Awareness of self begins to develop when infants and toddlers first smile at the reflection of their face in a mirror.

  Only humans have this built-in sense of self as reflected in recognition of their own faces (Kolb & Whishaw, 2009) just as fisherman captures what swims in the water, “whoever looks in the water sees his own image …” (Jung, 1990, p. 24).
- C. *For individuation and differentiation from others* (Jung, 1990). Necessary for normal social interaction and social development (e.g., Gallagher & Frith, 2003)
- D. *Self-regulation of attention, behavior, and learning* (Posner & Rothbart, 2007; Rothbart, Ellis, Rueda, & Posner, 2003). From personal experience, a sense of self emerges for self-regulating thinking and behavior; this self-regulation is responsive to training and also changes across life span development.

XV. **Other—not-self: humans** (Anderson, 1977), **animals** (Jung, 1990), and **theory of mind** (Fletcher et al., 1995; Gallagher & Frith, 2003; Happé et al., 1996)

- A. *Imitation of others* (Meltzoff, 2002)
- B. *Understanding perspectives of others* (Meltzoff, 2002)

XVI. **Other (spirituality)** (Alper, 2001; James, 1902; Jung, 1968, 1990; Newberg, D’Aquili, & Rause, 2001; Rosch, 2002)

XVII. **Personal biographical memory**. Personal life experiences (Freud and Adler’s personal unconscious accessed through free association, Jung, 1990), recorded in episodic memory, and represented in autobiographical memory (Anderson, 1977)

XVIII. **Family-specific or other social group-specific representations**. Based on life experiences in social groups in which the individuals lives

XIX. **Culture-specific representations**. For example, for indigenous culture, time is cyclical, and for Western culture, time is linear.

XX. **Symbols** (stand for something else, Jung, 1968)

XXI. **Abstractions—products of abstracting operations**

- A. Classes or categories or schemata or dimensions or general principles (see other kinds of cognitive representations in this table)
- B. Statistical regularities in recurring stimuli or events stored in episodic buffer (Mandelbrot, 1953; Pacton, Fayol, & Perruchet, 2005; Pacton, Perruchet, Fayol, Cleermans, 2001), such as three kinds of statistical regularities abstracted for words
  1. *Phonotactic knowledge* of sound identity, detecting change in sounds, and probable sound sequences and positions of sounds in spoken words
  2. *Orthotactic knowledge* of letter identity, detecting change in letters, and probable letter sequences and letters positions in written words
  3. *Morphotactic knowledge* of word parts including base words and affixes appended at the beginning and end of words to modify meaning or grammar of spoken and written words

TABLE 3.1 (continued) Kinds of Cognitions Represented in the Internal Mind

XXII. **Math and the quantitative domain** (Erdös—see Hoffman, 1998; Mandelbrot, 1982)

XXIII. **Humor** results from play with language (Mahony & Mann, 1992) or ideas (e.g., jokes, riddles, stand up comedy routines).

XXIV. **Common sense** (Minsky, 1986)

XXV. **Wisdom**

XXVI. **Values** personal choices about what matters most

XXVII. **Beliefs** strongly held views that may or may not be supported by evidence (including stereotypes)

XXVIII. **Species-specific, inherited collective unconsciousness that transcends consciousness of the personal self** (Jung, 1990)

A. **Jung's (1990) archetypes**—evidence exists from study of primitive societies for

1. 39 Symbols including these: (a) mermaids—erotic charm; (b) soul—the living breath that causes life; (c) man's animal instinct (physiological urges perceived by senses) engaged in combat between soul (angel of light or anima) and demons (darkness or shadow); (d) the wise old man; (e) paradoxes such as simultaneous old and young man; (f) the psychology of the child including the child god (e.g., Tom Thumb, dwarf child, elf); (g) animals; (h) gender; (i) hidden forces of nature; (j) regression of society based on overreliance on tradition and faith in the law; (k) progressive abstract ideals requiring break with tradition and belief in the potential of the future; (l) god and religious themes; (m) culturally specific myths and fairy tales with universal themes; (n) life as flux, flowing into the future, resulting in genesis of a self and self-concept; and (o) unconsciousness symbolized by night and dark and consciousness symbolized by day and light
2. Archetypes that are *a priori* inherited instincts and preformed patterns of functioning released by forms and situations, that is, procedural knowledge
3. Archetypes that emerge during early childhood, often through fairy tales, of which older individuals have no conscious memory. An important developmental event is improved synthesis of the unconscious and conscious
4. Archetypes that draw on mythology and comparative religion and can unify opposites, for example, good spirits and Trickster in the myths of the American Indian and concepts of quaternity and trinity (e.g., the Mandala circle in which the circle is squared in drawings or dance and multiples of four often appear in dreams)

B. **Plato's**[a] **idea**—*a priori* thought forms that are categories conditioned by language (Hubert & Mauss, 1909): All empirical knowledge is influenced by the *a priori* structures of cognition that are species-specific universals for all humans, in which the evolutionary stages of mankind may be represented. Newborn child may not be tabula rasa, consistent with recent work on the concepts underlying vocabulary learning early in language development (Gelman, 2003; Goldin-Meadow, McNeill, & Singleton, 1996; Waxman & Gelman, 2009)

XXIX. **Integration of brain activation across microlevel** (gene-related molecular chemical computations in nucleus of cell body of single neurons), **macrolevel** (large collections of neurons in myelinated pathways distributed across brain regions), and **higher-level cortical computation networks** (Berninger & Richards, 2002, 2010). Thus, the **unconscious is vast compared to what is experienced at the moment in consciousness, and writing is one way to gain access to what is in the unconscious, that is, by externalizing cognition** (Berninger & Winn, 2006; Hayes & Flower, 1980).

[a] Plato's allegory of the Cave has been extracted from certain dialogues by modern scholars. The term was used at least as early as Diogenes Laertius who called it (Plato's) "Theory of Forms": Πλάτων ἐν τῇ περὶ τῶν ἰδεῶν ὑπολήψει …., "Plato." *Lives of Eminent Philosophers*. Book III. pp. Paragraph 15.

mapping is often not a simple, one-to-one isomorphic set of relationships across two domains. Since cognition and language are supported by unique subsystems in brain, which do learn to communicate with each other (Berninger & Richards, 2010), the cross-talk systems that are constructed are critical to investigating how the translation process during writing develops.

Further complicating discovery of what is in the cognitive world of the human mind is that there are probably representations (Table 3.1) *and* operations that act on them (Table 3.2) or account for their change over time. To model the cognitive ← → linguistic translation process fully, we also need to consider mechanisms of access to cognitive representations and operations (Table 3.3) as well as ongoing cognitive ← → linguistic transformation processes and expression of their outcomes (Table 3.4). In addition, the multileveled brain with its time-, space-, and resource-limited working memory system supports access to the cognitive and linguistic systems that contribute to the cross-domain communication and transformations during the translation processes while writing (Table 3.5). Also, both affect and cognition are highly interrelated in writing and brain (e.g., Mishkin's studies showing limbic-cortical pathways, reviewed in Berninger & Richards, 2002).

We do not propose that all researchers adopt the same theoretical models or conceptual frameworks. The relevant one depends on the research question at hand. For example, Berninger et al. (2002) proposed a simple view of writing for an instructional experiment for at-risk third grade writers; the model included transcription, higher-order executive functions, and text generation—the three instructional components in that study. However, Berninger and Winn (2006)

TABLE 3.2 Nature of Cognitive Operations That Operate on Cognitive Representations

I. **Data for cognitive operations**
   A. *Source*: (a) innate inherited representations, (b) representations from life experiences, and/or (c) representations based on nature–nurture interactions
   B. *Nature*: (a) static and unchanging, (b) amorphous—amoebic-like changing and floating, and/or (c) self-generative, creating new idea bubbles (representations)

II. **Cognitive operations**
   A. May occur in unconsciousness while asleep or awake or consciousness while awake
      1. Jung's (1968) hypothesis: Unconsciousness is only source of construction of completely new thoughts and ideas, which then must be discovered in consciousness.
      2. Alternative view: Ideas can be discovered during knowledge constitution or formulation during writing (Galbraith, 2009) or flow (Kellogg, 1994).
   B. May be random connections or random walks among representations
   C. May be associations based on proximity in space and/or time: (a) stimulus–stimulus associations (S-S) or (b) stimulus–response (S-R) in classical conditioning or (c) response–reward associations in operant condition (Skinner, 1938)
   D. May be accessed automatically without conscious, controlled strategies (Schneider & Chein, 2003; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977)
   E. May involve conscious, strategic, controlled operations (Schneider & Chein, 2003; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977), which may be purposeful and self-organizing or reorganizing during learning, and involve changing connections or relationships among existing representations and/or constructing new structures for existing representations

TABLE 3.3 Gaining Access to Cognitions in Unconsciousness During Translation

I. **Implicit to explicit conversion**: According to K-line theory (Minsky, 1986), long-term memory has varying degrees of access over time. The contents of implicit memory become explicit only when what was previously accessed and stored is brought into consciousness through the support of the resource-, capacity-, and time-limited working memory system.

II. **Nonlinear flow** (Kellogg, 1994): Collective unconscious in mind streams in when the concentration of the conscious mind is reduced or ceases (Jung, 1968, 1990), for example, during and right after sleep (writing may proceed more easily in the morning) or setting aside conscious attempt to gain access (writing may proceed more easily after a break or setting the writing task aside for a while) or day-dreaming while awake—getting lost in one's own internal thoughts.

   A. *Water is recurring metaphor* for the unconscious (Jung, 1990) and the transition from cognition to language is often described as nonlinear flow that is transformed into a linear stream as language, which requires serial ordering of words. See Kellogg (1994) for discussion of writer's flow and how writing proceeds more easily when engaged in the flow than when flow is interrupted as during writer's block.

   B. Sometimes the flow is more like dumping (knowledge telling) (Bereiter & Scardamalia, 1987), whereas other times strategies are imposed on it like when a dam is built on a water body to tame it (e.g., transformation adapted to the needs of the audience, Bereiter & Scardamalia, 1987, or formation of new ideas, that is, knowledge constituting, Galbraith, 2009).

   C. *Spontaneous access during waking state* (pops into consciousness)

      1. Spontaneously and unexpected (not consciously retrieved)—often some of the best ideas appear suddenly from unconciousness accompanied by sense of something breaking into consciousness (Jung, 1968)
      2. May become available through inspiration (an experienced event that calls it forth) (Jung, 1968)
      3. May involve constructing new content that arises from the process that was not before conscious (Jung, 1968)

   D. *Rely on intuition*—feelings or sensations not easily articulated rather than logic (Hadamard, 1945; Jung, 1990). Hadamard (1945) reported that many major mathematical discoveries were preceded by long periods of unconscious "incubation" followed by sudden insight; he gave as an example Einstein's well-known claim that words and language did not play a role in his thinking, which relied instead on signs or images that can be reproduced or combined.

III. **Syntactic versus nonsyntactic access routes**

   A. Writing for many genre in academic register requires attention to not only word choice but also syntactic construction of sentences (language-specific word order, grammar conventions, genre-specific requirements).

   B. Both writing in academic register and oral register in conversation often use language-specific, nonsyntactic idioms, which also support translation.

   C. Poetry is typically not packaged in conventional syntax (e.g., prepositions, conjunctions, pronouns, articles) that provide structure for interrelationships among the content words, or grammar rules about agreement between subjects and predicates on number or gender. However, concepts are translated at the word level, often using words that reference nonverbal concepts and images. Words in poetry may not necessarily be packaged in syntax and comprehended based on language-specific word order and function words, but may be imagable or chosen for sound similarities and semantic relationships. Words in poetry may be combined in way to reflect melody and rhythm.

   D. Metaphors symbolize, that is, stand for the archetypal content (Jung, 1990) and analogies link two objects or concepts on basis of similarity; neither require syntax.

   E. Idea generation resulted in more nonverbal representations than verbal ones in preadolescent writers (Berninger et al., 2009).

(*continued*)

TABLE 3.3 (continued) Gaining Access to Cognitions in Unconsciousness During Translation

IV. *Gain conscious access to cognitions in unconsciousness in multiple ways*

A. *Free recall* (access through spreading activation along interconnected nodes of network) (Anderson HAM) or free associations (Freud, 1920).

B. *Search and find*. For example, give all the examples you can of words that begin with /s/. Now choose the one/s related to taste.

C. *Use word retrieval cues*. For example, when counting numbers, name the quantities can facilitate access to the concepts (Jung, 1968).

D. Because the same word can be associated with many different meanings or concepts, unless human beings have shared the same experiences, they may associate different concepts with the same word (Jung, 1968). Avoid jargon by using simple words (e.g., One Stone for Einstein) and only one or two syllable high frequency words in English of Old German–English origin. However, use of simple word does not always eliminate communication problems if the problem is related to lack of cognitive knowledge (e.g., about Einstein's theory of relativity, Hofstadter, 1998).

E. *Dictionaries*, which can be used to identify alternative concepts (meanings) associated with the same word spelling with a common pronunciation or sometimes alternate pronunciation or spelling, required many years to compile and emerged relatively late in human civilization. Samuel Johnson in the mid-eighteenth century compiled the first nationally recognized, widely accepted dictionary in England (Hitchings, 2005; Johnson, 1755); and Noam Webster (1806), who devoted nearly 9 years to compiling his dictionary at the beginning of the nineteenth century in the United States, introduced American spellings that sometimes contrasted with British spellings for the same word.

V. *Executive strategies for guiding translation process* (e.g., Hayes & Flower, 1980)

A. *Idea generation*. Think of all the ideas related to writing topic or task.

B. *Plan ahead*. Create a plan mentally, orally, or in writing with specific goals and strategies for achieving each goal.

C. *Plan during translation*. Plan while translating ideas into written language.

D. *Review the text in progress* (visual feedback via eye from writing).

E. *Revise to repair the text* through retranslation at any time during or after the composing (MacArthur, 2011).

VI. Reasoning (e.g., Kant, 1996)

A. Problem solving: Figure out what the problem is, consider all the evidence and perspectives for solving it, adapt problem-solving strategies as needed for context and configurations, and seek language to explain all these steps and observed patterns.

B. Inductive thinking: Abstractions of (a) classes or categories, (b) general principles or rules, (c) main ideas, and (d) supporting details

C. Deductive thinking: Applying abstractions or rules to problem solving

D. Analysis and synthesis: Finding main ideas, details, and patterns and then integrating these into unified representation

E. Reflection: Metacognitive awareness of thought processes

F. Controlled processing: Application of strategies in general (Schneider & Chein, 2003; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977) and writing strategies in particular (Graham & Perin, 2007; Harris, Graham, Mason, & Friedlander, 2008; MacArthur, 2011)

G. Play with ideas and language (Hofstadter, 1998) and rely on humor

VII. The writers might simply access their own unconscious mind to find out what they think rather than to write for a rhetorical goal to communicate with an audience.

TABLE 3.4 Conceptual Model Related to Translation Processes

I. **Translating** draws on brain's inner cognitive world, intermediate language world, and sensori messengers and motor actors on external world (Berninger & Richards, 2011).

   A. Translation between the language and sensorimotor worlds: Separate but interconnected via language by ear, language by mouth, language by eye, and language by hand functional systems (Berninger & Abbott, 2010)

   B. Bidirectional cognitive ← → language world translation via working memory system (which has phonological, orthographic, and morphological word form and syntax storage and processing units) (Berninger et al., 2006; Berninger, Raskind, Richards, Abbott, & Stock, 2008b)

II. **Thinking during self-regulated translation bouts** (see Chapter 5)

   A. Going beyond the information age (quick access to information via rapid search engines) to the thinking age requires ability to sustain cognitive ← → linguistic processing over time

   B. Thinking is flexible—modify an idea or adjust connections according to the context in which it occurs. Thinking is opposite of bureaucracy in which rules are applied rigidly without consideration of context or qualifying factors, which requires common sense. According to Garrison Keeler Prairie Home Companion September 26, 2010, "Intelligence is being able to hold two opposing ideas in mind and still being able to function."

   C. Chomsky's (1965) deep structures may not have proved fruitful in educational contexts because the deep structure exists not in language but rather in cognition or the complex and dynamic interconnections between two fundamentally different mental worlds—cognition and language. However, although the cognitive world exists to a large degree outside conscious awareness and independently of language, it can communicate with the language world through bidirectional translation mechanisms.

   D. Thinking during translation is not purely linear.

      1. Problem with widespread practice in United States of assessing composition quality based on correctly sequenced words in compositions—translation involves more than syntactic order.

      2. Unidirectional cognitive → language translation is knowledge telling (Bereiter & Scardamalia, 1987) or flow (Kellogg, 1994).

   E. Bidirectional cognition ← → language translation involves preplanning and online planning (thinking about text produced so far) and is knowledge transforming (Bereiter & Scardamalia, 1987).

III. **Thinking during production of translation outcomes**

   A. **Examples** (items to illustrate point)

   B. **Relational** (e.g., relationships among items in same or different categories or different codes for storage and processing in working memory)

      1. One-to-one correspondence (mapping)

      2. Complex correspondences (multidimensional or associational mappings)

      3. Metaphors (similarities in symbolic form)

      4. Analogies (similarities across two examples)

   C. **Contextual** (taking into account context or qualifying according to context)

   D. **Logical** (sequential ordering—what follows from what)

   E. **Idioms** (not learned as syntax units but as other arbitrary units that access cognitive representations). Approximately one-third of teachers' utterances contain multiple meaning words (the foundation of figurative expressions) or idiomatic expressions (Lazar, Warr-Leeper, Beel-Nicholson, & Johnson, 1989), and about 7% of reading materials used in elementary schools contains idioms (Troia, 2011).

(*continued*)

TABLE 3.4 (continued) Conceptual Model Related to Translation Processes

F. **Mapping cognitive representations onto multiple levels of language**
   1. *Words*: vocabulary, diversity in lexical neighborhoods and choice
   2. *Syntax*: Some, not all, kinds of thinking map easily onto syntax: can be sequenced; are content or function (glue) words; correspond to parts of speech—objects or concepts, actions or states of being, relationships, qualifications, or definite or indefinite designations; and perform speech acts (statements, questions, exclamations, and commands).
   3. *Discourse/text*
   4. *Interactions among words, syntax, and discourse* (Beers & Nagy, 2008, 2009, 2011)

G. **Audience**
   1. Need *theory of minds* (not just theory of mind, Liu, Sabbagh, Gehring, & Wellman, 2009) because of alternative perspectives and knowledge bases in minds of others
   2. *Writing for multiple audiences* (many readers with a variety of views and beliefs, which may be contrasting and even conflicting): (a) *hostile audience(s)* when there are conflicting views and (b) *ignorant audiences* (without conceptual foundations to understand)—to what extent can writing alone build that background knowledge so that the reader can comprehend the text? Writing depends as much on the audience being able to comprehend as for the writer to communicate.

proposed a not-so-simple view of writing for subsequent planned research on how externalizing cognition during writing may overcome limitations of working memory in supporting access to cognitions (e.g., through flow or active search or construction) and constructive processing during thinking (Berninger & Winn, 2006).

We emphasize that, without hypothesis testing and theoretical frameworks, statistical modeling alone or experimental comparison of treatment versus no treatment or of various treatments is unlikely to advance knowledge of translation. Examples of design features that are more likely to advance research knowledge of translation, especially if grounded in theory, are as follows: (a) rather than including only treated experimental and no-treatment control groups, include experimental and contrasting contact control groups to control for effects due to novelty (Shadish et al., 2002); (b) rather than including only one treatment group, also include an alternative treatment, which provides a theoretically contrasting approach to the other target treatment, both of which are researcher delivered; and (c) rather than using as a control the regular program (business as usual), which varies greatly when participants are from multiple classrooms, randomly assign all participants from the regular program to two or more groups (treatment and contact control, or alternative treatments with or without contact control).

To summarize, valid models of translation require careful attention to theory and not just focus on experimental design, multivariate statistical modeling, or description of data. Likewise, which measures are used in a particular research study should take into account (a) whether a measure has been validated in past research studies for specific assessment purposes based on its reliability and construct validity (whether the measure assesses the construct thought to be measured)

TABLE 3.5 Model of Relationship Between Executive Functions (EFs) and Working Memory (WM) and Role of WM in Translation

I. **Low-level EF supports WM via supervisory attention**
   A. Focus attention, which requires inhibition
   B. Switch attention, which requires flexibility—release inhibition, switch, and refocus
   C. Sustain attention over time
   D. Update (self-monitor WM contents and processes over time (see Richards et al., 2009)
   E. Search and find in long-term memory (LTM) (e.g., word finding and verbal fluency tasks for finding an exemplar)

II. **WM supports in turn the high-level EFs** during writing (planning, translating, reviewing online cognitive processes as they unfold in real time, and repairing and revising problems encountered while writing).

III. **WM has three kinds of limitations, which can pose challenges for translation**: **capacity** (space), **momentary time** (temporal) that constrains access to what is happening on many different time scales in the brain, and **efficiency** (coordination of the components that have to work together in space and time).

IV. **WM supports bringing cognitions from unconsciousness into consciousness through language and externalizing cognition through written language, which can be viewed and reinspected without the constraints of working memory** (Berninger & Winn, 2006). Also see Berninger & Richards, 2011; Hayes & Flower, 1980; Chapters 1, 2, and 4).
   A. On the one hand, initially language is not a fully conscious system. Developing writers have to acquire linguistic awareness for reflecting on the phonological, orthographic, and morphological units in spoken and/or written words and their interrelationships to learn word-level spelling skills that support translation and word-level reading skills that enable review of text written so far.
   B. On the other hand, cognition is not a fully conscious system and emerging metacognitions also play an important role in becoming aware of the complex aspects of the cognitive ← → linguistic translation process.

V. **WM challenges in translation**
   A. Dealing with diverse cognitive representations and operations (see Tables 3.1 and 3.2)
   B. Dealing with multiple access routes to and from the cognitive world (examples below)
      1. Automatic activation (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977)
      2. Search and find a simple or complex knowledge link
      3. Coordinate timing of flow (water metaphor for nonlinear to linear) (see Table 3.3)
      4. Apply controlled strategic processing, which involves preplanning and a plan with goals (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977)
      5. Transform by (a) creating (constructing) new knowledge, ideas, or perspectives (Galbraith, 2009); (b) synthesizing knowledge and conceptualizing knowledge frameworks; and (c) reframing (revising)
      6. Abstract patterns or main ideas
      7. Generate questions to identify what is unknown
      8. Acknowledge perspectives, form opinions, take and defend positions
   C. Dealing with multiple cognitive ← → language mappings and thinking jobs (see Tables 3.3 and 3.4) across (a) levels of language—words (vocabulary, diversity in lexical choice), syntax (order, content and structure/function words, parts of speech, grammar rules and usage, and phrases and clauses), discourse/text, and interactions among words, syntax, and discourse (Beers & Nagy, 2011); (b) propositions (arguments and predicates), (c) nonsyntactic idioms (Troia, 2011), (d) poetry, (e) nonverbal representations (imagery, scenes, events, and visual–spatial representations of abstract ideas), and (f) Schriver's (2011) design issues

Source: Based on Berninger, V. and Richards, T., *Future Neurol.*, 5, 597, 2010. With permission.

and (b) whether the construct is related to theory or conceptual framework relevant to the research question at hand.

Although standardized measures with age or grade norms were hardly available for writing 30 years ago, that has changed, at least for transcription skills and text generation at the sentence and short-text levels, for English-speaking students in North America.

1. Such measures now exist for *handwriting* (manuscript and/or cursive) and for different handwriting constructs including (a) *automatic* access, retrieval, and production of letters from ordered alphabet early in the process, (b) *sustained* access, retrieval, and production of letters from ordered alphabet over longer time interval when processing is more likely to be *controlled* rather than automatic, (c) handwriting *speed* (total time), and (d) handwriting *legibility* on tests when only handwriting is required and during composing when both handwriting and other cognitive, language, and motor processes contribute to written translation outcomes.
2. Such measures now exist for *spelling* including (a) spelling *dictated real words* in writing, (b) spelling *dictated pseudowords* in writing, and (c) *recognizing correctly spelled real words* that are chosen from phonological equivalents, neither of which requires handwriting.
3. Such measures now exist for *composing* (producing a written translation product) including (a) *combining* two sentences into one grammatically acceptable sentence, (b) using provided words to *construct grammatically acceptable sentences*, and (c) text composing for writing about prompts (pictures or verbal topics) designed to elicit *narrative or expository writing* (e.g., descriptive or informative), for adding sentences to *complete incomplete text*, and for *writing reports about read source material*. Some sentence or composing measures are timed, whereas others are not.

However, each researcher or research team has to decide if (a) measures already exist that can be used for the current research question at hand and are relevant to the theory or conceptual framework guiding the hypotheses to be tested or (b) experimenter-designed measures should be constructed to assess more appropriately the aspect(s) of translation being studied. In many cases, such measures are likely to include greater use of online experiments (see Chapters 11 through 13), which incorporate a variety of technology tools, and in some cases brain imaging studies to provide converging evidence at both the brain and behavioral levels of analysis.

Future Studies to Advance Understanding of Translation

One of the greatest research challenges is the normal variation among writers (Chapters 5 and 6). The hybrid research design (see Figure 3.1) introduced by Rijlaarsdam and colleagues offers great promise for dealing with the individual differences in writers (e.g., high, average, or low on a writing or writing-related skill, see Garcia, Abbott, & Berninger, 2010), along with controlling other influences that may mediate response to the treatment variables, in the experimental design.

Individual Differences Silliman and Berninger (2011), who initiated a cross-disciplinary dialogue between speech and language specialists and psychologists about the role of oral and written language in learning, explain why and how to use developmental, learning, and phenotype profiles to identify students who may require specialized instruction over and beyond what is required by writers showing normal variation. Developmental profiles are based on the five domains of development (cognitive, language, motor, social emotional, and attention/executive function). Learning profiles are based on academic skills such as handwriting, spelling, and composing. Phenotype profiles are based on behavioral expression of biological variables (gene and brain variables shown in research to be related to writing, see Berninger & Richards, 2010). Such profiles can be used to identify participants whose developmental profiles fall within the normal range, but not every skill in their learning profile or phenotype does (i.e., the learner process variables in Figure 3.1), for future research on the translation process as well as to apply the results of translation research to assessment and instructional practice.

Instruction Also relevant is the evolving concept of instructional treatment from one in which a teacher instructs and causes all to learn in the same way to emerging models that integrate teaching—what the teacher does—and learning—what the student does—to describe the variations and interactions among instructional and learner processes (see Figure 3.1). How can that multilevel conceptual framework be taken into account in designing and conducting research on translation during writing? On the one hand, what teachers do, which is not restricted to transmitting knowledge, has to be taken into account, as well as individual differences in how teachers teach and often accomplish the same instructional outcomes in different ways. On the other hand, individual differences in learners also need to be taken into account—abilities on many traits, developmental levels across the five developmental domains described earlier, and their constructive processes of the learner in response to the same teacher-provided instruction and in their own self-regulated learning. Thus, instructional and learning outcomes are probably the outcome of both teacher and learner variables (Berninger, 2009).

Online Processes However, instructional and developmental research should include measures of online translation in real time. These can be assessed with new technologies (Alamargot et al., 2011; van Waes et al., 2011; Chapters 12 and 13) for analyzing pause times (Chapter 11) before and after language bursts (Chapter 2), writing rate during language bursts (Chapter 11), and nature of language units in language bursts (Chapters 2, 5, 6, 11, and 12) and written spellings (Chapter 13). These measures can be investigated as a function of (a) research inclusion criteria for individual differences in cognitive, linguistic, or neuropsychological measures of learner processes and/or (b) experimentally manipulated, teacher-provided instructional treatments or cognitive processes (see Figure 3.1).

Meta-Analyses To begin with, as already discussed, meta-analyses should compare studies that use the same research inclusion criteria and research design to address the same research questions. More emphasis should be placed on the *external validity* of meta-analyses, that is, comparing studies in which participants are well-described and comparable, so it is known to which population results can be reliably generalized (Shadish et al., 2002). For example, in the United States, special education services in school are based on eligibility criteria, which vary from state to state and even within states, and not research-based diagnostic criteria that are comparable across states and local schools. Thus, given the immense variability in school-identified samples from special education classes, much special education research in the United States based on school-identified special education students lacks external validity—knowing to whom the results can be generalized. In addition, as already discussed, the results of meta-analyses are not interpretable if experimental design features are not comparable across the studies compared. To summarize, more attention should be given to selecting and comparing studies in which (a) participants are described and are comparable and (b) research design features and related theoretical or conceptual issues are described and are comparable. Best-evidence reviews (e.g., Slavin, 1987, 1990) are an important alternative to meta-analyses because they clearly identify differences among participants, research questions, design features, and theoretical issues and then restrict synthesis of findings and conclusions to comparisons of studies that are comparable in participant characteristics, research questions, design features, and theoretical issues. *Effect sizes may not be meaningfully interpreted apart from issues of external, internal, construct validity, statistical validity, or theory* (cf., Shadish et al., 2002).

Recommendations for Future Research There is, of course, no cookbook approach for generating research knowledge about the translation process. Like four-star chefs, who draw on knowledge often not in cookbooks, it will take thinking researchers with uncommon sense to generate the theory and conceptual frameworks about the complex cognitive ← → linguistic translation process that inform the future research questions, measures, and models. We propose that future research on translation

- Begin by considering the brain, cognitive, and linguistic processes supporting *the cognitive ← → linguistic transformations* during translation
- Develop a theory of the nature of cognitive representations and cognitive operations and how they are accessed, activated, engaged, and sustained in working memory during translation
- Employ online experiments that manipulate variables affecting translation during writing and the relationship of translation to other cognitive processes in writing
- Use new technologies for recording, storing, and analyzing translation products in real time

- Collect measures of individual differences among writers that may influence the translation process as it unfolds in real time
- Collaborate with a team of researchers (and teacher partners) with interdisciplinary expertise

Such *hybrid studies* (Rijlaarsdam et al., in press, and Figure 3.1), if carefully designed, executed, analyzed for both temporal and cognitive–linguistic parameters, and interpreted for both theory and writing practice, hold great promise to advance basic and applied knowledge of translation during writing and bringing about educational and psychological practices to support a population of universal writers (see Chapter 1).

APPENDIX: ACCESS TO RESEARCH LITERATURE AND SCHEMATA FOR WRITING HISTORY

Recent Writing Handbooks

Bazerman, C. (Ed.). (2008). *Handbook of research on writing: History, society, school, individual, text*. London: Taylor & Francis Group.

Bazerman, C., Krut, R., Lunsford, K., McLeod, S., Null, S., Rogers, P., et al. (Eds.). (2010). *Traditions of writing research*. New York: Taylor & Francis Group/Routledge.

Berninger, V. (Ed.). (2011). *Past, present, and future contributions of cognitive writing research to cognitive psychology*. New York: Psychology Press/Taylor & Francis Group.

Emig, J. (1971). *The composing process of twelfth graders*. Urbana, IL: NCTE.

Graham, S., MacArthur, C. A., & Fitzgerald, J. (2007). *Best practices in writing instruction*. New York: Guilford.

Grigorenko, E., Mambrino, E., & Preiss, D. (Eds.). (In press). *Handbook of writing: A mosaic of perspectives and views*. New York: Psychology Press.

MacArthur, C., Graham, S., & Fitzgerald, J. (Eds.). (2006). *Handbook of writing research*. New York: Guilford.

Myhill, D., Nystrand, M., & Riley, J. (Eds.). (2010). *Handbook of writing development*. London: Sage.

Rijlaarsdam, G., van den Bergh, H., & Couzijn, M. (Eds.). (2004). *Effective learning and teaching of writing. A handbook of writing in education* (2nd ed.). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Shulman, B., Apel, K., Ehren, B., Silliman, E., & Stone, A. (Eds.). (2004). *Handbook of language and literacy development and disorders* (pp. 600–624). New York: Guilford.

Swanson, H. L., Harris, K., & Graham, S. (Eds.). (2003). *Handbook of research on learning disabilities*. New York: Guilford.

Other Writing Books, a Monograph, and Chapters

Note: *Gert Rijlaarsdam is Series Editor for Studies in Writing.*

Alamargot, D. & Chanquoy, L. (2001). *Through the models of writing. Studies in writing* (Vol. 9). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Allal, G., Chanquoy, L., & Largy, P. (Eds.). (2004). *Revision. Cognitive and instructional processes. Studies in writing* (Vol. 13). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Berninger, V. & Richards, T. (2011). The writing brain: Coordinating sensory/motor, language, and cognitive systems in working memory architecture. In V. Berninger (Ed.), *Past, present, and future contributions of cognitive writing research to cognitive psychology* (pp. 537–563). New York: Psychology Press/Taylor & Francis Group.

Boscolo, P. (2008). Writing in primary school. In C. Bazerman (Ed.), *Handbook of research on writing* (pp. 289–305). Mahwah, NJ: Lawrence Erlbaum Associates.

Björk, L., Bräuer, G., Rienecker, L., & Stray Jörgensen, P. (Eds.). (2003). *Teaching academic writing in European higher education. Studies in writing* (Vol. 12). Dordrecht, the Netherlands: Kluwer Academic Publishers.

British Journal of Educational Psychology Monograph Series II (2009). *Teaching and learning writing*.

Camps, A. & Milian, M. (Eds.). (2000). *Metalinguistic activity in learning to write. Studies in writing* (Vol. 6). Amsterdam: Amsterdam University Press.

Courier, P. & Andriessen, J. (Eds.). (2000). *Foundations of argumentative text processing. Studies in writing* (Vol. 5). Amsterdam: Amsterdam University Press.

Graham, S. & Weintraub, N. (1996). A review of handwriting research: Progress and prospect from 1980 to 1993. *Educational Psychology Review, 8*, 7–87.

Harris, K. R., Graham, S., Mason, L., & Friedlander, B. (2008). *Powerful writing strategies for all students*. Baltimore: Brookes.

Hidi, S. & Boscolo, P. (Eds.). (2006). *Motivation in writing. Studies in writing* (Vol. 19). Originally Amsterdam: Elsevier, now Emerald, Australia.

Kostouli, T. (Ed.). (2005). *Writing in context(s). Textual practices and learning processes in sociocultural settings. Studies in writing* (Vol. 15). New York: Springer.

Le Ha, P. & Baurain, B. (Eds.). (2011). *Voices, identities, negotiations, and conflicts. Writing academic English across cultures. Studies in writing* (Vol. 22). London: Emerald.

Olive, T. & Michael Levy, C. (Eds.). (2002). *Contemporary tools and techniques for studying writing. Studies in writing* (Vol. 10). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Ransdell, S. & Barbier, M. L. (Eds.). (2002). *New directions for research in L2 writing. Studies in writing* (Vol. 11). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Rijlaarsdam, G., van den Bergh, H., & Couzijn, M. (Eds.). (1996a). *Effective teaching and learning to write. Current trends in research. Studies in writing* (Vol. 2). Amsterdam: Amsterdam University Press.

Rijlaarsdam, G., van den Bergh, H., & Couzijn, M. (Eds.). (1996b). *Theories, models and methodology in writing research. Studies in writing* (Vol. 1). Amsterdam: Amsterdam University Press.

Shiu-kee Shum, M. & Zhang, D. L. (Eds.). (2005). *Teaching writing in Chinese speaking areas. Studies in writing* (Vol. 16). New York: Springer.

Sullivan, K. P. H. & Lindgren, E. (Eds.). (2006). *Computer keystroke logging and writing. Studies in writing* (Vol. 18). London: Emerald.

Tolchinsky, L. (Ed.). (2001). *Developmental aspects in learning to write. Studies in writing* (Vol. 8). Dordrecht, the Netherlands: Kluwer.

Torrance, M. & Galbraith, D. (Eds.). (1999). *Knowing what to write. Conceptual processes in text production. Studies in writing* (Vol. 4). Amsterdam: Amsterdam University Press.

Torrance, M. & Jeffery, G. (Eds.). (1999). *The cognitive demands of writing. Processing capacity and working memory effects in text production*. Amsterdam: Amsterdam University Press.

Torrance, M., Van Waes, L., & Galbraith, D. (Eds.). (2007). *Writing and cognition: research and applications. Studies in writing* (Vol. 20). London: Emerald.

Troia, G. (Ed.). (2009). *Instruction and assessment for struggling writers. Evidence-based practices*. New York: Guilford.

Tynjala, P., Mason, L., & Lonka, K. (Eds.). (2001). *Writing as a learning tool. Studies in writing* (Vol. 7). Dordrecht, the Netherlands: Kluwer.

Van Waes, L., Leijten, M., & Neuwirth, C. (Eds.). (2006). *Writing and digital media. Studies in writing* (Vol. 17). London: Emerald.

Wood, C. & Connelly, V. (Eds.). (2007). *Reading and spelling: Contemporary perspectives*. London: Routledge/EARLI Writing Series.

For Adult Writing and Writing in the Work World

Alamargot, A., Terrier, P., & Cellier, J. M. (Eds.). (2007). *Written documents in the workplace*. London: Emerald.

Beaudet, C., Grant, P., & Starke-Meyerring, D. (2008). *Research communication in the social and human sciences. From dissemination to public engagement*. Cambridge, U.K.: Cambridge Scholars Publishing.

Schriver, K. (1997). *Dynamics in document design. Creating texts for readers*. New York: John Wiley.

Representative Journals That Publish Writing Research (Alphabetic Order)

Discourse Processes
Journal of Second Language Writing
L1_Educational Studies in Language and Literature
Reading and Writing. An Interdisciplinary Journal
Research on Teaching English
The Journal of Writing Research
Written Communication
Written Language and Literacy

Language and Thought (Not From Writing Research Field; From List Compiled by Professor William Nagy, Seattle Pacific University)

Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C. (2010). A systematic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research, 80*(2), 207–245.

Bloom, P. & Keil, F. (2001). Thinking through language. *Mind and Language, 16*(4), 351–367.

Boroditzky, L. Web site: http://www-psych.stanford.edu/~lera/papers/

Deutscher, G. (2010). *Through the language glass: Why the world looks different in other languages*. New York: Holt.

Gentner, D. & Goldin-Meadow, S. (Eds.). (2003). *Language in mind: Advances in the study of language and thought*. Cambridge, MA: MIT Press.

Gumperz, J. J. & Levinson, S. C. (Eds.). (1996). *Rethinking linguistic relativity*. Cambridge, U.K.: Cambridge University Press.

Lakoff, G. & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought*. New York: Basic Books.

Lazar, R., Warr-Leeper, G., Beel-Nicholson, C., & Johnson, S. (1989). Elementary school teachers' use of multiple meaning expressions. *Language, Speech, and Hearing Services in Schools, 20*, 420–430.

Malt, B. C. & Wolff, P. (2010). *Words and the mind: How words capture human experience*. New York: Oxford University Press.

Ng, S. S. N. & Ra, N. (2010). Chinese number words, culture, and mathematics learning. *Review of Educational Research, 80*(2), 180–206.

SCHEMATA FOR WRITING THE STORY OF HISTORY OF WRITING RESEARCH

(For each cell in each table, created by pairing one of the seven schemata for column headings with the life span schema for row headings, draw on all the relevant writing research across languages and over 40 countries in completing each cell.)

Possible Schemata for the Column Headings

Schema 1 Interdisciplinary Contributions to Writing Research

Develop Psych	Cognitive Psych	Linguistics	General Education	Special Education	Rehabilitation Medicine	Computer Science	Neurology

Schema 2 Methods of Writing Research

Descriptive	Correlational	Structural	Causal—Experimental	Causal—Treatment	Qualitative	Mixed

Schema 3 Learning to Write and Writing to Learn

Writing Activities—At Home	Writing Activities—At School	Writing Activities—Other Contexts	Instruction Other-Generated	Self-Generated Strategies	Alone versus Groups	Technology

Schema 4 Writing and Writing-Related Skills (Individual Differences)

Sensory Motor Skills	Language	Cognitive	Motivation	Attitude	Technology Knowledge

Schema 5 Normal Writing Development

Handwriting	Keyboarding/Mouse	Spelling	Composing	Reviewing	Revising

Schema 6 Writing Disorders—Diagnosis and Treatment

Acquired due to Brain Injury or Disease	Developmental—Neurogenetic	Developmental—Other	Comorbid with Other Conditions	Technology

Schema 7 Biological Bases of Writing

Twin Studies Heritability	Family Genetics Aggregation and Segregation	Gene Candidates	MRI	fMRI	DTI	ERPs

Row Headings for All Schemata

Infants, toddlers
Preschoolers
Early grades
Middle grades
High school
Higher education
Work world
Professional writers

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Part II

Individual Differences and Developmental Research Methods for Generating and Applying Theory of Translation at Different Levels of Language to Writing

4

Learning to Spell Words With the Pattern Analyzer, Oracle, Cross-Code Talker, Cross-Code Scribe, and Silent Orthographer

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In this chapter, we first review research evidence that transcription (handwriting, spelling, punctuation, and capitalization) supports translation, but that spelling, unlike handwriting, also plays a role in translation. We include research about levels of language and working memory, which are relevant to learning and applying transcription skills. Next, we define five evidence-based word-learning mechanisms and introduce a developmental model of how they emerge in overlapping, cascading fashion during development of spelling (and reading) written words. Finally, we share previously unreported findings related to the role of handwriting and spelling in this word learning (Tables 4.1 through 4.3). We also provide a brain-based model of word-learning mechanisms and cognitive ← → linguistic translation during writing (Table 4.4).

EARLY RESEARCH ON TRANSCRIPTION

Transcription

Findings of a cross-sectional study in grades 1–6 included the following. Handwriting, spelling, and composing are separable skills, even though writers draw on all three skills while writing (Abbott & Berninger, 1993). Both motor skills and orthographic skills are involved in handwriting, and both phonological and orthographic skills are involved in spelling (Abbott & Berninger). Consistently in grades 1–6, storing and processing written words and their letters in working memory (orthographic coding) contributed uniquely beyond (a) graphomotor finger functions to handwriting and (b) phonological coding (storing and processing spoken words and their sounds in working memory) to spelling (Abbott & Berninger). Both handwriting and spelling were related to length and quality of compositions, but at all grade levels handwriting and at some grade levels spelling contributed uniquely (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). In a 5 year longitudinal study, consistently spelling was significantly related to both itself and composing across adjacent grades 1–7 (Abbott et al., 2010). Punctuation and capitalization are not mechanical skills but rather *metacognitive transcription* skills for marking thought units in written language (Fayol & Abdi, 1988; Fayol & Lété, 1987).

Levels of Language

A student's relative ability at one level of language did not predict ability at another level of language (Whitaker, Berninger, Johnston, & Swanson, 1994). Intraindividual differences were observed in word choice (lexical diversity), sentence construction, and text composition. Different processes uniquely predicted different levels of written language—handwriting (subword letter writing), word spelling, and text composing in primary grade children (ages 6–8 years) (Berninger et al., 1992) and intermediate grade children (ages 9–12 years) (Berninger, Cartwright, Yates, Swanson, & Abbott, 1994). Yet variations in structure within a given level of language were also observed (Fayol, 1991), and structures for interrelating units of writing within and across the levels of language contribute to writing development (Chanquoy, Foulin, & Fayol, 1990; Costermans & Fayol, 1997; Fayol & Mouchon, 1997).

Working Memory

Individual differences in working memory contribute to writing independent of reading during the elementary grades (Swanson & Berninger, 1996a, 1996b). Experimenter manipulation of linguistic variables that affect working-memory load influenced written production processes in real time (Bourdin & Fayol, 1994, 2000; Chanquoy et al., 1990; Fayol, Largy, & Lemaire, 1994). Working memory for storing and processing *words* contributes uniquely to writing during the early elementary grades and thereafter, whereas working memory for storing and processing *sentences* begins to contribute uniquely to writing during the upper elementary grades (Berninger et al., 1994, 2010). Interdisciplinary research (genetics, brain imaging, and instructional) provided converging evidence for a *working-memory architecture* consisting of *storage units for three word forms* (phonological, orthographic, and morphological) *and syntax* for accumulating words, *two loops* (phonological and orthographic), and a *panel of executive functions for supervisory attention* (inhibition, switching, and sustaining). This working-memory architecture supports language learning in children with and without specific learning disabilities such as dyslexia and dysgraphia (Berninger et al., 2006, 2008a, 2008b;

Berninger & Richards, 2010, 2011; Richards et al., 2006). This working-memory architecture may be the biologically based language-learning mechanism, which Chomsky (1965) proposed and Snow (1972) and others showed requires appropriate environmental interactions and input to function normally (see Berninger et al., 2010).

In fact, working memory rather than irregular orthography may be the culprit across languages in dyslexia, which is a spelling and reading disorder. For example, in a cross-country study involving English speakers in the United Kingdom and Italian speakers, groups with and without dyslexia differed on both a behavioral measure of working memory and brain activation in a region associated with working memory (Paulesu et al., 2001). Likewise, Chinese speakers with and without dyslexia differed in middle frontal gyrus, a region associated with working memory (Tan, Spinks, Eden, Perfetti, & Siok, 2005), just as the English speakers with and without dyslexia in a U.S. sample did (Richards, Berninger, & Fayol, 2009). Even though children in the Richards et al.'s (2007) study normalized in brain regions associated with phonological processing, which was emphasized in the instructional intervention, they did not in working memory (Richards et al., 2009); however, when both the phonological loop and orthographic loop were trained, functional connectivity emanating from regions associated with working memory was normalized (Berninger & Richards, 2008).

Teaching Transcription

When a writer can produce letters automatically, load on working memory is reduced and working-memory resources are freed up for the writer to attend to other writing goals such as choosing words, constructing sentences, and composing text for specific writing goals (e.g., Berninger et al., 1992). Teaching the following strategies improved automatic, legible letter writing and transferred to improved composing: (a) using numbered arrow cues for writing component strokes of letters, (b) repeatedly associating names with letter forms to create verbal retrieval cues for the visual letter, and (c) storing letters in working memory ("mind's eye") for increasing durations (Berninger et al., 1997). Teaching the following strategy improved spelling in the current grade and gains were maintained in the subsequent grade: spelling across levels of language close in time (subword alphabetic principle in spelling direction—phoneme to grapheme; spelling single dictated words and words in dictated sentences; and spelling during text composing using cue cards for phoneme → grapheme correspondences and high frequency spelling words) (Berninger et al., 1998, 2000).

On the one hand, drilling writing skills in isolation may not transfer to creating a functional writing system in which multiple components are coordinated in time in working memory. On the other hand, teaching writing to all levels of language close in time facilitates the orchestration of working-memory components that support writing. Writers' Workshop, a widely adopted instructional approach in North America can be adapted to provide explicit writing and reading instruction to develop the temporal coordination of the relevant levels of language and cognitive processes needed for integrated writing–reading activities in school curricula (Berninger et al., 2008; Wong & Berninger, 2004).

WORKING-MEMORY SUPPORT FOR FIVE WORD-LEARNING MECHANISMS

The working-memory loops (see Table 3.5) involve internal phonological or orthographic language codes as well as sensory and/or motor codes. These loops support five different mechanisms for word learning, which in turn enable the child to translate cognitions into both written and spoken words. Both the phonological and orthographic loops of working memory contribute through cross-code integration to written word learning (Table 3.5). Baddeley, Gathercole, and Papagno (1998), who studied the role of phonological loop of working memory in learning vocabulary words through naming visual objects, called attention to role of the phonological loop in cross-code integration.

However, we begin the story not with the loops themselves, but rather with the overlooked, but critically important, episodic storage and processing system, which records frequency of exposure to specific spoken and written words. Without the writer's conscious awareness, episodic memory abstracts statistical regularities of words in working memory and stores these statistical regularities in implicit memory where they can be accessed without conscious awareness. Statistical regularities include (a) frequency of occurrence of specific words, (b) frequency of occurrence of component sounds or letters in them, (c) probable positions in which the sounds or letters occur within the words, (d) probable sequencing of sound or spelling units, and (e) abstracted discrete sounds (phonemes) corresponding to alphabet letters. Syllables may also have both phonetic (rime) and phonemic (onset before rime unit) sound units (Treiman, 1985). These abstracted statistical regularities for spoken words (phonotactics, Kessler & Treiman, 1997), written words (orthotactics, Pacton, Fayol, & Perruchet, 2005; Pacton, Perruchet, Fayol, & Cleeremans, 2001), and morphology (morphotactics, see Pacton & Deacon, 2008) may be applied in addition to alphabetic principle in learning to spell and read words in morphophonemic orthographies such as English and French. For example, pronunciation of multi-letter units corresponding to morphemes (e.g., the *ion* in *passion* and in *nation*) (Nunes & Bryant, 2006) and rimes or word families (e.g., *ould* in would and could) is typically quite regular and predictable.

Each of the following learning mechanisms for spoken and written words and their interrelationships is supported by both a biologically based, working-memory architecture and environmental interactions with others who nurture the learning mechanisms.

Pattern Analyzer

Baddeley (2002) conceptualized not only phonological and visual–spatial storage units in working memory but also an episodic buffer that records and stores events experienced in daily living (cf., Tulving, 1972, 1983, 2002). Initially, children record and store in the episodic buffer spoken words they hear. In contemporary society, educated parents are also likely to begin to read to their infants and toddlers and expose them to written words, which may also be recorded in the episodic buffer.

Thus, beginning early and extending across reading and writing development, exposure to spoken and written words is likely to be recorded in the episodic buffer of events experienced across time. Relatively little research has addressed the nature of the statistical analyzer that operates on what is stored in the episodic buffer of working memory and abstracts statistical regularities. An exception is the work of Pacton and colleagues (e.g., Pacton et al., 2001, 2005).

Evidence does exist that the following kinds of statistical regularities may be abstracted from heard spoken words or orally produced words by mouth:

- *Detecting change* over time in unfolding, sequentially heard speech components (changing syllables in heard nonsense words) (see Roeske et al., 2009)
- *Counting frequency* of spoken words or sound elements in real heard or pronounced words (Carroll, Davies, & Richman, 1971; Zeno, Ivens, Millard, & Duvvuri, 1995)
- *Computing statistical regularities* (permissible and probabilistic positions and sequences) for sounds in heard or spoken words (phonotactics, Kessler & Treiman, 1997) and morphological regularities

The analyzer also likely abstracts various kinds of *statistical regularities from viewed written words* in books or reading material or handwriting:

- *Detecting change* across sequential letters within a written word (letters change faster than words)
- *Counting frequency* of viewed or written words or letter elements in them
- *Computing statistical regularities* such as permissible and probabilistic letter positions and letter sequences in viewed or written words (orthotactics) or morphological regularities

More research is needed on abstracting statistical regularities in heard spoken words and speech (phonotactics), viewed or written orthography of written words (orthotactics), and morphological regularities (morphotactics) of both spoken and written words and how these regularities are applied to written and spoken word learning (e.g., Pacton & Deacon, 2008). Indeed, it was a surprise when research showed that kindergartners and beginning first graders (ages 5–6 years) could accurately judge whether written stimuli (letter strings that differed in whether they conformed to permissible letter sequences in English) could be real English words before they could use grapheme–phoneme correspondences to decode words—pronounce them orally (Berninger, 1988).

Oracle

The phonological loop, with its auditory sensory to internal language codes at the word level and oral-motor output pathways through the mouth (see Table 3.5), plays a role in oral language development, enabling not only the production of spoken words but also the connections between spoken words and concepts in the internal mind (e.g., Waxman, 1999; Waxman & Gelman, 2009; see Table 4.4). These concepts may have a biological basis in humans* (see Chapter 3) and have direct contact with the external environment only via language and its paths to sensory and motor channels for interacting with language users such as mother, other family members, and care takers. That is, this pathway from mental concept to language, which is communicated through the oral-motor systems of speech that receive aural sensory feedback, is essentially an *oracle*, sharing features of the oracles in ancient Greece. An oracle creates communication channels from an unseen source of knowledge (e.g., the inner cognitive world, see Table 4.3) to observable expression of that knowledge through the human voice (and its connections with language and motor codes acquired through experience).

For the developing child learning to talk and produce single words, the oracle links experience in the "real" world with the concepts in the internal mind, which may be refined through experience, but the concepts are not created entirely through direct contact with the external world.* Early vocabulary is learned both by orally repeating heard familiar speech patterns in the environment and by connecting, via the oracle that guides the language-learning child's interactions with others and the physical environment, those speech patterns for visualized objects that also have *associated cognitive concepts or other representations in mind* (see Gelman, 2003 for similar model).

Cross-Code Talker

Learning oral vocabulary involves cross-domain integration (visual, oral, and conceptual) rather than only integration of two kinds of codes (aural and oral) within the same domain (language). During the preschool years or early school years, the language learner acquires a new word-learning mechanism that supplements rather than replaces the oracle or the pattern analyzer. Just as the Choctaw Native Americans, who were not yet U.S. citizens, were the first code talkers to use their native language to develop secret codes for U.S. military operations in World War I, so were the Navajo the next code talkers in World War II. Their work required cross-code connections between secret and known codes. Likewise, children learn to be cross-code talkers by acquiring connections between internal codes that represent letters or written words they view and do not yet know *and* spoken words they already know. The phonological loop of working memory (see Table 3.5) enables this cross-code learning through the oracle, which orally names written words (or synthesizes phonemes corresponding to sequential alphabet letters in the written word), and the pattern analyzer, which detects regularities in the written word. Thus the cross-code phonological loop plays an important role in learning to decode written words, that is, transform written words into spoken words that can be pronounced via the oracle. Thus, decoding is accomplished by integrating, via the phonological loop, three kinds of internal language

* Plato's allegory of the Cave has been extracted from certain dialogues by modern scholars. The term was used at least as early as Diogenes Laertius who called it (Plato's) "Theory of Forms": Πλάτων έν τῆ περὶ τῶν ἰδεῶνὑπολήψει…, "Plato." *Lives of Eminent Philosophers*. Book III. pp. Paragraph 15.

codes—orthographic storage and processing of letters and written words, phonological storage and processing of phonemes and spoken words, and morphological storage and processing in both spoken and written words (see Table 3.5).

Statistical regularities abstracted by the pattern analyzer may also play a role in decoding written words (transforming them to spoken words during oral reading) or encoding spoken words (transforming them to written words during spelling) in morphophonemic languages such as English and French (Venezky, 1970, 1999). Moreover, comparing written orthographies only on the contrast between transparency (invariance in grapheme–phoneme correspondences) and nontransparency (alternative grapheme–phoneme correspondences) may not be the most valid or fruitful way to classify orthographies. Morphophonemic orthographies, which code meaning and grammar information in morpheme word parts as well as alternative grapheme–phoneme correspondences (Nunes & Bryant, 2006), may have an advantage in access to the cognitive world. *There may be trade-offs between ease of access to a pronunciation of a spoken word and ease of access to the underlying cognitive concept through the morphology.* These potential trade-offs have not been adequately investigated to date, but could be in future research on translation during writing, which also employs an orthographic loop as discussed next.

Cross-Code Scribe

Cross-code connections can also be formed in the spelling direction from heard words to written words by the orthographic loop. This orthographic loop enables writers to encode written words by hand (see Table 3.5) (a) during dictated spelling as heard words are transformed into internal phonological and orthographic (and morphological) codes and then into written spelling by hand and (b) during composing as internal orthographic codes (with links to phonology and morphology) are transformed to written spelling. In the early stages of invented spelling, the child creates connections between the internal codes for speech sounds and internal orthographic codes for letters or written words and then the motor codes for output through the hand. Then as the child has experience in spelling dictated words in writing, connections form between the auditory to phonological (phoneme or whole word) code to orthographic (grapheme or whole word) code (and to morphology codes in both spoken and written words) to motor output through the hand (see Table 3.5). With learning and practice during translation while writing to express ideas, spelling begins to rely increasingly on the skilled cross-talking scribe, that is, the direct route from internal phonological–orthographic (and morphological) connections to written spelling output through the hand (see Table 3.5).

Written word learning relies on both the phonological loop, which enables oral word reading, and the orthographic loop, which enables written word spelling (Berninger & Chanquoy, 2011). However, the phonological loop and the orthographic loop contribute in different ways to learning written words. On the one hand, the phonological loop supports development of a talking orthography and knowledge of alphabetic principle in the grapheme-to-phoneme or reading direction. On the other hand, the orthographic loop supports development of a written orthography in the phoneme-to-grapheme or spelling direction. In English, the alphabet principle in the reading direction is not identical to the alphabetic principle in the spelling direction (Venezky, 1970, 1999). Not surprisingly then, word decoding and word spelling are related but not identical processes (Abbott et al., 2010). In fact, children may be impaired in spelling but not word reading (see Chapter 5 for dysgraphia without dyslexia). Estimates for this dissociation range from 4% in a large French sample (Fayol, Zorman, & Lété, 2009) to 2.9% overall in a longitudinal sample in the United States, which was described in Abbott et al., to 1% for Arabic speaking children in Egypt (Mohamed, 2010).

Silent Orthographer

Fayol's studies (e.g., Fayol et al., 1994) provided evidence for yet another word-learning mechanism that involves silent orthography and represents a more mature mechanism than the cross-code talker or scribe. Once the translation of spelling into speech and speech into spelling is learned, word-specific spellings are represented in the long-term memory storage system, which can be accessed autonomously without engaging the cross-code talker or scribe. This mechanism is silent in that it can function independently of phonology, even though it does have links to phonology. For example, in the lexicon (mental dictionary) in long-term memory, the silent word-specific orthographic entry has links to word pronunciation, morphological properties, and meaning (semantic representations in cognitive realm), but its entry can be accessed independently of those links. This word-specific autonomous silent orthographic representation, which represents an integration of phonological, orthographic, and morphological codes, may have an advantage for faster access than if each code has to be accessed separately and then integrated; as a result, the silent orthographer may contribute to development of writing and reading fluency.

NEW RESEARCH FINDINGS

Three previously unreported research findings contribute new knowledge about (a) the role of finger sequencing in the orthographic loop in written word learning and written production of translation outcomes, (b) relationship of different orthographic loop components to manuscript and cursive handwriting, and (c) development of the silent orthographer that learns through the act of writing by hand (see Tables 4.1 through 4.3).

The first new research finding is that growth in finger sequencing from grades 1 to 4 contributes uniquely to letter writing and text composing. Growth curves were computed to describe change from grades 1 to 4 or 3 to 6 (see Table 4.1) for finger sequencing skills using the same procedures as Berninger et al. (2010) had used for phonological, orthographic, and morphological measures. The finger sequencing measure was the finger succession task scored for time to perform five repeated touches between each finger and the thumb in sequence without any visual feedback (Altemeier et al., 2008). Note that finger sequencing does not assess motor execution

TABLE 4.1 Slopes of Orthographic Coding and Finger Succession Growth Curves (Grades 1–4 or 3–6) as Predictors in Multiple Regressions for Handwriting and Written Composition Outcomes at Grade 4 or Grade 6: Finger Succession Growth Curves Contributed Uniquely and Positively to the Outcomes

Outcomes with Finger Succession[a] Growth Curves as Predictors	R^2	F(df = 2,222),	p	β	t,	p
Alphabet 15 s by pen[b]	.07	8.39,	.001	.198	2.90,	.004
Alphabet 15 s by keyboard[b]	.38	66.77,	.001	.155	2.77,	.006
WIAT II written composition[c]	.10	12.49,	.001	.197	2.93,	.004

Note: For details about measures, see [a]Altemeier, Abbott, and Berninger (2008), [b]Berninger, Abbott, Augsburger, and Garcia (2009a), and [c]Abbott, Berninger, and Fayol (2010).

TABLE 4.2 Orthographic Loop (Receptive Orthographic Coding, Expressive Orthographic Coding, and Finger Succession) and Executive Function Predictors (Rapid Automatic Switching Timing and Examiner Ratings of Switching) in Multiple Regressions for Manuscript Printing and Cursive Handwriting Outcomes at Grade 4

Outcome/Predictor	R^2	F(df),	p	β	t,	p
Third grade alphabet 15 s by pen	.15	4.10 (4, 94)	.004			
Receptive orthographic coding				.21	2.14,	.035
Third grade alphabet 15 s cursive	.12	2.32 (4, 68)	>.05			
None						
Fifth grade alphabet 15 s by pen	.24	2.88 (5, 99)	<.05			
Expressive orthographic coding				.45	3.52,	.001
Fifth grade alphabet 15 s cursive	.14	2.96 (5, 95)	<.05			
Switching attention rating				2.15	2.15,	.034

For each outcome (in italics), the predictor is below.

Notes: Only significant findings are reported. At third grade there were no significant findings for cursive. Neither the finger succession nor orthographic coding measures in these analyses were based on slopes of growth curves—but rather they were single scores or ratings during assessment at target grade level. For details about measures, see Berninger et al. (2006) for cohort beginning in grade 3.

skills alone but rather the cognitive planning, control, and execution of serial organization of finger movements sequenced over time. Although finger sequencing did not contribute uniquely to spelling, it may be related to word learning indirectly via its unique contribution to handwriting, which in turn affects spelling. Finger sequencing underlies the formation of the graphomotor envelope by which the orthographic loop clusters letters into word spellings (Berninger et al., 2009a).

Although slopes of growth curves for receptive orthographic coding ($p < .001$) and finger succession (p ranging from .015 to <.001) were significantly correlated with the handwriting, spelling, and composing outcomes, multiple regression with both as predictors showed that only growth in finger succession contributed

TABLE 4.3 Slopes of Growth Curves for Phonological, Orthographic, and Morphological Word-Form Coding Units for Word Storage and Processing as Predictors in Multiple Regressions for Year 4 (Grades 4 or 6) Spelling, Word Reading, and Composing Outcomes

Outcome/Predictor	R^2	F(df),	p	β	t,	p
WIAT II real word spelling with handwriting	.30	31.69(3, 221),	.001			
Receptive orthographic coding slope				.186	2.25,	.026
WJ III Pseudoword spelling with handwriting	.23	21.75(3, 221),	.001			
Receptive orthographic coding slope				.24	2.71,	.007
PAL II timed word-specific spelling without handwriting	.47	64.74(3, 221),	.001			
Receptive orthographic coding slope	.67	9.31,	.001			
Morphological coding slope				.13	2.21,	.001
WIAT II real word reading accuracy	.38	45.71(3, 221),	.001			
Receptive orthographic coding slope				.297	3.83,	.001
TOWRE real word reading rate	.10	8.43(3, 219),	.001			
Receptive orthographic coding slope				.22	2.30,	.022
WIAT II pseudoword reading accuracy	.32	34.16(3, 221),	.001			
Receptive orthographic coding slope				.41	4.96,	.001
TOWRE pseudoword reading rate	.21	19.78(3, 220)				
Receptive orthographic coding slope				.173	1.97,	.05
WIAT II written expression	.29	29.82,	.001			
Receptive orthographic coding slope				.25	2.98,	.003

For each outcome (in italics), the predictor is below.

Notes: See text for significant correlations. Only predictors that explained unique variance in multiple regressions and had positive t tests are reported in this table. For details about predictor measures see Berninger, Abbott, Nagy, and Carlisle (2010) and about outcome measures see Abbott et al. (2010) and Berninger et al. (2006). WIAT II = Wechsler Individual Achievement Test, 2nd edition; TOWRE = Test of Word Reading Efficiency; WJ III = Woodcock Johnson Psycho-educational Battery, 3rd edition; PAL II = Process Assessment of the Learner, 2nd edition.

uniquely to handwriting (number of legible letters in the first 15 s when writing by hand or keyboard) and written composition (standard score for age based on word writing fluency, sentence combining, and essay writing) outcomes. For each analysis, the regression accounted for a significant amount of variance and beta was positive (see summary results in Table 4.1).

This finding contrasts with that of Abbott and Berninger (1993) who found that orthographic coding contributed uniquely over and beyond finger function to letter writing by pen—but Abbott and Berninger used a latent factor for a fine motor function predictor with indicators that included more finger tasks than finger succession and a handwriting outcome factor that had indicators not restricted to automatic letter writing and did not include written composition as an outcome in these analyses. Also, Abbott and Berninger used single assessments in cross-sectional studies rather than growth based on multiple assessments over time as in the longitudinal analyses reported in this chapter. Thus, which component of the orthographic loop—orthographic coding or sequential finger movements—contributes uniquely to writing may depend on the exact predictor and outcome measures used as indicators of a factor in a model and whether an assessment measure at a single point in time or growth in it over time is used. Note that in both the cross-sectional and longitudinal studies, samples included typically developing child writers.

However, finger sequencing did not contribute directly to word learning; it did contribute uniquely to letter writing, which in turn, could have contributed uniquely to word spelling. Receptive orthographic coding assesses orthographic loop's internal language code for written words. Finger succession assesses orthographic loop's serial motor output through hand (see Table 3.5). Thus, additional analyses were performed to evaluate if results depend on the letter format for handwriting—manuscript (printing) or cursive—and results showed that they do.

The second new finding was that different processes contribute to manuscript and cursive writing (Table 4.2). Because in the United States cursive writing is typically not taught until third and fourth grade, and typically not thereafter, in the longitudinal study cursive writing was assessed at the beginning of third grade, when cursive is just being introduced and in fifth grade after children had received at least 2 years instruction in cursive writing. Results of the multiple regressions for both manuscript (printing) and cursive handwriting are summarized in Table 4.2. In third grade, receptive orthographic coding (viewing written word briefly displayed and then deciding if a whole word matches it or a displayed single letter or a letter group was in the word) contributed uniquely and positively only to printing. In fifth grade, only expressive orthographic coding (same as receptive but the whole written word or designated letter or letter group is written from memory once the briefly displayed word disappears) contributed uniquely and positively to printing but not to cursive. In third grade, neither orthographic coding nor rapid automatic switching contributed uniquely to cursive writing, but in fifth grade the examiner's rating of the quality of the child's switching attention throughout the testing session, but not time costs for naming on a rapid automatic switching (RAS) task, contributed uniquely and positively to cursive writing.

These results suggest that orthographic coding of written words in manuscript format is uniquely related to handwriting in the same format (printing) but not to cursive writing. Further research is needed to determine whether the efficiency of the orthographic loop may be specific to writing format (e.g., manuscript letters) and whether this format-specific relationship plays a role in developing the silent orthography for written words, which are frequently encountered in manuscript (printing) format, but not in cursive format, in books and word processing or web entries. A child's ability to switch attention may, in contrast, be more related to cursive writing with its loops for connecting letters that switch in letter identity—at least after 2 years of instruction in cursive, but not in the early stages of learning it. Again, further research is warranted before drawing firm conclusions.

The third new finding replicates and extends prior findings: silent orthography (receptive orthographic coding) integrates the phonological, orthographic, and morphological word forms and parts and is uniquely related to spelling and composing skills (see Table 4.3). When slopes for growth curves from grades 1 to 4 for phonological phonemes, orthographic receptive, and morphological coding (word-form storage and processing) were separately correlated with spelling achievement in grade 4 or grade 6, the correlations were consistently significant ($p < .001$ except $p = .003$ for morphological slope for rate of real word reading) but negative (because sometimes the lower scoring children grew more than the ones who started out high or vice versa). However, when slopes of growth curves from grades 1 to 4 for each of the three kinds of coding—phonological phonemes, receptive orthographic, and morphological coding—were included as simultaneous predictors in multiple regression for spelling achievement as the outcome in fourth or sixth grade, *only receptive orthographic coding uniquely and positively predicted spelling achievement* (dictated real words and pseudowords spelled in handwriting). Likewise, *only receptive orthographic coding uniquely and positively predicted reading real words and pseudowords* (accuracy and rate) *and composing* (see Table 4.3). Remarkably, the sign of beta weight and *t*-value changed from negative in correlations to positive in multiple regressions for orthographic coding and only for orthographic coding—not for phonological or morphological coding, which remained negative, for these outcomes. The orthographic word form may have a unique capability for integrating the interrelationships among all three linguistic word-form codes.

The one exception was for the timed word-specific receptive spelling task without handwriting requirements for which the slope of the growth curve for phonological phonemes did not contribute significantly and was negative, but the slopes of the orthographic and morphological growth curves contributed significantly and were positive. Consistent with the findings of Pacton et al. (2001, 2005), both orthographic and morphological regularities may contribute uniquely to this word-learning mechanism of the silent orthographer.

RELATIONSHIPS OF BRAIN, WORD LEARNING, WORKING MEMORY, AND TRANSLATION

The just discussed findings in Table 4.3 are of considerable theoretical interest because good spellers differed from those with dysgraphia (spelling disability) in blood oxygen level–dependent (BOLD) activation during functional magnetic resonance imaging (fMRI) while performing a word-specific spelling task (silent orthography in long-term memory) in a brain region associated with cognitive concepts and thinking (Richards et al., 2009). Thus, by grade 4 (ages 9–10 years) silent orthography may facilitate the translation process of cognitions into written language through connections of word spelling with the cognitive portal through which writers gain access to cognitions (e.g., concepts corresponding to written word vocabulary). Also see Berninger et al. (2009b).

To understand the functional significance of the claim just made, we briefly review the role of the brain in learning the word mechanisms discussed in this chapter. Three kinds of brain systems contribute to word learning: (a) the sensory (input) and motor (output) systems that have direct contact with the external world, (b) the internal language systems that communicate with the external world only through the sensory and motor systems, and (c) the internal cognitive system that for purposes of written language learning communicates with the external world only indirectly through the language system and its connections with sensory and motor systems (Berninger & Richards, 2011). To apply this concept to mechanisms of word learning and translation, see Table 4.4, which summarizes the sensory and motor systems and the interconnections they develop and provides a schema for how the three kinds of brain systems—sensory and motor, language, and cognition—contribute in unique ways to translation during writing. We now consider how each of these systems illustrated in Table 4.4 contributes to each of the word-learning mechanisms.

The *pattern analyzer* operates on sensory stimuli (from ears, eyes, or tactile feedback to hands) recorded in the episodic buffer to abstract statistical regularities, as explained earlier. If subsequently in the time course of processing, those incoming sensory stimuli are recoded linguistically, then the pattern analyzer may operate on phonological, orthographic, and/or morphological word forms in working-memory storage and processing units. The output of the pattern analyzer is statistical regularities about language codes, which may be stored and accessed in implicit long-term memory outside conscious awareness. These regularities probably do not have direct connections to the semantic system that links cognitive concepts with linguistic word forms, but may facilitate crossword form language mapping, which in turn makes connections via the word-specific orthographic spelling with the concepts in the cognitive system (semantic memory) (see Table 4.4). Alternatively, these statistical regularities may be directly mapped through fast lexical mapping across spoken and written words (see Bahr, Silliman, & Berninger, 2009).

The *oracle* receives incoming auditory sensory information, recodes it into language representations for heard words (e.g., phonological word form that stores phonetic representations of syllables or whole words or phoneme sound units within syllables), and then recodes them into motor codes for articulatory gestures for tongue and lip movements and vocal tract activity in spoken word production. The received heard words and spoken words produced by the oracle are only comprehended if the inner language codes also activate cognitive codes for concepts (see Table 4.4).

The *cross-code talker* receives incoming visual sensory information, recodes it into language representations for visible words (orthographic word form and its parts), and then links those to a corresponding phonological (or morphological) word form in the language system, which is then translated, as for the oracle, into a motor code for articulatory gestures and vocal tract activity. *This cross-code talker plays an important role in learning to read orally, but also learns another mode of output—muted for oral output—and this covert inner speech output mode plays an important role in silent reading and written spelling.* The cross-code inner speaker may also play a role in sustaining in working-memory written language processing during self-regulated translation bouts (see Chapter 5). Whether the cross-code talking is overt or covert, words are only comprehended if the inner language codes also access cognitive codes for meaning (see Table 4.4; also Stahl & Nagy, 2005).

During dictated spelling, the *cross-code scribe* receives incoming auditory sensory information, recodes it into language representations for heard words

TABLE 4.4 Brain Systems That Communicate Between the External World and Inner Mental World and Support Translation of Ideas into Verbal and Nonverbal Expression

I. End organs having direct contact with the external world
  A. *Sensory input* channels (sensory input channel in parentheses)
    1. Auditory (ears)
    2. Visual (eyes)
    3. Vestibular (inner ear—motion of body or body parts and position in space and movement in space over time)
    4. Touch sensation—localization (skin)
    5. Touch sensation—pressure (skin)
    6. Touch sensation—temperature (skin)
    7. Touch sensation—kinesthesia for sequential movements on skin (skin)
    8. Touch sensation—pain (skin)
    9. Taste (tongue)
    10. Smell (nose)
  B. *Motor output* channels
    1. Fine motor
      a. Oral motor—mouth (mouth movements, tongue movements, passage of air over vocal tract)
      b. Graphomotor hand (finger movements, hand positions, gestures)
      c. Face (movements that express in nonvocal and nonverbal formats)
    2. Gross motor
      a. Arms
      b. Legs
      c. Body torso

II. Internal mind with no direct contact with the external world
  A. Language (internal mediator between the end organs that have direct contact with external world and the inner cognitive world without direct contact with the external world)
    1. Language creates connections between each end organ (sensory and motor output channels with direct contact to world) to create mental networks that learn indirectly from the external world by listening through ear or reading through eye and communicate indirectly to the external world by speaking with mouth or writing by hand.
    2. Resulting mental networks also communicate indirectly with cognitive representations outside conscious awareness via working-memory storage and processing units for words and syntax/grammar.
  B. Cognition (inner mental world)
    1. Nature of the cognitive representations is not fully understood but most likely is heterogeneous and influenced by both genetic and experiential variables (see Chapter 3).
    2. Cognition involves systems that are even more removed from direct contact with the external world than language but can be translated into language and other formats, which in turn may have contact with the external world.
    3. Nonlanguage internal cognitive systems create connections with (a) gesture, facial expression, body motion for the performing arts (dance and other forms of expression of the body in motion), each linked to motor output as well as sensory input channels and (b) with arm, hand, and finger movements linked with internal imagery and external sensory input as in the visual arts (photography, drawing, painting, etc.).

TABLE 4.4 (continued) Brain Systems That Communicate Between the External World and Inner Mental World and Support Translation of Ideas into Verbal and Nonverbal Expression

4. Cognitions exist in the unconscious mind (never before accessed) or implicit memory (previously accessed and stored in long-term memory, which can be accessed through working memory) unless brought into consciousness temporarily through working-memory support.
5. These cognitive representations, whether stemming from species-specific genetic code (Jung, 1968, 1990) from birth[1] (Plato & Jowett, 1941) and/or experiences in the external world via sensory and motor end organs, are the cornerstone from which the inner mind or mental world is constructed.

Source: Based on Berninger, V. and Richards, T., *Past, Present, and Future Contributions of Cognitive Writing Research to Cognitive Psychology*, Psychology Press, New York, 2011.

(phonological and morphological word forms and their parts) and visible words (orthographic and morphological word forms and their parts), and then links those to motor codes for output through sequential finger and hand movements. *During spelling while composing*, the *cross-code scribe* can initiate the process directly from the internal orthographic, morphological, and phonological word forms and their parts to the motor output codes for fingers and hands. The written word can be used to express a concept or idea only if the prior word-form coding also accesses a cognitive code for meaning (see Table 4.4).

The silent orthographer accesses a cross-mapped linguistic code for the interrelationships among the phonological, orthographic, and morphological word forms and their parts, which is stored in a word-specific orthographic spelling that also has links to cognitive code(s) for meaning (see "amalgamation theory" in Ehri, 1980a, 1980b). This silent, internal multi-linguistic code with cognitive connections is then coded for motor output through sequential finger and hand movements (see Table 4.4).

A unique feature of the oracle, cross-code talker, cross-code scribe, and silent orthographer word-learning mechanisms is that they are all coded into word-form storage and processing units of verbal working memory. Loops of verbal working memory, which communicate between the external physical and social worlds with which the brain interacts *and* the internal mental world in brain (see Table 4.4), manage the language-learning activities of each of these word-learning mechanisms (see Table 3.5 for various kinds of loops working-memory constructs to support its activities). Some loops involve more than visual sensory and motor output connections or auditory sensory and motor output connections. In addition to those connections, these language-learning loops also have interconnections between internal language codes (orthographic for written words and letters, phonological for spoken words and phonetic and phonemic sounds, or morphological for both spoken and written words) (e.g., see Mann & Liberman, 1983). Whereas auditory sensory stimuli are coded for intensity (loudness) and timing (frequency), phonological codes are specific to language (aural input via ear that is later recoded phonetically for syllables and phones in heard or produced speech and other aspects of language such as abstracted phonemes, morphology, etc.). Phonemic codes, which mark sound units that make a difference in meaning, rather than phonetic codes in speech perception and production, correspond to the spelling units of the language in alphabetic principle that are relevant to learning to spell and read words (see Venezky, 1970, 1999). Yet even after spelling units (one- and two-letter graphemes) are translated into phonemes, phonetic codes also contribute to integrating these sequenced phonemes within and across syllables into a whole spoken word in which an intonation contour holds all the sounds together.

As developing writers engage each of the word-learning mechanisms, they receive sensory feedback from their motor acts (cross-code talking or scribing), which may then engage other learning mechanisms. For example, consider the eye and pen studies of Alamargot and colleagues (e.g., Alamargot, Chesnet, Dansac, & Ros, 2006; see Chapters 12 and 13), which show how writers view text produced so far in writing. Thus, the act of spelling words may engage the cross-code talker (muted speaker in silent reading mode), cross-code scribe, and/or the silent orthographer. To clarify, the five word-learning mechanisms discussed in this chapter are not necessarily acquired in isolation of one another. Rather, learning to translate during writing may draw on all or combinations of them as learners engage in writing and also in reading–writing activities involving reviewing text composed so far or words copied or reading source material to write reports.

FUTURE RESEARCH

Future research might investigate whether the silent orthographer has a relative advantage compared to the cross-code talker or scribe in gaining access to the cognitive portal of mind and if so why. For three reasons, the silent orthographer may have an advantage during language ← → cognition translation in gaining semantic access.

First, silent orthography has integrated the phonological, orthographic, and morphological codes in spellings for specific words. Prior research showed that a second-order factor underlying the three word-form coding factors (phonological, orthographic, and morphological) better predicted reading and writing outcomes than any single word-form factor alone (Berninger et al., 2008).

Second, according to Juel's Simple View of Writing, idea-spelling translations are at the heart of learning to write (Juel, 1988; Juel, Griffith, & Gough, 1986). Thus, spelling is not a mechanical skill but rather a mechanism for bidirectional translating of cognition into written language.

Third, the word-level portal of mind, accessed through the silent orthography with its coding of the interrelationships among phonology, orthography, and morphology in a morphophonemic language, may also facilitate access to multi-word syntactic constructions and corresponding cognitions in implicit memory through a variety of mechanisms. However, research is needed to investigate mechanisms of access to cognitions via word-level spellings alone or in other contexts:

- Word frequency, recorded in episodic buffer of working memory, may affect speed of access in additive or multiplicative manner.
- Lexical diversity may be enhanced if word-specific spellings are easily accessed but compromised if word-specific spellings are not readily available to access multiple potential words for the same meaning.

- Use of idioms or mental images (nonsyntactic language) may or may not be readily accessed through word-specific spellings.
- Adding grammar rules, syntax structures, and syntax markers (e.g., derivational suffixes that mark part of speech) on single words may provide multiple access routes (at different levels of language) to ideas through the cognitive portal.

Research is also needed on how cognitive processes may affect how easily each of the five word mechanisms is learned.

Automatic and Controlled Word Learning in Working Memory During Translation

To the extent that any of word-learning mechanisms becomes automatic, that is, requiring few working-memory resources and readily accessible through direct route for retrieval, working-memory load is lightened, freeing up space for other processes that are resource demanding to support them for conscious processing. Schneider and Shiffrin (1977) and Shiffrin and Schneider (1977) showed that during the learning of new words participants applied conscious, controlled, strategic processing, but once skills were practiced to mastery, they may switch from controlled strategies to automatic pilot. However, although automatic processing tends to be fast, the initially slow, conscious, and controlled, strategic processing may, with practice, become very fast, but not necessarily automatic (Schneider & Chein, 2003). Thus, time costs for task performance may not be the sole indicator of automatic processing.

In the early grades after letter writing and alphabet have been taught and practiced, children show individual differences in how automatic they are in accessing, retrieving, and producing legible letters automatically during an initial 15 s interval; and these differences are related to composing (Berninger, 2009). However, little is known about whether and, if so how, fast controlled and sustained handwriting may contribute to spelling during composing. Future research might address how a variety of handwriting skills may contribute to development of the pattern analyzer, the cross-code talker, the cross-code scribe, and the silent orthographer.

Flexibility in Memory During Translation

Current cognitive research on reading has moved beyond exclusive focus on automatic and controlled processing to research on flexibility in reading, that is, ability to shift among different kinds of processing as may be appropriate for the reading task at hand (Cartwright, 2008). Skilled readers can flexibly apply many knowledge sources and strategies and know when to automatize and when to engage in reflection or flexibly adopt other strategies or metastrategies (see Cartwright). Likewise, for the importance of flexibility in learning to write, see Boscolo, Gelati, and Galvan (in press). Future research might investigate interactions among spelling knowledge, vocabulary knowledge, and flexible word choices during translation in writing.

Mechanisms of Translation

Neisser (1967) launched the cognitive tradition in psychology, which in turn has generated a large body of knowledge about the variety of cognitive representations that appear to exist in unconsciousness or implicit memory or explicit conscious memory (see Table 3.1) and the operations that may operate on them (see Table 3.2) and access to them during translation (see Table 3.3). One mechanism of translation is *flow* (Kellogg, 1994) of the nonlinear stream, for example, from a calm pool, rushing water fall, or gusty wind storm, which may, for example, be transformed into linear stream if the format is language, which requires serial ordering, or verbal (poetry) or nonverbal (visual–spatial) imagery, or body movement or motion, or vocal expressions. A second mechanism of translation is *strategic*, that is, controlled with a cognitive plan that mediates the translation process rather than an unregulated flow and often includes some degree of preplanning (Chapter 2; Hayes & Flower, 1980; Scheider & Shriffin, 1977; Shriffin & Scheider, 1977). A third mechanism of translation is *generative* in which new ideas are created or new knowledge is formulated (constituted) (Galbraith, 2009; Jung, 1990). Further research is needed to evaluate whether there are important developmental differences in which of these translation mechanisms is employed or whether there are reliable individual differences in these among developing writers. If so, does skill in word-learning mechanisms interact with these translation mechanisms?

Moreover, given the generativity of both human thought and human language (infinite constructions from finite items), the mind, in general, and cognitive ← → linguistic translation, in particular, require a panel of executive functions for mental self-government to manage this complexity. Just like the Académie Française, the guardian of the French language, which regulates the words that can be used in French, a panel of executive functions is needed to regulate the translation of ideas into language. These include the lower-level executive functions of working memory and the higher-order executive functions for managing cognitive operations (see Chapter 3). Inhibition, switching attention, and sustained attention (lower-level executive functions) regulate the working-memory architecture, which in turn supports the higher-level executive functions of translation for transforming unconscious or implicit cognitions into conscious or explicit written language during writing (see Table 3.5), including planning, reviewing, and revising, that is retranslating (see Chapters 2 and 5). Lower-order executive functions play a role in written spelling, whereas higher-order executive functions play a role in self-regulation of translation during composing (see Table 3.5) by facilitating communication among various sensory, motor, language, and cognitive systems (see Table 4.4). Further research is needed on developmental patterns and individual differences in the low-level and high-level executive functions in developing writers.

SUMMARY AND CONCLUSIONS

Translation is a higher-level executive function that (a) regulates access to cognitions in the vast unconsciousness and implicit, long-term memory and transforms them via conscious, goal-directed working memory into written language and (b) transfers ideas expressed or constructed in written language to the cognitive system in the mental world. This executive function enables access to cognitive representations outside awareness and conscious expression of cognitions in language to meet a variety of goals, including creating new cognitions or knowledge structures, educating, entertaining, governing, defending, and honoring the sacred (see Chapters 1 and 3).

On the one hand, translation in writing operates at the word level and may rely on any of the word-learning mechanisms discussed in this chapter, but the silent orthography may have a special advantage in accessing cognitive representations and translating them into written language. Because morphology is represented in both spoken and written words, it may be a bridge between spoken and written words that is as important as alphabetic principle in a morphophonemic orthography. However, further research is needed on this issue. See Chapter 15 for the importance of grounding such research not only in language users as in Chapter 4 but also in language as a system.

On the other hand, translation operates at many levels of language and words are only one of the levels involved. Much remains to be learned about how the word level interacts with the syntax or text levels during the cognitive ← → language translation process. For example, morphology may also be the bridge between the word level and syntax level that enables both written expression of ideas in text and reading comprehension of text. Although spelled words undoubtedly play an important role in writing, it is unlikely that words alone are involved in the translation process during writing. Thus, in Chapter 5 we investigate not only the word level (cross-talking readers and scribes and silent orthographers) but also other levels of language in a longitudinal study of the translation process in 20 individual child writers across the first five grades of formal schooling, 12 of whom are grade-appropriate or better in written word-learning mechanisms and 8 of whom are not.

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5

Longitudinal Individual Case Studies of 20 Children on Writing Treks in Grades 1–5

VIRGINIA WISE BERNINGER and JOHN R. HAYES

INTRODUCTION

Following Emig's (1971) and Rogers' (2011) recommendations for longitudinal individual case studies of the same students, we report case studies for 10 girls and 10 boys, who attended schools in the Pacific Northwest of the United States at the beginning of the twenty-first century and were assessed annually for the first five grades (ages 6–11 years). The individual child writers were English-language users even if other languages were spoken at home. According to parent report, two were African American, two were Asian American, and the rest were European American; only one was adopted. Their parents' educational levels ranged from community college to college to graduate school. They were selected from a sample of over 200 unreferred children in a 5 year longitudinal study of writing, reading, and oral language development because they had also participated in brain imaging at the end of the longitudinal study.

The goals of the research were to *characterize* (a) *the writer* behind the writing during the developmental journey in learning to translate (Hayes, Chapter 2; Hayes & Flower, 1986) and (b) the *nature of the translation* (Chapters 2 through 4) and *translation-related processes* (Chapters 2 through 4) that contribute to learning to write. To accomplish the first goal, seven kinds of measures were used to describe the individual child writer at each of five annual assessments in the first few months of grades 1–5. To accomplish the second goal, we examined for each individual child writer patterns related to the nature of translation and related processes; the patterns were used to generate hypotheses to test in future research with a larger sample of longitudinal case studies, as explained in the "Discussion" section.

MULTIPLE METHODS FOR ASSESSING TRANSLATION AND RELATED PROCESSES

This study applied multiple methods to assess writing development in individual child writers over five grades. These methods are described in this section (also see Appendix A). Results are provided in Appendix B for each of the 20 child writers in grades 1–5. Patterns based on the various methods that were observed across individual profiles are described and discussed.

Psychometric Tests of Research-Validated Constructs

These measures had been validated for research in prior programmatic research (multiple regression, confirmatory factor analysis, structural equation modeling, and instructional studies) (for review, see Berninger, 2008, 2009; Berninger & Richards, 2010). Personal profiles for each of the 20 child writers across five grades included the following standardized test measures: (a) *WISC III verbal comprehension factor*, in grade 2, and *WISC IV verbal comprehension index* (based on most recent norming sample), in grade 5 and (b) *PAL alphabet writing* (printing the alphabet in order and scored for legibility and correct order in the first 15 s to assess *automatic retrieval and production of ordered alphabet letters*), *WIAT II spelling* (*writing dictated real words*), *WJ III spell sounds* (*phonological spelling of pseudowords*), and *WIAT II written expression* (*sentence combining*, grades 1–5, and *text composing*, grades 3–5). In each profile's section on writing development, overall patterns are described for response on *phonological spelling* (pseudowords), which assesses phonotactic knowledge (e.g., permissible letters in specific word positions) and phoneme–grapheme correspondences in alphabetic principle (in spelling direction), and *word-specific orthographic spelling* (correct real-word spelling selected from phonological equivalents but no handwriting required).

Measures of phonological, orthographic, and morphological coding are included in each profile (see Appendix B) because *English is a morphophonemic orthography* (Venezky, 1970, 1999): PAL *orthographic coding of written words* (receptive grades 1–3, expressive grades 4 and 5; word-specific orthographic spelling on word choice, grades 1–4), PAL phonemes (*phonological coding of spoken words*), and UW comes-from task (*morphological coding of word parts—bases and affixes marking meaning and grammar—in written and spoken words*). These were used in evaluating working memory components that support both oral and written language learning (Berninger, 2007, 2008; Berninger & Richards, 2010): *phonological, morphological, and orthographic word form coding units* (storage and processing) and also *phonological loop* (RAN letters) and *orthographic loop* (automatic letter writing on alphabet task), and *executive functions* and Finger Succession. Note that in contrast to measures with accuracy scores, for *RAS and inhibition, which are time scores, those with negative signs are above the mean and those with positive signs are below the mean*. We also assessed *phonological working memory* (naming heard digits, which can be visualized as symbols corresponding to digit names, in reverse order, *WJ-R digits reversed*), and *orthographic working memory—letters* (accessing and retrieving from long-term memory a letter in the ordered set of alphabet letters and holding it in working memory while producing the one that comes before or after the designated letter) and *words* (analyzing letters in various word positions in written words held in working memory), all of which are related to literacy learning (Berninger et al., 2010).

See Abbott, Berninger, and Fayol (2010) and Garcia, Abbott, and Berninger (2009) for task descriptions and reliabilities and publishers for tests given each year. When a test was not given because a parent brought the child late or had to leave early from the annual assessment session, or, as happened only rarely, the child asked, per human participant assent procedures used, not to do the task, then *n.a.* (not available) appears in the table of a profile. Data may also be missing because a measure was not given to any children at a certain grade level and then the space is blank. For the standardized tests with age or grade norms, scores fell along a scale with a *standard score* for age (mean of 100 and standard deviation of 15), a *scaled score* for grade (mean of 10 and standard deviation of 3), or a *z-score* (mean of 0 and standard deviation of 1 based on the mean and standard deviation for grade from national norming sample or longitudinal research sample). Percentiles are reported for standard scores. The following scheme, which has been adopted by convention, is used to describe the range in which a score falls because ranges are more reliable than individual scores:

Just below +⅔ to −⅔ standard deviation (SD) (*average*, 68% of population)
Just below 1⅓ SD to +⅔ SD (*above average*)
Just below 2 SD to 1⅓ SD (*superior*)
2 SD and above (*very superior*)
Just below −⅔ SD to −1⅓ SD (*low average*)
Just below −1⅓ to −2 SD or lower (*below average*)

Parent Questionnaires

Parents completed a questionnaire about developmental history and educational services, and rating scales of child's ability to regulate attention and behavior. For all children, these parent ratings fell in the range of normal variation and none met criteria for attention-deficit hyperactivity disorder (ADHD). However, when parents noted problems with self-regulation of attention or behavior even though not severe enough to diagnose ADHD, these problems are noted. Parents were asked to share classroom samples of their child's writing with the research team. When available, we describe their nature to provide some information about the kinds of writing activities children experienced at school, but these were often the final of multiple drafts, which were completed with teacher and parent feedback. All children used computers at home for school activities (e.g., homework) and nonschool activities (e.g., games). Children were more likely to use computers for homework activities than during writing instruction and activities at school. For further information about the home literacy activities involving computers in the whole longitudinal sample, see Alston-Abel (2009). Parents were also asked about special services—special education (individualized education plans [IEPs]) or other kind of services at school (Chapter 1 or extra help of some kind) or outside school.

Educational Services

Information was collected about educational services outside the regular program because of the growing trend for U.S. parents to seek individual tutoring and other educational services outside the regular school system to optimize their child's academic achievement. Of those without dysgraphia (impaired spelling) (see the text at the end of "Introduction"), *half received some kind of educational services beyond the regular program* (extra help in writing from the regular teacher in third, fourth, and fifth grade, Chapter 1 services in grade 4, ongoing private tutoring outside school, early physical therapy services, physical therapy and speech services, or ongoing speech services). *Of those with dysgraphia, three-fourths received some kind of educational services beyond the regular program* (tutoring outside school in grades 2–4, tutoring outside school in grade 4, tutoring in and out of school in grades 2, 3, and 5 and occupational therapy in grade 5, special services for speech and language from grades 1 to 4, special education services in grade 4, or tutoring outside school in grades 2–5 and special education services in grade 5).

Researcher Ratings

Research assistants rated each child at each annual visit on focused, switching, and sustained attention. These reflect attention regulation during the assessment.

Researcher-Designed Writing Tasks

Rijlaarsdam and Van den Bergh (2011), based on Verheyden (2010) and Verheyden, Van den Branden, Rijlaarsdam, Van den Bergh, and De Maeyer (2010), called attention to the importance of drawing conclusions about writing processes and their development based on results for multiple writing tasks. Thus, multiple writing tasks were administered: narrative by pen (grade 1), the same narrative as in grade 1 by pen and by keyboard (grades 3 and 5), same essay by pen and by keyboard (grades 2 and 4), and the same four genre by pen (narrative, informative essay, compare and contrast essay, and persuasive essay [grades 3 and 5]). See Appendix A for details about each task. See section on "Nature of Translation" (and also "Discussion") for the theoretical basis for these measures and how these were examined to describe patterns and generate hypotheses for future research.

Writing by Pen and Keyboard and Self-Generated Revisions

All writing during the annual visit was done with a pen or a keyboard and children were instructed to cross out and rewrite above or use keyboard backspacing to make any revisions they wished as they performed all writing tasks. However, despite these instructions, many children revised by superimposing another letter on the one being revised rather than crossing out a letter and writing another letter above it when handwriting by pen. Two kinds of self-generated revisions of handwriting in the written protocols were coded—superimposing another letter and crossing out letters (whether or not another letter followed). This information provided clues about developing ability to self-generate revisions when handwriting difficulties are encountered during translation. Self-generated revisions in spelling, word choice, and text repair were also noted.

Researcher-Designed Think-Alouds for Self-Regulated Oral Translation

Think-alouds, which have been used to study adult skilled writers (Berninger, Fuller, & Whitaker, 1996; Hayes & Flower, 1980, 1986) and developing child writers (Costa et al., Chapter 8), were collected prior to or after but not during writing: (a) idea generation (about computers or robots) in grades 2 and 4 prior to essay writing by pen or keyboard and in grades 3 and 5 prior to persuasive writing, (b) planning organization prior to persuasive writing in grades 3 and 5, and (c) planning revision after persuasive essay writing in grades 3 and 5. Past research focused on the nature of the ideas expressed orally (Berninger et al., 2009) or number of ideas expressed when writing by pen compared to writing by keyboard (Hayes & Berninger, 2010), but the current research focus was on the relationships between ideas expressed in oral self-regulated translation and then in written self-regulated translation that followed. These "think-alouds" also offered insight into the relationships of developing translation to other developing cognitive processes (Hayes, Chapter 2). For example, did the written translation products reflect the orally generated ideas or organizational plans before writing? Does the proposed revision focus only on changes in surface features or deeper changes in meaning expression for revising the just produced written translation outcome?

Child Attitude and Motivation for Writing

Attitude toward writing, based on ratings on 12 items for writing—smiles (most favorable), neutral expressions (somewhat positive), frowns (somewhat negative), or anger (very negative)—of Garfield, the cat (Graham, Berninger, & Abbott, in press), is noted in grades 1–3. Motivation for writing, based on item that loads on approach-avoidance gradient (Berninger, Abbott, Whitaker, Sylvester, & Nolen, 1995), is noted in grades 4 and 5.

Metacognition About What Writing Is

In grade 1, children explained orally what writing is to a kindergartner, and research assistants transcribed the oral protocols into writing. In grade 5, children explained in writing what writing is to a kindergartner, third grader, and fifth grader. These were inspected for insights into developing writers' metacognitions about writing. For example, are they focused only or primarily on transcription and/or idea expression? Do they show insight into developmental changes in writing based on tasks children are expected to complete?

NATURE OF TRANSLATION

The research approach was grounded in multiple theoretical or conceptual frameworks about what translation is and what variables contribute to the translation process.

Self-Regulated Translation Bout

Much writing in school or at home is scaffolded by an adult, older child, or peer who offers feedback; the writing may then be revised and the final product may be the result of multiple writing sessions and drafts. In contrast, the multiple writing tasks used in the research were designed to study *self-generated, sustained, unaided translation bouts* during a 5 or 10 min independent writing sample in a single session without scaffolding (guided assistance of someone else) other than an initial provided topic (task requirement).

Self-Regulated Written Translation Time Across Genre

Research assistants (testers) recorded the total time individual children remained engaged in self-regulated written translation bouts for each of four genre-specific composing tasks (narrative, informational, compare and contrast, and persuasive). Of interest was whether children exhibited individual differences in how long they could sustain the self-regulated writing bout—continuing until the time limit was reached or ceasing at various times before the time limit—and whether these times varied across four genre of written translation. Working memory limitations may contribute to shorter self-regulated translation bouts.

Prompts During Oral Think-Alouds

Testers also noted if children stopped before the time limits for the oral think-alouds, and when they did, prompted them to continue: What else can you think of? Sometimes children did not cease altogether, resulting in the tester prompting them to continue, but rather produced filled pauses, like *um*, which serve as a place holder during momentary difficulties in the cognitive ← → linguistic translation process. Continuing to think aloud after a prompt probably requires reengagement of a cycle of working memory, in contrast to a filled pause, which probably does not reflect a complete disengagement of a working memory cycle, but rather a momentary stalling within a given working memory cycle for extra time to find the needed word to express the idea being translated. Of interest was whether either disengagements or momentary disruptions of working memory occur during translation for oral language, which does not have written transcription requirements. If so, then the translation process is vulnerable to working memory limitations independent of transcription requirements.

Mechanisms of Translation and Relationships to Other Processes

During translation, cognitive representations may be accessed in nonlinear time through *flow* (Kellogg, 1994) or *knowledge telling* (Bereiter & Scardamalia, 1987), *strategic plans for finding and organizing knowledge* (Hayes & Flower, 1980), *transformation of knowledge* for rhetorical goals or audience needs (Bereiter & Scardamalia, 1987), or *knowledge constitution* in which access itself leads to discovery or transformation leads to construction of new knowledge (Galbraith, 2009). To gain insight into how developing child writers might be translating ideas into written language, several research approaches were used. First, the number of ideas generated during oral think-alouds was compared to number of ideas expressed in writing tasks. When more ideas were expressed orally, with no written transcription requirements, than in writing, with written transcription requirements, there is reason to believe that written transcription requirements may be limiting idea expression during translation. When the number of ideas expressed orally and in writing is equivalent, it may be because transcription is not interfering. However, written transcription may not be the only source of constraints; another possibility is working memory, which is why the number of prompts needed during oral self-generated translation on oral think-alouds, which have no written transcription requirements, was also considered. In addition, when new ideas appear in writing not evident during the oral idea generation, then there is reason to believe that online planning is contributing to some degree to translation. The evidence is even stronger for strategic planning if an articulated plan during an oral think-aloud for organization, for example, specifies a beginning, middle, and end of planned text, and then that organization appears in writing. However, when a whole text rather than idea string is generated during the think-aloud and then is reproduced in writing, the writer may be in flow rather than strategic mode. So mechanism of access to cognitions (Table 3.3)—flow versus strategy-based—can also be a source of constraint.

Mapping Cognitions Into Levels of Language

Some ideas (e.g., concepts) are translated into words. Some ideas are translated into syntax: nouns (concrete or abstract objects or concepts), verbs (actions or states of being), adjectives (qualifying descriptors of nouns), adverbs (qualifying descriptors of verbs), or function words—conjunctions, prepositions, articles—which have no meaning of their own but create meaning by linking other words in a clause. However, more than the structural unit of language is involved—the resulting syntax units signal functions, for example, topic–comment units. At a minimum, there is a topic and comment: (a) predicate and its argument or (b) subject—noun, noun phrase, or noun clause and a predicate—simple verb, verb phrase, or verb clause. Often genre-specific discourse schema are also observed with a main idea or integration device (higher-level topic) and supporting elements for it (higher-order comments), for example, in oral format (e.g., conversation, oratory, story-telling, or play script) or written format (e.g., narrative or expository—informative, compare and contrast, persuasive).

Linear and Global Translation

Translation is a higher-order executive function in the cognitive system, supported by working memory (Table 3.5; Berninger & Richards, 2002), which transforms cognitions into language (and vice versa) and in the case of written language involves (a) *linear transcription* (linear ordering of writing units—component strokes in letters and ordered letters in spelled words), (b) *linear text generation* (linear ordering of words in sentences), and (c) *nonlinear text structures* (unifying whole texts, e.g., with paragraphs organized by main idea and supporting details or genre-specific discourse schema with topic sentences, paragraphs, and/or larger organizing devices). For example, in a cross-sectional study grades 1–9, Fuller (1995) and Berninger et al. (1996) identified (a) 21 local algorithms that children in

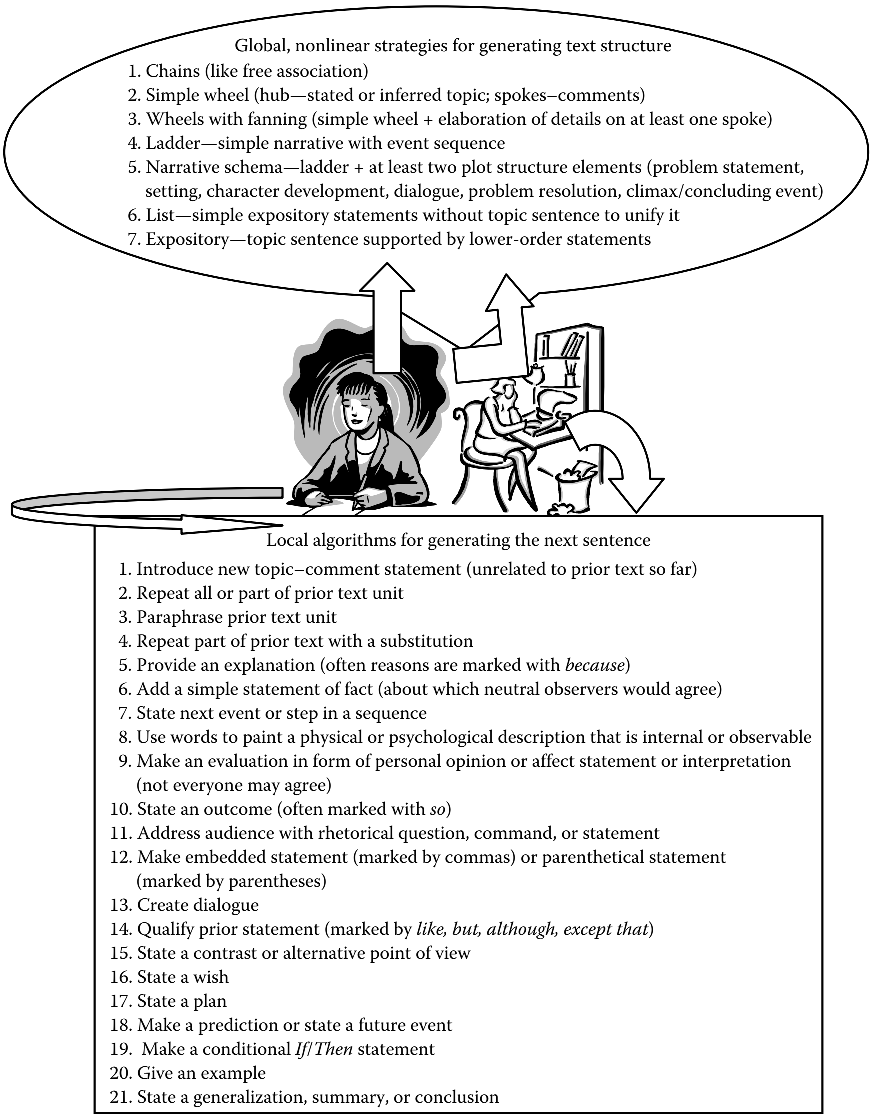

Figure 5.1 Local strategies for generating next text while keeping text generated so far and global text-generating strategies in mind in cycles of working memory.

a cross-sectional sample grades 1–9 used in generating the next written sentence to comment on a prior reference (topic) in the unfolding text—often but not always the immediately preceding sentence and (b) 7 global structures child writers used during the same writing tasks to create higher-level, organizing schema about a discourse topic, which ties local units to the whole text (see Figure 5.1).

In the longitudinal study across a smaller grade range (1–5) more writing tasks were included (see Appendix A) than in the prior cross-sectional study and examined for evidence of these same local and global structures. Both the linear and global strategies involve topic–comment units. Children's first language constructions larger than a single word are topic–comment units (e.g., cookie more), which continue to underlie language learning and use across development. During the course of writing development, the topic–comment units become larger (e.g., topic sentence and sentences that comment on that topic in paragraph or integrative statement and paragraph comments related to it).

Translation Theory Informing the Individual Longitudinal Investigation

Thus, this empirical, descriptive, longitudinal study of multiple individuals was grounded in a theoretical framework drawing on cognitive psychology, neuropsychology, and linguistics. Translation was conceptualized as a higher-level executive function that supports communication across different mental domains during bidirectional cognitive ← → linguistic translation. The transformation underlying translation during a self-regulated translation bout may have a variety of outcomes depending on the total duration before all translation ceases. For example, outcomes may vary from partial to complete syntax structures to multi-sentence text. The translation outcomes while in process and production are supported by working memory, which has temporal, capacity, and efficiency limitations, all of which may be affected by nature of the task requirements and individual susceptibility to disruptions in working memory cycles over time or momentary word finding difficulties during the currently engaged working memory cycle.

PERSONAL PORTRAITS OF CHILD WRITERS

Longitudinal Case Studies of Individual Child Writers

The goal was not to test the reliability or validity of a coding scheme hypothesized to capture fully the translation process, but rather to use the method of glossing employed by linguists to examine oral and writing language productions for patterns in the data, which provide clues to the translation processes contributing to the translation outcomes. Whenever local and global strategies are described for an individual child writer, readers are encouraged to refer to Figure 5.1.

Readers are also encouraged to examine each of the 20 profiles (in Appendix B), which report scores for oral verbal comprehension ability, handwriting, spelling, written composing, and components of the verbal working memory system, for patterns in how individual writers varied (a) within themselves within a given grade and across their own writing trek and (b) across individuals within a grade and across grades. Readers who are accustomed only to quantitative data and inferential statistical analyses may be overwhelmed by the sheer volume of these descriptive, quantitative data and verbal qualitative observations about linguistic data. The approach is essentially the clinical method used by scientist–practitioners in psychology. In essence, summaries of 100 psychological assessment reports (5 years of assessment for each of 20 children) are presented in Appendix B, which accounts for the exceptional length of this chapter.

Analyzing these patterns should yield insights into the challenges facing teachers in providing differentiated writing instruction to help all child writers develop their translation processes (Rijlaarsdam & Van den Bergh, 2011). The stories of individual writing treks capture the writer apart from the writing environment (Hayes, Chapter 2) in theoretical models as well as the reality of individual differences and dynamic processes—no two writers and developmental writing treks are exactly the same.

Interindividual Differences in Transcription Disabilities-Impaired Spelling

Research-supported criteria were used to identify individuals in *grade 5* with dysgraphia: (a) automatic/legible handwriting falling below –1 SD (16%tile) or (b) spelling falling below mean and at least one SD below grade 5 verbal comprehension (or written composing meeting the same criteria due to spelling or handwriting errors lowering composition score); research has shown that verbal comprehension explains unique variance in spelling and written expression (composition) but not handwriting (see Berninger, 2009; Berninger & Richards, 2010). The diagnosis of dysgraphia, which is noted only when the evidence supported it in grade 5, was found consistently across individuals in this sample only for spelling impairment (see profiles 13–20 in Appendix B). Of interest, parents reported history of writing problems in the cross-generational nuclear and extended family about as often for children with as without dysgraphia (about 50%), consistent with family history being a risk factor but not determining factor in development of writing disability.

Interdisciplinary Approach

In this exploratory, interdisciplinary, longitudinal study of 20 individuals on a writing trek in developing expertise in translating their cognitions into language and vice versa, methods employed are those used by *clinical psychologists* (individual, descriptive assessment of multiple data sources), *linguists* (analysis of levels of language and global and local topic–comment units), and *cognitive psychologists* (theoretical and empirical analyses of the cognitive and language processes underlying oral and written translation).

RESULTS

Personal Literacy Treks for 20 Child Writers

Writing development showed considerable variation not only among child writers but within the same individual child writer across the first five grades. In the discussion, we consider theoretical implications of what was observed and hypotheses generated by the in-depth examination of 20 longitudinal case studies to be tested in future research.

Self-Regulated Translation Bouts

The time each child engaged in self-regulated translation for each of 4 composition genre in both 3rd and 5th grade is reported in the first 2 columns of Table 5.1. At each grade level, the duration of the written translation bout was correlated across

TABLE 5.1 Time Durations (s) for Engagement in Self-Regulated Translation Bout for Four Written Genre and Oral Think-Alouds before or after Persuasive Writing in Children without or With Dysgraphia-Impaired Spelling

	Grade 3	Grade 5	Grade 3	Grade 5
	Nar Inf CC Per	**Nar Inf CC Per**	**IG ORG REV**	**IG ORG REV**
Group 1—Children without dysgraphia-impaired spelling				
Child 1	180, 286, 255, 148	218, 270, n.a., n.a.	33, 57, 49	n.a., n.a., n.a.
Child 2	300, 300, 300, 300	300, 278, 265, 300	52, 56, 30	69, 31, 28
Child 3	300, 300, 300, 300	49, 126, 86, 120	177, 56, 30	20, 20, n.a.
Child 4	300, 300, 300, 300	300, 300, 300, 300	63, 96, 121	127, 20, 40
Child 5	300, 300, 300, 300	307, 297, 294, 290	108, 108, 47	119, 46, 15
Child 6	285, 172, 138, 170	207, 300, 251, 300	72, 68, 22	48, 12, 25
Child 7	300, 276, 99, 300	176, 156, 161, 199	43, 68, 27	129, 175, 44
Child 8	300, 300, 300, 300	259, 300, 256, 300	120, 135, 115	19, 30, 15
Child 9	300, 235, 300, 238	300, 300, 300, 300	206, 27, 18	259, 71, 32
Child 10	300, 300, 257, 196	300, 225, 300, 300	171, 171, 80	100, 159, 44
Child 11	240, 260, 286, 071	300, 282, 300, 300	122, 46, n.a.	57, 28, 21
Child 12	135, 66, 137, n.a.	84, 140, 055, 130	48, 91, n.a.	52, 2, 18
Group 2—Children with dysgraphia-impaired spelling				
Child 13	33, 42, 118, 54	88, 069, 90, 74	27, n.a., 10	79, 21, 17
Child 14	No writing	253, 183, 168, 290	153, 190, n.a.	99, 93, 44
Child 15	294, 294, 300, 300	300, 300, 285, 224	31, 34, 21	151, 125, 54
Child 16	300, 215, 246, 268	300, 300, 300, 300	147, 117, 66	155, 109, 74
Child 17	190, 129, 126, 164	300, 300, 300, 300	67, 72, 61	112, 25, 40
Child 18	300, 294, 282, 300	300, 300, 300, 300	113, 53, 38	201, 63, 55
Child 19	112, 159, 300, 300	300, 300, 300, 300	191, 28, 49	143, 95, 105
Child 20	154, 180, 129, 82	300, 300, 300, 300	86, 56, 43	86, 36, 20

Note: Time < 300 s indicates cessation in self-regulated translation before time limits despite tester prompts. Nar = Narrative, Inf = Informational, CC = Compare and contrast, Per = Persuasive, IG = Idea generation, ORG = Plan for organizing, REV = PLAN for revising.

genre, considered 2 at a time. Results were as follows: in grade 3—narrative and information, $r = .82, p < .001$; narrative and compare and contrast, $r = .49, p = .032$; narrative and persuasive, $r = .64, p = .004$; informative and compare and contrast, $r = .69, p < .001$; informative and persuasive, $r = .60, p = .008$; and compare and contrast and persuasive, $r = .55, p = .019$—and in grade 5—narrative and information, $r = .86, p < .001$; narrative and compare and contrast, $r = .95, p < .001$; narrative and persuasive, $r = .91, p = .031$; informative and compare and contrast, $r = .92, p < .001$; informative and persuasive, $r = .88, p < .001$; and compare and contrast and persuasive, $r = .88, p < .001$. Thus, time engaged in self-regulated translation exhibited stable interindividual differences across four writing genre within individual children. However, the magnitudes of the correlations increased across grade levels from third to fifth grade showing increasing stability of the duration of self-regulated translation bouts. As also shown in the last 2 columns of Table 5.1, developing writers in grades and 5 showed inter individual differences in temporal duration of self-regulated oral idea generation, plan for text generation, and plan for revising. Future research might extend this research on self-regulation of both oral and written translation.

Cessations in Self-Regulated Oral Translation

See Table 5.2 for the frequency of tester prompts to continue following cessations in translation in grades 2–5. Children without dysgraphia (impaired spelling) required prompts less than those with dysgraphia did. Future research should investigate patterns of cessation of self-regulated translation (frequency and duration) and of nature of translation when self-regulated translation resumes, if it does, as a function of experimenter-manipulated variables, task variables, or individual difference variables (see "Discussion"). Inability to reengage in self-regulated translation may reflect difficulty in reengaging a working memory cycle in sustaining working memory over time. Research is also needed on how teaching explicit strategies for self-regulation (reviewed by Costa et al., Chapter 8) may support that reengagement.

Filled Pauses During Online Translation

See Table 5.2 for child-generated filled pauses during momentary breakdowns in the self-regulated translation process. In grades 2 and 3, but not grades 4 and 5, children with dysgraphia produced more filled pauses than those without dysgraphia. Of great interest for translation, the frequency of filled pauses (Table 5.2) was significantly correlated with oral generation of an organization plan, $r = 0.64$, $p < .003$ in grade 5 but not in grade 3, when fewer child writers could plan aloud; also prompts were not correlated with filled pauses in grade 5, suggesting that they reflect different kinds of individual differences at that developmental level. Thus, future research is needed on how filled pauses may reflect moment-to-moment, online decision making while translating, whereas complete cessation of self-regulated translation reflects disruption of the working memory cycle supporting translation. Research is needed on the frequency and duration of cessations in

TABLE 5.2 Tester Prompts Following Long Pauses and Filled Pauses during Self-Regulated Oral Translation for Children Without or With Dysgraphia-Impaired Spelling

	LPs Followed by Prompts				FPs			
Grade	**2**	**3**	**4**	**5**	**2**	**3**	**4**	**5**
Group 1—Children without dysgraphia-impaired spelling								
Child 1	0	0	1	0	0	2	1	0
Child 2	0	0	3	0	3	2	0	0
Child 3	4	0	7	0	0	0	12	0
Child 4	3	0	6	0	2	0	10	0
Child 5	0	0	1	0	0	0	0	0
Child 6	4	0	2	0	1	4	0	1
Child 7	2	0	0	0	1	0	0	0
Child 8	0	1	0	0	4	0	0	0
Child 9	0	0	0	0	0	3	0	4
Child 10	0	0	0	1	0	0	0	9
Child 11	1	1	4	0	0	0	0	0
Child 12	0	0	4	3	0	0	0	0
Group 2—Children with dysgraphia-impaired spelling								
Child 13	1	0	0	0	0	0	0	0
Child 14	4	7	2	0	0	10	0	3
Child 15	2	1	3	0	4	0	3	7
Child 16	0	0	4	0	4	3	0	3
Child 17	2	2	5	1	3	0	0	0
Child 18	4	0	5	0	4	1	0	0
Child 19	0	0	0	0	0	0	0	0
Child 20	0	4	3	4	0	0	0	0

Notes: In grades 2 and 4 based on oral idea generation before essay writing by pen or by keyboard. In grades 3 and 5 based on oral idea generation, planning organization, and planning revision before writing persuasive essay by pen. LP = Long pauses (cessations in translation); FP = Filled pauses (stalling for time with an oral production).

self-regulated translation (oral and written), probability of subsequent reengagement of self-regulated translation, and nature of translation outcomes before or after cessations.

Self-Regulated Revision During Self-Regulated Translation

See Table 5.3 for the frequency of different kinds of self-generated revisions: in handwriting (superimposing one letter form over another letter or crossing out letters), word spelling, and word choice and text organization. In general, children made more transcription (handwriting and spelling) than text generation (word choice and text organization) revisions, but there were individual differences, with

TABLE 5.3 Self-Revising of Transcription (Letter and Spelling) Errors and Translation (Word Choice and Text Construction) Errors of Children Without and With Dysgraphia-Impaired Spelling

	Superimposed Letter on Another Letter	**Crossed Out Ill-Formed or Unrecognizable Letter**	**Revised Spelling**	**Revised Word Choice (WC) or Text (TX)**				
Grade	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**	**1**	**2**	**3**	**4**	**5**
				WC TX	**WC TX**	**WC TX**	**WC TX**	**WC TX**
Group 1—Children without dysgraphia-impaired spelling								
Child 1	0, 0, 2, 0, 0	0, 2, 4, 0, 0	0, 0, 6, 1, 2	0, 0	1, 0	0, 0	0, 0	2, 0
Child 2	0, 0, 0, 0, 2	0, 0, 0, 2, 0	0, 0, 0, 2, 0	0, 0	0, 0	0, 0	0, 0	0, 0
Child 3	0, 0, 13, 0, 0	0, 0, 0, 0, 0	0, 0, 3, 0, 0	0, 0	0, 0	5, 1	0, 0	0, 0
Child 4	0, 0, 0, 0, 0	1, 0, 0, 0, 0	0, 0, 3, 5, 0	0, 0	0, 0	4, 0	3, 1	0, 0
Child 5	3, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 1, 4	0, 0	0, 0	0, 0	0, 0	3, 1
Child 6	3, 0, 1, 0, 3	1, 1, 0, 0, 2	0, 1, 0, 0, 0	0, 0	0, 0	0, 0	0, 0	1, 0
Child 7	0, 2, 2, 0, 9	1, 0, 1, 0, 3	0, 0, 1, 0, 1	0, 0	0, 0	0, 0	6, 0	3, 0
Child 8	0, 0, 0, 0, 1	0, 0, 0, 2, 1	1, 0, 1, 0, 0	0, 0	0, 0	3, 1	0, 0	1, 0
Child 9	0, 1, 0, 0, 0	0, 0, 3, 0, 0	0, 0, 3, 0, 1	0, 0	0, 0	1, 3	1, 0	1, 0
Child 10	0, 0, 2, 0, 1	0, 0, 7, 3, 7	0, 0, 1, 0, 2	0, 0	0, 0	2, 2	0, 0	1, 0
Child 11	0, 0, 0, 1, 9	0, 0, 5, 0, 2	0, 0, 3, 1, 6	0, 0	0, 0	4, 0	0, 0	2, 0
Child 12	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 1, 0, 0, 0	0, 0	0, 0	0, 1	0, 0	0, 0
Group 2—Children with dysgraphia-impaired spelling								
Child 13	0, 1, 0, 0, 4	0, 0, 0, 1, 0	0, 0, 0, 1, 0	0, 0	0, 0	0, 0	1, 0	1, 0
Child 14	0, 0, 0, 0, 2	0, 0, 0, 1, 3	0, 0, 0, 0, 8	0,0	2, 0,	0, 0	0, 0	0, 0
Child 15	0, 3, 4, 0, 0	1, 0, 6, 0, 0	0, 0, 0, 0, 0	0, 0	0, 0	0, 0	0, 0	0, 3
Child 16	0, 0, 5, 0, 6	0, 0, 0, 0, 5	0, 1, 2, 1, 1	0, 0	0, 0	1, 0	1, 0	4, 0
Child 17	0, 0, 1, 0, 6	0, 0, 1, 0, 6	0, 0, 0, 1, 1	0,0	0, 0	0, 0,	0, 0	2, 0
Child 18	1, 0, 0, 0, 1	0, 3, 11, 12, 27	0, 0, 1, 0, 0	0, 0	0, 0,	0, 0	0, 0	0, 1
Child 19	1, 5, 4, 5, 4	0, 4, 25, 3, 7	0, 0, 1, 0, 1	0, 0	0, 0	2, 0	0, 0	4, 2
Child 20	0, 0, 0, 1, 3	0, 3, 1, 1, 9	0, 0, 0, 0, 1	0, 0	0, 0	0, 0	0, 0	6, 1

Note: The frequency of revision attempts are based on all writing tasks administered at each grade level except the metacognitive tasks in grade 5. Child 4 in grade 3 revised one punctuation error and one capitalization error. Child 11 in grade 4 made two revisions of punctuation.

some child writers showing evidence by grade 2 of revisions in word choice and by grade 3 of revisions of text. However, revisions of word choice were more common than of text in grades 2–5. Overall, developing writers in grades 1–5 were more likely to self-generate transcription revisions of surface features, but some individual children were beginning to pay attention to whether changes in word choice or text organization might improve quality of expression of ideas. More research is needed to determine if this pattern generalizes to other samples and populations of child writers.

DISCUSSION

Dynamic yet Patterned Journey of Translation Development

In Chapter 2, Hayes presents a theoretical model that takes into account both the individual writer and task environment. This chapter provides detailed portraits of 20 individual child writers—the writer behind the writing, based on multiple kinds of measures administered in a research task environment outside the classroom. On the one hand, both quantitative scores and qualitative analyses of oral and written protocols for self-regulated translation of these child writers demonstrated the variable pathways individuals followed in developing written translation and translation-related writing skills within and across grades 1–5. Development of translation did not appear to be a simple linear, incremental process, but rather to be dynamically changing and variable within and across individual child writers. On the other hand, despite the variations and fluctuations, patterns emerged, some of which are relevant to the translation process itself and others to the relationship of translation with other cognitive processes such as planning or revision, another theme of Chapter 2. These patterns are discussed next to stimulate future research about them.

Translation Process Translation outcomes varied as to whether translation appeared to occur only at the word level (rare), word and syntax level (more common), or word, syntax, and text levels (mode for the upper grades studied). However, the cross-cognitive and linguistic mapping during translation involved not only levels of language but also topic–comment strategies at the local and global levels (Figure 5.1), as previously investigated and applied in the current study. The demands on working memory are greater during global strategies for keeping in mind text produced so far, text in process, and planned text than for during the local strategy of producing the next sentence (see Figure 5.1). Indeed, converging evidence from psychometric measures and observed cessations in oral self-regulated translation pointed to working memory vulnerabilities disrupting translation. In addition, translation outcomes were expressed in not only language but also art (drawings) as a supplement to, not substitution for, translation into written language (see Chapter 10).

Other Cognitive Processes: Planning and Revising Many children generated more ideas orally than in writing, suggesting that both translation and revision occurred during written composing, but some generated fewer ideas orally than during written composing, suggesting that both planning and translation occurred during written composing. Expression of a plan during an oral think-aloud, which was then implemented in written translation outcome, was more likely in grades 4 and 5 than earlier grades. A few children orally generated a text rather than idea string prior to writing and then wrote that complete text, which had previously been generated before being transcribed; such a pattern may reflect strategic preplanning. Although most self-generated revisions involved transcription, others involved word choice (beginning in grade 2) and text (beginning in grade 3), indicating that some children are beginning to think about processes beyond transcription in translation to produce written language.

Insights Into the Cognitive ← → Language Translation Processes

Sources of Constraints Translation is much more complex than transcription at the word level and text generation at word, sentence, and text levels, which support (or interfere with) translation, but do not fully explain translation. When children could generate far more ideas orally than they could express in writing, the cognitive ← → language translation process may have been compromised by transcription difficulties. However, written transcription requirements (handwriting and spelling) alone may not account for translation outcomes because children with dysgraphia tended to require more prompts to continue oral translation than did children without dysgraphia. Oral generation does not require written transcription (handwriting or spelling), but does have working memory requirements. Working memory vulnerabilities may compromise self-regulated translation bouts, whether oral or written. Moreover, when others prompt a child to continue following cessation of self-regulated translation, only if the child can reengage a working memory cycle to support self-regulated translation is translation likely to continue. Translation is supported not only by temporal coordination of component processes in working memory (its efficiency) but also by sustaining working memory over time, which, if disrupted in real time, requires reengagement of a subsequent working memory cycle. Individual differences in duration of self-regulated translation bouts, which require sustained working memory, were stable across four writing genre in third and fifth graders (see Table 5.1). Sometimes momentary, online problems in translation within a self-regulated translation bout occurred, for example, marked by self-generated filler words (Table 5.2), which hold one's place while finding a word within a sustained working memory cycle but are unlikely the result of a complete disruption of a working memory cycle.

Flexibility and Translation in Serially and Hierarchically Ordered Real Time On the one hand, the local and global strategies observed in prior studies (Berninger et al., 1996, 2009; Figure 5.1) were also observed in the current study and capture some, but undoubtedly not all, of the translation processes. Translation is not a fixed routine drawing on a closed set of possibilities—more likely, it is a flexible process that draws on multiple representations and operations (see Chapter 3), depends on the nature and requirements of the task at hand, and changes from moment to moment and across development. On the one hand, written letters have to be sequenced in written words, written words have to be sequenced in the composed sentences, and sentences have to be sequenced in the text being constructed, so strategies for sequencing or organizing across linear time and space (unfolding text on paper or screen) contribute to the translation process. On the other hand, translation not only depends on local decisions about what to write next in the evolving text, which at one level is generated in linear real time, but also occurs at a global level, which employs nonlinear, hierarchical organization to structure the various local-level translation outcomes. (Also see Chapter 14 regarding linear versus nonlinear processes in writing.) Thus, the widely adopted practice in the United States of assessing writing quality on the basis of correctly sequenced words probably does not capture all the relevant dimensions of translation that contribute to the quality of writing. All of a text may be correctly sequenced, but the text can still be improved by other transformations that contribute to the quality of the translation product at a more global level or in other ways. Individual differences in emergence of both the local and global strategies were observed.

Multiple Mappings The cognitive ← → language translation process appeared to vary in units of translation outcomes: (a) word level, (b) syntax level, (c) text level, (d) combinations of two or more of the first three possibilities, (e) nonsyntactic language formats, (f) nonlanguage formats (drawings), or (g) combination of any of the first five with the sixth. Yet much remains to be learned about the nature of cognitive representations and operations accessed during translation and the mechanisms underlying cognitive ← → linguistic translation in individual, developing child writers (see Chapter 3).

Noncognitive, Attitude, and Motivation Issues Of greatest surprise was the number of children who had grade-appropriate or better writing skills and reported nonpositive attitudes toward writing or tendency to avoid rather than to approach it, and the number of children who reported positive attitudes or approach to writing despite struggles with writing acquisition. Also surprising was the dynamic change in these noncognitive variables, which did not remain consistently positive or negative within each individual child writer across writing development. Often, motivation for writing appeared more positive in grade 5, which is the second year of the fourth-to-fifth grade transition in writing development when curriculum requirements become more complex and increase (Berninger et al., 1995), than had been the case for attitude in earlier grades. Future research might investigate the interrelationships of cognitive and noncognitive variables in grade 5 and evaluate whether factor scores (e.g., for the revised Nolen motivation survey for both reading and writing, Hamilton & Nolen, submitted for publication) yield more reliable conclusions about motivation for writing than those based on single item as in this study.

Generating Research Hypotheses for Future Research

Planned Study for Another Larger Sample From the Longitudinal Study The current study was conducted to generate coding schemes and hypotheses for a planned study of consistently superior spellers (n = 20), average spellers (n = 20), and poor spellers (n = 20) in grades 1–5 (Garcia, Abbott, & Berninger, 2010) from the same longitudinal study, thus controlling for transcription ability and providing greater power for inferential statistical analyses. Linguistic coding schemes, for which inter-rater reliability would be established, can be used to identify cognitive ← → linguistic translation mechanisms (a) at the word, syntax, and/or text levels of language; (b) at the local or global levels for translation strategies; (c) for the nature of the cognitions (Table 3.1), cognitive operations (Table 3.2), cognitive access mechanisms (Table 3.3), transformations (Table 3.4), and executive support (Table 3.5); and (d) for the nature of the translation products (syntax-based language, nonsyntax-based language, or nonlanguage, see Chapter 10).

Other analyses will compare oral and written self-generation bouts, which differ in transcription mode (speech or writing), to determine whether (a) mode influences length or number or nature of ideas expressed, (b) ideas expressed orally prior to writing are or are not expressed in writing, (c) ideas expressed in writing are or are not in the earlier oral think-aloud for idea generation or plan for organizing or subsequent plan for revising, and (d) text format generated orally is or is not identical to the text generated subsequently in writing. Role of noncognitive variables (attitude and motivation) in translation and their relationship to cognitive writing variables will also be explored using factor scores for multiple self-rated items on attitude and motivation surveys. Once a formal scheme for coding metacognitions is also available, an important research question will be whether their relationships to written translation are unidirectional (if so, in which direction) or bidirectional. For example, are noncognitive attitude and motivation factors (or metacognitions) predictors of translation outcomes or the developmental outcome of written translation outcomes or both predictors and outcomes?

Future Online Experimental Studies The self-regulated translation bout in child writers probably includes at least one, but often more than one, language burst, which is written language production followed by a pause (e.g., 2 s or more, see Chapter 2) and then self-regulated resumption of translation (Chenoweth & Hayes, 2001, 2003; Hayes, 2009; Kaufer, Hayes, & Flower, 1986; Chapter 2) without prompting to continue. Researchers can use Eye and Pen© technology on laptops (Alamargot, Chesnet, Dansac, & Ros, 2006) to record and analyze written translation outcomes such as language bursts marked by pauses in written language production. They can use the resulting data to investigate the following at different developmental levels and for different populations: (a) language bursts followed by resumed self-generated translation after a relatively brief pause and (b) complete cessations of translation requiring other-generated prompts to continue, which are or are not followed by resumption of translation. Results can be analyzed to answer a variety of questions including the nature of the translation product during a language burst or subsequent written production when self-regulated translation resumes as a result of the other-generated prompt in response to cessation of self-regulated translation, and their interrelationships. Important dependent (outcome) measures would include frequency and duration of pauses marking language bursts during self-regulated translation in progress, and following complete cessations in self-regulation translation. These outcomes can be investigated as a function of experimenter-manipulated variables and/or measures of individual differences for translation or translation-related skills.

Other Future Studies Given that translation appeared to emerge earlier in all children than planning to organize and planning to revise, future studies might examine individual differences in development of these nontranslation cognitive processes and their relationships to translation (Hayes, Chapter 2). Some children showed signs that they were preplanning and using a plan in their writing, whereas others did not—they seemed to be in flow only—during the developmental window studied. For the most part the oral idea generation protocols yielded strings of ideas, but sometimes orally generated text, which had the discourse features of written text in academic register—as if the written text was being generated orally in advance. Future research might also investigate, at targeted times in development, individual differences in duration of self-regulated translation bouts in oral and written modes across genre for written translation when there is no time limit. Although many children in the current study ceased writing prior to time limits, not all did, and some could have continued beyond the time limit.

Specific Writing Disabilities Versus Normal Variation in Writing Skills

If the beginning of the writing journey does not fully determine the outcome (e.g., compare grade 1 and grade 5 scores in individual profiles), then when and how can children be identified who are at risk and need specialized intervention for prevention of writing problems especially in translation? A thorny problem is whether differences between children reflect only normal variation or disability (educationally handicapping conditions) (see Berninger, 2009). In the current study, children exhibited normal variation in their profiles even though eight children met behavioral criteria for dysgraphia (impaired spelling) in grade 5. In other research in which these 20 children participated, those with and without dysgraphia also showed significant group mean differences in handwriting and written expression of ideas and brain differences in (a) working memory supporting idea generation, (b) serial organization of finger movements over time, (c) receptive orthographic coding, (d) word-specific orthographic spelling, and (d) automatic letter writing (for review, see Berninger & Richards, 2010, 2011). Table 5.4 summarizes the loops among sensory, language, and motor codes that are involved in written language learning. Weaknesses or impairments in any of these systems may interfere with learning transcription or translation skills for writing.

In the current study, children with dysgraphia had mean scores lower than those without dysgraphia on these measures at specific grade levels: *receptive orthographic coding* (grade 1), *phonological* coding (grades 1–4), *orthographic working memory—word* (grades 2–4), *orthographic loop* (grade 4), *morphological coding* (grades 3–5), *word-specific orthographic spelling* (grades 1–5), *spell sounds (pseudowords)* (grade 4), *phonological working memory* (grade 4), and *finger succession* (grades 2–4). Late emerging pseudoword spelling and phonological working-memory differences, not apparent until grade 4, raise an intriguing question to address in future research—whether these problems exert causal influences in learning to spell or may be the effect later in writing development of not learning to spell. Also noteworthy is the consistent finding of impaired word-specific orthographic spelling in grades 1–5, which appears to be an evidence-based marker of dysgraphia in the primary and intermediate grades of elementary school.

At the same time, not all the specific writing disabilities are related to transcription (handwriting and/or spelling) and related language processes such as orthographic coding. Although some children with and without dysgraphia did not meet the evidence-based criteria for ADHD in DSM-4R at the time this study was conducted, on the parent rating scale used in the current study (research-supported

TABLE 5.4 Working Memory Loops That Support Translation and Language Learning

I. Motor → sensory feedback loops
   A. Oral motor → auditory sensation feedback loops
   B. Oral motor → touch sensation feedback from articulatory gestures (which transmit somatosensory feedback sensed by mouth and tongue movements and passage of air through the vocal tract)
   C. Graphomotor → visual sensation feedback (from viewing what has been written; Alamargot et al., 2006)
   D. Graphomotor → vestibular sensation feedback (from finger, hand, and eye movements and position in space during act of writing)
   E. Graphomotor → touch sensation feedback (of any kind but especially localization and kinesthetic)

II. Sensory → motor loops (bypassing internal language codes but not internal cognitive codes)
   A. Auditory → mouth (e.g., imitating singing of tonal scales or humming melody but not singing songs with words)
   B. Auditory → hand (e.g., playing musical instrument by imitating what is heard but without written notation for sequencing and timing of tones)
   C. Visual → hand (e.g., visual–motor copying of geometric forms or drawing)
   D. Visual → mouth (e.g., humming without words from written notation for tones and their sequencing and timing)

III. Sensory → internal code (sensation received from external world connects with internal language code to create working memory loop that supports translation)
   A. Auditory → receptive phonological codes (syllables, phonemes, rimes)—phonological loop
   B. Auditory → internal receptive phonetic codes based on feedback from articulatory gestures—phonological loop
   C. Visual → receptive orthographic codes (written words, single letters, letter groups)—orthographic loop
   D. Touch sensation → internal spelling codes based on feedback from graphomotor production of written spellings—orthographic loop

IV. Internal language code → motor output
   A. Phonetic or phonological code → oral motor output through mouth (self-generating spoken words through speech—phonological loop)
   B. Receptive orthographic coding → graphomotor output through hand (self-generating written letters or words through handwriting—orthographic loop)

V. Interconnecting sensory → internal language code → motor output loops
   A. Auditory sensory → phonetic and/or phonological code → oral motor output through mouth (in response to heard words generating spoken words through speech, phonological loop)
   B. Auditory sensory to phonetic or phonological code → receptive orthographic codes → graphomotor output through hand (in response to dictated spelling words or internally generated written words during composing—phonological and orthographic loop functions)
   C. Visual sensory → receptive orthographic codes → graphomotor output through hand (in response to viewed words during composing, accessing internal orthographic codes and self-generating written letters or words through handwriting, an orthographic loop function)

VI. Constructing interconnected loops in working memory
   A. Internal codes can be receptive phonetic or phonological with or without coding of sensory feedback from motoric production, receptive orthographic and morphological with or without coding of sensory feedback from motoric production, or morphological coding of heard speech or viewed spelling
   B. Motoric codes can be oral motor via mouth or graphomotor via hand

TABLE 5.4 (continued) Working Memory Loops That Support Translation and Language Learning

C. Integrations of A and B; for example, naming of visual stimuli requires visual sensation, cross-code integration, and oral output through mouth (Baddeley et al., 1998)

D. Internal cross-code integration of spoken words and written words and their morphological word parts in storage and processing units → graphomotor output (phonological ← → orthographic ← → morphological mapping expressed via hand and assessed with spelling tasks or expressed via mouth and assessed with oral reading tasks (Garcia et al., 2010))

VII. Sensation → internal code or integration of internal codes → motor output → sensory

A. Feedback and recycling of loop during ongoing oral language or written

B. Language activities

The content in Table 5.4 is based on research findings discussed in Berninger and Richards (2002, 2009, 2010, 2011), Richards, Berninger, and Fayol (2011) and Chapters 3 and 4 this volume.

factor scores yoked to DSM IVR; Thomson et al., 2005), some parents reported problems with self-regulation of attention and behavior of concern. Executive function dysfunctions may lie along a continuum such that ADHD is a diagnostic clinical category, which indicates that attention and executive functions in general fall outside the normal range. However, some children may show selective difficulty on one or more than one (but not all) indicators of impaired self-regulation of attention and/or executive function, which otherwise are in the normal range; these selective relative weaknesses can interfere with development of translation and translation-related writing skills (Thomson et al.). Thus, a comprehensive model of specific writing disabilities affecting translation or translation-related processes should take into account (a) transcription (handwriting and/or spelling) (Chapters 2 through 14), (b) lower-level executive functions for supervisory attention (Tables 3.5 and 4.4 in Chapters 3 and 4, respectively.), and (c) higher-order executive functions (e.g., planning and revising, see Chapters 2, 3, 6, 8, 10 through 13) and Table 3.5 in Chapter 3 and the last 2 columns in Table 5.1 and all of Tables 5.2 and 5.3 in this chapter).

CONCLUSIONS AND FUTURE DIRECTIONS

In-depth study of 20 individuals across 5 years of writing development afforded insights not always apparent in group analyses using inferential statistics. Translation draws on (a) automatic and flexible changing processes, even playful ones (Boscolo, in press; Gelati, 2011; Chapter 3) and (b) multiple mechanisms from simple one-to-one mapping (e.g., name of letter form) to complex, cognitive ← → linguistic transformations. Nevertheless, future studies comparing self-regulated translation bouts in child writers in many languages and cultures may identify cognitive ← → language universals in translation, despite variations across individuals resulting from the intrinsic generativity of the biologically based language-learning mechanism that supports interrelationships of listening, speaking, reading, and writing, and cognition as individual human brains interact with their social and physical environments. These universals may emerge in predictable ways across development, even though they change dynamically from moment to moment within and across individuals at one stage of development and across development, because of species-specific mechanisms for cognitive ← → linguistic translation (see Chapter 3).

ACKNOWLEDGMENTS

Grant HD25858 from the National Institute of Child Health and Human Development (NICHD) supported the longitudinal study in which the individual child writers in this study had participated.

The first author thanks the mother in the larger sample in the longitudinal study who wrote her a note after receiving the annual test report with psychometric test scores. She expressed that even though her child appeared to be average for grade in writing, she thought test scores failed to capture her child's emerging writing ability, which she treasured—every word of it—and asked if the researchers were also reading what the children were writing. In this era of emphasis on tests (criterion referenced for state standards or norm-referenced for tracking individual progress and obtaining special services), the written products of translation also provide a useful and inspiring window from which to view the emerging and developing translation process underlying writing in individual students.

APPENDIX A: TASKS FOR WRITTEN AND ORAL SELF-GENERATION (PROMPT = TOPIC FOR WRITTEN OR ORAL TRANSLATION OR PROMPT BEFORE TIME LIMIT = WHAT ELSE CAN YOU THINK OF?)

Grade 1

Written narrative by pen (prompt also given in grades 3 and 5): "One day at school a funny or surprising thing happened" (10 min limit but prompt if child stops before time limit).

Child's oral reading of text just written
Tester-transcribed oral text for metacognitions about writing
Explaining writing to a kindergartner

Grade 2 (Also Given in Grade 4)

Oral protocol for idea generation: The child was given these instructions: "Here is a computer. [Show laptop.] Tell me all the ideas you can about computers. Tell me what you know about computers. Also use your imagination and tell me your own original ideas about computers. Tell me as many ideas as you can" (5 min limit).

Written essay by pen: The child was given these instructions: "Explain what a computer is and what it does to someone who has never seen or used one" (10 min limit but prompt if child stops before time limit).

Oral protocol for idea generation: The child was given these instructions: "Here is a robot. [Show picture of robots.] Tell me all the ideas you can about robots. Tell me what you know about robots. Also use your imagination and tell me your own original ideas about robots. Tell me as many ideas as you can" (5 min limit but prompt if child stops before time limit).

Written essay by keyboard (prompt): "Explain what a robot is and what it does to someone who has never seen or used one" (10 min limit but prompt if child stops before time limit).

Grade 3

Written narrative by pen (prompt also given in grades 1 and 5): "One day at school a funny or surprising thing happened" (10 min limit but prompt if child stops before time limit).

Written narrative by keyboard (prompt also given in grade 5): "One weekend at home a funny or surprising thing happened" (10 min limit but prompt if child stops before time limit).

Four genre (time in parentheses is translation bout or thinking aloud in seconds) also given in grade 5; all by pen

Written narrative: The child was given these instructions: "Please read silently while I read aloud the text about Mt. St. Helens, which has the title, 'The Glacier Covered Volcano in the Cascade Mountain Range that Shook and Exploded.' Now look at these post cards. Please rearrange them to share the correct order of events. Now please write a narrative that tells the story of 'The Day Mt. St. Helens Blew Its Top!' " Time limit 5 min, prompt if writing stops before time limit.

Informative essay: The child was given these instructions: "Please read silently while I read aloud this text about Mt. Rainier, which has the title, 'The Many Seasons at Mt. Rainier National Park.' Now look at these post cards that depict the different seasons at the mountain and how the mountain seems to change with the seasons. Now please write an informative essay that describes Mt. Rainier, which has the title 'The Changing/Changeless Mt. Rainier,' so that someone who has never visited the mountain can visualize what it looks like." Time limit 5 min, prompt if writing stops before time limit.

Compare and contrast essay: The child was given these instructions: "Please read silently while I read aloud this text that contains many facts about both Mt. St. Helens and Mt. Rainier. Now compare and contrast these mountains. Write a descriptive essay that tells how the mountains are alike and that tells how they are different." Time limit 5 min, prompt if writing stops before time limit.

Oral think-aloud (oral brainstorming ideas, then planning/organizing, then written persuasive essay followed by oral revising)

Oral brainstorming ideas: The child was given these instructions: "Now read along silently while I read another text about the controversies about these mountains. Controversies mean that different people have different opinions or points of view. Now I want you to write a persuasive essay in which you explain the different points of view about each controversy, give your opinion or point of view about each controversy, and defend your argument and convince the reader against the opposing opinion or point of view. First, I want you to brainstorm your ideas. Think-aloud, let the ideas flow about what you might include in your persuasive essay. You don't have to write yet. Just let your idea generator pump out ideas. I will tape record them so I remember them." Time limit 5 min, and if stops before time limit, then prompt.

Oral planning and organizing: The child was given these instructions: "Now I want you to plan how you will go about writing your essay. What are your goals? How will you organize the essay? How will you start? How will you end?" Time limit 5 min, and if oral generation stops before time limit, then prompt.

Written persuasive essay: The child was given these instructions: "Now you can write your persuasive essay titled, 'Defending My Opinions on Some Controversies about Mt. St. Helens and Mt. Rainier.'" Time limit 5 min, and if writing stops before time limit, then prompt.

Oral revising: The child was given these instructions: "Finally, I am going to read what you have written aloud. Then I am going to give you an opportunity to tell me how you might change your essay to make it better." Time limit 5 min, and if oral generation stops before time limit, then prompt.

Grade 4 (Also Given in Grade 2)

Oral protocol for idea generation: "Here is a computer. [Show laptop.] Tell me all the ideas you can about computers. Tell me what you know about computers. Also use your imagination and tell me your own original ideas about computers. Tell me as many ideas as you can." Five-minute limit but prompt if stops before time limit.

Written essay by pen (prompt): "Explain what a computer is and what it does to someone who has never seen or used one." Ten-minute limit but prompt if stops before time limit.

Oral protocol for idea generation: "Here is a robot. [Show picture of robots.] Tell me all the ideas you can about robots. Tell me what you know about robots. Also use your imagination and tell me your own original ideas about robots. Tell me as many ideas as you can." Five-minute limit but prompt if stops before time limit.

Written essay by keyboard (prompt): "Explain what a robot is and what it does to someone who has never seen or used one." Ten-minute limit but prompt if stops before time limit.

Grade 5

Written narrative by pen (prompt also given in grades 1 and 3): "One day at school a funny or surprising thing happened." Ten-minute limit with prompts if stops before time limit.

Written narrative by keyboard (prompt also given in grade 3): "One weekend at home a funny or surprising thing happened." Ten-minute limit with prompts if stops before time limit.

Four genre (time in parentheses is translation bout or thinking aloud in seconds) (also given in grade 3; all by pen)

Written narrative: The child was given these instructions: "Please read silently while I read aloud the text about Mt. St. Helens, which has the title, 'The Glacier

Covered Volcano in the Cascade Mountain Range that Shook and Exploded.' Now look at these post cards. Please rearrange them to share the correct order of events. Now please write a narrative that tells the story of 'The Day Mt. St. Helens Blew Its Top!' " Time limit 5 min, but prompt if stops before time limit.

Informative essay: The child was given these instructions: "Please read silently while I read aloud this text about Mt. Rainier, which has the title, 'The Many Seasons at Mt. Rainier National Park.' Now look at these post cards that depict the different seasons at the mountain and how the mountain seems to change with the seasons. Now please write an informative essay that describes Mt. Rainier, which has the title 'The Changing/Changeless Mt. Rainier,' so that someone who has never visited the mountain can visualize what it looks like." Time limit 5 min, but prompt if writing stops before time limit.

Compare and contrast essay: The child was given these instructions: "Please read silently while I read aloud this text that contains many facts about both Mt. St. Helens and Mt. Rainier. Now compare and contrast these mountains. Write a descriptive essay that tells how the mountains are alike and that tells how they are different." Time limit 5 min, but prompt if writing stops before time limit.

Oral think-aloud (oral brainstorming ideas and then planning and organizing and then writing persuasive essay followed by oral revising)

Oral brainstorming ideas: The child was given these instructions: "Now read along silently while I read another text about the controversies about these mountains. Controversies mean that different people have different opinions or points of view. Now I want you to write a persuasive essay in which you explain the different points of view about each controversy, give your opinion or point of view about each controversy, and defend your argument and convince the reader against the opposing opinion or point of view. First, I want you to brainstorm your ideas. Think-aloud, let the ideas flow about what you might include in your persuasive essay. You don't have to write yet. Just let your idea generator pump out ideas. I will tape record them so I remember them." Time limit 5 min, but prompt if stops before time limit.

Oral planning and organizing: The child was given these instructions: "Now I want you to plan how you will go about writing your essay. What are your goals? How will you organize the essay? How will you start? How will you end?" Time limit 5 min, but prompt if stops before time limit.

Written persuasive essay: The child was given these instructions: "Now you can write your persuasive essay titled, 'Defending My Opinions on Some Controversies about Mt. St. Helens and Mt. Ranier.' " Writing time limit 5 min, but prompt if stops before time limit.

Oral revising: The child was given these instructions: "Finally, I am going to read what you have written aloud. Then I am going to give you an opportunity to tell me how you might change your essay to make it better." Time limit 5 min, and if oral generation stops, prompt limit. *Note*: As explained in Introduction (psychometric tests) 2-Scores for Inhibition, RAS, and Finger Succession are based on time scores and negative ones are better (faster).

Writing prompts for metacognitions about writing: In writing *explain* to a kindergartner what writing is. In writing explain to a third grader what writing is. In writing explain to a fifth grader what writing is.

APPENDIX B: PERSONAL WRITING TREKS FOR 20 CHILDREN AT END OF FIFTH GRADE

Personal Writing Trek 1 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy played with crayons at 36 months, wrote the alphabet and used invented spellings at 48 months, and spontaneously composed short texts at 60 months. No developmental problems were reported except feeding problems during infancy. He is an able reader (all reading skills at or above the population mean at end of fifth grade) with well-developed oral language skills (above or very near the mean). Phonological spelling (pseudowords) and word-specific orthographic spelling fell in the average range. Researcher ratings of selective, maintaining, and switching attention ranged from fair to good (grade 1) to excellent (grade 2) to fair (grade 3) to good to very good in grade 5, and were not available in grade 4.

Profile 1 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		111, 77%tile			108, 70%tile
Writing skills					
Letter writing	−1.09	1.29	0.59	−0.81 (see note at bottom of table)	0.11
Dictated written spelling	104, 61%tile	106, 66%tile	96, 39%tile	96, 39%tile	101, 53%tile
Written expression	77, 6%tile	123, 94%tile	106, 66%tile	102, 55%tile	107, 68%tile
Word form coding					
Phonological	1.10	1.16	0.91	0.16	
Morphological			0.21	−0.31	n.a.
Receptive orthographic	1.22	−0.48	0.21	−0.97	
Orthographic loop					
Finger succession	−0.09	−0.38	−1.02	−0.20	
Expressive orthographic				0.22	
Executive functions					
Inhibition		n.a.	12	13	14
RAS	0.92		0.73		0.43
Working memory					
Phonological		106		113	
Orthographic—letter		0.38	−0.07	1.03	
Orthographic—word		0.74	−1.15	0.01	

Note: The score is probably an underestimate. The task was first given after child had arrived 80 min late; two errors were made but correctly self-corrected in the first 15 s.

Profile Analysis This boy's transcription (letter writing and spelling) and written composing (written expression) showed variability across the grades, but by grade 5 his writing skills were all above the population mean for his age or grade and were developed to a level consistent with his verbal reasoning ability (average range). No significant working memory or related processing problems were observed in grade 4 or 5. However, results of grade 4 assessment indicate that he might benefit from explicit instruction aimed at morphological and receptive orthographic coding.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The boy's narrative composing by pen reflected word-level and syntactic-level translation in the one sentence written; some spelling was phonetic (letters related to sounds in their names). Legible, automatic letter retrieval and production on the alphabet writing task were underdeveloped, and his handwriting deteriorated when both letter writing and other skills were required to spell and compose. When asked how he felt about writing at school or at home, he circled frowning Garfields.

Grade 2 Alphabet writing was no longer a problem. The boy's two-sentence (three clause) essay by pen contained three ideas from the preceding oral idea generation protocol and one new one; the oral idea generation protocol contained ideas that did not appear in the essay, that is, not all ideas were translated into writing. Thus, his translation appeared to involve a transformation beyond idea generation alone. However, he could not create a written translation product by keyboard. Attitude toward writing was very positive even though writing seemed laborious for this child when more than handwriting was involved in the writing task. Handwriting on classroom writing samples for reading, math, and writing assignments was legible and appeared grade appropriate. When asked how he felt about writing at school or at home, he circled the smiling Garfield.

Grade 3 The tester noted that the child's handwriting skills were above average. His narrative writing by pen increased from one sentence in first grade to three sentences in third grade. He could copy a writing prompt by keyboard but not translate his ideas into writing by keyboard. On the four-genre comparison, he translated his ideas into words and one complete sentence and the beginning of another on the narrative, one complete sentence with a grammar error on the informative essay, two complete sentences including one qualification on the compare and contrast essay, and one sentence on the persuasive essay. However, on the oral protocols, he could not generate any ideas, his planning for organization was to think of a good sentence that ends with a period, and his revision plan just repeated what he had written. Development of planning and revision appeared to be lagging behind translation. When asked about how he felt about writing for fun at home, he chose a smiling Garfield, but for writing at school he chose a frowning Garfield.

Grade 4 The mother shared a sample of the boy's excellent cursive writing at school for spelling practice, but he used manuscript, also well formed, for composing activities during the session. Ideas were translated into the essay by both pen and keyboard (for the first time), but some ideas expressed in writing had not been expressed during the preceding oral idea generation protocols. Some of the ideas first expressed in oral idea generation were expressed using synonyms in the written translation product. However, new ideas appeared as well. Evidence was observed of both *global translation*, that is, a higher-order list structure holding the overall text together as it was produced over time, and of *local translation, that is, use of specific algorithms* for the next sentence (see Figure 5.1). The global translation resulted in sequenced text constructed of (a) topic sentence followed by four supporting examples; (b) a repetition of the topic sentence, followed by a fifth example; (c) a qualification; (d) a generalization with examples to support the generalization; and (e) a personal opinion followed by a summary statement with another example. Examples of the algorithms for local translation that resulted in each of the next sentences were the statements with (a) supporting examples, (b) repetition, (c) qualification, (d) generalization, (e) personal opinion, and (f) summary statement. Highly positive approach toward writing was noted on the Nolen survey.

Grade 5 In fifth grade, the boy's one-sentence narrative by pen reflected translation at the word level and the syntax level. As in third grade, for narrative composing by keyboard, he again copied the topic sentence for the essay despite instructions not to do so, but in fifth grade his translation by keyboard now resulted in three additional sentences including dialogue. Of note, by fifth grade he was not showing evidence of global strategies for text writing, just local algorithms for constructing one or a few sentences. Because of limited time due to late arrival, on the four-genre tasks by pen, he only composed a narrative consisting of three complete sentences (four clauses) and a partial sentence within the time limits. In this annual visit, Child 1 shared that he enjoys writing by computer more than by hand, but has not yet learned to type; he wants to learn to type. He displayed a sense of humor and an interest in telling stories and writing about topics on which he was knowledgeable. A fifth grade classroom personal narrative appeared grade appropriate in legibility, word choice, sentence structure, and text organization (two paragraphs with indentation), but some words were misspelled. On the Nolen questionnaire, he did not show writing avoidance. In grade 1, he explained writing as what is written on paper (words, math, one's name). Because of his late arrival, this task could not be given in grade 5.

Personal Writing Trek 2 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with a crayon and first produced the written alphabet at 36 months, first wrote words at 48 months, and first wrote text at 60 months. No developmental problems were reported. All reading and oral language skills were consistently above average to superior.

Phonological spelling (pseudowords) and word-specific orthographic spelling fell in the above average range. Researcher ratings of selective, maintaining, and switching attention ranged from consistently excellent (grades 1–3) to very good (grades 4 and 5).

Profile 2 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		146, 99.9%tile			146, 99.9%tile
Letter writing	−0.65	−0.79	0.29	−0.81	−0.83
Dictated spelling	133, 99%tile	118, 88%tile	110, 75%tile	102, 55%tile	127, 92%tile
Written expression	100, 50%tile	106, 66%tile	126, 96%tile	123, 94%tile	121, 96%tile
Word form coding					
Phonological	0.62	0.71	1.02	−0.89 Note rime 0.65	
Morphological			0.67	0.76	1.03
Orthographic—receptive	0.82	−0.25	0.21	−0.16	
Orthographic loop					
Finger succession	0.36	−0.38	−0.26	−0.77	
Expressive orthographic				0.44	
Executive functions					
Inhibition		12	12	13	14
RAS	−0.18		0.40		0.13
Working memory					
Phonological		97		98	
Orthographic—letters		0.38	−0.07	−0.33	
Orthographic—words		0.30	0.44	0.01	

Profile Analysis This girl's transcription and written composing showed variation within and across grade levels. By grade 5, her spelling and composing were relative strengths (superior range) approaching her verbal reasoning ability (very superior range). The only working memory weakness observed was in phonological working memory (grades 2 and 4) and phonological coding (grade 4)—but note the relative strength in rimes (part of syllable without phoneme/s at the beginning), which may reflect the normal developmental trend to segment spoken words in larger phonological units as reading and spelling increasingly involve longer polysyllabic words. A diagnosis of dysgraphia was ruled out for two reasons. First, despite the alphabet writing score in grade 5 for printing in the first 15 s (see Profile 2), none of her other scores for printing (total time or total legibility) on the alphabet task or for these same scores on cursive alphabet letter writing (grades 3–5), which are not in the table, met the criteria for dysgraphia. Second, her handwriting did not interfere in a major way with her written expression of ideas either during the session nor classroom writing.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The girl's written narrative by pen consisted of seven independent clauses and one dependent clause and phrases. Evidence was observed of both a global strategy for simple narrative structure (sequence of events) and local algorithms (statements of facts, psychological descriptions, qualifications, and summary statement). For the most part, she circled a smiling Garfield.

Grade 2 The girl's essay by pen contained ideas not in her oral idea generation, for example, using the computer to receive email and study; and her oral idea generation contained ideas not included in her essay—for example, the screens and buttons on computers. All her ideas in the essay by keyboard had been expressed in her preceding oral idea generation, which contained many ideas not expressed in the written translation product. Thus, her transformation processes during translation appeared to draw on more than idea generation. Her second grade classroom writing portfolio included a variety of kinds of writing, all of remarkably good quality for a second grader and many of which were illustrated. For writing at school, she circled a smiling or neutral Garfield.

Grade 3 The narrative by pen was now composed of five sentences, two of which had an independent and dependent clause, with clauses separated by spaces and often capitalized and occasionally punctuated, but the narrative by keyboard was a string of clauses without capitalization and punctuation. Regardless of transcription mode (pen or keyboard), at the global level, both showed signs of transition between simple narratives to ladders, that is, event sequences, but with a setting or statements about characters; at the local level, both used statements of the next event as algorithms. On the four-genre writing tasks, the girl's narrative was more like a wheel with fanning—seven comments, three of which had elaborations; her informative essay had a topic sentence at the end (with a contradiction in the claim) and a set of statements about each of two related subtopics before it; her compare and contrast essay had a clear topic sentence about the similarities between the two mountains followed by statements about how they differ; and her persuasive essay consisted of a position statement followed by an acknowledgement of an alternative position and positions on two other topics with little evidence to support any of the positions. Her oral idea generation for the persuasive essay reflected her multiple perspectives and reluctance to take a single position; her oral plan for organization was to state the various perspectives, as she did; her oral plan for revising was to leave it as is because she liked it as is. Examples of her creative narrative writing and writing homework to go with reading assignment were shared. Her handwriting was easy to read but she made some spelling errors related to choosing vocabulary words requiring spelling ability above her current grade level. For the most part, she circled a smiling or neutral Garfield for writing.

Grade 4 The girl's oral idea generation protocols were longer and her written essay by pen was longer than in grade 2; the tester noted that while composing the child looked back and forth at the text written so far. Her global strategy for essay by pen was a list with seven descriptive statements, two embedded statements, and a final summary statement. Her global strategy for essay by keyboard began with a statement of fact with an embedded statement, which served as a topic sentence—a definition of the topic—and was followed by four factual statements, which offered elaborations and qualifications about the definition. Her letter writing time during first 15 s of the alphabet task may be related to one self-corrected reversal and not representative of her automatic letter writing at the time. The relative weakness in phoneme awareness observed for the first time in grade 4 was offset by a relative strength in rime awareness (the part of the syllable after the initial phoneme) and may reflect the normal developmental trend toward becoming aware of larger phonological units in polysyllabic words. No indication of writing avoidance was noted on the Nolen survey.

Grade 5 No errors were made on the alphabet writing task and the slow writing on that task may reflect perfectionist tendencies rather than impaired letter writing automaticity. The narrative by pen had a beginning sentence that set the scene and introduced the characters and plot, followed by one physical description and two events; it showed evidence of a global narrative strategy despite lack of time to complete the entire narrative. Likewise, the narrative by keyboard began with a statement setting the scene and introducing the main character, followed by a next event and physical description. On the four-genre tasks, the girl's narrative exhibited a ladder schema including an introductory statement with time, place, and event and summary statement that prepares the reader for the text to follow—sequence of events punctuated with physical descriptions of the effects of these events; her informative essay began with a topic sentence followed by two statements, one of which had an embedded comment, to support it with well-constructed sentences and interesting word choice; her compare and contrast essay began with a complex sentence with contrasts between the mountain followed by statements about the similarities, again exhibiting excellent word choice; and her persuasive writing began with a statement about the current state of affairs, followed by statements about her position, alternative perspectives, and then evidence to support her position and examples of how to implement her recommended policy. Although two different issues came to surface during the oral idea generation, the written persuasive essay took and defended a position on only one of them. Her oral planning of organization referred to the beginning, next steps, and then wrap-up at end. Her oral revising plan was to add more examples.

Clearly by grade 5, this child writer had developed the ability to compose at both a global and local level and across all the levels of language, from words to syntax (simple and complex with independent, dependent, and embedded clauses) to global strategies for construction of different text genre and was developing cognitive processes beyond translation. Across the grades her oral idea generation and written expression were related but not identical, indicating that this child's translation involves more than idea generation or written language production alone. No indication of writing avoidance was noted on the Nolen survey. Classroom writing samples included letters, poetry, and personal narratives, which indicated no problems in handwriting but did reflect writing talent in a child writer.

The girl's metacognitions about what writing is showed awareness of how writing changes developmentally. In grade 1, she explained to a kindergartner that writing is something to do on paper. In grade 5, she explained to a kindergartner that writing is writing words that make a story and putting that story on paper so that others can read the story; to a third grader that writing can include poems, your life, or fiction (not real) stories, and books—it is putting ideas on paper for others to read, but should be interesting and important to you as the writer; and to a fifth grader that writing is talking on paper and good writing is detailed and really means something to the author regardless of whether writing about something real or fiction.

Personal Writing Trek 3 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with crayon at 16 months, first produced the written alphabet at 24 months, and first wrote words and text at 60 months. No developmental problems were reported other than in speech. She had average to above average (grades 1 and 2) and above average to superior (grades 3–5) reading and oral language skills. Her phonological (pseudoword) and word-specific orthographic spelling fell above the mean. Researcher ratings of selective, maintaining, and switching attention ranged from good to fair (grades 1 and 4) to good to very good (grade 2) to fair (grade 3) to good (grade 5). In grade 4, she was assessed outside the school and a recommendation was made that she take Ritalin, after which moderate changes were noted in these parent ratings, but she was not taking medication when tested in grade 5.

Profile 3 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		133, 99%tile			121, 92%tile
Letter writing	−0.65	0.04	0.88	3.26	1.68
Dictated spelling	103, 58%tile	102, 55%tile	101, 53%tile	106, 66%tile	115, 84%tile
Written expression	98, 45%tile	107, 68%tile	103, 58%tile	101, 53%tile	97, 42%tile (see note)

(continued)

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Word form coding					
Phonological	0.74	0.93	0.91	0.68	
Morphological			−0.58	0.41	0.41
Receptive orthographic	−0.16	−0.70	−0.26	−0.70	
Orthographic loop					
Finger succession	−0.09	−0.65	−0.83	−1.63	
Expressive orthographic					0.67
Executive functions					
Inhibition		10	8	16	12
RAS	n.a.	−0.07	−0.71		
Working memory					
Phonological		82		131	
Orthographic—letters		−0.97	0.52	0.35	
Orthographic—words		0.30	0.44	−0.76	

Note: She was distracted by remembering that her father was going to pick her up today; thus, this score is thought to be an underestimate of current composing ability.

Profile Analysis The only processing weakness observed was in phonological working memory (grade 2) and receptive orthographic coding (grades 2 and 4) and orthographic working memory (letters, grade 2; words, grade 4), which has been shown to be influenced by attention (Thomson et al., 2005). Prior parent ratings indicated some difficulty with self-regulation of attention and behavior, but not sufficient to diagnose ADHD. The girl's problems may have been more severe in the classroom. Her lower written composing in grade 5 compared with grades 2–4 is unlikely due to dysgraphia (transcription skills were a relative strength with letter writing consistently at or above mean grades 2–4 and spelling consistently above the population mean from grades 1 to 5), but may be due to not taking the medication she usually did for her attention problems.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The girl could not write anything for the narrative by pen; however, she could orally dictate 31 words that showed evidence of narrative schema. Mostly neutral Garfields were circled. No classroom writing samples were provided.

Grade 2 Although the girl's oral generation of ideas consisted of four statements and one personal opinion, her written essay by pen contained only one idea about a computer—it is something that you write on. Likewise, many more ideas were generated orally before writing by keyboard than when writing an essay by keyboard—but what was expressed showed imagination and creativity (e.g., robots can ski and snowboard on the moon). Most frequent were smiling Garfields. Next most frequent were neutral Garfields. The parent shared a letter the child had written.

Grade 3 The girl's written narrative by pen showed well-developed narrative schema at the global level—a setting (playground), an initial event (walking on her hands), followed by a sequence of events leading to a problem (walking on her hands and standing on head in the classroom and then being sent to the principal's office), and concluded with a problem resolution (sending her home). Her written narrative by keyboard was shorter but also had a setting (home back yard), initial problem event (fell off the swing), event sequence (resumed swinging but kept getting hit by another swing, and next door neighbor child laughed at her), and concluding event (main character getting angry at the child who laughed). On the four-genre writing tasks, she used a variety of the local algorithms for writing the next sentence and all genre had a clear global strategy: narrative (setting, main character—the mountain, events—blowing its top and earthquakes, and problem resolution—mountain healing); informative essay (topic sentence followed by a list of factual statements about the topic mixed with personal examples); compare and contrast essay (introductory statement of difference, illustrated with three pictures she drew, factual statements about one mountain with more illustrations in art, followed by summary statement of similarity, a picture, and a supporting statement); and persuasive essay (statement of overall controversy, followed by statement of each position). Considering that in first grade she equated writing with drawing, it is interesting that she spontaneously drew as she wrote—she may have a future as an illustrator of translated products. Her oral idea generation before writing the persuasive essay reflected inner conflict about whether she cared enough about the controversy related to naming the mountain—name given by indigenous natives who lived there or the European who explored it. Her oral plan for organization was to order the perspectives in writing about them. Her oral plan for revising indicated she did not know what to change and that she really was not very interested in the issue. Most frequent were neutral or frowning Garfields. Classroom writing samples included four personal narratives (possibly from a writing journal), which appeared to be grade-appropriate in handwriting, spelling, and composing.

Grade 4 The girl's oral idea generation protocols were notable for being the longest in the sample within the constant time limits. The one about computers contained many comments about what a computer is not rather than focusing on what a computer is. The one about robots contained many repetitions of words, for example, for 6, 9, 12, 16, or 17s repeated the same word. This pattern suggested difficulties in translation due to problems in accessing cognitive representations to meet task demands (e.g., relevant to a specific topic). Her written essays, whether by pen or by keyboard, seemed like a free flight of ideas rather than a well-organized structure at the global level and again contained many statements about what computers cannot do (fly or tell people apart). Yet she could use local algorithms. Classroom writing sample was an extended narrative with much dialogue; it was well done, interesting, and advanced for grade level in content and organization. It was not clear how much other- supported regulation of the translation process she may have received for these; clearly, she had extreme difficulty with self-regulated translation in grade 4, which was not observed in earlier grades. Her response on the Nolen survey showed ambivalence toward writing.

Grade 5 Evidence of a global level schema was noticeably absent in the girl's narrative writing by pen and by keyboard and on the four-genre tasks, as was also the case in grade 4 but not earlier. Persuasive essay writing was halted when she refused to continue, crawled under the table, and said quietly, "I don't like writing and I don't like it when people read it out loud. I don't know why, I just don't." Note that the number of prompts and filled pauses was excessively high in both grades 4 and 5 for this girl (see Table 5.2). In grade 1, after first denying that she knew what writing is, she explained to a kindergartner that writing is like drawing, like writing letters. In grade 5, she explained writing to a kindergartner as a way to say "stuff like real quiet if you are mute … technically it is a bunch of shapes and lines"; to a third grader as a bunch of lines used to communicate if you are mute; and to a fifth grader as "stuff you can read … in case you can't remember something you write it down or if you are mute … and it is also a way to write to friends when the teacher is not looking." Her classroom writing sample was a poem. Her response on the Nolen survey showed no avoidance of writing.

However, despite average ratings in attention by the tester during the session, the girl was slow to warm up, was not taking her medication, seemed distracted by anticipation of her dad coming to take her home, and refused to complete some writing tasks (including written expression, lowering that score). Assessments in grades 4 and 5 were probably influenced by beginning to take medication (grade 4) or not taking medication before session (grade 5) or attitude toward participating in the research study, or other personal or social or family or school issues. On standardized tests she consistently performed a little above or a little below the mean on written expression of ideas but well within confidence intervals (based on measurement error) for average range and well below her superior verbal comprehension ability—but not due to dysgraphia (spelling disability). Her decline in writing performance from the first three grades to grades 4 and 5 may be related to significant impairment in the lower-order and higher-order executive functions and working memory that support writing (see Table 3.5). She might benefit from an instructional program that taught self-regulated writing strategies (Harris, Graham, Mason, & Friedlander, 2008) and nurtured her interest and motivation in writing.

Personal Writing Trek 4 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with crayon at 21 months, first produced the written alphabet at 36 months, and first wrote words and text at 60 months. The only developmental problems were strength and range of motion in left upper body gross motor system. Reading and oral language spanned the average to above average to superior ranges. However, she is a quiet, shy child who did not talk much and often was visibly upset if she did not know an answer to a question. Her phonological spelling and word-specific spelling were above average. Researcher ratings of selective, maintaining, and switching attention were consistently excellent (grades 1–5); so were parent ratings of attention and behavioral self-regulation excellent.

Profile 4 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	**Grade 2**	**Grade 3**	**Grade 4**	**Grade 5**
Verbal comprehension		92, 30%tile			106, 66%tile
Letter writing	0.65	1.24	−0.29	0.67	−0.20
Dictated spelling	111, 77%tile	120, 91%tile	119, 90%tile	121, 91%tile	115, 84%tile
Written expression	98, 45%tile	105, 63%tile	135, 99%tile	127, 96%tile	105, 63%tile
Word form coding					
Phonological	1.45	0.37	0.91	0.68	
Morphological			0.32	0.76	0.10
Receptive orthographic	1.80	0.66	0.45	−0.15	
Orthographic loop					
Finger succession	−0.39	−0.79	−1.21	−1.34	
Expressive orthographic				1.11	
Executive functions					
Inhibition		18	13	14	14
RAS	n.a.	−0.92	−1.14		
Working memory					
Phonological		134		111	
Orthographic—letters		−0.30	0.52	0.35	
Orthographic—words		1.17	−0.09	0.77	

Profile Analysis The girl's transcription skills (especially letter writing) and written composing showed variability within and across the first five grades, but no sign of dysgraphia. No indicators of working memory weaknesses were observed. Initially, her attitude about writing was negative in the first two grades. However, her attitude became more neutral in third and fourth grade and showed a positive approach to writing by grade 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On the narrative by pen the girl composed only one independent clause. She mostly chose angry Garfields.

Grade 2 Both in the girl's oral generation of ideas and in her written essay by pen, she expressed the same two ideas (e.g., you can play games on computers and computers are fun). Likewise, in her oral generation of ideas and written essay by keyboard, she expressed the same ideas about robots. She reported that she does not like to write. There were as many frowning as angry Garfields. Classroom writing samples were two extended narratives, one with illustrations; both were of excellent quality for a second grader.

Grade 3 Both the girl's narrative by pen and her narrative by keyboard exhibited a ladder schema (list of related events) at the global level and statements of sequential events (three independent clauses in three sentences by pen) or statements of sequential events with one qualification (three sentences with five independent clauses by keyboard) at the local level. On the four-genre writing tasks, her narrative showed a ladder schema (statements about three sequential events); her information essay showed a list structure (two factual statements with descriptive statements as evidence to support them; her compare and contrast essay began with a statement of similarity and was followed by a statement about a difference; and her persuasive essay stated a position and offered one argument (evidence) to support the position. Her oral idea generation referenced an information source in the read material for position adopted; her oral plan for organization designated a beginning, middle, and end for presenting the argument; and her oral plan for revising focused on what else she would write to continue to make the argument (because she had to stop when the self-regulated translation reached the time limit). Most Garfields were now neutral toward writing, but one was smiling for "I feel good about my writing at school." Seven classroom writing samples, with prompts for creative story writing, were shared, all of which were of excellent quality for a third grader.

Grade 4 In contrast to grade 2, the girl's narrative by pen contained many ideas not in her preceding oral generation of ideas and the ideas were related to practical experiences in using computer–web interfaces. Her narrative by keyboard began with a topic sentence, which was followed by statements with facts or opinions to offer supporting evidence, some of which were repeated. Her response on the Nolen survey was neutral on the writing avoidance item. Her four high-quality classroom writing samples were mostly multipage, written in cursive, and used paragraph formatting.

Grade 5 The girl's narrative by pen began with a setting, followed by incomplete fragments about sequential events; the translation process was still in process when the time limit was reached. Her narrative by keyboard introduced a setting and a main character and stated one event before the time limit. On the four-genre writing tasks, her written narrative (four sentences with an independent clause, one sentence with two independent clauses, and one run-on sentence with two independent clauses) was a ladder with narrative schema at the global level. Her informative essay was organized into two paragraphs (one with three sentences with an independent clause and one sentence with an independent and dependent clause and one with two sentences with an independent clause, one sentence with an independent and dependent clause, and one with an introductory clause still in progress at time limit); all sentences were appropriately capitalized and punctuated. Her compare and contrast essay was a written plan with four facts for one mountain and five facts for the other. Her persuasive essay was organized into three paragraphs—in the first, she took a position on one issue and gave a reason for it; in the second, she took a position on a second issue and gave a reason for it; and in the third, she took a position on a third issue and gave a reason for it. By grade 5, there were many indicators of increasing reliance on planning at the global level and not just the local level. Her response on the Nolen survey showed a tendency to approach writing. Her fifth grade classroom writing samples (a classroom newspaper and two expository texts with appropriate photographic illustrations from web source) were of high quality. In grade 1, she had no idea how to explain writing to a kindergartner. In grade 5, she explained writing as making up a story or sentence but writing it down on paper with pen or pencil instead of talking (to a kindergartner), as a story using many different words to make it more interesting (to a third grader), and as describing things with example of horse as a large animal with four legs in all different colors (to a fifth grader).

Personal Writing Trek 5 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first used a crayon at 18 months and first wrote the alphabet at 36 months; when she first spelled words and wrote text was not reported. Other than sleeping problems in infancy, no developmental problems were reported. This child's reading and oral language skills spanned the average to above average to superior ranges and were mostly above average to superior. Her phonological spelling and word-specific spelling fell in the average range. Researcher ratings of selective, maintaining, and switching attention ranged from good to very good (grade 1) to very good (grade 4) or excellent (grades 2, 3, and 5).

Profile 5 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		117, 87%tile			117, 87%tile
Letter writing	0,22	0.04	−0.29	−0.27	0.11
Dictated spelling	115, 84%tile	107, 68%tile	101, 53%tile	101, 53%tile	106, 66%tile
Written expression	98, 45%tile	103, 58%tile	120, 91%tile	129, 97%tile	114, 82%tile
Word form coding					
Phonological	0.86	1.61	1.02	0.16	
Morphological			1.01	0.94	0.72
Orthographic	0.24	−0.93	−0.26	1.46	

(continued)

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Orthographic loop					
Finger succession	=0.54	−0.38	−0.64	−0.20	
Expressive orthographic				0.22	
Executive functions					
Inhibition		8	8	10	10
RAS	n.a.	−0.85	2.63		
Working memory					
Phonological		81		91	
Orthographic—letter		−1.64	−0.07	−1.01	
Orthographic—words		0.74	0.97	0.77	

Profile Analysis The girl's transcription skills (letter writing and spelling) and written composing skills showed variability within and across the first five grades. No indicators of working memory weaknesses were observed, except for switching attention (grade 3) and receptive orthographic coding (grade 2), phonological working memory (grades 2 and 4), and orthographic working memory—letters in grades 2 and 4. Relative strengths in morphological coding were observed. Of concern, her initially positive attitude toward writing in the first two grades became more neutral in the next three grades.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The girl's narrative by pen consisted of three independent clauses with transcription errors (handwriting revised) and her spelling was typically phonetic rather than phonemic and conventional. Most often she circled a smiling Garfield and next most often a neutral Garfield, with an occasional frowning (free time writing) or angry Garfield (writing instead of playing).

Grade 2 Both oral idea generation protocols had the form of organized dictated text rather than unrelated ideas. Both the essay by pen and essay by keyboard began with a topic sentence defining the topic—computer or robot—and then statements about the computer or robot's functions and physical description. More ideas were generated orally than expressed in writing. The girl circled neutral Garfields most often with smiling Garfields a close second. Her classroom writing samples were a letter and a worksheet on adjectives.

Grade 3 On the four-genre writing tasks, global schema were evident in the narrative (wheels with fanning—comments, some with additional details, about the topic—the mountain) and lists of different kinds of statements (physical descriptions in the informative essay, summary generalizations about similarities in the compare and contrast essay, and three event statements in the persuasive essay).

The girl's oral idea generation consisted of five stated facts, only two of which then appeared in the written persuasive essay. She did not understand the oral think-aloud task for planning for organization. Her oral think-aloud plan for revising was to add more information about the Native Americans who lived by the mountain first and had already named it. She mostly chose neutral Garfields, but sometimes frowning Garfields. Her classroom writing samples were three creative narratives, one with a story prompt.

Grade 4 Translation outcomes were longer (39 independent and dependent clauses for computers; 43 independent and dependent clauses for robots) when generated through oral think-alouds than in writing (10 independent and dependent clauses for computers and eight independent and dependent clauses for robots), which has written transcription (handwriting and spelling) requirements that require more time than speaking. Whether writing by pen or keyboard, the global structure was a list of statements without a well-constructed topic sentence to organize them. At the local level, most statements were facts about physical description or functions. Response on Nolen survey was neutral for writing avoidance. The girl's classroom writing samples included two poems, a letter, and two expository texts—both were extended with paragraph structure and were first drafts, complete with corrections in response to teacher-provided signals.

Grade 5 Both the girl's narrative by pen and her narrative by keyboard showed evidence of global strategy—beginning with a setting and problem followed by resolution and outcome—and of local strategies including engaging dialogue in the narrative by pen, which supported the plot. Likewise, on the four-genre writing tasks, her narrative showed evidence of both global and local strategies and engaging dialogue that supported the plot. Her information essay was a list of statements without a topic sentence; the statements included facts, generalization, and opinion and were written in an interesting way often beginning with phrases rather than subject of the sentence. Her compare and contrast essay, organized as a list, contained a statement about similarities, a statement of differences, and a statement of personal opinion. Her persuasive essay was also organized as a list with a statement about her position, support for that position, followed by a statement about a position on another topic. Her oral think-aloud reflected more ideas than she could express in writing during the time period allocated for written translation. Her oral think-aloud with plan for organization was implemented at the beginning but not the end of the written essay. Her oral think-aloud for a revision plan was to make the text longer by telling more of the story. Response on Nolen survey was neutral for writing avoidance. She was talkative, appeared to enjoy writing, and sometimes sang along as she wrote. In grade 1, she explained writing to a kindergartner as something you do with your hand—take a pencil and write a word. In grade 5, her explanations about what writing is ranged from putting words on paper with a pencil (to a kindergartner) to writing is talking but you put the words on paper with a pen or pencil (to a third grader) to writing is expressing yourself privately on paper with pencil or pen.

Personal Writing Trek 6 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention When this boy first used a crayon was not reported. He first produced the written alphabet at 20 months, first wrote words at 36 months, and first wrote text at 60 months. No developmental problems were reported other than feeding and sleeping problems during infancy. An active child who stood most of the time during grade 1 session, his reading and oral language skills generally fell in the superior or very superior range (occasionally above average or average). Tester noted that he could use sounds to read and spell words that he had trouble producing in speech. His phonological spelling and word-specific spelling fell in the above average and superior ranges. Researcher ratings of selective, maintaining, and switching attention ranged from very good (grade 1) to good to fair (grade 2) to consistently good (grades 3 and 5) to very good to good (grade 4).

Profile 6 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		137, 99%tile			132, 98%tile
Letter writing	1.96	0.04	0.29	2.15	1.36
Dictated spelling	120, 91%tile	115, 84%tile	115, 84%tile	121, 92%tile	118, 88%tile
Written expression	123, 94%tile	111, 77%tile	133, 99%tile	130, 98%tile	117, 87%tile
Word form coding					
Phonological	1.45	1.49	1.02	0.68	
Morphological			−0.24	1.12	0.72
Orthographic	1.61	0.66	0.45	0.92	
Orthographic loop					
Finger succession	−1.13	−1.21	−0.26	−1.34	
Expressive orthographic				1.33	
Executive functions					
Inhibition		15	13	14	13
RAS	−1.09	−1.56	−1.50		
Working memory					
Phonological		154	134	115	123
Orthographic—letters		−0.30	0.52	1.03	
Orthographic—words		0.74	−0.09	0.77	

Profile Analysis The boy's transcription skills (letter writing and spelling) and written composing showed variability within and across the first five grades, but were all superior to very superior in grade 4 and above average in grade 5. No working memory weaknesses were observed. His negative attitude toward writing in the first three grades became more neutral in the fourth and fifth grades.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The boy's six-clause (one embedded) narrative by pen showed evidence of a global strategy for a series of events and included statements about both events and a physical description. He chose neutral and frowning Garfield's about equally often and only smiling Garfield for sharing writing with others.

Grade 2 The oral idea generation protocols had many more ideas than the three ideas expressed in the written translation product by pen, only two of which appeared in the oral idea generation for computers. Of the two ideas that appeared in the written translation product by keyboard, neither had appeared in the oral idea generation for robots. The essay by keyboard was not even on the correct topic (robots); it was about the earlier topic (computers). Parent reported that the boy reads voraciously but does not like writing. The classroom writing sample was a multipage imaginative story, with high-quality content and organization and spelling and handwriting. With one exception, he chose Garfield's with neutral expressions about writing.

Grade 3 The boy's narrative by pen had a ladder structure with sequenced events. His narrative by keyboard was a wheel with fanning—comments and related details about the topic. On the four-genre task, his narrative was a ladder structure with sequenced events. His information essay had an expository schema at the global level—a topic sentence about how the mountain changes with the seasons with supporting statements that described the mountain in each of the seasons. Both his compare and contrast essay (an initial list of how the two mountains are the same followed by a list of how they are different) and his persuasive essay (list of opinions each with one reason for the opinion) were list structures. His oral idea generation was not related to the ideas expressed in his persuasive essay. His oral plan for organization, a planned order for the controversies, did not correspond to the order in which the controversies were discussed in the persuasive essay. His oral plan for revisions included the spelling of one word, adding words to make it longer, and adding more details. His Garfields were mostly frowning, with an occasional neutral or angry one. Parent reported that he was fascinated with learning cursive but has not practiced it sufficiently to use it in his writing. His classroom writing sample showed a sense of humor and wisdom beyond his age level.

Grade 4 Many more ideas were expressed in the oral think-alouds for computers and robots than were expressed in the written essays by pen or by keyboard; at the global level, the essay by pen was a list without a topic sentence and the essay by keyboard was a topic sentence without supporting statements. The boy was neutral toward writing on the Nolen survey. Parent noted that the intensive approach to writing at school has caused him anxiety and may not be developmentally appropriate. His writing samples consisted of two creative narratives with appropriate paragraphing.

Grade 5 Both the boy's narrative by pen and his narrative by keyboard were lists of statements rather than a series of events. On the four-genre tasks, he wrote a narrative schema—an introductory statement describing the precipitating event, which is the topic of the essay, followed by a series of events and a concluding outcome statement. His two-paragraph informative essay contained an introduction to the mountain followed by description of winter on the mountain. His compare and contrast essay was a list of statements not grouped by similarities and differences. His persuasive essay exhibited an essay schema at the global level—a topic sentence with a position statement for one controversy and then two supporting statements, but at the local level some statements were fragmented (not syntactically complete). The oral idea generation contained many more ideas than expressed in the written essay, but he could not create an oral plan for organization or for revision. He wore a splint on his right wrist due to a recent sprain, which may have interfered with transcription. He was neutral toward writing avoidance on the Nolen survey. Classroom writing assessments included written responses to questions for a reading assignment and two word processed narratives. In grade 1, he explained writing to a kindergartner by modeling how to spell *and* or *is*. In grade 5, his explanations of writing were as follows: (a) "writing is how you write a butterfly story." (scribbled out story and gave an example, "Like this. The Butterfuly flew into The tree.") (for a kindergartner); (b) "Writing is how you write report on animal. Like: My animal is the Moel etc." (for a third grader); and (c) "Writing is what you do when you do a biography. You describe in detail. Like: Babe Ruth made so much money she got paid more then President Hoover!" (for a fifth grader).

Personal Writing Trek 7 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with crayon at 8 months, first produced the written alphabet at 36 months, first wrote words at 45 months, and first wrote text at 60 months. No developmental problems were reported. His reading skills developed from low average to average (grades 1 and 2) to average to above average to superior (grades 3–5). His oral language skills developed from below average to low average (grades 1 and 2) to average to above average to superior (grades 3–5). His phonological spelling fell in the above average range and his word-specific orthographic spelling fell in the average to above average range. Researcher ratings of selective, maintaining, and switching attention ranged from good to very good (grades 1 and 3) to excellent (grade 2) or to very good to excellent (grades 4 and 5).

Profile 7 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		114, 82%tile			108, 70%tile
Letter writing	−0.65	0.46	0.88	0.30	0.11
Dictated spelling	114, 82%tile	112, 79%tile	120, 91%tile	125, 95%tile	119, 90%tile
Written expression	87, 19%tile	101, 53%tile	104, 61%tile	120, 91%tile	106, 66%tile
Word form coding					
Phonological	1.33	1.27	1.24	0.68	
Morphological			0.67	0.58	n.a.
Receptive orthographic	1.02	0.89	0.69	1.46	
Orthographic loop					
Finger succession	n.a.	n.a.	n.a.		
Expressive orthographic				1.78	
Executive functions					
Inhibition		11	9	11	8
RAS	−0.23	0.94	−0.45		
Working memory					
Phonological		95		128	
Orthographic—letters		−0.30	−0.07	−0.33	
Orthographic—words		0.74	0.44	0.01	

Profile Analysis The boy's transcription (letter writing and spelling) and written composing skills showed variation within and across grade levels, but were with the exception of grade 1 above the population mean. No working memory weaknesses were noted except for switching attention and possibly phonological working memory in grade 2. Except for grade 3, attitude toward writing was generally positive and approach to writing became stronger from grades 4 to 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The boy's narrative by pen consisted of a string of random lowercase and capital letters and scribbling. He mostly chose smiling or neutral but occasionally frowning or angry Garfields.

Grade 2 The boy's oral idea generation of ideas contained many more ideas than expressed in his essay by pen or by keyboard, both of which had two clauses. Again he mostly chose smiling or neutral Garfields, but no angry ones. A classroom fill-in-the-blank planning worksheet was shared.

Grade 3 Both the boy's narrative by pen and his narrative by keyboard were only one-sentence long. On the four-genre writing task, his narrative contained only one clause, but his informative essay contained four clauses organized as list of statements and his compare and contrast essay contained two clauses—one stating a difference and one a similarity. Although three ideas were expressed in the oral think-aloud protocols, only one was expressed in the persuasive essay. He was not able to complete the other oral think-alouds for planning or revision. In contrast to past grades, only one smiling Garfield was chosen and several angry, frowning, and neutral Garfields. One worksheet on writing vocabulary that goes with written definitions was shared. Parent noted more enthusiasm for reading than writing. In the one-to-one situation, he was highly engaged in writing tasks.

Grade 4 Although the oral think-aloud protocols contained substantially more ideas than the boy's written essays by pen or by keyboard, in fourth grade, his written translation of ideas had improved greatly—the texts were longer and better constructed. His essay by pen had 11 clauses and his essay by keyboard had 10 clauses; both were organized as a list of statements without a topic sentence. His response on the Nolen survey indicated a moderate approach to rather than an avoidance of writing. Classroom writing samples included an activity in which the task was to copy sentences written in cursive and a dictated spelling task.

Grade 5 The boy's narrative by pen had eight clauses, organized as a ladder of sequenced events. His narrative by keyboard had three clauses, organized as list of statements that offered explanations. On the four-genre writing tasks, his narrative consisted of a ladder of three sequenced events; his informative essay had five clauses, organized as a list of statements; his compare and contrast essay contained four clauses, organized as a list of statements two of which are qualifications; and his persuasive essay contained four clauses, organized with an expository schema with a topic sentence and then statements with examples, an opinion, and a summarization. More ideas were expressed in the oral think-aloud than the written persuasive essay; his oral think-aloud proposed an excellent plan for organization, which was only partially implemented. His oral plan for revising was to add more information if he knew more about the species of plants and animals. His cognitive processes beyond translation were developing. His response on the Nolen survey indicated a strong approach to writing. One classroom writing sample was shared—a personal narrative with five paragraphs printed in manuscript format. In grade 1, he explained writing to a kindergartner by modeling how to spell *and* and *is*. In grade 5, he did not complete the metacognition task.

Personal Writing Trek 8 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with crayon at 12 months, first produced the written alphabet at 36 months, first wrote words at 48 months, and first wrote text at 60 months. No developmental problems were reported. This child's reading and oral language skills spanned the above average to superior to very superior ranges. Her phonological spelling was above average to superior and her word-specific orthographic spelling was average to above average. Researcher ratings of selective, maintaining, and switching attention ranged from excellent (grades 1, 3, and 4) to good to very good (grade 2) or very good (grade 5).

Profile 8 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		114, 86%tile			126, 96%tile
Letter writing	0.22	0.46	0.29	3.63	0.42
Dictated spelling	147, 99.9%tile	141, 99.7%tile	129, 97%tile	124, 95%tile	124, 95%tile
Written expression	107, 68%tile	123, 94%tile	118, 88%tile	131, 98%tile	129, 97%tile
Word form coding					
Phonological	1.81	1.61	1.02	1.21	
Morphological			0.10	0.58	0.41
Orthographic	1.02	0.89	1.17	1.46	
Orthographic loop					
Finger succession	2.15	−0.24	−0.08	0.09	
Expressive orthographic				1.78	
Executive functions					
Inhibition		13	12	13	13
RAS	−0.57	0.06	−0.45		
Working memory					
Phonological		144		162	
Orthographic—letters		0.38	0.52	1.03	
Orthographic—words		0.74	0.97	0.77	

Profile Analysis The girl's transcription (letter writing and spelling) and written composing skills showed variation within and across the first five grades. No significant working memory weaknesses were noted other than finger succession in grade 1. Her generally neutral attitude toward writing in the first four grades developed into a positive approach orientation in grade 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On the narrative by pen, the girl wrote four clauses, organized into a beginning and an end, which made two event statements. Mostly she chose neutral Garfields, but twice a smiling one and twice a frowning one.

Grade 2 The girl's oral idea generation contained many more ideas than were expressed in her essay writing by pen or by hand. Her essay by pen contained six clauses organized into a list with statements, which defined and explained functions and provided physical descriptions. Her essay by keyboard contained two clauses, organized as a wheel—three comments about the stated topic. She chose smiling and neutral Garfields equally often. Her classroom writing samples included a letter, journal entries about the daily school activities, and two personal narratives, expository writing about the steps of a science experiment, sentence-construction activities, and a prewriting activity.

Grade 3 The girl's narrative by pen, which had 15 clauses, reliably marked capitalization at the beginning of sentences and with two exceptions marked punctuation (periods, exclamations, and quotations). The series of events had narrative schema—setting, main characters, problem statement, plot, and outcome; dialogue was also used to tell the story in an interesting way. Her narrative by keyboard, which had six clauses, was a ladder with a series of events in story order but narrative features were not as clearly marked as in the other narrative. On the four-genre writing tasks, her narrative was a ladder with a series of four related events in the form of factual statements; her informative essay was a list of five statements of fact that did not reference events; her compare and contrast essay was a list of five statements, organized into two sets that contrast the first mountain to the second mountain on a comparable characteristic; and her persuasive essay was organized by a clear statement of both positions, a statement of personal opinion about which position was correct, and then a transition to another controversy without any discussion of the evidence to support the first position. She was unable to generate any ideas orally prior to writing the persuasive essay, but could orally generate a plan for organization, the first part of which was expressed in her written essay before the time limit was reached. Not surprisingly, her plan for revision was detailed with what she had in mind to continue writing had there been more time. Of interest, her strategy for revising involved rereading orally parts of which she had written and then commenting on the need to add additional clarifying information to specific parts of the produced text. Clearly, her cognitive processes beyond translation were continuing to develop. She chose neutral Garfields more often than smiling Garfields. Parent described the child as a voracious reader and reported that she enjoys her child's writing. No classroom writing samples were provided.

Grade 4 The girl's essay by pen, which reflected ideas that appeared in her lengthy oral idea generation protocol, was a list of factual statements about function and physical description without a unifying topic sentence. Her oral idea generation for the essay by keyboard contained many personal statements including comments about not liking robots—the topic at hand. Her essay by keyboard was notably briefer than by pen, and consisted of two statements of generalization, which captured the essence of what robots are—mechanical humans who do things humans want them to do. On the Nolen survey, her approach-avoidance for writing was neutral. Her classroom writing samples were sentence-construction activities.

Grade 5 Both the girl's narrative by pen and her narrative by keyboard were organized by narrative schema including suspense, with the initial mystery resulting in events leading to solving the mystery (by pen), or surprise, with adversity being transformed into unexpected success (by keyboard). On the four-genre writing tasks, all were organized with appropriate genre-specific schema: narrative with the events leading up to the tragic event of the mountain exploding with loss of life; informative essay with a topic sentence and supporting information presented in a lively, engaging writing style; compare and contrast essay with initial discussion of how the mountains were alike and how they were different and then ending with a summary generalization that they are both alike and different; and persuasive essay stating both sides of the argument, taking a stand on one side of the argument, providing one statement in support of that side, and moving to the next controversy. By grade 5, her oral generation of ideas was almost indistinguishable from her oral plan for organizing—as a writer, she appeared to draw on preplanning and not flow of ideas during the translation process. Her oral plan for revising was to elaborate on her opinions. On the Nolen survey, her response showed strong approach to writing. Her classroom writing sample, which was a creative narrative with an embedded letter, was word processed and showed imagination and writing talent. In grade 1, she explained to a kindergartner that writing is not drawing and drawing is not writing. In grade 5, time did not permit her to complete the written metacognitive task.

Personal Writing Trek 9 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with crayon at 18 months, first produced the written alphabet at 36 months, and first wrote words and text at 54 months. No developmental problems were reported. The child's reading and oral language skills were consistently in the above average, superior, or very superior ranges. Her phonological spelling skills ranged from above average to very superior, and her word-specific orthographic spelling skills ranged from average to above average. Researcher ratings of selective, maintaining, and switching attention ranged from excellent (grades 1 and 2) to very good to excellent (grade 3) to excellent (grade 4) to good and very good (grade 5).

Profile 9 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		130, 98%tile			114, 82%tile
Letter writing	2.83	2.54	0.88	2.52	0.20
Dictated spelling	120, 91%tile	126, 96%tile	130, 98%tile	125, 95%tile	127, 96%tile
Written expression	129, 97%tile	133, 99%tile	124, 95%tile	127, 96%tile	122, 93%tile

(continued)

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Word form coding					
Phonological	1.57	0.37	1.24	1.21	
Morphological			0.32	0.94	1.33
Orthographic	2.39	1.57	0.93	2.00	
Orthographic loop					
Finger succession	−1.28	−1.35	−1.21	−1.91	
Expressive orthographic				1.33	
Executive functions					
Inhibition		10	13	14	14
RAS	−1.22	−1.41	−1.41		
Working memory					
Phonological		129		147	
Orthographic—letters		1.05	0.52	1.03	
Orthographic—words		0.30	0.97	0.77	

Profile Analysis The girl's transcription (letter writing and spelling) and written composing showed variation within and across the first five grades, although spelling and text composing were generally in the superior to very superior range. All working-memory skills were relative strengths. Her attitude to writing became more positive across grades 1–3 and tendency to approach writing increased from grades 4 to 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On the narrative writing by pen, the girl completed a narrative schema with a setting and precipitating event, with a series of four more events including a culminating event clearly tied to the precipitating event. Local statements were not restricted to events and also included explanations and dialogue. For writing, she chose frowning or angry Garfields equally often.

Grade 2 Not all ideas in the oral idea generation protocols appeared in the written essays (e.g., only 3 of the 13 ideas orally generated appeared in the essay by keyboard); and not all ideas expressed in the written essays had appeared in the oral idea generation (e.g., using computers for maps in the essay by pen). Moreover, the oral protocols often showed greater evidence of global schema than did the written essays. For writing, for the most part the girl chose smiling or neutral Garfields. Her classroom writing samples were illustrated letters to her mother and other children.

Grade 3 On the narrative by pen, the girl's global strategy was a ladder with a series of events and implicit but not explicit narrative schema. On the narrative by keyboard, she provided an opening that set the scene and introduced the plot but did not have time to complete the narrative schema. On the four-genre writing tasks, capitalization and punctuation were not for the most part used to mark sentence units in any of the genre. The global strategies across the narrative, informative, and compare and contrast genre appeared to be knowledge telling—generating one statement after another as quickly as possible without consideration of how to organize them into a coherent text with or without a topic sentence to integrate the statements. However, for persuasive writing she stated a position, placed a qualification on it, provided awareness of the reason for the alternative position, and provided a reason for the position. Many of the ideas expressed during her oral generation of ideas were expressed in writing, and she could not orally generate a plan for organizing her writing or for revising, suggesting that she was relying on flow or knowledge telling. For writing, for the most part she chose smiling or neutral Garfields but occasionally frowning ones. Her classroom writing samples were illustrated letters to her mother and other children.

Grade 4 The ideas generated orally were expressed in the girl's essay by pen and for the most part in her essay by keyboard, and in both cases were still a listing of statements without an organizing schema. On the Nolen survey, she showed a neutral approach-avoidance to writing.

Grade 5 The girl's narrative by pen and by keyboard showed the first evidence of global strategy for writing. Both began with a topic sentence and exhibited elements of a narrative schema including two mysteries or one mystery to solve and resolution of both or one, respectively. On the four-genre writing task, she also used global writing strategies for her narrative, informative essay (including appropriate paragraph organization), compare and contrast essay (paragraph structure for differences), and persuasive essay (stated position on three controversies and supporting evidence provided for the second one). She generated more ideas orally than expressed in her written persuasive essay, but in grade 5 she now also generated orally a plan for organizing her writing, which was evident in the organization of the written essay. She could also now, compared to grade 3, generate orally a plan for revising the text, which was to add statements with evidence to support her position on the controversies. By grade 5, the cognitive processes beyond translation were developing. On the Nolen survey, she showed a strong tendency to approach rather than to avoid writing. As she wrote during the research testing sessions, she spontaneously used talk-aloud strategies to guide the writing process. Although no classroom writing samples were shared, this student reported that she enjoys writing in her free time at home. In grade 1, she could not explain what writing is. In grade 5, she explained writing based on the alphabet: writing is words on paper to tell a story and all the words you know how to say can be written on paper using the alphabet (to kindergartner); writing uses all the letters of the alphabet to form words we use (to third grader); writing is formation of letters arranged in a certain order to create words (to a fifth grader).

Personal Writing Trek 10 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with crayon at 24 months, first produced the written alphabet at 30 months, and first wrote words and text at 36 months. No developmental problems were reported. Her reading and oral language skills were consistently in the above average to superior range. Her phonological spelling ranged from superior to very superior and her word-specific orthographic spelling ranged from average to above average. Researcher ratings of selective, maintaining, and switching attention ranged from average to excellent (grade 1), average to very good (grade 2), very good to excellent (grade 3), and consistently excellent (grades 4 and 5).

Profile 10 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		127, 96%tile			124, 95%tile
Letter writing	0.65	1.29	1.18	0.30	n.a.
Dictated spelling	123, 94%tile	125, 95%tile	119, 90%tile	114, 82%tile	106, 66%tile
Written expression	102, 55%tile	125, 95%tile	110, 75%tile	125, 95%tile	114, 82%tile
Word form coding					
Phonological	1.69	1.49	1.24	0.68	
Morphological			0.67	.78	1.03
Receptive orthographic	0.82	−0.02	−0.50	−0.16	
Orthographic loop					
Finger succession	−0.24	−0.10	−0.45	−1.34	
Expressive orthographic				1.33	
Executive functions					
Inhibition		11	13	14	15
RAS	−0.96	−0.38	−1.23		
Working memory					
Phonological		122		160	
Orthographic—letters		1.72	−1.24	−1.01	
Orthographic—words		0.30	0.97	0.77	

Profile Analysis The girl's transcription (letter writing and spelling) and written composing skills showed variation within and across grade levels. No working memory weaknesses were noted other than orthographic letters in grades 3 and 4. Her initial neutral attitude toward writing in grades 1–3 gave way to a tendency to approach writing in grades 4 and 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On narrative writing by pen, the girl wrote a two-clause sentence with a stated event and reason this event was unexpected. Pencil grip was noted to be a possible problem only at this grade level. With one exception, for writing she chose neutral Garfields.

Grade 2 At least three new ideas were introduced in the girl's essay by pen that were not in the prior oral idea generation, suggesting translation beyond simply retelling the ideas previously generated orally, but essay by keyboard appeared to be a continuation of text generation begun during the oral idea generation rather than a planned strategy to transform what had just been generated into a different format for expression. For writing, she chose mostly neutral Garfields. Classroom writing samples included independent activities for (a) choosing words for sentence context based on pictorial illustrations of the sentences, choices provided, hints (partial spellings of words); (b) writing answers to questions about story to be read; (c) handwriting task (copy a poem); and (d) personal narrative compositions about a provided topic on lined paper with one illustrated in the space above.

Grade 3 On narrative writing by pen, the girl's written story had ladder schema with a series of events organized, beginning with event (topic) that tied the succeeding events (comments) together, and offered an implicit, emergent narrative structure. On narrative writing by keyboard the narrative schema was more explicit, beginning with three sentences to describe an unexpected event requiring problem solving followed by one event and a final outcome statement. On the four-genre writing tasks, transcription errors were often self-revised during the translation process in all four writing tasks. Her narrative exhibited narrative schema, with an initial problematic event followed by a series of events, resulting in an outcome event statement. Her information essay began with a topic sentence but she had time only to elaborate on the first of four subtopics (each season) implied in this topic sentence about changing seasons on the mountain. Her compare and contrast essay began only with a topic sentence marking many breakdowns in transcription that could have been the result, not cause, of the translation difficulties she was having. Her persuasive essay, again marked by many transcription problems, consisted of what might have turned into a topic sentence and a partially constructed topic sentence. Her oral generation of ideas was anchored to a new and intriguing fact from the source material she had read, which was related to the meaning of the name given to the mountain by the native peoples. Her oral planning for organization generated a well-constructed topic sentence and concern with an overall title. Her oral revising plan was to add to the text content that had not been expressed in the essay; this observation suggests that she is keeping a plan for text generation and organization in mind across cycles of working memory during a self-regulated written translation bout and no longer engaged in flow from ideas to writing as in second grade. For writing, she consistently chose neutral Garfields (only for reading did she chose smiling Garfields). Classroom writing samples included (a) computer-generated adventure story, (b) writing answers to questions about story to be read, (c) dictated spelling activity, and (d) written math fact practice.

Grade 4 For the first time in the girl's writing development, both the written essays by pen and keyboard have more ideas and better organization than the preceding oral idea generation protocols. Moreover, there are still self-generated revisions of the transcription errors during the self-regulated translation bout by pen. As such, both of these observations provide more evidence for her engaging nontranslation cognitive processes during translation (Hayes, Chapter 2). On the Nolen survey, her response indicated tendency to approach writing. Classroom writing samples included (a) computer-generated science presentation on molecules, (b) letters to family members, (c) essays about her father and her family, (d) independent work sheet on applying phonics to journal entries and written vocabulary building (synonyms and riddles), and (e) written math problem solving that included written problem representation.

Grade 5 For writing narratives by both pen and keyboard, the girl shows evidence of the narrative schema, beginning with an interesting first event to be explained, followed by subsequent events, which lead to an outcome event that results in change in state of affairs compared to the initial event. However, she still produces many transcription errors by pen but not by keyboard, maybe because she is increasingly composing by keyboard, for example, on long-term writing assignments completed at home, and letter production by pen is not as practiced on a daily basis. Of interest, her frequent self-revising of letter formation in prior years is notably absent when writing by pen in grade 5 when she may be more focused on global schema and sentence construction (all capitalized and punctuated appropriately). On all four-genre writing tasks, her writing shows application of global writing strategies (topic sentences, and for compare and contrast essay paragraphs) and local strategies (well-constructed sentences with attention to capitalization and varied and appropriate use of punctuation marks). However, the oral idea generation and organizational plan, both of which are well organized into global text schema, are outstanding and exceed what she was able to produce in writing during the 5 min time limit. Because she is able to both preplan and engage in longer self-regulated translation bouts, she may need longer time periods to produce the outcome of her self-regulated written translation than she needed in the earlier grades. On the Nolen survey, her response indicated tendency to approach writing. Her classroom writing sample consisted of a five-page handwritten (printed), well-developed narrative with clear paragraph structure. It was stamped by the teacher as read but not edited. In grade 1, she explained writing as holding a pencil to write things (demonstrated and pointed to chart on wall with pencil grips). Her metacognitions about writing in grade 5 were adapted to some degree to developmental level of writing and changing writing requirements: To a kindergartner, "Writing is a way to show your feelings. Also when the teacher says to write you have to write." To a third grader, "Writing is a fun subject in school and life. You can also express feelings, show what you believe in, and have fun." To a fifth grader, "Writing is very important. This year we will be doing a lot of writing essays. It can be boring but most of the time it is super fun."

Personal Writing Trek 11 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with crayon at 24 months, first produced the written alphabet at 36 months, first wrote words at 48 months, and first wrote text at 54 months. No developmental problems were reported. Initially, in grade 1, reading skills were below average for decoding, low average for real-word reading, and average for reading comprehension, but by grade 2 all these skills were in the average range for accuracy; however, in grade 2, rate of real-word reading was below average and rate of phonological decoding was low average. By third grade, no concerns with reading were noted for accuracy and rate of real-word reading (above average), accuracy (border average and above average) and rate (above average) of phonological decoding, and reading comprehension (very superior range commensurate with verbal IQ). During fourth grade, reading skills at the word level remained average to above average, but were superior to very superior for reading vocabulary meaning and reading comprehension. Phonological spelling spanned above average to average and orthographic word-specific spelling spanned average to above average. Her oral language trajectory shows that in a child whose development is within the normal range both receptive (understanding) and expressive (constructing and producing) language may change and improve across early and middle childhood. Initially both receptive and expressive were in the average range in grade 1, above average (receptive) to superior (expressive) in grade 2, very superior (receptive) to average (above the population mean) in grade 3, average to very superior (receptive language) and above average (expressive language) in grade 4, and superior (receptive and expressive) in grade 5. Researcher ratings of selective, maintaining, and switching attention ranged from good (grade 3) to very good (grades 1, 2, and 4); they were not available in grade 5.

Profile 11 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		144, 99.8%tile			144, 99.8%tile
Letter writing	1.09	0.04	0.29	0.30	0.74
Dictated spelling	120, 91%tile	111, 77%tile	96, 39%tile	113, 81%tile	111, 77%tile
Written expression	126, 96%tile	118, 88%tile	123, 94%tile	129, 97%tile	117, 86%tile
Word form coding					
Phonological	0.86	1.16	0.91	0.68	
Morphological			0.78	0.58	1.03
Orthographic	0.24	−0.02	−0.02	0.65	

(continued)

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Orthographic loop					
Finger Succession	−0.24	−0.10	−0.08	−0.20	
Expressive orthographic				0.00	
Executive functions					
Inhibition		4	7	8	9
RAS	n.a.	−0.16	0.86		
Working memory					
Phonological		89		101	
Orthographic—letters		−0.97	0.52	−1.69	
Orthographic—words		−0.14	−0.09	−0.76	

Profile Analysis The girl's transcription (letter writing and spelling) and written composing skills showed variability within and across the first five grade levels. No working memory weaknesses were noted other than executive functions—inhibition in grades 2 and 3 and switching attention in grade 3—and selected orthographic skills—orthographic letters in grades 2 and 4 and orthographic words in grade 4. Her initially positive attitude toward writing in grade 1 became more variable in grade 2 and negative in grade 3. The tendency to avoid writing in grade 4 changed to a tendency to approach writing in grade 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The girl's narrative writing by pen consisted of four clauses (one independent, three dependent), which set the scene for a narrative with events to follow. Her Garfields were consistently smiling.

Grade 2 The oral idea generation about computers consisted of four ideas marked by pauses and ending with a note of humility—an admission that the child did not really know what a computer is even though she could list facts about one—and of nine facts about robots marked by frequent pauses and ending with an admission she also did not know much about robots. Her awareness of the limitations of what one knows may be an early sign of an emerging real thinker. Both written essays, by pen and by keyboard, were very brief (one or two statements of fact, respectively). Her attitude to writing was variable, ranging from smiling to neutral to frowning to angry Garfields. The mother noted that the child, who lacks confidence in her writing and therefore finds it stressful, enjoys reading more than writing. Classroom writing samples, all of which reflected quality writing for grade level, included (a) writing vocabulary development (vocabulary words organized by alphabetic order for writing about topic and vocabulary word meaning represented in conceptual maps for a topic student completed); (b) answering questions about assigned reading passages; (c) crossword puzzles; (d) guided story writing using written vocabulary, pictures, and question prompts; and (e) written activity comparing the alphabet forms used across written languages.

Grade 3 The girl's written narratives by both pen and keyboard began with an interest-capturing first event, and the one by pen also included additional statements of a physical description and two more events that followed. On the four-genre writing tasks, only the informative and compare (one statement of physical description followed by a statement about personal question) and contrast essays (one topic sentence followed by one statement of the difference between the mountains) were completed. Garfields were either frowning or angry. Classroom writing samples included (a) a weekly outline of integrated reading–writing activities including answering factual and inferential questions about the text(s) read, (b) crossword puzzles, (c) rearranging sentences to create texts for specific genre (e.g., interviews), (d) a written biography of her father, and (e) an extended narrative with illustrations for evolving events.

Grade 4 Although oral idea generation protocols were still longer than written essays, the length, content, and organization exhibited substantial developmental improvement since grade 2. For one thing, the oral protocols appeared to be knowledge telling, whereas the written essays showed signs of knowledge transformation for the audience. Here is the narrative by pen, which also shows imagination, for which transcription errors are corrected for clarity regarding content:

> Computers are really annoying machines and have a mind of their own. They decide if they want to listen to you or not. If they let you, you can possibly type or maybe play a game. The ones at school listen more because they have a teacher who teaches them. Computers at home haven't had any schooling so they don't listen to you. That is all I have to say about computers.
>
> Robots are free machines that play games with you if programmed correctly. Otherwise they can take over your house. Some are powered by battery and others are powered by their own mind. In the future robots might do all our boring chores.

The girl's response to the Nolen writing survey indicated a tendency toward writing avoidance. Classroom writing samples included (a) spelling tests; (b) weekly schema for integrating reading and writing lessons about both nonfiction and fiction texts, with examples of the vocabulary building, spelling, reading comprehension, and writing activities for meaning-making including written answers to questions about reading assignment, for which she used art to answer one question; (c) a computer-generated written report, with paragraph structure, for a social studies project; and (d) four-page creative writing with numerous illustrations that was printed in manuscript.

Grade 5 The narrative writing by pen was a series of events based on a real-world incident on the school bus that was upsetting to the child writer. The narrative written by keyboard was a series of events in which family members were the main characters (mom, dad, the child writer, and the family dog) and was humorous. This child may show signs of a future in professional writing. On the four-genre writing tasks, her narrative transformed the facts she read in the source material into an interesting narrative that holds the reader's attention; her informative essay employed many interesting word choices to convey the information in a way that holds the reader's attention; her compare and contrast essay first highlights two statements of fact about how the mountains differ, and then ends with a summary statement about how they are the same; and her persuasive essay states a position, presents two statements with supporting evidence, and finally considers the alternative perspective. Her oral idea generation protocol showed evidence of not only generating ideas but also thinking about them and how they would be presented in the essay, even though she could not think of what to include in an oral plan for organization (maybe because she had already generated one). The only thing she could think of in her oral plan for revising was to include more examples. On the Nolen survey, she showed a tendency to approach rather than to avoid writing. The research team member who worked with this student noted how invested she was in the writing tasks, her creativity, and her thoughtfulness. No classroom writing samples were provided.

The girl's metacognition about writing showed developmental leaps from first grade to fifth grade. In first grade, she explained writing to a kindergartner as "Take a pen or pencil you rub it around a bit." However, by fifth grade she had developed metalinguistic awareness of levels of language. She explained what writing is to a first grader this way: "Writing is putting your ideas down on paper to make a sentence. After you have written many sentences, you will have made a paragraph. After a few paragraphs you will have made a story. To write a sentence, it is good to think of your ideas and put them into words. Make sure that all your writings go well together." To a third grader, she explained "Writing is a way to communicate by putting words down on paper. Choose your favorite ideas, along with good words and you will have sentences. Each paragraph should have an opening and closing sentence for about 5 sentences. All your stories have an opening and closing paragraph for a total of at least 3 paragraphs." To a fifth grader, she explained "Writing is putting the ideas that you want others to know down on paper. Your sentences should have all 6 traits and also make sure there is good flow. All the paragraphs should go together easily and the reader should be able to understand it without any difficulty." Note that six traits, one of which is voice of the writer, is a program of writing instruction used in the United States to teach self-generated goals and evaluation criteria for writing.

Personal Writing Trek 12 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with a crayon at 30 months, produced the written alphabet and wrote words at 66 months, and wrote written text at 72 months. No developmental problems were noted other than hearing and vision problems during infancy. Initially, in grade 1 word reading was in the low average range and phonological decoding and reading comprehension were in the below average range but by grade 2 all reading skills were in the average to above average range, and remained in the average (above the population mean) to above average range thereafter to grade 5. Initially in grade 1, oral language skills fell in the low average and below average range, and in grades 2–4 ranged from the below average to the low average and average ranges; however, by grade 5 both receptive and expressive oral language fell in the average range (receptive, 102, 55%tile; expressive, 93, 92%tile). Although her phonological spelling fell in the average range just below the population mean, her word-specific orthographic spelling fell consistently above the mean. Tester ratings ranged from below average (selective), to low average (maintaining), to very good (switching) in grade 1, to low average (selective and maintaining) to very good (switching) in grade 2, to below (maintaining) to low selective and switching in grade 3, to very good (selective) to average (maintaining) to excellent (switching) in grades 3 and 4, to consistently very good in grade 5. Parent's rating of self-regulation of attention and behavior indicated some areas of concern, but did not meet the diagnostic criteria for ADHD (inattentive, hyperactive, or mixed) in grades 2–4; the second grade teacher had recommended testing for ADHD. Parent reported ongoing concerns with the child's comprehension and behavioral management at home.

Profile 12 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		85, 16%tile			87, 19%tile
Letter writing	−0.65	0.04	0.59	3.63	1.05
Dictated spelling	104, 61%tile	105, 63%tile	96, 39%tile	104, 61%tile	99, 47%tile
Written expression	81, 10%tile	94, 34%tile	98, 45%tile	111, 77%tile	110, 75%tile
Word form coding					
Phonological	−0.10	0.15	0.13	−1.42 (rime 0.65)	
Morphological			−0.70	−0.84	−1.45
Orthographic	0.82	0.43	−0.02	−0.70	
Orthographic loop					
Finger succession	0.66	0.32	0.30	0.09	
Expressive orthographic				0.22	
Executive functions					
Inhibition		7	3	10	9
RAS	−0.88	0.06	0.07		
Working memory					
Phonological		86		85	
Orthographic—letters		−0.97	−1.83	−1.01	
Orthographic—words		−0.14	−0.09	−0.76	

Profile Analysis The girl's transcription (letter writing and spelling) and text composing showed variability within and across the first five grades but were consistently in or above the average range in grades 2–5. It is not known if her hearing and vision problems, which were not severe enough to be sensory handicapping conditions, might have interfered with her language processing in subtle ways even though she did not show indicators of dysgraphia. Her spelling consistently exceeded her verbal comprehension ability, which requires listening, and her text composing exceeded her verbal comprehension ability in grades 2–5. Working memory weaknesses were sometimes observed in measures that require initial hearing or visual processing: phonological and orthographic coding (grade 4 only) and morphological coding (grades 4 and 5), phonological working memory (grades 2 and 4) and orthographic working memory—letters in grades 2–4 and words in grade 4. The phonological coding problem in grade 4 was based only on phonemes but not on rimes (at upper limits of average range, see her learning profile) and again may reflect a developmental shift in unit of metalinguistic awareness as reading and spelling polysyllabic words increases. Her attitude to writing was generally positive in the first two grades and then neutral thereafter.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On the narrative writing by pen, the girl wrote one sentence (one independent and one dependent clause) with a comment that did not appear to be related to the topic provided. For writing, she almost always chose smiling Garfields.

Grade 2 The three ideas generated orally were not translated into the written essay by pen, which consisted of one sentence that was a vague comment about the provided topic. The four ideas generated, which could have been related to many other topics than the one provided, were translated into writing with vague comments, which did not clearly relate to the topic. For writing, for the most part the girl chose smiling Garfields but occasionally neutral or frowning ones. Classroom writing samples were spelling tests.

Grade 3 On the narrative writing by pen, two clauses were produced, which were an appropriate comment for the topic provided. On the narrative writing by keyboard, a single independent clause was written that was a comment relevant to the provided topic. So ability to make comments relevant to the topic had improved compared to the earlier grades. On the four-genre writing tasks, the girl's narrative consisted of two clauses that made statements about serial events; her informative essay consisted of two clauses each of which stated facts about the provided topic; her compare and contrast essay consisted of a wheel with four comments about the topic (similarities about two mountains); her persuasive essay consisted of one statement of a position and a statement of agreement with it. All four genre were noticeably brief for grade level. Her oral idea generation showed awareness of two of the controversies but a position on only one of them.

She could not engage in oral planning for organization or revising. For writing, for the most part she chose neutral Garfields but occasionally a smiling or frowning one. Classroom writing samples included dated journal entries of neatly printed sentences and related art work.

Grade 4 The girl struggled to maintain oral self-regulated idea generation before each essay. On the essay by pen, she could state an opinion and give two examples and then state another opinion and give one supporting reason and this statement was repeated. On the essay by keyboard, she was able to write one statement with a generalization and give one example. Her response on the Nolen survey indicated a neutral stance to writing. The mother noted that the child does better with cursive than manuscript writing. Classroom writing samples included (a) cursive handwriting practice, (b) dated journal entries printed in manuscript, (c) sentence-construction activities, and (d) examples of her best writing in classroom writing portfolio, a printed personal narrative without paragraph structure followed by a self-reflection.

Grade 5 The girl's narrative by pen consisted of a wheel—a topic and three comments. Her narrative by keyboard consisted of four clauses constructed to set the opening scene for a narrative, which was presented as a mystery. On the four-genre writing tasks, her narrative was a wheel—a topic with four comments (not related to each other in organized way); her informative essay was also a wheel—a topic with four unrelated comments; her compare and contrast essay consisted of one sentence comparing the two mountains on a difference (whether each has erupted); her persuasive essay indicated awareness of the controversies, lack of interest in taking a position, and then a proposal for a completely new name not related to the controversies. Her oral idea generation proposed a resolution to the controversy other than two in the read source material; her oral plan for organization recognized that an essay should have a beginning and end (goal is to finish it); her oral plan for revising was to add more words to make it longer. Her response on the Nolen survey indicated neutral stance to writing. No grade 5 classroom writing samples were provided. When she was in first grade, she explained writing to a kindergartner as something you write. In fifth grade she explained writing to a first grader, third grader, and fifth grader as "Writing is where you get a prompt and you write to that prompt."

Personal Writing Trek 13 Girl

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This girl first wrote with a crayon at 18 months, produced the written alphabet in 38 months, wrote words and written text at 60 months. No developmental problems were reported other than feeding problems during infancy. In grade 1, her real-word reading and reading comprehension accuracy were in the low average range but her real-word reading accuracy was in the average range. In grades 2, 4, and 5, these skills fell in the average range. When these reading skills or oral passage reading were timed, scores were in the low average but by grades 4 and 5 fell consistently in the average range. In grade 1, receptive oral language was below average; in grade 2, receptive oral language was at the border of average and above average range and expressive oral language was low average; in grade 3, both receptive and expressive oral language fell in the average range; in grade 4, expressive oral language fell in average range (above the population mean); and in grade 5, receptive oral language fell in average range and expressive oral language in the above average range. Although her phonological spelling ranged from above average to average, her word-specific orthographic spelling was consistently below average from grades 1 to 4. A possible pencil grip problem was noted in grade 1 but not thereafter. Researcher ratings of selective, maintaining, and switching attention ranged from fair to good to very good (grade 1), good to very good (grade 2), fair to good (grade 3), to fair (grade 4), to fair to good (grade 5). The mother reported that the child tends to daydream at school but is easier to manage at school than home. The fourth grade tester noted that child's attention was easily managed with verbal prompts (e.g., Listen) and visual gestures that directed her where to focus. She also noted that the child was most invested in the writing tasks, but spelling seemed to interfere. The fifth grade tester noted that the child was energetic and highly talkative.

Profile 13 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		93, 32%tile			104, 61%tile
Letter writing	0.65	0.04	0.29	1.41	1.05
Dictated spelling	93, 32%tile	91, 27%tile	89, 23%tile	87, 19%tile	87, 19%tile
Written expression	108, 70%tile	90, 25%tile	96, 39%tile	89, 23%tile	98, 45%tile
Word form coding					
Phonological	−0.10	−0.30	0.24	0.16	
Morphological			−2.63	−3.69	n.a.
Orthographic	−1.33	−1.16	−1.21	−0.70	
Orthographic loop					
Finger succession	n.a.	−0.24	−.08	−1.06	
Expressive orthographic				−1.11	
Executive functions					
Inhibition		8	10	13	10
RAS	n.a.	−0.31	−0.45		
Working memory					
Phonological		108		95	
Orthographic—letters		1.72	−0.07	−1.01	
Orthographic—words		−0.57	−0.09	−2.29	

Profile Analysis The girl's handwriting remained consistently above the mean on the alphabet letter writing task across the five grades. Her spelling remained consistently below the mean and showed relative decline across the five grades. Her written composing was above the mean in grade 1 but thereafter below the mean. Despite tutoring, the writing problems persisted and in grades 3–5 this child met the criteria for diagnosis of dysgraphia on basis of spelling below the mean and at least a standard deviation below grade 5 verbal reasoning. The spelling problems were due to a severe deficit in orthographic skills—both receptive orthographic coding (grades 1–4) and expressive orthographic coding (grade 4), orthographic working memory—letters in alphabet (grades 2 and 4) and in written words (grade 4), and word-specific orthographic real-word spellings in long-term memory. Remarkably, despite well-developed letter retrieval and production on the alphabet writing task (orthographic loop), her ability to create long-term representations of written spelling of specific written words, which require alternative correspondences between phonological (sound) units and orthographic (spelling) units, including coding of silent letters in specific words, was not developing normally. Weaknesses also occurred in phonological coding of spoken words (grade 4) and morphological coding of spoken and written words (grades 3 and 4). It was not clear how the occupational therapy she was receiving would address these writing-related issues that were due to language and working memory weaknesses rather than to motor or sensory integration problems.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On narrative writing by pen, the girl produced seven word-like productions separated by spaces and composed of random letter strings, which did not appear to be invented spellings that represent speech sounds. She chose smiling Garfields most often, but also the neutral, frowning, and angry Garfields.

Grade 2 Only one of the ideas in the longer oral idea generation protocol showed up in the essay written by pen, which was a simple wheel containing two comments about the provided topic, which was not explicitly referenced. Only two of the ideas in the longer oral idea generation protocol showed up in the essay written by keyboard, which was also a wheel containing two comments about the provided topic not explicitly referenced. The girl chose frowning Garfields most often, but also the smiling, neutral, and angry Garfields. Her classroom writing samples were two daily dated writing activities—writing two sentences and completed two written word analogies.

Grade 3 On the narrative by both pen and keyboard, two comments were provided, which were statements about events relevant to the provided topic sentence. On the four-genre writing tasks, the girl did not write a narrative or compare and contrast essay. On the informative essay, she made one comment about the provided topic in a statement of fact. On the persuasive essay, she wrote one statement of opinion about the topic, which was related to one of the three ideas in her oral generation protocol. She was unable to generate an oral plan for organization or revision.

Most frequently, she chose neutral Garfields, with frowning Garfields a close second. Her classroom writing samples included an essay text of 13 printed lines and one period in the middle and an illustration to go with it.

Grade 4 On written essays by pen (six comments on provided topic) and keyboard (five comments on provided topic), more ideas from the prior oral idea generation were expressed in writing than had been the case in grade 2. The girl's response on the Nolen survey showed a tendency to approach rather than avoid writing. No classroom writing samples were provided.

Grade 5 On narrative by pen, the girl wrote four statements of events that were clearly related to the provided topic. On the narrative by keyboard, she produced eight statements, which were related to the provided prompt and included statements of a series of events and a summary statement of the outcome. On the four-genre writing tasks, her narrative consisted of one statement about an event related to the topic and a second comment that provided a reason (explanation); her informative essay consisted of three statements about physical description; her compare and contrast essay consisted of two statements—one about the similarities and one about the differences; her persuasive essay did not show the requested genre-specific schema; it was noticeably brief without a clear stand on the controversies, which was the topic. In contrast, the oral idea generation protocol was long and filled with many relevant ideas and organized by grade-appropriate global schema that in writing. She could not provide an oral plan for organizing or revising. So she was delayed not only in transcription—spelling but also in development of cognitive processes beyond translation. Her response on the Nolen survey was completely writing avoidance. No classroom writing samples were provided. In grade 1, she explained writing as ABCs and stuff. In grade 5, she explained writing as taking a pencil and making a lot of different letters (to kindergartner), as doing a lot of things (to third grader), and as "if you can write you can go to college and do many things" (to fifth grader). Multiple variables might have contributed to or been the result of her writing problems, including transcription skills (spelling and related orthographic and morphological processes), inattention (e.g., to topic) and disregulation of higher-order as well as lower-order executive functions (Table 3.5), lack of metacognitive awareness of what writing is and ability to integrate translation with other cognitive processes for planning and revising (Hayes, Chapter 2), and attitude and motivation issues related to writing. Yet, despite her dysgraphia, her writing in grade 5 had shown improvement and development since grade 1.

Personal Writing Trek 14 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with crayon at 24 months, first produced the written alphabet at 54 months, and first wrote words and text at 72 months. No developmental problems were noted. Initially, his phonological decoding fell in the low average range but real-word reading and reading comprehension fell in the average range and above the population mean. In grades 2–5, all reading skills fell at least in the average or above average range. Oral language skills ranged from average to above average to superior. His phonological spelling was average, but his word-specific orthographic spelling in long-term memory was below average across grades. By grade 4, his relative ability in orthographic and phonological coding decreased, possibly because he did not receive accurate feedback from spelling words in writing. Researcher ratings of selective, maintaining, and switching attention ranged from fair to good (grades 1–5) to excellent (grade 2) to poor (grade 3) to fair to good (grade 4).

Profile 14 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		122, 95%tile			114, 82%tile
Letter writing	0.22	0.04	0.00	0.67	−0.20
Dictated spelling	106, 66%tile	106, 66%tile	96, 39%tile	88, 21%tile	94, 34%tile
Written expression	89, 23%tile	106, 66%tile	118, 88%tile	113, 81%tile	103, 58%tile
Word form coding					
Phonological	0.26	−0.19	0.47	−1.42	
Morphological			−0.24	0.23	0.10
Orthographic	−1.14	0.20	0.21	−1.51	
Orthographic loop					
Finger succession	1.25	−0.10	−0.26	−0.77	
Expressive orthographic				−0.89	
Executive functions					
Inhibition	10	8	10	12	
RAS	0.34	n.a.	0.60		
Working memory					
Phonological		99		110	
Orthographic—letters		1.72	−0.07	−1.01	
Orthographic—words		−0.57	−0.09	−2.29	

Profile Analysis Alphabet letter writing fell consistently in the average range with some variability within that range across the first five grades. However, in grades 3–5, this boy meets the criteria for dysgraphia on basis of spelling below the population mean and at least a standard deviation (15 points) below his verbal comprehension factor in grade 5 (see learning profile). Text composing varied from low average to average to above average, but showed relative decline from grades 3 to 5. Impaired orthographic skills were contributing to his spelling problems: receptive orthographic coding in grades 1 and 4, expressive orthographic coding in grade 4, orthographic working memory—letters and words (grade 4); and creation of word-specific orthographic spelling representations of the written word apart from phonology (grades 2–5). Note that although he received speech and language services, such services typically focus on oral language rather than orthography (visible language). Weaknesses in phonological coding were also observed in grade 4 and in phonological working memory in grades 2 and 4. Attitude to writing was extremely variable in the first three grades. Extreme avoidance of writing in grade 4 was replaced with tendency to approach writing in grade 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The boy could not write anything but dictated a topic related to the provided prompt and two statements of related events. For writing, most often a frowning Garfield was chosen but also sometimes an angry, neutral, or smiling Garfield. A possible pencil grip problem was noted only in grade 1.

Grade 2 Both essays by pen and by keyboard were extremely brief compared to the prior oral generation protocols. For the essay by pen, examples that followed from the orally generated ideas were provided but the written production was poorly constructed (not a complete clause). For the essay by keyboard, one comment was two statements about function, but not decipherable in writing, only in the oral rereading of what the boy had written. For writing, angry and frowning Garfields were chosen equally often with an occasional neutral or smiling one. Classroom writing samples were (a) home–school worksheets for which the task was to describe or depict the meaning of provided vocabulary words in written sentences and (b) two writing samples, which were printed in legible letters without consistent relative proportionality, and content reflecting creative imagination.

Grade 3 On the narrative by pen, the boy wrote a string of words without normal syntactic structures. On the narrative by keyboard, he produced a simple narrative that included statements of events and psychological descriptions for the main characters. On the four-genre writing tasks, he could not write the narrative (said he could not think of anything to write), informative essay, compare and contrast essay, or persuasive essay. Yet, he could generate ideas orally for the persuasive essay but required three prompts to keep generating, suggesting problems in self-regulated translation even when written transcription was not required. He could not orally generate plans for organizing or revising. Smiling Garfields occurred as often as angry Garfields, but neutral and frowning Garfields were also chosen. Six pages of classroom writing samples were unique in that the writing was arranged in two columns, just like printed matter, but the large amount of drawings to illustrate the ideas was far greater than the amount of writing expressing ideas. The handwritten text contained illegible letters and frequent misspellings. Some, but not all of the sentences, could be understood. Parent reported that his handwriting is atrocious and his spelling poor and he will not try hard in his writing, but he will write any sentence he can say.

Grade 4 Although the boy's oral idea generation protocol was much longer than his written essay by pen and the essay was full of transcription errors (handwriting and spelling), there was a charm in the ideas expressed when the transcription errors were corrected: "A computer is a small tv with a key (not the ones to your house), a mouse (not the one that squeaks), and an internet (link to all computers). If you have never used one, it is useless …" (translation is probably not completed when time limit reached). Unfortunately, because of his severe typing problems, his essay by keyboard could not be deciphered fully, but it appeared to be a topic sentence about a favorite personal robot given a name. On the Nolen survey, his response showed the strongest writing avoidance. No writing samples were provided. Parent comments indicated ongoing difficulties with spelling and handwriting but ability to express ideas in writing.

Grade 5 The boy's narrative writing by pen showed narrative schema with dialogue, but was very difficult to decipher due to frequent transcription errors (handwriting and spelling). His narrative writing by keyboard was shorter but contained the elements of a narrative schema. On the four-genre writing tasks, his narrative had a series of event statements; the informative essay had statements of facts related to the provided topic; the compare and contrast essay consisted of one statement of similarities and one statement of differences; and his persuasive essay consisted of statements about the controversy and about taking a stand and providing a reason (he does not like to change his mind even about his spelling mistakes, which apparently are upsetting to him). All written genre were difficult to decipher due to the transcription errors (spelling and handwriting). He was more able to easily generate ideas orally than in writing; for example, he could more easily generate a good plan for organizing his essay orally than implement it in writing, and he could orally generate a plan for revising, which included rereading the text written so far. On the Nolen survey, his response showed a tendency toward approaching writing. Classroom writing activities included (a) adding details to given paragraph to expand it, (b) printing answers to reading questions, (c) writing first draft of a creative writing assignment, and (d) writing in his science notebook that included illustrations. In grade 1, he explained writing as "It's two words that rhyme; they have the same letters and sounds alike." In grade 5, he explained that writing is a way to communicate with others and gave an example of written dialogue ("Hi," said ric") (to a kindergartner), as a way to communicate with others and gave as an example of written dialogue ("Hi how are you?" said Frank. "Good" said Bob. "Thanks for asking.") (to a third grader), and as a way to communicate (to fifth graders).

Personal Writing Trek 15 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with crayon at 12 months and first wrote text at 48 months; other milestones were not reported. No developmental problems were reported. Except for phonological decoding, which was low average in grade 1, all reading skills were in the average range or above. Oral language skills were consistently at least average and sometimes listening comprehension was higher. His phonological spelling (pseudowords) fell just below the population mean and his word-specific orthographic skills fell at that mean. Researcher ratings of selective, maintaining, and switching attention ranged from fair (grade 1), fair to good (grade 2), to poor (grade 3) to fair to good to very good (grade 4); tester ratings are not available for grade 5.

Profile 15 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		108, 70%tile			116, 86%tile
Letter writing	0.65	−0.38	0.88	1.41	−0.20
Dictated spelling	112, 79%tile	109, 73%tile	101, 53%tile	104, 61%tile	102, 55%tile (99 spell sounds)
Written expression	108, 70%tile	99, 47%tile	105, 63%tile	109, 73%tile	97, 42%tile
Word form coding					
Phonological	−1.05	0.15	0.69	−0.89	
Morphological			−0.02	0.05	−1.14
Orthographic	0.04	0.43	−0.02	−0.16	
Orthographic loop					
Finger succession	−0.54	−0.38	−0.26	−0.77	
Expressive orthographic				−0.22	
Executive functions					
Inhibition		11	12	13	13
RAS	n.a.	−0.82	−1.23		
Working memory					
Phonological		87		82	
Orthographic—letters		−0.30	n.a.	−2.37	
Orthographic—words		−0.57	n.a.	−0.76	

Profile Analysis Despite tutoring outside school for three years, this child showed indicators of dysgraphia. His letter writing on the alphabet task was variable (both below the mean where it was in grade 5 and at times above the mean) during the first five grades, suggesting that access to and retrieval of letters in the ordered set of alphabet letters in memory and subsequent written production were not automatic. Spelling dictated real words varied from above average in grade 1 to average in grade 5 (but shy one point from being 1 SD below grade 5 verbal comprehension); spelling sounds met the full criteria for dysgraphia—both below the population mean and more than 1 SD below grade 5 verbal comprehension; and word-specific orthographic spelling, which was just at the population mean, was more than a standard deviation below verbal IQ. Written composing also met the criteria for dysgraphia; the relatively lower score in grade 5 compared to earlier grades was due in part to the large number of spelling errors. Working memory weaknesses were observed in phonological coding (grades 1 and 4), morphological coding (grade 5), phonological working memory (grades 2 and 4), and orthographic working memory—letters and words (grade 5). His attitude to writing was variable from grade 1 (negative) to grade 2 (positive) to grade 4 (avoidance) to grade 5 (tending to approach).

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The boy's narrative by pen was hard to make sense of because of the transcription errors, but his oral reading of what was written identified two statements of events related to the provided topic. For writing, his Garfields were mostly angry.

Grade 2 The boy's oral idea generation protocols were substantially longer than what he could write by pen (one statement about computers helping people talk and two statements with examples of how long it takes to send a message to America or England) or by keyboard (one vague statement about robots—doing stuff for you). Most of his Garfields were smiling.

Grade 3 The boy's written narrative by pen was longer than in grade 1 but it was not clear how the clauses/comments were related to each other or to the provided prompt. His narrative was shorter by keyboard than by pen, but the relevance of the statements to each other and to the provided topic was clearer by keyboard than by pen (but not perfectly clear because of transcription errors by both keyboard and pen). On the four-genre writing tasks, his narrative was a list of statements of events; his informative essay, compare and contrast essay, and persuasive essays were not readable due to the number of transcription errors. He struggled with the oral idea generation and plan for organization and said he did not understand. Not surprisingly, for his oral plan for revision, he wished he could make sure that the words were spelled right. Due to time constraints, it was not possible to give the Garfield attitude scale. Classroom writing samples included (a) a cursive writing copy practice; (b) a manuscript printing for copy, cover, say, check activity; and (c) writing sample not possible to understand because most of the words were misspelled.

Grade 4 Although the oral idea generation protocols were longer than the written essays, the quality of the written essays had improved since grade 2. On the essay by pen, the translation product consisted of a statement that made a generalization followed by a statement with a reason followed by a statement with a personal opinion. On the essay by keyboard, the translation product consisted of a list of statements, which made generalizations and offered reasons. Even though transcription errors still occurred, they were less frequent and easier to decipher. On the Nolen survey, the boy's response showed the strongest writing avoidance. Classroom writing samples included (a) seven written activities for various social studies lessons and (b) sentence and paragraph composing items.

Grade 5 The boy's narrative writing by pen and by keyboard were not only longer than in earlier grades but also used a clear, simple narrative structure. His four-genre writing tasks included a well-written, nine-clause narrative with a clear narrative schema at the global level and interesting sentences at the local level, an informative essay with well-constructed statements about the provided topic, a compare and contrast essay with statements about similarities and differences, and a persuasive essay that stated a position on each of three controversies but no evidence to support any position. The oral idea generation protocol and oral plan for revision had more fleshed out discussion of positions and supporting evidence than did the written essay. His oral plan for revision was to make the spelling and handwriting better but to keep his positions on issues. On the Nolen survey, his response showed a tendency to approach writing, which is interesting because grade 5 writing tasks showed marked improvement in written translation. Classroom writing samples included three daily entries in writing journal. In grade 1, he explained writing as stuff you write with a pen or pencil. In grade 5, he explained writing as "used for writing messages to people in different places and explaining things using words … also useful to keep track of things and extremely useful for life" (to a kindergartner), as "useful for keeping documents and important information … in English there are 26 letters and a number of other important marks" (to a third grader), and as "used for keeping documents and other things of importance … used for writing books and stories" (to a fifth grader).

Personal Writing Trek 16 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with crayon at 24 months, first produced the written alphabet at 36 months, and first wrote words and text at 60 months. No developmental problems were noted except for sleep during infancy. Except for grades 1 and 3 when phonological decoding was low average, phonological decoding and real-word reading were average. Reading comprehension was at least average from grades 1 to 5. Oral language skills ranged from average to above average to superior. Researcher ratings of selective, maintaining, and switching attention ranged from poor to fair (grades 1 and 2), fair to good (grade 3) to very good (grade 4) to very good to excellent (grade 5).

Profile 16 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		116, 86%tile			128, 97%tile
Letter writing	−0.65	0.46	0.00	0.67	−0.83
Dictated spelling	104, 61%tile	93, 32%tile	99, 47%tile	91, 27%tile	95, 37%tile
Written expression	76, 5%tile	96, 39%tile	115, 84%tile	116, 86%tile	104, 61%tile
Word form coding					
Phonological	0.02	1.04	0.91	0.16	
Morphological			0.55	−0.13	n.a.
Orthographic	−1.33	0.43	0.69	−0.16	
Orthographic loop					
Finger succession	−0.09	0.18	−0.64	−0.20	
Expressive orthographic				0.22	
Executive functions					
Inhibition	7	9	10	10	
RAS	n.a.	1.78	1.90		
Working memory					
Phonological		94		98	
Orthographic—letters		−0.30	1.10.	−0.33	
Orthographic—words		−0.14	0.44	0.01	

Profile Analysis The boy's letter writing was variable from below the mean (grade 1), to above the mean (grade 2), at the mean (grade 3), to border average/above average (grade 4) to low average (meeting criteria for dysgraphia, grade 5). Spelling remained consistently in grades 2–5 in the average range, but below the mean and more than 1 SD below his grade 2 and grade 5 verbal comprehension; thus spelling meets criteria for dysgraphia. Written composing varied from below average (grade 1) to average and below verbal comprehension (grades 2 and 5) to above average (grades 3 and 4). Working memory weaknesses were identified in receptive orthographic coding (grade 1, low average), inhibition (grade 1, low average), switching attention (grades 2 and 3, below average), and phonological working memory (grades 2 and 4, below the population mean and more than 1 SD below verbal comprehension). His attitude toward writing was highly variable across the first five grades and in grade 5 was neutral along the approach-avoidance gradient.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 On narrative writing by pen, the boy could write only PS (but the S may have been a b, s, or 5). For writing, his Garfields were mostly smiling or angry with occasional neutral or frowning ones.

Grade 2 Oral idea generation protocols were substantially longer than written essays by pen or keyboard on both provided topics. The statements in these had grammatical errors. For writing, the boy's Garfields were mostly neutral or frowning.

Grade 3 The narrative by pen had five comments in the form of statements about events; and the narrative by keyboard had two comments that were also statements about events. In both cases, the comments were relevant to the provided topic. For writing, the boy's Garfields were mostly neutral but sometimes smiling, frowning, or angry. Classroom writing samples were seven written activity sheets from an integrated reading–writing program on which he answered comprehension questions, completed a flow map, and wrote a summary for each chapter. By parent report, school assessment indicates that he is an excellent reader and he enjoys reading.

Grade 4 As in grade 2, the oral idea generation protocols were substantially longer than the written essays by pen or keyboard. Nevertheless, the translation to oral language ceased during each idea generation protocol resulting in a tester prompt, which may indicate difficulty in sustaining working memory during the self-regulated translation bout. Thus, transcription difficulties may not be the only factor contributing to the boy's shorter products of written translation. For the essay by pen, he transformed earlier ideas into statements with two generalizations as well as two physical descriptions. For the essay by keyboard, he displayed creativity and imagination in the content of his writing despite his transcription difficulties. For example, there was a theme of contrasting options in robots illustrated by examples (e.g., can be used for mass destruction or as maids). On the Nolen survey, his response indicated strong avoidance of writing. His classroom writing sample was a well-written, computer-generated essay on a science topic but full of misspellings.

Grade 5 For narrative by pen, the boy wrote a highly imaginative story with an interesting beginning—a giant alien cat landed on the school—and a surprise ending. Likewise, his narrative by keyboard was a highly entertaining story that displayed not only the narrative schema at the global level but also writing talent in constructing very interesting sentences. Although he made many transcription errors in both handwriting and spelling when writing by pen, he made only a few spelling errors by keyboard, which may be a preferred transcription mode for him. On the four-genre writing tasks, his narrative was engaging and of about the same length as his prior narratives in the session, but his informative, compare and contrast, and persuasive essays, which had interesting sentences, were shorter. Again his oral idea generation protocol was long, indicating that he did not lack ideas to write about in expository schema. Whereas he had to be prompted in grade 4 during oral idea generation, now he used filler pauses to self-regulate his momentary disruptions in the translation process. His oral plan for organization was exceptionally well done for his grade level and took into account how to make his writing interesting—not boring—and persuasive. His oral plan for revision was to add more to the evidence for his position. On the Nolen survey, his response indicated neutrality on the approach-avoidance gradient for writing. In grade 1, he explained writing as words. In grade 5, his explanations of what writing is were not completed. However, we note that this child writer may be twice exceptional—he showed hints of writing talent and yet also of writing disability due to transcription (automatic letter writing and spelling skill) and vulnerabilities in working memory and executive functions for regulating the translation process. The observations of his translation products in oral and written format supplemented the test scores in identifying his unique profile of writing ability and disability.

Personal Writing Trek 17 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with crayon at 48 months, but no other information was reported on writing milestones. No developmental problems were reported other than sleep problems during infancy. Reading was generally average with reading comprehension superior by grades 4 and 5. Oral language skills were consistently average to above average. His phonological spelling ranged from average to above average and his word-specific orthographic spelling from below average to average. Researcher ratings of selective, maintaining, and switching attention during annual writing sessions ranged from poor to fair to very good (grade 1), to good to very good (grade 2), to fair to good (grade 3), to good to very good (grade 4), and to very good to excellent (grade 5). Although parent ratings indicated some problems with self-regulation of attention and behavior, not enough consistent problems were reported to consider a diagnosis of ADHD.

Profile 17 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		100, 50%tile			128, 97%tile
Letter writing	−0.65	0.04	0.00	−0.07	−2.09
Dictated spelling	98, 45%tile	101, 53%tile	98, 45%tile	94, 34%tile	93, 32%tile
Written expression	82, 12%tile	94, 34%tile	104, 61%tile	93, 32%tile	112, 79%tile
Word form coding					
Phonological	0.38	0.71	0.69	0.16	
Morphological			−0.24	0.05	−0.52
Orthographic	−0.35	−0.02	−0.02	−0.43	
Orthographic loop					
Finger succession	2.30	0.32	0.11	0.09	
Expressive orthographic				−0.44	

(continued)

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Executive functions					
Inhibition		16	12	10	10
RAS	n.a.	n.a.	n.a.		
Working memory					
Phonological		101		99	
Orthographic—letters		−0.97	−1.83	−0.33	
Orthographic—words		0.30	−1.15	0.01	

Profile Analysis The boy's alphabet letter writing was variable from the lower limit of average range (grade 1) to at or near the population mean (grades 2–5) to below average (grade 5). His spelling was consistently average, but below the mean except for grade 2 and consistently across all grades more than 1 SD below his grade 5 verbal comprehension. In grade 5, he met criteria for dysgraphia in letter writing and in grades 1, 3, 4, and 5 he met the criteria for dysgraphia in spelling. Working memory weaknesses were noted in finger succession (grade 1), phonological working memory (grade 4), and orthographic working memory—letters (grades 2 and 3) and words (grade 3). His attitude toward writing tended to be negative in grades 1–3, but more positive thereafter.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 For writing a narrative by pen, only the first three words could be deciphered—I had a, which were followed by words that either could not be related via invented spelling to speech sounds for real words or letter forms were not recognizable. For writing, most Garfields were angry, next most often they were frowning, but occasionally smiling or neutral.

Grade 2 The boy's oral idea generation protocols were rich with ideas, which were not expressed in his essay by pen (three short sentences) and by keyboard (two short sentences). For writing, almost all Garfields were angry. Pencil grip was noted to be a possible problem—he put all fingers around pencil except pinky.

Grade 3 For the narrative by pen, the boy wrote one well-constructed, humorous sentence, which was related to the prompt. For the narrative by keyboard, he wrote two sentences, which were spin-offs of what he had written for the narrative by pen. For the four-genre writing tasks, his narrative consisted of two statements—a setting and an event; his informative essay contained two sentences—one a repetition of the statement in the narrative and then a statement with a qualification; his compare and contrast essay consisted of two statements with physical descriptions; and his persuasive essay consisted of three questions (without question marks), which were unrelated to the provided topic. His oral protocols for idea generation and planning showed comprehension of the task but were not as long as others he produced in the study; he could not produce an oral plan for revising. All of his writing had frequent transcription errors (handwriting and spelling). Garfields were most often frowning and next most often neutral or angry. Classroom writing samples included (a) math fact practice and problem solving work sheets and (b) a printed writing sample with two unrelated sentences.

Grade 4 The boy's oral protocols for idea generation required multiple prompts to keep writing, indicating disruption in sustained working memory during oral self-regulated translation. His written essay by pen, which had transcription errors, contained six ideas—statements about the functions of computers—but lacked a topic sentence. His written essay contained four statements—one comparing robots to computers, two about the unique capabilities of computers, and one about his personal opinion—but no topic sentence; only two transcription—spelling errors were noted—apostrophe missing for possessive form and creation spelled with an *sh* (Anglo-Saxon phonics) rather than *ti* (Latin phonics), both of which are typical grade 4 spelling errors. On the Nolen survey, his response indicated a strong approach gradient to writing. Parent reported that the child is beginning to express ideas in writing and is showing imagination but tends to spell the way words sound rather than with conventional spelling. His classroom writing sample was legibly printed in pencil on lined paper with many misspellings but an interesting, sensible story line in a mystery narrative with a setting, conflict, and conflict resolution.

Grade 5 The boy's written narrative by pen was an interesting, six-sentence story with narrative elements about Halloween being canceled. His written narrative by keyboard was five clauses in length and written as two sentences; it was a list of events without explicit elements of narrative schema. On the four-genre writing tasks, his narrative consisted of an interesting, four-sentence introduction to a story; his informative essay had statements about each of the seasons but was very difficult to read because of transcription errors; his compare and contrast essay contained a topic sentence and statements about similarities with embedded comment about subtle differences; his persuasive essay was creative—he proposed creating a new name for the mountain that integrated the Native American and European explorer names given to it, and he approached the issue of paying fees to enter national parks from the perspective of business and the market. Again, he is able to express far more ideas orally than in writing. Moreover, his oral plan for organization showed awareness of need to sequence statements and his oral plan for revision dealt with how he might continue to defend his position on the controversies. On the Nolen survey, his response indicated a tendency to approach writing. In grade 1, he explained writing as something you write. In grade 5, he explained writing to kindergartners, third graders, and fifth graders as "a way to express yourself in a whole bunch of ways. You use letters and make words that make sentences that make stories." Thus, he had become aware of levels of language in writing. Again, like Child 17, this child writer may be twice exceptional—showing signs of emerging writing talent despite difficulties with transcription and sustaining working memory to support translation.

Personal Writing Trek 18 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with crayon at 12 months, produced the alphabet in writing at 60 months, and wrote text at 72 months. No information was reported as to when he first wrote words. No developmental problems were reported other than sleep problems during infancy. Reading was consistently average to above average. Oral language skills ranged from average to above average to superior. His phonological spelling was average, but his word-specific orthographic spelling was below average. Researcher ratings of selective, maintaining, and switching attention ranged from very good to excellent (grades 1 and 2), to fair to good to very good (grade 3), and to very good to excellent (grades 4 and 5). Parent ratings of self-regulation of attention and behavior indicated some problems but not enough that were consistently problems to qualify for a diagnosis of ADHD disorder (inattentive, hyperactivity, or mixed).

Profile 18 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		125, 95%tile			119, 90%tile
Letter writing	0.65	−1.21	0.29	−0.81	−1.15
Dictated spelling	98, 45%tile	93, 32%tile	95, 95%tile	84, 95%tile	88, 95%tile
Written expression	93, 32%tile	79, 12%tile	81, 10%tile	90, 25%tile	80, 9%tile
Word form coding					
Phonological	0.50	0.37	0.24	0.16	
Morphological			−0.32	−0.31	−0.21
Orthographic	−0.55	−1.61	−1.21	−0.70	
Orthographic loop					
Finger succession	0.06	−0.38	−0.26	−0.49	
Expressive orthographic				−1.33	
Executive functions					
Inhibition		7	8	9	9
RAS	−0.52	−0.24	−0.10		
Working memory					
Phonological		98		93	
Orthographic—letters		1.05	−1.24	0.35	
Orthographic—words		−1.01	0.44	0.01	

Profile Analysis The boy's alphabet letter writing was highly variable from upper limit of average range (grade 1), to low average (grades 2, 4, and 5), to average (grade 3). His dictated spelling was consistently below the mean and more than 1 SD below either his grade 2 or grade 5 verbal comprehension; thus, he met the criteria for dysgraphia-impaired spelling. Also, his word-specific orthographic spelling was severely impaired. His written composing varied from lower limits of average range (grades 1 and 4), to upper limits of below average range (grade 2) to lower limits of low average range (grades 3 and 5). Working memory weaknesses were identified in receptive orthographic coding (grades 2–4), expressive orthographic coding (grade 4), inhibition (grade 2), and orthographic working memory—letters (grade 3) and words (grade 2) and phonological working memory (grade 2). His attitude to writing was highly variable in the first three grades. However, in grades 4 and 5 he began to show signs of approaching writing.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 For narrative writing by pen, the boy's written product for the translation outcome was not readable, but his oral telling of what he had written was two complete sentences displaying first grade male humor. Most Garfields were angry except for three that were smiling.

Grade 2 The boy's oral idea generation protocols were much longer than his written essays, but he required two prompts on each and also produced several filled pauses on each (see Table 5.2). Thus, his problems in written translation may be related not just to transcription but also to problems in maintaining and sustaining cycles of working memory, which affects both oral translation without written transcription requirements and written transcription. Again, his oral reading of the text written was necessary to interpret his essay writing by pen; this oral reading indicated that text he had composed in his mind contained four ideas, only three of which were expressed in syntax (clauses). His essay writing by keyboard was readable and consisted of a string of four ideas—two of which were repetitions of the ideas for the narrative by pen. Most Garfields were smiling or neutral. Classroom writing samples included (a) a work sheet for a book report—characters, (b) a worksheet for writing answers to questions for reading program, and (c) an essay on a science topic that was printed but did not use conventional spelling or punctuation or capitalization—the picture provided was not interpretable.

Grade 3 The boy's narratives by pen and keyboard were longer than in grade 1; although many transcription errors still occurred, the narratives were more readable than in the past and both appeared to be a series of events. On the four-genre writing tasks, his narrative displayed a clear narrative schema and five of the six sentences were clearly marked with capital letters and punctuation; his informative essay consisted mainly of statements of opinion and physical description; his compare and contrast essay consisted of one statement of similarity and two statements about differences; his persuasive essay was a long run-on sentence in which he took a position and provided some support for it. Again, his oral idea generation protocol was much longer than the written essay, but his oral plan for organization just dealt with ideas, not organization, and he could not think of anyway to revise. Garfields were equally divided between neutral and frowning with some smiling or angry. Classroom writing samples included (a) two worksheets on reordering sentences that were also illustrated to create a logical linear order for essays on science topics and (b) a two-sentence essay about rainbow flowers with an illustration.

Grade 4 The boy's oral idea generation protocols were again substantially longer than his written essays, even though the latter were longer than in grade 2, but the oral think-alouds required prompting (three times for computers and two times for robots) when self-regulated translation ceased. Despite the transcription errors, a list structure with expository statements was evident in the content in the essay by pen. However, for the essay by keyboard, he wrote a creative adventure story about robots. His response on the Nolen survey indicated a tendency to approach writing. Parent reported that learning cursive has improved his handwriting and motivation to write.

Grade 5 Most of the boy's written translation products were difficult to read because of the numerous transcription problems, whether writing by pen (handwriting and spelling) or keyboard (spelling), but he used simple narrative structure in the form of a series of statements about events plus some statements with physical descriptions or qualifications. His informative, compare and contrast, and persuasive essays were so difficult to decipher, due to handwriting and spelling difficulties (e.g., writing random letter strings); thus, it is not possible to describe the schema used to organize the content. Of note, his oral idea generation protocol, which again is substantially longer than his written essay, would yield well-formed text if transcribed into writing by a scribe. Moreover, it showed evidence of thinking through the issues (reasoning) beyond just accessing or generating ideas; also no prompts were required in grade 5 as had been the case in the past. His oral plan for organizing was to use a format a fourth grade tutor outside the school had taught him so that he would not get frustrated. His oral plan for revising was to "talk to himself while writing to get his full potential for writing" and "put in a few more things in there if my hand didn't cramp up every so often." We note that this young man was receiving no special help or services at school or elsewhere for handwriting or spelling. Despite his frustrations, his response on the Nolen survey indicated a tendency to approach writing. In grade 1, he explained writing as your name. In grade 5, he explained writing to a kindergartner as a way to tell something to someway who is away like in a letter like in NY, NY; to a third grader as a way to express your feelings like in poetry and even if feelings do not make sense you learn how the writer is feeling; and to a fifth grader as a way to create a visual effect in your mind like going to another place—you get a letter saying what the place is and where. Clearly, he had normal metacognitions about writing even if he had severe transcription problems.

Personal Writing Trek 19 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first produced the written alphabet at 48 months, and first wrote words at 60 months; no other writing milestones were reported. Early in development, he had ear and medical problems. Reading was consistently average to above average and in grades 4 and 5 reading comprehension was superior. Oral language skills were consistently above average or superior. Both his phonological spelling and word-specific orthographic spelling fell in the average range. Tester ratings of selective, maintaining, and switching attention during annual writing sessions ranged from very good to excellent (grade 1), to very good (grades 4 and 5), to excellent (grades 2 and 3).

Profile 19 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		101, 53%tile			112, 79%tile
Letter writing	−0.65	1.71	1.18	1.41	0.11
Dictated spelling	101, 53%tile	96, 39%tile	92, 30%tile	96, 39%tile	96, 39%tile
Written expression	85, 16%tile	105, 63%tile	110, 75%tile	116, 86%tile	93, 32%tile
Word form coding					
Phonological	0.86	1.49	0.80	0.68	
Morphological			0.32	0.41	0.52
Orthographic	−0.75	−0.93	0.21	0.65	
Orthographic loop					
Finger succession	n.a.	−0.65	−0.26	−0.49	
Expressive orthographic				0.44	
Executive functions					
Inhibition		7	10	10	9
RAS	0.08	−0.09		0.42	
Working memory					
Phonological		120		119	
Orthographic—letters		1.05	1.10	0.35	
Orthographic—words		0.30	−0.09	0.77	

Profile Analysis Alphabet letter writing was variable from lower limits of average (grade 1) to above average (grades 2, 3, and 4) to average (grade 5). The boy's spelling fell consistently in the average range, but in grades 2–5 below the population mean and more than 1 SD below his grade 5 verbal comprehension; thus, he met criteria for a diagnosis of dysgraphia. His written composing, which previously varied from low average to average to above average, met the same criteria as did spelling in grade 5 suggesting that the dysgraphia may have been influencing his written expression of ideas. Working memory weaknesses were identified in receptive orthographic coding (grades 1 and 2) and inhibition (grade 2). His attitude to writing was generally positive except for grade 3.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 For narrative writing by pen, this boy wrote a nine-word sentence full of transcription errors, which might be translated into "I walked into class and saw my teacher's rabbit," but when asked to read it aloud, all he could recall was walked. All Garfields were smiling except one.

Grade 2 Of note, the boy's written essay by pen was longer than his oral idea generation protocol for the same topic, and when asked to read what he had written, he readily supplied seven sentences. However, his written essay by keyboard was short (two sentences) and much briefer than his oral idea generation protocol on the same topic. All Garfields were smiling except two.

Grade 3 The boy's narrative by pen was a series of four statements of events. His narrative by keyboard was a series of three statements of events. On the four-genre writing tasks, his narrative consisted of two statements of events; his informative essay consisted of three statements of fact; his compare and contrast essay consisted of a hub with two comments about both mountains and two comments about each of the mountains separately; his persuasive essay consisted of one statement about his position and one statement with a reason to support it. All these were difficult to read because of numerous transcription problems. His oral idea generation protocol contained more ideas than his written translation outcomes; he could not generate oral plans for organizing or revising (just repeated his position). All Garfields were frowning. Parent reported that the child will drag his feet and whine about writing for hours before beginning, but reading is one of his favorite things to do. Writing samples included a school writing sample and a home writing sample. Words were clearly spaced but often misspelled. Handwriting was legible.

Grade 4 Both oral idea generation protocols were substantially longer than the written essays regarding transcription mode (pen or keyboard), but the boy did not need prompting during oral idea generation. For the essay by pen, he produced a hub with nine comments on the topic. For the essay by keyboard, he produced a wheel with fanning. Nolen survey indicated a tendency to approach writing. Parent reported that the child did not mind writing as much as in the past. Classroom writing sample included a handwritten science project and two computer-generated texts, one with illustration from web. One was well structured and one appeared to be a listing of items from web without logical sequencing.

Grade 5 For both narrative writing by pen and narrative by keyboard, the boy used a ladder with a series of statements about events. For the four-genre writing tasks, his narrative consisted of an introduction (statement about key event followed by statement qualifying what was unique about the event); his informative essay consisted of a list of statements of facts; his compare and contrast essay consisted of two statements following the topic ALIKE and two statements following topic DIFFERENT; his persuasive essay consisted of taking both positions and providing support for both. Both his oral idea generation and planning for organization reflected an internal dialogue about which perspective to take and his oral plan for revision reflected ongoing thinking about the issue with related targeted additions to the text. Nolen survey indicates a tendency to approach writing. Classroom writing samples included (a) handwritten (printed) and illustrated biography of famous American, (b) handwritten (printed) and illustrated essay on a famous place in America, and (c) computer-generated narrative with dialogue. In grade 1, writing is a word, letters put together. In grade 5, he was not able to complete the written explanations of what writing is.

Personal Writing Trek 20 Boy

Writing Milestones, Developmental History, Reading, Oral Language, and Attention This boy first wrote with a crayon at 18 months, first wrote the alphabet at 48 months, and first wrote words at 84 months. No information was provided on when he first wrote text. No developmental problems were noted other than problems with sleep, attention, vision, and hearing during infancy. This child had a history of reading problems, beginning in grades 1 and 2 when accuracy of phonological decoding, real-word reading, and reading comprehension accuracy was below average to low average. However, in grade 3 these skills fell in the average range, and in grades 4 and 5 decoding and word reading fell in the average range and reading comprehension in the above average range. Reading rate measures fell in average or low average ranges from grades 3 to 5. Oral language skills spanned average to above average to superior ranges but receptive (understanding) scores were always higher than expressive (producing) ones. His phonological spelling was low average and his word-specific orthographic spelling was below average. Researcher ratings of selective, maintaining, and switching attention ranged from poor (grades 1 and 3) to poor to fair (grade 2) to good (grade 4) to fair to good (grade 5). Parent ratings of self-regulation of attention and behavior indicated some problems, but not of a sufficient number of consistent problems to qualify for a diagnosis of ADHD. In grade 3, he began taking medication for ADHD for a year and was taking it the day of testing and thereafter. After medication, fewer problems were noted on rating scale but they did still occur with some frequency.

Profile 20 of Verbal Comprehension, Writing Skills, and Working Memory Components

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Verbal comprehension		95, 37%tile			127, 96%tile
Letter writing	−0.22	−1.21	0.29	−0.44	−0.20
Dictated spelling	90, 25%tile	87, 19%tile	85, 16%tile	78, 7%tile	84, 14%tile
Written expression	91, 27%tile	n.a.	81, 10%tile	95, 37%tile	83, 13%tile
Word form coding					
Phonological	0.02	0.03	0.47	0.16	
Morphological			−0.36	−0.84	0.41
Orthographic	−0.35	−1.16	−0.74	1.51	
Orthographic loop					
Finger succession	n.a.	0.04	1.62	0.66	
Expressive orthographic			−1.11		
Executive functions					
Inhibition		3	8	7	
RAS	n.a.	0.65	1.21		
Working memory					
Phonological		78		119	
Orthographic—letters		−1.64	−1.83	−1.01	
Orthographic—words		−2.75	0.44	−2.29	

Profile Analysis The boy's alphabet letter writing was always in the average range, except for grade 2 (low average), but was always below the population mean. He met criteria for dysgraphia for spelling dictated words and for recognizing correct written spellings for specific words. His dictated spelling was consistently below the population mean and more than 1 SD below his grade 5 verbal comprehension; except for grade 1 (lower limit of average range), his spelling was low average (grades 2, 3, and 5) or below average (grade 4). His word-specific orthographic spelling was also below average. His written composing was consistently below the population mean and more than 1 SD below his grade 5 verbal comprehension. Working memory weaknesses were identified in morphological coding (grade 4), receptive orthographic coding (grades 2 and 3), expressive orthographic coding (grade 4), finger succession (grades 3 and 4), inhibition (grades 2 and 4), switching attention (grades 2 and 3), phonological working memory (grade 2), and orthographic working memory—letters (grades 2, 3, and 4) and words (grades 2 and 4). His attitude toward writing was highly variable across the grades, but showed an approach tendency in grade 5.

Self-Regulated Translation Bouts, Metacognition About Writing, and Writing Attitude/Motivation

Grade 1 The boy's narrative by pen was not decipherable, due to numerous spelling and handwriting difficulties, until he read it aloud: "My guinea pig dived from my legs into a bucket of water." Clearly, his word choice and syntactic/sentence construction were developing faster than his transcription skills. Half of the Garfields were smiling and half were angry.

Grade 2 The boy's oral idea generation protocols were not much longer than his written essays, which still were not decipherable, due to transcription difficulties, until read orally. For example, his oral reading of just produced text by pen was "On computers you can write and play games on it." Most of the Garfields were neutral or angry. The classroom writing sample was a sentence printed on primary grade lined paper with half of the page an elaborate drawing.

Grade 3 For narrative writing by pen, the boy wrote Evere tning was upsi boun! We translated that as Everything was upside down! For the first time, the reader could begin to decipher his writing's message. For narrative writing by keyboard, he just copied the provided topic sentence. For the four-genre writing tasks, his narrative consisted of a sentence (dependent and independent clause) that described an event; his informative essay consisted of one sentence; his compare and contrast essay was abandoned as just too difficult to do; and his persuasive essay consisted of two independent clauses both statements of opinion. Of note, he could not complete the oral idea generation protocols and frequently complained of forgetting while translating both orally and in writing. More Garfields were neutral, but smiling, frowning, and angry Garfields were also chosen. Classroom writing samples included spelling test, writing activities for reading program, and writing for science project with illustrations.

Grade 4 The boy's oral idea generation protocols were short like his written essays and required one or two prompts before ceasing altogether. He complained of not being able to remember. Response on the Nolen survey indicated neutrality in approach-avoidance tendency. Classroom writing samples consisted of spelling tests, sentence-construction activities, and a book contract to write a fantasy book and computer-generated summary. Both the handwritten and computer-generated part were difficult to read because of the number of words not spelled in conventionally. Also amount written was brief for a fourth grader. Parent noted progress especially when he started using computer tools, and not just scribes, and, for this progress, credited teachers at school and tutor outside school and art program at school.

Grade 5 For narrative by pen, the boy wrote three statements about events but as he wrote he supplied orally many of the intended words because he knew he was not spelling them correctly. For narrative writing by keyboard, in response to the prompt One week end at home a surprising thing happened, he wrote "aleans kame and abducted my giny pig! when they gave him back he kude speak." On the four-genre writing task, his transcription difficulties also made it difficult to translate his written translation outcomes. His narrative appeared to be four statements of events; his informative essay appeared to have statements of facts about each of three seasons. His compare and contrast essay appeared to have one statement about a difference and one statement about a similarity. His persuasive essay consisted of one statement about position and one statement in support of this position and then another statement about a second position. Of note, he needed two prompts during oral idea generation; only abbreviated versions of these ideas were expressed in his written essay. He could not generate an oral plan for organizing or revising despite one prompt for each. Response on the Nolen survey indicated strong approach gradient. In grade 1, he could not explain what writing is. In grade 5, he refused to explain what writing is. Again, this response raises the issue of whether metacognitive awareness or lack thereof is an influential variable in translation development and if so in which direction.

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6

Translation Skills and Trade-Off in Young L2 Learners' Written Narrations

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In Flemish primary schools, 8-year-old children are expected to produce written texts that meet a gradually increasing number of content-related and formal demands. Teachers are very much aware that writing requires a lot of effort from their young pupils. For pupils who must write in a language that is not their mother tongue, the challenge may be even more daunting. For these pupils, finding the right words to convey their ideas or intentions is particularly hard work, especially when they are expected to produce the kind of academic language with which they are not familiar at home; this challenge, for instance, is the case for children of low-SES[*] parents. As a result, it should come as no surprise that the written output produced by young low-SES, second language learners is scored lower in terms of text quality compared to the written output of high-SES, L1[†] speakers (Braun, Forges, & Wolmainck, 1997; Krom, Verhelst, & Veldhuijzen, 2004).

In this chapter, we will focus on the development of text quality by young low-SES L2 learners enrolled in Dutch-only schools. Over a one school year period of time, the children wrote six narratives based on a nonverbal comic, four times guided by their teachers while doing so. The parameters we selected to evaluate text quality are closely linked to Skehan and Foster's (2001) *limited attentional capacity* mode, more in particular to their concepts of "complexity" and "accuracy."

[*] SES = Socio Economic Status refers to an individual's or family's social and economic position, based on income, education, occupation and/or wealth.

[†] L1 being referred to as the language of instruction in a certain linguistic area, being Dutch in Flanders.

Microgenetic analyses of the children's written output and the classroom environment in which the texts were written will be reported with a view to gaining a deeper insight in children's development of translation skills and the variables that impact upon this development.

This chapter will illustrate the impact of the teachers' pedagogical choices during writing sessions on the interplay of "complexity" and "accuracy" in the written narrations of young second language learners. The analyses show that a learner who is encouraged to pay all his attention to accuracy at word and sentence level is hindered as far as complexity development is concerned, whereas a learner who is supported in his ambition to build more complex sentences in order to tell a story also shows progression as far as accuracy is concerned. Trade-off is not a necessity, but a feature of the pedagogical approach.

PRESSURES OF YOUNG WRITERS AT RISK DURING THE TRANSLATING PHASE

From the age of 8 years onward, children are expected to produce communicative, and increasingly extensive, written messages: Thoughts have to be put in words, words need to be combined in sentences, and sentences must shape texts that meet growing demands of communicative effectiveness, content-related appropriateness, and form-related accuracy. Most 8- to 10-year-old children are motivationally ready to take up this challenge (Kress, 1994), but find it hard to meet all those demands at the same time for three reasons.

First, 8- to 10-year-old children are still limited in terms of working memory capacities, which are necessary for the coordination of the multiple processes that writing requires, for example, "planning and generating content, finding language to express content, organizing text, and monitoring what is being written" (Berninger & Swanson, 1994). Writing research amply shows that young writers may devote considerable resources to the demanding transcription processes of writing letters and individual words (Berninger, 1999; Berninger et al., 1992; McCutchen, 2000; Medwell & Wray, 2008). As a result, little mental space remains for the higher-order processes that are crucial for constructing sentences and coherent text.

Second, young children's approach to writing assignments has been described by Bereiter and Scardamalia (1987) as "knowledge telling": Single thoughts are put on paper one after the other, with the writer paying little heed to the contextual coherence between them. Berninger and Swanson (1994) described young writers' planning processes as online and local, as compared to the global preplanning of more experienced writers. The latter reach the stage of "knowledge transforming": The messages they put on paper reflect mature knowledge that has been transformed in the process of creatively revising and reshaping text in line with the functional goals the output needs to meet.

Third, young children may experience a lot of difficulties familiarizing themselves with the particularities of the new communicative situation that writing entails: They are not yet used to communicating without the instant support of an interlocutor who provides them with online clues about the comprehensibility of their messages, the amount of information they should provide, and the kind of information for which the receiver is looking (Bereiter and Scardamalia, 1987). Eight-year-old children lack the full competence to "imagine" the absent reader, taking into account his/her potential needs. As a result, children write in a "writer-based" rather than a "reader-based" way (Flower, 1979). For children, writing is far more "symbolic play" than communicative behavior, at least when practiced a solitary way rather than in the social context of writers' workshops. The child gets fully immersed in the process of experimenting with verbal symbols, instead of focusing on the production of a reader-friendly message (Perfetti & McCutchen, 1987).

Producing written text may be particularly demanding for young second language learners of Dutch (the main medium of instruction in Flemish compulsory education).* One contributing factor is that a great proportion of the non-Dutch-speaking pupils in Flemish education belong to socioeconomically disadvantaged families and their parents have not had as much formal education as have the parents of more socioeconomically advantaged students. Numerous studies illustrate the strong impact of family support of early literacy development on the development of reading and writing skills (Lanauze & Snow, 1989; Snow, Burns, & Griffin, 1998), irrespective of the language in which this support is provided (Reese, Garnier, Gallimore, & Goldberg, 2000). Wells (1985) and Genesee and Riches (2006), among others, show strong correlations between the social status of families (SES, as indicated by the parents' educational degree) and the available sociocultural capital, including the importance attached to literacy (e.g., reading bedtime stories). In line with this research, Dutch national assessments show that the writing skills of children of less educated parents significantly lag behind, both halfway and toward the end of primary education, in terms of the communicative and linguistic quality of the texts the children produce (Krom, Verhelst, & Veldhuijzen, 2004; Van de Gein, 2005). In Flanders, Colpin, Heymans, and Rymenans' (2005) pilot study showed a positive effect of the variable "member of a library and/or a school of music" on various parameters of output quality, including "content," "organization of information," "formal text structure," and "goal directedness." Likewise, in the United States, Moats, Foorman, and Taylor (2006) identified more problems in the narratives of 10-year-old socioeconomically disadvantaged Afro-American pupils than in middle-class children's output.

Socially disadvantaged children, who are supported to a lesser degree by their parents while developing their emergent literacy skills, will probably be less acquainted with the typical features of written language. They may assume that writing equals speaking on paper. They may not fully appreciate the wide potential of written language in expressing ideas or intentions (also see "Formulation" in list that follows). They may be less familiar with communicative situations in which absent and distant interlocutors participate. As a result, they may be far more dependent than children of highly educated parents on the teacher's support when trying to produce written output. For these children, the teacher will act as the

* We may call them DLL (Dutch Language Learners) in parallel with the term ELL (English Language Learners) as used for children whose mother tongue is different from English.

main, if not the sole, agent of literacy. The teacher, then, has a great responsibility when it comes to familiarizing these children with the demands of writing tasks.

In addition, a child's oral language skills and reading skills in a particular language have a direct impact on the written output they produce in that language (Reese, Garnier, Gallimore, & Goldberg, 2000). For pupils of Flemish primary education who were raised in another language than Dutch, and whose Dutch language proficiency has been shown to be significantly lower than their Dutch-speaking peers (Ramaut, Roppe, Verhelst, & Heymans, 2007), producing Dutch written output may turn out to be a daunting challenge. Alamargot and Chanquoy's (2001) model of translating—the second component in Hayes and Flower's (1980) writing process model—may be helpful to grasp fully this challenge. Integrating ideas and concepts of, among others, Hayes and Flower (1980), Hayes (1996), Bock and Levelt (1994), Grabrowski (1996), and van Dijk and Kintsch (1983) in their model, Alamargot and Chanquoy distinguish four levels of translating:

1. *Elaboration*: This phase "consists of retrieving and elaborating the text content from a piece or the totality of the text plan" (Alamargot & Chanquoy, 2001, p. 68). The result is *multidimensionality or hierarchically organized content*, considered to be an elaboration and a specification of main ideas mentioned in the text plan.
2. *Linearization*: In this phase, the hierarchically arranged content is transformed into a *linear preverbal semantic–syntactic structure* (subject–predicate), that is, "an interfacing representation between the thought (concepts) and the language (i.e., the transformation of concepts into words)" (Alamargot & Chanquoy, 2001, referring to Bock, 1982). This transformation implies the making of semantic choices: Which proposition or knowledge unit will be considered as "given"? Which one as "new"? What will be the "topic"? What is going to become "comment"? The choices also imply that an order is imposed on the various knowledge units. Basically, a natural/functional order could be respected, but pragmatic needs or rhetorical decisions, for example, may necessitate a different order. In that way, the communicative effectiveness and/or the aesthetic appreciation of the text may be strengthened.
3. *Formulation*: At this level of processing, the preverbal semantic–syntactic structure is matched with grammatical and lexical structures, so as to produce a *verbal entity, a sentence.* Local models of oral sentence production and general speaking (and writing) help to understand this phase. Bock and Levelt's (1994) sentence production model divides the formulation phase into two processing levels:
   a. The "functional level" composed of two subprocesses: (1) lexical concepts that are identified in order to translate the concepts of the message into language ("lexical selection") and (2) grammatical functions and relationships that are appointed to each lexical concept ("function assignment").

   b. The "positional level" on which the order of the words and their morphology are determined.

      Grabrowski's (1996) generic model introduces auxiliary systems, which prepare the preverbal message for its linguistic formulation and, in particular, for writing. Specific processes or kinds of processing in the auxiliary systems for written encoding do not offer the same possibilities as in oral encoding, for example, for emphasis. "The markers and modalities of marking therefore differ between the media" (Alamargot & Chanquoy, 2001, p. 78).

4. *Execution*: In this phase, the writer must effectively *transcribe* the sentence that has been processed. It contains the programming and the execution of necessary motor and eye movements to produce a text, either by handwriting or by typewriting, and check what has been written.

Formulation can be expected to be highly complicated for children with limited target language proficiency: They will often lack the grammatical and lexical resources and/or skills to turn a preverbal message into an adequate verbal construction. This tension is likely to come to the surface of these young children's texts in different ways. First, they may avoid treating certain aspects of the message they want to convey because they cannot find the right words. Second, looking for alternative ways to get parts of their message across, they may lose the general overview of what they have written so far, and as a result, produce incoherent text (Weigle, 2002). Third, the language they ultimately put on paper will reflect their current state of interlanguage (Braun et al., 1997; Ellis, 1985), including sentences that do not yet meet the lexical and/or syntactic standards of native speaker language. Fourth, the attention they have to devote to trying to express complex ideas may be at the cost of accuracy (or vice versa), in line with Skehan and Foster's (1997, 2001) and Skehan's (2007) limited attention hypothesis (see also Nelson & Van Meter, 2007).

A recent study of two-way immersion education (Howard, Christian, & Genesee, 2004) confirmed that young second language learners produced texts of a significantly lower quality than mother-tongue speakers, at least with regard to "composition," "grammar," and "spelling/punctuation." In this study, the differences between the two groups diminished as the children grew older (between third and fifth grade), but did not fully disappear. The authors also noticed a wide variation in the quality of the second language learners' texts. In a similar vein, the Flemish pilot study of the national assessment of 12-year-old pupils' writing skills revealed a significant effect of the variable "home language other than Dutch (spoken with parents)" on one aspect of "communicative effectiveness," that is, "goal directedness" (Colpin et al., 2005). Cameron and Besser (2004) found a negative effect of "mother tongue not English" on the variables "accuracy of expression (formulaic speech)," "use of prepositions," "sentence complexity (subordination)," and "complexity of the verbal predicate" in the written narratives of 10- to 11-year-old pupils. They found no impact of "home language not English" on "lexical richness"; for "spelling" the second language learners even outperformed the mother-tongue speakers of English.

TRADE-OFF BETWEEN COMPLEXITY AND ACCURACY?

Although focusing on adult L2 learners, the Limited Attentional Capacity (Skehan, 2007; Skehan & Foster, 1997, 2001) may provide a useful description of the pressures inherent in the translating phase of young L2 writers at work:

> … attentional limitations for the L2 learner and user are such that different areas of performance compete for one another for the resources that are available (Skehan & Foster, 2001, p. 205).

With regard to formal aspects of writing tasks, a tension is bound to arise between conservatism and risk taking, which Skehan (2007) refers to as a tension between "form-as-accuracy" and "form-as-ambition" (referring to complexity), and which may be influenced by the way in which the process of task performance is handled (e.g., including a planning phase or not). Skehan and Foster's (1997) review of two cross-sectional studies (Foster & Skehan, 1996; Skehan & Foster) led to a similar conclusion:

> The evidence for trade-off effects is very strong. Learners required to complete tasks seem unable to prioritize equally the three performance aspects of fluency, accuracy, and complexity. Achieving more highly in one seems mostly to be at the expense of doing well on the others, with competition between accuracy and complexity particularly evident (Skehan & Foster, 1997, p. 207).

Skehan and Foster (1997) see their model primarily as a way of explaining what happens while students are performing writing tasks. The empirical support for their model is mainly drawn from cross-sectional studies. For young learners in particular, we may wonder whether trade-off has a major impact on children's *growth* of writing skills. In this respect, Weigle (2002) has claimed that different aspects of writing proficiency may develop at divergent rates; as a result, the relationship between the progress measured in different parameters may be subject to large interindividual variation: Different aspects of writing ability develop at different rates for different writers (Weigle, 2002, p. 121). This possibility may imply that trade-off may be a feature of any individual performance, as well as a feature of developmental processes: Substantial progress for one feature may lead to another feature being put "on hold." This possibility of both individual and developmental influences raises the question of whether there is a limited set of learning trajectories focusing on a particular configuration of target features while significant gains in other sets of features are delayed. Can we identify interconnected sets of features that progress along the same steady lines, for instance, because they are conceptually linked, resulting into high positive correlations between the learning gains for these features (e.g., between "orthography" and "accuracy at sentence level")? And does the progress with regard to a particular feature warrant firm predictions about the regress of another feature (e.g., the tension between meaning and form, form-as-ambition versus form-as-accuracy), giving rise to negative correlations between their respective gains scores?

WRITTEN NARRATIONS OF YOUNG L2 LEARNERS AT RISK: COMPLEXITY VERSUS ACCURACY

Do Children All Have the Same Concept of What Constitutes a Good Text?

In an empirical study, we analyzed short narratives (describing a cartoon) written by young third-grade DLL (age 9) belonging to socioeconomically disadvantaged families. In this study, the low correlations between various parameters for text quality indicate that different children have different conceptions of what constitutes a good text. In particular, we focused on the correlations between the accuracy of the T-units (syntactical correctness) and the complexity of the T-unit (number of words per T-unit). Below, the two plots in Figure 6.1 show that all possible combinations actually occur, at the beginning (Occasion 1) as much as at the end (Occasion 2) of grade 3: The plot includes texts with high or low scores on both features, as well as texts combining high scores on one feature with low scores on the other. Thus, in grade 3, those two aspects of text quality are not linked with each other in any systematic way in a measurement at a specific moment.

Do Children Change Their Conceptions of Text Quality over Time?

Pupils make significant gains for both variables in the course of the school year. However, when we correlate scores for the parameters denoting accuracy and complexity, using T-unit accuracy and T-unit complexity, between the beginning and at the end of grade 3, the analyses show correlations of $r = .45$ ($p < .001$; $N = 106$) (for accuracy) and $r = .25$ ($p < .05$; $N = 106$) (for complexity). This finding implies that both variables are quite unstable over time. Pupils who were quite good in one or both aspects of text quality at Occasion 1 will find themselves in the lower ranges of the distribution of scores at Occasion 2, even more so for complexity than for accuracy. Their conceptions of text quality are not stable.

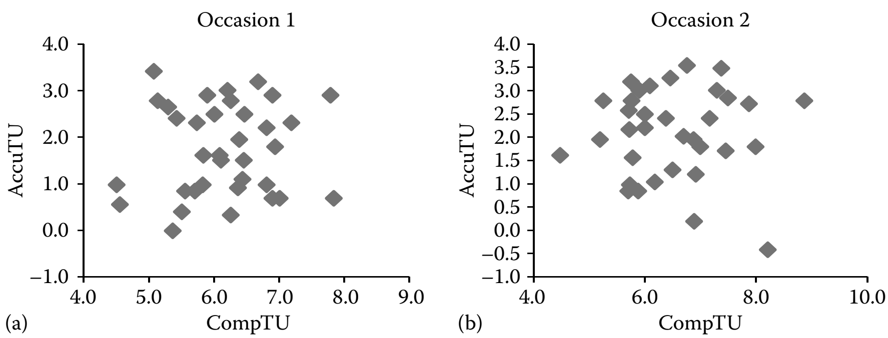

Figure 6.1 Scatterplots between complexity and accuracy of T-units in narratives written at the beginning (Occasion 1) and the end (Occasion 2) of grade 3 (age 9).

Do Children Invest in One or Both Parameters of Text Quality?

Because we have established that complexity and accuracy do not seem to be related in grade 3 narratives of DLL (low correlations) and that neither of the text features is stable over time (low correlations again), we now wonder whether children, when developing their written production skills, invest in both variables or focus on one of them, at the cost of the other variable, in the latter case pointing to different patterns of growth. Inspection of learning gains may shed light on this issue. The weak and negative correlations between the learning gains in complexity versus accuracy in grade 3, viz. $r = -.27$ ($p < .05$; $N = 106$), empirically substantiates a trade-off effect. Young writers who invest more in accuracy during the year seem to be losing some grip on complexity and vice versa. Figure 6.2 shows a graph of this negative correlation.

In sum, the results of our study on two occasions regarding the early development of text quality partially corroborate Foster and Skehan's (1996) and Skehan and Foster's (1997) findings substantiating a tension between risk taking and conservatism. Form-as-ambition and form-as-accuracy seem to be in competition with each other. In contrast with Skehan and Foster's cross-cohort studies, our research findings are based on gain scores: Progress made for form-as-ambition tends to show (weak) negative correlations with progress for form-as-accuracy. Pupils who make significant progress for form-as-ambition tend to be risk takers, who dare to trust bold ideas to the paper, and are not afraid to make errors. But other children seem to be far more conservative in the way they handle their writing: They show learning gains for form-as-accuracy (syntactic accuracy), but almost no progress for features related to form-as-ambition (complexity of the T-unit). In the next paragraph, we will see that choices these two types of learners made are influenced by the pedagogical choices made by their teachers.

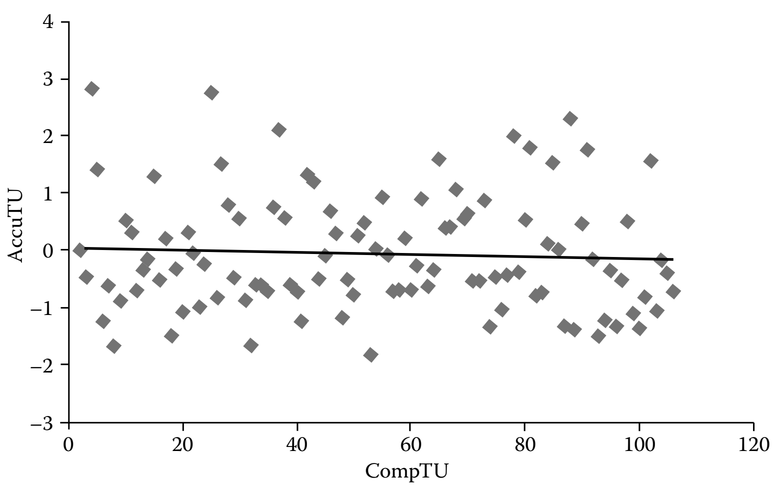

Figure 6.2 Scatterplot of learning gain scores of T-unit complexity and T-unit accuracy during grade 3.

TRADE-OFF OR NO TRADE-OFF? A TALE OF TWO CHILDREN

Here, we present the cases of two students, one of whom can be characterized as a conservative writer, the other one as a risk taker. Pupil 1, Merve (9 years old), is in Miss Wonny's class, which is heterogeneous as far as the students' home language is concerned (Dutch being the lingua franca). Merve is the child of Moroccan, less educated parents. She is assertive and communicative. She likes socializing, talks a lot, and admires her teacher. Merve's Dutch language proficiency is intermediate: She speaks fluently, but finds reading quite hard. Pupil 2 is a boy called Muhammet. He is also 9 years old. He is in Miss Teresa's class. Like most of his classmates, he is the child of Turkish, less educated parents. Muhammet is rather shy and quiet, but he often shows to be strongly involved with what goes on in the classroom. The pupils in this classroom are expected to speak Dutch all the time. Yet Turkish is ubiquitous, within and outside the classroom. Muhammet's Dutch language proficiency is intermediate: He does not speak very fluently, but is a relatively good reader.

We followed Muhammet and Merve at six occasions within the same school year (2006–2007): twice during a non-guided writing session at the beginning and the end of the school year (also see the section "Written Narrations of Young L2 Learners at Risk: Complexity Versus Accuracy" earlier in this chapter), and four times during a guided session (see Table 6.1 for an overview).

At the beginning and the end of the school year, the pupils were asked to perform individually a writing task during a non-scaffolded writing (NSW) session; they were not supported by their teachers or peers during these sessions. In the course of the school year, they performed similar writing tasks four times, while being supported by their respective teachers, Miss Wonny and Miss Teresa (scaffolded writing (SW) sessions). The pupils were asked to write a narrative based upon a cartoon, which differed for each session (e.g., ICE-CREAM, Appendix 1). These guided sessions were spread over 2 days. The teacher was asked to present the writing assignment on day 1, and to make sure that every pupil could hand in an individual text at the end of that day; on day 2, the teacher reflected on the children's output. Every teacher organized these sessions in the way she saw fit. The cartoons were handed over to the teachers about a fortnight before the actual session.

During the writing sessions, we observed teacher and student actions (using video and audio recordings). We also conducted interviews with the teachers and collected all students' output together with the oral and written feedback from teachers. We analyzed our data using a narrative analysis approach: We arranged

TABLE 6.1 Writing Sessions: Time and Type

September	November	January	March	May	June
Y_n	Y_n	Y_{n+1}	Y_{n+1}	Y_{n+1}	Y_{n+1}
NSW1	SW1	SW2	SW3	SW4	NSW2

Note: Y: Year; NSW: non-scaffolded writing session; SW: scaffolded writing session.

our data in a chronological order, allowing us to situate changes in specific parameters in a coherent framework of resources and variables (Lavelli, Pantoja, Hsu, Messinger, & Fogel, 2005; Polkinghorne, 1995).

COMPLEXITY AND ACCURACY IN WRITTEN NARRATIONS: QUANTITATIVE RESULTS

The graphs in Figures 6.3 and 6.4 describe the evolution (over six occasions) of four parameters of text quality and of the production rate of Merve's and Muhammet's narratives:

1. Complexity of the T-unit (CompTU): mean number of words per T-unit
2. Complexity of the clause (CompCL): mean number of words per clause
3. Accuracy of the T-unit (AccuTU): the probability that the next T-unit will be accurate
4. Spelling (spelling): the probability that the next content word will be spelled correctly
5. Length: the absolute number of words per text

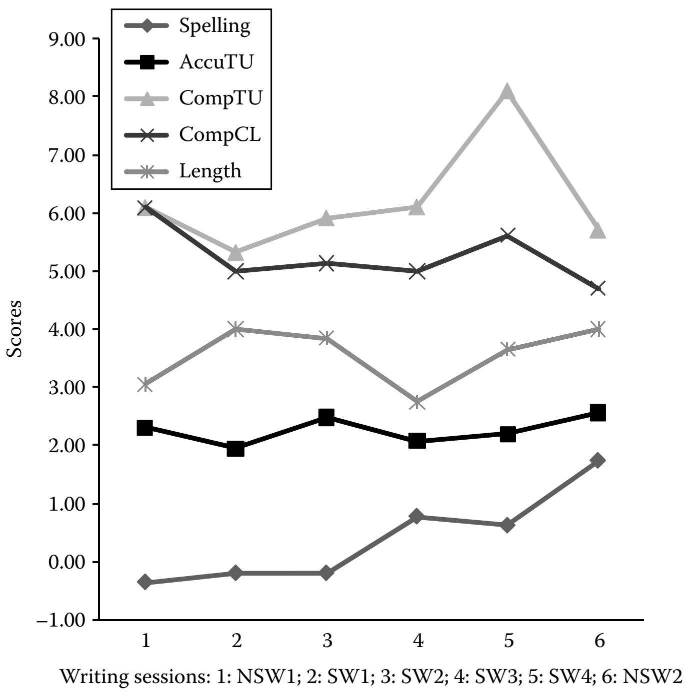

Figure 6.3 Results for each occasion for accuracy spelling (spelling), complexity T-unit (CompTU), complexity clause (CompCL), accuracy T-unit (AccuTU), and length (divided by 6) in the first (or only) drafts of Merve, Class 1.

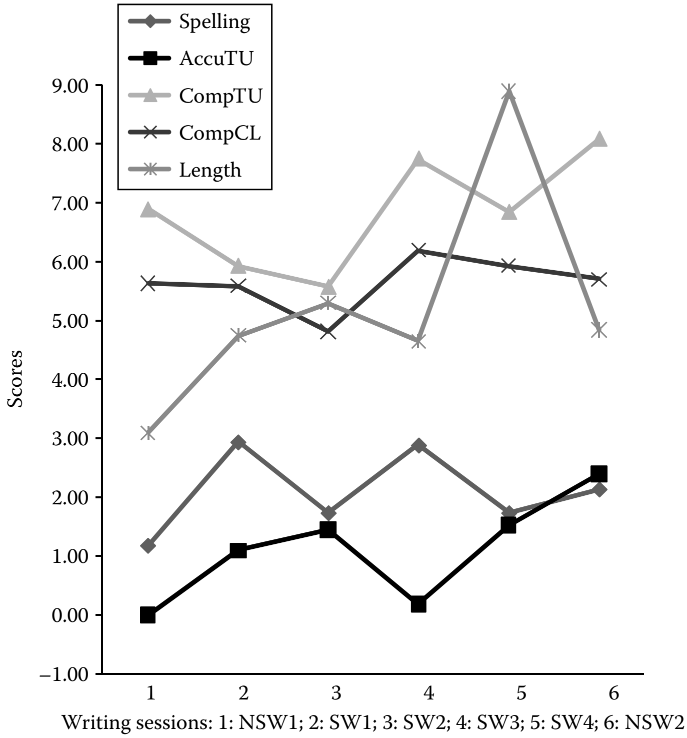

Figure 6.4 Results for each occasion for accuracy spelling (spelling), complexity T-unit (CompTU), complexity clause (CompCL), accuracy T-unit (AccuTU), and length (divided by 6) in the first (or only) drafts of Muhammet, Class 1.

The capriciousness of the developmental trajectories of the variables and the interplay of the capricious variables produce fascinating patterns. To allow the reader to picture the concrete scene behind the graphs, we add the first and last text of each of the pupils (texts at occasions 1 and 6 in Figures 6.3 and 6.4).

Writing Product 1: Class 1, Merve, NSW1

Mneer jan gaat naar de markt //	Mister john goes to the market
En hij wilt een ijsje // mar het was veel	And he wants an icecream bt it was much
Te duur // dus koopt hij 1 kg banan. //	Too expensive so he buys 1 kg bananas.
En hijj tXXX éénte je op // het schiltj	And hea XXX one the skin
gooi de hij op dgrond. //	he throws on thground.
Els hat een ijsje gekogt. //	Els hat bouht an icecream
Els struikde met haar ijsje // meneer jan	Els stumed with her ice cream mister john
kwam kijken. //	came to take a look.
Mener jan koopten een nieXXXijsje	Mistr john buyed a neXXXice cream
voor Els // en mneer jan goojde zij	for Els and mster john threu hi
schieltje in de vuilbak. //	skeen in the dustbin.

// indicates the end of the T-unit.

Writing Product 2: Class 1, Merve, NSW2

Meneer Jansens gaat naar de winkel // hij koopt een tros	Mister Johnson goed to the shop he buys a bunch of bananaas. He eats ones.
banaaen. // Hij eet er eenteje op. //	
Meneer Jansens gooit de schil op de grond. //	Mister Johnson throws the skin on the ground.
daar is Lies // ze koopt een ijsje // ze loopt	there is Lies she buys an icecream she walks
verder // Ze ziet de schil niet ligen // valt.	on She does not see the skin falls.
Meneer Jansens ziet Lies // Ze is boos.	Mister Johnson sees Lies. She is mad.
Meneer Jansens helpt Lies op / en zegt sori /	Mister Johnson helpf Lies to get up and says sorry
ik heb zeeker neit juist ge miekt // kom //	i have noot ??? come
dan koopt ik een niewe ijsje. //	i'll buy you a new ice cream.
En Lies gaat zonder te	And Lies goes home without
valen naar huis met een ijsje. //	falling with an ice cream.

// indicates the end of the T-unit; / indicates the end of the clause within a T-unit.

Writing Product 3: Class 2, Muhammet, NSW1

Er was eens man / die fruit wild. //	There was a man who wante fruit.
En kijkt hij naar de baanaan. //	And he looks at the banaana.
en dan eet ze de banaan // en gooit hij de schil //	And then she eats the banana and he throws the skin
En dan gaat er een meise / die karlien heet. //	And then there a gil goes who is called karlien
En glijd ze op de grond. //	And slip on the ground.
En o het meise is ge valen. //	And o the gil has fall en.
En de man gaat turug naar de winkel. //	And the man goes bak to the shop.
En de man geeft zij een ijsje //	And the man gives she an ice cream
En karlien gaat turug huis //	And karlien goes bak home

// indicates the end of the T-unit; / indicates the end of the clause within a T-unit.

Writing Product 4: Class 2, Muhammet, NSW2

Een man was naar een fruitenwinkel gegaan /	A man was gone to the fruits shop
En heeft een banaan gekoopt voor 1 euro //	And has buyed a banana for 1 Euro
De man gaat naar huis // de man was vergeten om te gooien naar vuibak. //	The man goes home the man had forgotten to throw to dusbin.
Hij heeft de schil op de grond gegooit. //	Hij has thrown the skin on the ground.
Karin was een ijsje gekoopt / en gaat naar huis //	Karin was buyed an ice cream and goes home
Karin was op het banaan getrapt / en heeft gevalt //	Karin was treaded on the banana and has falled
Dan was Karin boos // en de man kijkt //	Then Karin was mad and the man looks
De man gaatnaar bij leon / en koopt nieuwe ijsje //	Then the mangoes to leon and buys a new ice cream
Dan heeft de man de schil terug naar de vuilbak gegooit. //	Then the man has thrown the skin back to the dustbin.
En Karin was terug blij // want de man had een nieuwe ijs gekoopt	And Karin was happy again for the man had buyed a new ice

// indicates the end of the T-unit; / indicates the end of the clause within a T-unit.

The graphs vividly display the unpredictability of the output: The different variables behave in a whimsical way across the occasions (cf., Larsen-Freeman, 2006; Verspoor, de Bot & Lowie, 2004). Verheyden (2010) demonstrated that we should refrain from interpreting the capriciousness as trivial, meaningless "noise," but rather should view it as meaningful intraindividual variance in its own right, that is, "music" not noise!

Unexpectedly high or low scores, for example, for length (low for both pupils in session 4 and high in session 5 for Muhammet) might indicate a certain task effect, for instance one having to do with the topic raised in the cartoon (Rijlaarsdam and Wesdorp, 1988; van den Bergh, de Glopper, & Schoonen, 1988). Some topics might elicit more language and more elaborate stories than others. In this respect, the drop in number of words that both pupils display in session 4 might be influenced by the rather technical topic of the cartoon: To describe how a technical problem can be solved, pupils need to mobilize a lot of specific vocabulary. This necessity may have inspired the pupils to adopt avoidance strategies. At the same time, topics may give rise to interindividual differences: Children differ in their preferences for certain topics, as might be the case in session 5.

Sudden jumps in the pupils' scores might also provide an indication of learning that is going on (Larsen-Freeman & Cameron, 2008). Merve shows two sudden jumps for spelling in an otherwise gradually increasing curve. On these occasions, she seems to be better able to keep the number of spelling errors under control. This interpretation may indicate that she has now captured certain spelling rules, or has had the chance to practice certain word images, or is now paying more conscious attention to spelling in her written output.

The patterns may also be influenced by children's change of focus as they are trying to deal with the multiple demands of writing assignments. In the translation phase, children need to cope with a multitude of different subroutines and processes. Chances are that immature, second language learners may selectively attend to those different aspects, focusing on one particular on one occasion, and on another on the next occasion (cf., Skehan, 2007; Skehan & Foster, 1997, 2001). This explanation might also account for the lack of significant correlations between the results for AccuTU and CompTU, both for NSW1 and for NSW2 (cf., Figure 6.1, Occasion 1 and Occasion 2). We cannot ascertain which variables trigger the change of focus, but task effects (certain stories trigger more accurate formulations because the reader needs specific details) or teacher effects might be at play here (Skehan & Foster, 1997).

The change of focus also points toward relationships between growth patterns of different parameters (Weigle, 2002). In this respect, we must distinguish a simultaneous increase or decrease (parallel movements) from trade-off processes, in which the increase of one parameter goes hand in hand with a decrease for another parameter. Earlier, we claimed that *form-as-ambition* (complexity) and *form-as-accuracy* might be in competition. This insight might explain some of Merve's patterns. Her sudden jumps for spelling between sessions 3 and 4, on the one hand, and sessions 5 and 6, on the other hand, go hand in hand with a decrease in the scores for other parameters, such as number of words and complexity at sentence level. Between sessions 1 and 2 something similar appears to happen: While her spelling scores of session 2 are higher than those of session 1, the complexity of her sentences decreases and the number of words is on the rise.

Muhammet's output displays similar patterns: Although complexity at sentence level decreases, the number of words and spelling scores increase. These patterns might be influenced by the mere fact that session 1 is a non-guided session and session 2 is scaffolded. Evidently, the teacher has the potential to have a strong impact on the children's focus while they are writing. This likely possibility might, at the same time, explain why Merve's patterns are not simply reproduced by Muhammet. In his case, the rise in complexity at sentence level is complemented with an increase of spelling scores and accuracy of the T-unit.

In terms of trade-off, the two children show opposite tendencies across the occasions. Merve's output shows a clear decrease of complexity of the clause (–20%), which is more or less compensated with a slight rise of "CompTU," which she basically owes to a number of juxtapositions (with ellipsis) in the writing product of SW4 (e.g., "The man gets out of the car and calls the ambulance"). Conversely, she shows clear gains at the level of spelling: In text 1, Merve spells 8 out of 18 selected words correctly (while 10 contain an error). In text 6, 17 out of 20 selected words are spelled correctly. "AccuTU" shows no movement in Merve's output, possibly because of ceiling effects: In the first half of the year (NSW1, SW1, SW2) only one out of 10 to 12 (simple) sentences contains an error, which sometimes might be attributed to an attitudinal problem (no revision), rather than to a lack of insight or competence. "But al ended came al well in the end" (SW2). In Muhammet's case, we see positive tendencies for all parameters. Contrary to Merve, his scores for "AccuTU" are relatively low at the beginning of the year: His text at NSW1 (Writing Product 3) contains 10 sentences out of which five are correct and five contain errors at sentence level; his text at NSW2 (Writing Product 4) includes 12 sentences, only one of which contains errors. Combined with the rise in complexity at sentence level, this growth of "AccuTU" is quite significant. Across the different assignments, Muhammet does not seem to be paying a price for raising the complexity of his sentences.

MERVE AND MUHAMMET'S NARRATIVES: QUALITATIVE ANALYSES

In this section, we discuss to what extent an analysis of the teachers' pedagogical choices produces any elements that might explain why certain parameters of Merve's and Muhammet's text quality behave in such idiosyncratic ways. We offer a *dynamical description* (Larsen-Freeman & Cameron, 2008; Van Gelder & Port, 1995) of Miss Wonny's (Class 1) and Miss Teresa's (Class 2) classroom practice during the four scaffolded writing sessions (SW1–4). We refer to the concrete interactions between the teachers and the two pupils, which do not significantly deviate from the teachers' interactions with the other pupils in the same class. We limit our discussion to the passages that help us explain why Merve (Class 1) and Muhammet (Class 2) show different growth patterns.

We add excerpts taken from (semi-structured) interviews we conducted after each session with the teachers, the latter discussing the rationale behind their interventions.

Writing Sessions in Miss Wonny's Class

The four writing sessions in Miss Wonny's classroom follow a similar procedure. During lesson 1, an introduction is organized (during which the contents of the story are discussed) and the pupils write a first version of their stories. Lesson 2 is devoted to offering collective feedback, individual feedback, and practice in reading aloud a number of stories and the spelling of misspelled words. Only in SW3 (and for some pupils in SW4), the teacher works with a draft version and a revised version.

The *introductory phase* consists of three parts. First, the topic of the cartoon is introduced: The teacher invites the pupils to talk about their personal experiences related to the topic. Then the teacher shows the cartoon and constructs the story together with the most talkative (and verbally proficient) pupils in an average of 4 min, as illustrated in the following (Student–Teacher Dialogue 1). The cartoon is added in Appendix 2.

Student–Teacher Dialogue 1: Class 1, SW1

LK:	Het is aan't regenen. En hij komt juist uit't bad, en wat gebeurt er dan? (Verschillende LLN steken vinger op, onder wie Valerie) Valerie!	T:	It's raining. And he has just finished his bath, and then, what happens next? (Some children raise their fingers, among whom Valerie[a]) Valerie!
Valerie:	Het hondje springt in een plas en hij wordt helemaal nat.	Valerie:	The dog jumps into a puddle and he gets wet all over.
LK:	Ja, nat en vuil en vies. Dus wat moet de jongen daarna doen?	T:	Yes, wet and dirty and muddy. So what does the boy heve to do?
Valerie:	Nog es in bad.	Valerie:	Back to the bath.
LK:	Terug in bad, ja. En op het volgende prentje … wat zie je daar?	T:	Back to the bath, yes. And the next picture … what does it tell?
	LK: leerkracht a: Valerie is een van de KOP-leerlingen van de klas.		*T: teacher a: Valerie is head of the class.*

Afterward, the pupils together with the teacher formulate the most important things to keep in mind while writing: Spelling in particular and the level of the sentence (capitals, punctuation) are highlighted.

SW1: Teacher: "So what are we going to pay attention to when we are writing sentences?" The correct answer is "capitals and punctuation."

SW2: Teacher: "When we start writing, we mind our spelling, capitals and punctuation; don't write long sentences; vary at the beginning of the sentence." In addition, the pupils are invited to cover the contents of the story and to produce a title. In SW3 and SW4, the same items are highlighted.

The next *phase of individual writing* is different in SW1 and SW2 from SW3 and SW4. In SW1 and SW2, this phase takes approximately 30 min: the pupils write one draft. In SW3 and SW4, however, a full hour is devoted to this phase because Miss Wonny allows the children to produce a first draft and a revised version. The pupils do not completely use the available time in any of the sessions. When they are ready (some of them already after 10 min), they occupy themselves in silence (e.g., coloring the cartoon).

In SW1 and SW2, the teacher interactionally supports the children as they are writing. She responds to individual children's questions, which are mostly about spelling, and points out inadequacies with regard to layout, neat writing, contents, or spelling. She offers advice: "You should try to formulate short sentences. Don't write long sentences." To Merve, she makes remarks about her handwriting ("I can't read that") and corrects some of her spelling mistakes, verb conjugations, and capital letters. She rounds off with some positive feedback: "very good."

In SW3 and SW4, Miss Wonny starts experimenting with a new approach: The children must (SW3) or are allowed (SW4) to write a draft and a revised version. They are not interactionally supported while writing, however. In SW3, they are not offered interim feedback (between first draft and revision). Only pupils who ask the teacher a question (mainly with regard to spelling) are offered advice and support. The teacher advises the children to read through their first draft. She again points out a number of focal points, such as capital letters, punctuation, short sentences, and spelling. In SW4, the teacher is intensively involved with the children who produce a draft version. She runs over the whole draft, and mainly corrects errors related to spelling, punctuation, and capitals. Merve elicits the teacher's support once: "How do you write *ambulance*?" In SW4, Merve produces only one version.

In the *feedback phase*, we can distinguish individual feedback (delivered both orally and in writing) from collective feedback. On day 2, the pupils receive individual feedback about their stories: The teacher has marked, underlined, or corrected a number of errors related to neat writing, spelling, capitals, and punctuation. Here and there, sentence construction is marked or corrected. If necessary, the teacher indicates a gap in the contents of the story. At the bottom of the page, a verbal evaluation or mark (or both) is jotted down; some of these are accompanied by a personal hint, for example, "Where is your title?"

Writing Product 5: Class 1, Merve, SW2, Plus FB (Excerpt)

Julie heben tog niet het zotke uit gangen	**Yo havn't been fueling around**
Julie heb*b*en to*ch* niet het zotke uit*gehangen*	Yo hav*e*n't been f*oo*ling around
toen ik weg was! Ja julie moeten neiuwen vas	**when I was away! Yes, yo've got to bye neu vas.**
toen ik weg was! Ja julie moeten neiuwen vas	when I was away! Yes, yo've got to bye neu vas.
koopen. Jan en Doenja haten hun lesje	**John and Doenja hat learnd their lesson.**
koopen. Jan en Doenja ha*dd*en hun lesje	John and Doenja ha*d* learnd their lesson.

(continued)

geleert. Maar alls kwam tenslot kwam alls wergoed.	**But everthing in the ent everthing turned out alrigt.**
geleert. Maar alls kwam tenslot kwam alls weergoed.	But everthing in the ent everthing turned out alright.
Ze gaan andere bloemen kopen!	*They are going to buy new flowers!*
Goed Waar is je titel?	*Good Where is the title?*

Bold: The text as written by the child.
Default + italics: the text plus what the teacher added, for example, corrections, an addition related to content, a verbal evaluation.

The same points that deserve attention are reformulated during the collective feedback phase. In this way, the pupils are offered explicit signals about the teacher's focal points of attention, the criteria she uses to distinguish good stories from weak ones, and her likes and dislikes. In sum, Miss Wonny emphasizes the importance of correct language at the word and sentence level on the one hand, and completeness at the content level on the other hand. In both the introductory and the feedback phase, the same points for attention recur: spelling, capitals, and short sentences. For this teacher, telling a written story is a linguistic exercise in the first place, an exercise that will offer chances to the pupils to raise the accuracy levels of their written output at word and sentence level. Covering the contents of the story is essential, but writing these down is correct because error-free language is of primary importance.

This focus is consistent with the major goals of her writing sessions and criteria for evaluation that Miss Wonny mentions in the interviews. Discussing SW1, for instance, the teacher mentions a twofold objective: (1) making sure the pupils understand the story (cause–effect) and (2) reminding them to avoid a number of problems such as producing long sentences and to spell and use capitals and punctuation correctly. The writing process is reduced to complying with construction rules at word and sentence level. During the interview following SW3, the teachers mentioned that one of her main objectives is for the pupils to monitor their sentence constructions and use of capitals. She further adds that her written feedback is focused on the very same points; for purposes of evaluation, she focuses on contents and "to some extent" on sentence construction. Spelling was not a criterion for evaluation, she adds, although she corrected a lot of spelling errors, which is due to the pressure from the headmaster and the parents.

The importance this teacher attaches to short sentences is quite intriguing. In the interview following SW4, we asked Miss Wonny whether she prefers advising her pupils to produce short sentences, if in that way they can avoid producing a lot of errors, or encourages them to produce longer sentences even if this results in more errors. Miss Wonny replied that her pupils are allowed to stretch their muscles and take risks, even if that gives rise to errors. She also added that this option primarily applies to her best pupils (whom she calls by name) and not for the pupils who perform less well. The latter pupils she would advise to write short, concise sentences.[*] She concluded by saying that it is very easy to write short sentences (SW4). It seems as if Miss Wonny aims to reduce the first phase in these children's writing development to a focus on accuracy. Her motto goes as follows: avoid errors, play safe, so write short sentences!

Merve appeared to respond to her teacher's advice in an exemplary manner: In her narratives, the attention she paid to spelling gradually intensified, whereas her average clause length decreased. As for the latter, at one particular occasion, we were able to notice quite clearly that Merve had registered Miss Wonny's advice and paid heed to it. In SW1, Miss Wonny tried to make clear to Merve why short sentences are so important (cf., Student–Teacher Dialogue 2).

Student–Teacher Dialogue 2: Class 1, SW1

LK:	Ik heb het gisteren al gezegd, kortere zinnen schrijven. Ja bij u (=leerling van wie ze de tekst bespreekt) was het ook aan één stuk he. [de juf hapt hoorbaar naar lucht]. Ik was helemaal buiten adem als ik het aan het lezen was. Dus begin elke keer met een hoofdletter en eindig met een punt.	T:	I've already told you yesterday, write short sentences. Yes, you too (=the student whose text the teacher was discussing). In your text it went on and on and on [the teacher showed physically how she is out of air]. I was completely breathless while reading your text. So please don't forget the capitals and the punctuation marks.
LL:	(die zich het gesprek van de dag voordien herinnert): Juffrouw na **drie** zinnen was u al moe!	S:	(who remembers the interaction of the day before): Yes miss, after **three** sentences you were tired to death!
	LK: leerkracht; LL: leerling		*T: teacher; S: student*

In SW2 (6 weeks later), the teacher again formulated the motto "short sentences." She also referred back to the previous session. Merve clearly remembered: The picture of the teacher who was "out of breath" has stayed with her (Student–Teacher Dialogue 3). Her sentences clearly illustrated that this message was imprinted in her memory.

Student–Teacher Dialogue 3: Class 1, SW2

LK:	X, ik geloof da jij da vorige keer was. En er waren nog kindjes. Die schrijven maar, ma je moet af en toe es stoppen hé. Want anders heb ik geen adem meer om te kunnen lezen hé. Dus korte zinnekes maken.	T:	X, I think it was you last time. But there were others too. They go on writing, but, you've got to stop from time to time, haven't you? Because otherwise I don't have enough breath to read your text. So please write short sentences.
Merve:	Juffrouw, ene keer toen gij had XXX (=overstaanbaar) blaadje gelezen, en ge hebt **drie** zinnen gelezen en ik wist ni meer XXX (=onverstaanbaar) lezen.	Merve:	Miss, one time, then you had XXX (unintelligible) read a text, and you have read **three** sentences and I didn't know XXX (unintelligible) read.
	LK: leerkracht		*T: teacher*

[*] Merve is counted among the latter group. "She is at the tail, but she tries her best" (SW3).

Merve clearly understood Miss Wonny's advice. "Short sentences" constitute one of the main criteria for evaluating written narratives. Merve also inferred from the various lesson phases that this advice may actually have multiple meanings: Sometimes Miss Wonny mentioned "short sentences" when discussing the formal boundaries that are expected when producing written language, but at other moments the same motto seems to refer to the splitting of juxtaposed sentences. In oral accounts, these units are connected with "and," but in written language this use of "and" needs to avoided. In addition, Merve had built up the idea that "short sentences" are also linked with error-free, accurate sentence constructions: Simple sentences stand a better chance of remaining without errors. Merve seems to have incorporated all this instructional feedback pretty well, as her draft version of SW3 amply illustrates: Writing Product 6.

Writing Product 6: Class 1, Merve, SW3

Amber gaat fietsen	Amber goes for a bycicle ride
maar ze nog niet vertroken	but before she has even leaft
en haar bande is al plat.	her tyr is flat.
Dus gaat ze gereedschap pakken.	So she goes inside to catch some tools.
Amber haalt het ventiel eraf.	Amber takes off the valve.
En papa komt helpen.	And daddy gives a hand.
Ze haalen de binnenband eruit en stopen het in een emer waater.	They tak out the inner tyre and pud it in a buccet of waater.
Ze werken en werken tot alls klaar was.	They work and work untill everhting was finished.
En Amber kost gaan fietsen.	And Amber cold go for a ride.

Writing Sessions in Miss Teresa's Class

Miss Teresa adopted the same procedure during the four writing sessions, each consisting of two lessons. At the beginning of lesson 1, an introduction was organized during which the contents of the story were discussed, after which the children wrote a first draft. Lesson 2 was devoted to collective feedback, individual feedback, and the writing of a revised version (final draft).

The *introduction* of day 1 served one major goal: reconstructing the story together with the pupils. This phase took approximately half an hour. For Miss Teresa, two lesson objectives, which have to do with writing development, are linked to this introduction. On the one hand, she discussed the contents that need to be covered in the stories: focus on the main ideas and the story line (rather than on every single detail), and make sure that a reader who cannot see the pictures is able to follow the story. On the other hand, Miss Teresa tried to demonstrate how the children can put these ideas into words. She urged the children to come up with appropriate sentences and tried to co-construct exemplary formulations for each scene in the story: The pupils offered chunks and formulas, which were taken up by the teacher to paraphrase the story in more appropriate and genre-specific formulations. The following excerpt (Student–Teacher Dialogue 4) provides a nice illustration of this double focus: Miss Teresa drew the children's attention to important events in the story, while at the same time inviting the pupils to verbalize these contents in "nice sentences": "Who can say that in a nice sentence?", "What's a nice way of saying that?"

Student–Teacher Dialogue 4: Class 2, SW3

LK: Wie kan iets vertellen over tekening 1? LL1!	T: Who can tell something about the first picture? S1!
LL1: Juffrouw, de kindjes speelt met zen auto.	S1: Miss, the kids plays (sic XXX) with his car.
LK: Dat kindje, ja, speelt met zijn auto ja.	T: The kid, yes, the kid play with his car, yes.
LL1: Die heeft in zijn hand zo iets.	S1: He's got something in his hand.
LK: Wat is da?	T: What is it?
LLn: Afstandsbediening, machine	Sn: Remote control, machine.
LK: Af-stands-bediening. Ik zal dat woord aan 't bord schrijven.	T: Re-mote Con-trol. I'll put the word on the blackboard.
De Af-stands-bediening.	The re-mote-con-trol.
LK schrijft "afstandsbediening" op het bord. Geroezemoes.	T writes "remote control" on the blackboard. There is some buzz???
LL2 zegt stil iets over een afstandsbediening.	S2 says something about the remote control.
LK: Wablief?	T: I'm sorry?
LL2: Dan gaat hij de afstandsbediening, op de knop drukken, en dan gaat de auto …	S2: The remote control, he wants to, to push the button and the car goes …
De leerlingen praten door elkaar.	The students all answer at the same time.
LK: Vooruit of achteruit. Die gaat bewegen hè. Of naar rechts of naar links.	T: Forward or backward. It's going to move, isn't it? Or to the right or to the left.
LL2: Op zijn auto is vlaggetje.	S2: On the car there is a flag.
LK: Aan zijn auto hangt een vlaggetje, ja. Euhh.Da kun je natuurlijk allemaal vertellen in uw verhaaltje hè. [suggestief] Maar is da heel belangrijk da ge zegt "er zit een vlaggetje aan die auto?"	T: Yes a flag is attached to the car. Of course you can tell all that in the story you're going to write, [leading question XXXX] but is it very important to tell "there's a flag attached to the car"?
LL2: Nee	S2: No.
LK: Nee, want 't gaat over wat er gebeurt in het verhaaltje. Het gaat nie over die éne tekening, het gaat over het verhaaltje alles samen. [alsof dicterend] Dus, een jongen … [normaal] hoe kun je da nu kort zeggen met 1 of 2 zinnetjes? Wat is die aan het doen?	T: No, indeed, because it's about what is happening in the story. Your text is not about that one picture, but about the story, about all pictures together. [writing aloud] So, a boy … [normal] how are we going to say all that in one or two sentences? What is he doing?
LL3: Ja, een jongen die rijdt met zijn auto.	S3: Yes, a boy is playing with his toy car.
LK: [alsof dicterend] Een jongen is aan het spelen met zijn auto op af-stand-be-die-ning, [normaal] zo zeggen we dat hè.	T: [writing aloud] A boy is playing with his re-mote con-trol car; [normal] that's how we say it.
LK: leerkracht; LL1–3: leerling 1–3	*T: teacher; S1–3: students 1–3*

At the end of her introduction, Miss Teresa repeated the written assignment, emphasizing that the children need to write a "nice story." She also reviewed a number of secretarial criteria such as punctuation, capitals, and spelling.

The next phase, which consists of *guided individual writing*, took approximately 30 min and was highly similar for the four sessions. The children were writing: Some were ready after 10 min and were allowed to color the pictures of the cartoon. Miss Teresa only intervened when the children asked her a question. She urged them repeatedly to work independently. Exceptionally, the teacher read what the children had written (over their shoulder) and corrected minor linguistic errors. The teacher did not attempt to support the children in formulating their ideas or intentions; she did not mirror in this phase what she had been doing during the collective introduction. For an illustration, see Student–Teacher Dialogue 5.

Student–Teacher Dialogue 5: Class 2, SW3

LK:	Allez probeer maar hè. Welke tekening zijt ge?	T:	Come on, have a try. Which picture are you at?
	Bilal: Daar juffrouw		Bilal: There miss.
LK:	Goed. Vertel gewoon. [alsof dicterend] Opeens of plotseling stopt de auto met rijden. Hij is sip. [gewoon] En dan? … volgende tekening. Ik had u gezegd nummertje daar … Allez, probeer maar Bilal. Probeer het maar.	LK:	Good. Tell me. Just tell. [writing aloud] All of a sudden the car stops. He is sad. [normal] And then? … next picture. I've told you already, a number … Number 3 … Come on, Bilal, have one more try. Have a try.
	LK: leerkracht		*T: teacher*

On day 2 of each writing session, Miss Teresa offered a dual form of *feedback*: On the one hand, she offered each pupil individual feedback, which is written on the child's first draft; most of the teacher's remarks concerned secretarial aspects (spelling, capitals, and punctuation) and (occasionally) sentence construction. On the other hand, she discussed a number of stories with the whole class. In SW1 and SW2, this feedback took approximately half an hour; in SW3 and SW4, this feedback took only 10 min. In SW1 and SW2, a number of sentences were reformulated collectively, which some children found rather difficult because they could not see the text. The teacher read the sentences aloud, one at a time. She asked the children to listen very carefully and to evaluate whether the sentence was nice or correct. The children were invited to identify the error and to correct it orally. If they failed to do so, the teacher took over. In SW3 and SW4, Miss Teresa focused more on the assessment of the overall texts: she again pointed out the crucial importance of "nice sentences," as illustrated in the excerpt Student–Teacher Dialogue 6.

Student–Teacher Dialogue 6: Class 2, SW4

LK:	Ik ga eens kijken wie een mooie zin gemaakt had of mooie dingen had verteld … LL1 had dat goed gedaan hé. Mooie zinnen. Eens kijken wat er staat. Ze had een titel gekozen "Een cadeautje voor Ender en Nermin." En luister maar eens wat een mooi ver …, wat een mooie zinnen ze gemaakt heeft. [leest hardop] "Ender en Nermin krijgen een cadeautje ze doen het pakje open en kijken." Seg maar hoeveel zinnen zijn dat eigenlijk zo als ik dat lees? "Ender en Nermin krijgen een cadeautje ze doen het pakje open en kijken." Is dat één zinnetje of zijn er meer zinnetjes?	T:	I'm going to have a look at who has written nice sentences or who has told nice things … S1 has done a good job! Nice sentences. Let's have a look. The title is "A present for Ender and Nermin." And listen, it's such a nice story …; they are such nice sentences she has written. [reading aloud] "Ender and Nermin receive a present they open the present and take a look." But tell me, how many sentences have I been reading? "Ender and Nermin receive a present they open the present and take a look." Is that only one sentence or are there more sentences in what I've read?
LLn:	Eén	Ss:	One
LK:	Meer zinnen. Ik zou daar puntjes zetten en een hoofdletter maken. Twee zinnetjes van maken hé. En dan wordt het zo "Ender en Nermin krijgen een cadeautje." Mooie zin hé … Stop, de zin is gedaan. Punt hé. "Ze doen het pakje open en kijken." Is da ook een mooie zin?	T:	More than one. I would introduce a full stop and write a capital to make two sentences. Then we get: "En dan wordt het zo 'Ender and Nermin receive a present.'" Nice sentence. Full stop. This is one sentence. "They open the present and take a look." Is that a nice sentence too?
	LLn.: ja	Ss:	Yes
LK:	Oké, die is prima.	T:	Okay, that's fine.
	[…]		[…]
LK:	LL1! Goed, jij hebt dat goed gedaan. Mooie zinnen. Euh juf heeft ook gelet op een paar schrijffoutjes. Jij gaat die proberen te veranderen maar het was een heel goed verhaal met mooie zinnen. Prima.	T:	S1! Good, you've done a good job. Nice sentences. I've also highlighted some small writing mistakes. You're going to try to correct them, okay? But it was a very nice story with very nices sentences. Well done!
	LK: leerkracht; LLn.: leerlingen		*T: teacher; Ss: students; S1: student 1*

Starting from a number of incomprehensible stretches of text in the stories produced by the children, the teacher also drew the children's attention to the reader's perspective: "You are supposed to give your story to someone who cannot see the pictures, and this person reads your story, and then he is supposed to be able to picture the story, and to say: ah that's the way the story goes." Afterward, Miss Teresa offered all pupils the opportunity to rewrite their own stories: They do not have to stick to their original versions. They are allowed to rewrite and revise at leisure. They are granted ample time to do so (on average 25 min). During this revision phase, the teacher did not offer any individual support. The pupils could only make use of the written feedback they received.

In sum, we conclude that this teacher follows the same pattern during days 1 and 2 of each session. During collective (introductory) moments, she emphasized both what the children should write about and how they can construct nice formulations: A story needs to be told in a clear and coherent way, using nice sentences. Co-constructing examples of nice sentences, the teacher demonstrated how these genre-specific formulations come about. When the students started writing or revising, they are working independently, and are mainly left to their own devices. The pupils also had to pay attention to criteria such as “spelling,” “capitals,” and “punctuation,” but the teacher exerted little pressure in this respect.

Asking about her main goals and objectives during the interviews, Miss Teresa mentioned a number of elements that may sound familiar by now: First, her main objective she formulated as follows: “You should be able to write a story using a number of pictures, and you should be able to tell what is happening.” In addition, the children need to pay attention to spelling, capitals, and punctuation, “because you want them to write accurately, and you are afraid that some errors are going to fossilize.” Nevertheless, errors are not what she is primarily worried about. Second, building contents and sentences needs to be done through oral interaction. Everything starts with the orals skills; writing comes afterward: “If you can’t say it, you cannot write it down in any way.” Finally, the teacher is not convinced that advising less proficient children to write short sentences is the proper thing to do. She commented on this with a rhetorical question: “So you would say to the children that a short sentence is better, but is this always the case?”

As one of the introverted children, Muhammet hardly participated in the collective (introductory) phases of “picture reading” and “oral rehearsal.” These interactions were dominated by a few very assertive pupils, whom the teacher failed to control. Maybe she didn’t even want to do so, because she is convinced that listening can be a very rich experience for the less skilled children (interview following SW3). During the guided individual writing, we could not mark any relevant interactions between Muhammet and the teacher that dealt with spelling or sentence construction. Muhammet did, however, receive positive feedback and a number of hints and error corrections: “Nice,” “Very nice,” “Well done,” combined with a large number of corrections (mainly spelling errors and capital letters). In SW3 and SW4, the teacher also drew attention to problems with sentence construction, two of which are quite surprising (Writing Product 7). The teacher revised an essential part of sentence 1: throwing the marble is an essential action in the game that is played in the story. Sentence 2, which contained an interesting juxtaposition of two sentences (with ellipsis), is reduced to two shorter sentences, while other instances of juxtaposition are left untouched.

Writing Product 7: Class 2, Muhammet, SW4, First Draft Plus FB (Excerpt)

(zin 1)	(sentence 1)
jan Pakt de knikker en gooit en Lies pakt de knikker En gooid	**john Takes a marble and throws and Lies takes a marble And throwz**
jan Pakt de knikker en gooit en Lies pakt de knikker ~~*En gooid*~~	john Takes a marble and throws and Lies takes a marble ~~*And throwz*~~
(zin 2)	(sentence 2)
Jan gaat naar zijn mama. En zegt warom heb jij dit gedaan dat was ongelukig.	**John goes to his mother. And says whay have you done this it was unhapy.**
Jan gaat naar zijn mama. *Hij* ~~*En*~~ zegt warom heb jij dit gedaan dat was ongeluk*k*ig.	John goes to his mother. *He* ~~*And*~~ says whay have you done this it was unhap*p*y.

Bold: The text as written by the child.
Default + italics: the text plus what the teacher added, for example, corrections, an addition related to content, a verbal evaluation.

Obviously, Muhammet himself considers objections against these actions, for in the second version we read (Writing Product 8)

Writing Product 8: Class 2, Muhammet, SW4, Second Draft (Excerpt)

(zin 1)	(sentence 1)
jan Pakt de knikker en gooit Lies pakt de knikker En gooit	**john Takes a marble and throws Lies takes a marble And throws**
(zin 2)	(sentence 2)
Jan gaat naar zijn mama en zegt warom heb jij dit gedaan dat was een ongeluk	**John goes to his mother and says whay have you done this it was an accident.**

The corrections make clear that Muhammet makes his own decisions with regard to sentence construction: He does not incorporate some of the teacher's feedback.

SUMMARY

In the case of Miss Wonny's writing sessions, it seems that the way the sessions have been set up and the feedback given to the children, rather than focusing on writing a story considering a reader, in fact, they highlighted mainly the accuracy aspect of language use. Despite all the possibilities of the writing task, the way in which the teacher interacted with the children before, during, and after the writing placed the emphasis on accuracy only. The pictures as such, and the introductory talks, which could have generated lots of ideas for writing, were marred by the repeated remarks about full stops, capital letters, spelling, and short sentences. Being an exemplary pupil, Merve followed her teacher's advice, which led in her particular case to a dramatic trade-off between the learning gains for form-as-accuracy (i.e., spelling) and for features related to form-as-ambition (complexity of the T-unit). The microgenetic analyses show that this girl, who was encouraged to pay all her attention to accuracy at word and sentence level, was hindered as far as complexity development is concerned.

In Miss Teresa's writing classes, lengthy oral rehearsal phases were introduced in order to help the children to tell/write a story about the given content to/for a possible reader: Under the guidance of their teacher, children talked in whole-class sessions right before (re)writing. These talks were focused on the content they were going to tell and on the words, chunks, and sentences they could use. This approach does not mean that Miss Teresa neglected the secretarial aspects of writing. The checking for spelling, punctuation, and neatness was relegated to the phase when children had to write a second draft. These writing sessions gave Muhammet the input to get along with his written language acquisition. His graph shows some capriciousness of the developmental trajectories of the variables: the boy's written language was changing at many levels. After one school year, his learning trajectory led to better results as far as accuracy and complexity were concerned. Writing indeed is a dynamic process.

DISCUSSION: A TALE OF TWO TEACHERS

Translation, as defined by Hayes and Flower, and explored even further by Alamargot and Chanquoy among many others, is a very intricate stage in the writing process. During translation, the activity of producing, creating, writing text is taking place. For young learners, especially when they are low-SES, second language learners, the transition from non- and preverbal constructs to verbal constructs (formulation) on paper (transcription) is extremely challenging: They have to find the right words in the right combination and the right order and write them down according to orthographic conventions and in a legible handwriting. Apart from the impact of transcription skills on text quality (Berninger, 1999; Berninger et al., 1992) and in line with Limited Attentional Capacity (Skehan, 2007; Skehan & Foster, 1997, 2001), it should not come as a surprise that signs of trade-off between aspects of text quality, that is, accuracy and complexity, can be observed in the daily writing of children as well as in their developmental trajectories. Quantitative analyses have indeed revealed that these two aspects of text quality are not linked with each other in any systematic way (partial idiosyncratic trade-off) and that learning gains for complexity and accuracy are weakly negatively correlated, which points at a certain degree of trade-off. Indeed, the microgenetic analyses of narrations written by two 9-year-old pupils in two different classrooms during third year of primary school, and the classroom contexts in which they were produced, have demonstrated that trade-off is *not* necessarily a necessity, but that it may depend on the teachers' pedagogical choices during writing sessions. The analyses show that a learner who is encouraged to pay all his attention to accuracy at word and sentence level is hindered as far as complexity development is concerned: trade-off takes place. On the contrary, a learner, who is supported in his ambition to build more complex sentences in order to tell a story, also shows progression as far as accuracy is concerned.

In the two cases we have elaborated, the teachers' pedagogical choices had a critical influence on written language development (Moats et al., 2006; Nye, Konstantopoulos, & Hedges, 2004). The first teacher stressed the importance of accuracy before, during, and after writing, and in doing so she reinforced the priority children spontaneously give to surface features such as neatness and accuracy (Fisher, Jones, Larkin, & Myhill, 2009). Merve, one of her pupils, did the utmost to live up to these criteria, which the teacher overtly reinforced. However, this girl was not challenged nor given any scaffolding nor sense of security to invest more in the complexity of translating ideas into writing, that is, moving her own boundaries when trying to "translate" (Hayes & Flower, 1980), for example, about the story characters and their adventures. Skehan and Foster (1997) would call this pupil conservative in the way she handles her writing. We would rather talk about a conservatism-promoting *teacher*. Being a low-SES second language learner, a child such as Merve is almost completely dependent upon her teacher to learn about the criteria to which her writing has to meet (Oliver, Philp, & Mackey, 2008). Mercer (1995) expressed the learner–teacher interactions as follows

> … that a learner's actual achievement is never just a reflection of that individual's inherent ability, but is also a measure of effectiveness of the communication between a teacher and a learner (Mercer, 1995, p. 72).

The second teacher did not completely neglect the secretarial aspects of the writing product, but she made them subordinate/secondary to more quintessential criteria of story writing: content and formulation. In order to make the pupils aware of these criteria, the teacher introduced different kinds of talk (Fisher et al., 2009): (a) *talk for idea generation*, which implies talking about the content of writing separate from the act of writing, (b) *oral rehearsal*, the "oral" translation of spoken ideas into written sentences just before they are written, and (c) *talk for metacognitive activity*, that is, thinking aloud about writing. These interactive scaffolds, which also broadened the pupils' thinking of what good story writing is, helped students when they tried to "translate" what they wanted to tell, for content had been selected and formulation was modeled. The talk supported the pupils, including Muhammet, to take the risk of trusting bold ideas to the paper. These well-scaffolded and secured trials encouraged him to move his boundaries. Because secretarial aspects were not neglected, but relegated to the end of the writing session, when a second draft had to be written and the (spelling) errors of the first draft could be corrected, Muhammet could also make progress as far as written language accuracy is concerned. Skehan and Foster (1997) would call Muhammet a risk taker. Parallel to our suggestion earlier, we would call the *teacher* a promoter of risk taking, and this low-SES second language learner benefits from his teacher's input.

Studying language development via microgenetic analyses of learning trajectories with multiple texts and contexts has proven to be fruitful. Instead of average results of different cohorts at different ages in a cross-sectional research study, completely cutoff from the contexts in which the studied products were realized, this approach of studying the learning when and where it takes place reveals how development or change in learning to write occurs over time (Lavelli et al., 2005; Siegler, 2006; van den Bergh, 2009) and which context factors have what kind of impact. As far as second language writing development is concerned, Larsen-Freeman (2006) and Verspoor et al. (2004) have applied this microgenetic approach from a Dynamic Systems Theory perspective (Larsen-Freeman & Cameron, 2008):

> I do not think that the effects of instruction can be factored later, any more than learner factors can be included after we have figured out the learning process. Remember that in (dynamic) complex non-linear systems, the behavior of the whole emerges out of the interaction of its parts. Studying parts in isolation one by one will tell us about each part, but not on how they interact (Larsen-Freeman, 1997, p. 157).

These authors referred to the capriciousness of the learning trajectories as "the waxing and waning of patterns," and concluded

> It is by looking at "the messy little details" that we see that behavior is variable and context dependent (Larsen-Freeman, 2006, p. 611).

Modeling 30 third-graders' development of text quality observed at six occasions spread over one school year, Verheyden (2010) operationalized the messy little details, statistically known as intra- and interindividual variability, which should not be considered mere error: Young second language writers follow their own changeable developmental path, as was also found for those whose first language was English (see Chapter 5). Larsen-Freeman links this kind of observation to the essence of language development:

> While all this instability might have been seen at the time as a threat to the systematicity of ILs (=interlanguages), chaos theory is reassuring in this regard. For as Percival notes, there is persistent *instability* in complex dynamic *systems*. If we view ILs as complex dynamic systems, a perspective I am advocating, then the problem of reconciling systematicity and instability is eliminated—an unstable system is not a contradiction in terms (Larsen-Freeman, 1997, p. 156).

> IL must be conceived as the evolving grammar of the learner adapting to an evolving target grammar, not as one of a set of successive approximations to a steady-state grammar (Larsen-Freeman, 1997, p. 159).

Further and more thorough quantitative investigation is needed to examine whether context-related factors such as writing instruction in interaction with individual learners can explain part of the inter- and intraindividual variance. In that respect, this qualitative study of two individual trajectories has already revealed that writing instruction ("focus on accuracy" versus "talk to support writing") and teacher support might indeed explain part of the observed variance between the two pupils.

CONCLUSION

Qualitative microgenetic analyses of the writing development of two low-SES, DLL third graders (9 years old) from two different language backgrounds, revealed that diverse kinds of pedagogical interventions, focused at the translating phase (Hayes and Flower, 1980), may be related to the progress or lack of progress that individual pupils make, due to trade-off or no trade-off between the learning gains for sentence complexity and sentence accuracy plus spelling. A writer-based writing approach stimulated child 1 to focus on forms: In order to be as accurate as possible, the child wrote short sentences, supposedly to avoid risks—trade-off between accuracy and complexity. The reader-based writing approach child 2 could enjoy challenged him to tell a story in well-constructed sentences for a possible reader. Because secretarial aspects were given attention as well, be it limited, the second child progressed in both aspects—complexity and accuracy. These microgenetic analyses may inform researchers of second language development as well as teachers of young low-SES second language learners. Our data and Fisher et al. (2009) provide support for the interesting perspective of "*Using Talk to Support Writing*."

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Part III

Instructional Research With Improving Translation in Mind

7

Impact of Teacher Professional Development in Handwriting on Improved Student Learning Outcomes in Writing Quality

DIAN JONES and CAROL A. CHRISTENSEN

Using an available longitudinal sample, Jones (2004) analyzed the year 2 through year 7 data for 114 Australian students and replicated prior research showing that (a) automaticity of letter writing predicts compositional quality and (b) gender differences occur with boys having poorer automaticity. She also showed that the relationship between letter automaticity and quality of composition extends further in development than previously reported; these findings are consistent with those of investigators in England (Connelly, Campbell, MacLean, & Barnes, 2006) and USA (Peverly, 2006), who are also finding that this relationship between automaticity of alphabet letter writing and composing and note-taking ability extends to high-school and college students. Controlling for reading ability, Jones extended prior work by showing that automaticity of letter production contributes to spelling as well as handwriting.

Study of the transition from manuscript print to cursive writing is of great importance to the field. Australia provided a unique cultural context to study this transition because students are eventually allowed to choose their preferred script. Jones' (2004) results that have implications for how the translation process is supported by transcription included the following: (a) In year 5, students using one script exclusively did better than those who used a mix. (b) In year 7, over twice as many chose manuscript printing as those as who chose cursive, and those who used print did better than those who used cursive or mixed. These findings are especially timely as more tablet laptops, which offer the capability of writing tablet with a stylus, are increasingly available.

Jones (2004) also studied a novel approach to teaching preschool writing by first teaching automaticity of recognizing letter forms before automaticity of producing letter forms. All too often handwriting instruction may be delayed in the preschool and kindergarten years because children are thought not to have the motor control skills to produce letters. Still, letter skills can be taught that will facilitate handwriting development and thus the ability to translate ideas into written language.

Jones (2004) also introduced an approach to professional training teachers to deliver instruction within an experimental design. The teachers who were trained had students who improved significantly more in handwriting, quality of composing, and spelling (bi-grams) than the control teachers who were not trained regarding the importance of automated letter writing. The finding that the preexisting gender differences (boys lower than girls) were eliminated in the students whose teachers received handwriting instruction focusing on developmentally appropriate strategies is an extremely important one as well. Likewise, trained teachers made the most difference with average and below-average students, which has important implications not only for on the professional development of teachers but also prevention of writing problems.

The current study extends the prior large-scale dissertation research, but with focus on the early school years and prevention of writing problems. Thirty teachers working with children who were in their first year of schooling, were assigned to one of two professional development groups. Professional development sessions lasted one hour. Control group teachers had a program that examined traditional curriculum on teaching handwriting and written language. Experimental teachers had a program that emphasized retrieval of letters from memory and development of fluency in handwriting.

Before reporting the results and discussing their significance for the translation process in writing, we make the case from theoretical and empirical perspectives for the importance of teaching handwriting in early writing instruction. It is perhaps counter-intuitive to some readers to suggest that handwriting is closely related to students' ability to produce high-quality written text. However, both theory and prior research suggest that proficiency in handwriting is essential to the production of creative, logically organized, and well-structured written text.

THEORETICAL PERSPECTIVE

From a theoretical perspective the relationship between handwriting and quality of written text is based on limitations of working memory (Berninger, 1999, Graham, Berninger, Abbott, Abbott, & Whitaker, 1997). Essentially, beginning writers are more likely to have sufficient attention to execute one conscious intellectual activity if letter writing is automatic. The attentional demand of a task is referred to as cognitive load (Sweller, 1988). As writing develops beyond the very beginning stages, production of written text potentially has multiple sources of cognitive load. For example, to generate high-quality text, writers must generate a series of creative and interesting ideas, logically organize and sequence these ideas, ensure that the text is technically accurate in terms of spelling and grammar, consider the audience and ensure that the language used is appropriate and the text is clear for the audience, and ensure that structures are consistent with the genre to be employed.

From a cognitive perspective, writers cannot focus attention on all these aspects of writing at the same time; they can only attend to one element of the task at a time. There are two ways for individuals to resolve the issues of cognitive load limitations. First, they can sequence attention-consuming aspects of tasks. Thus, writers can initially focus on generation of ideas during planning; and then sequence those ideas in a first draft. Finally, they can edit their writing for technical accuracy and pragmatic awareness.

Sequencing different aspects of writing is a useful strategy in many circumstances, but cannot alleviate the problem of multiple attentional demands when multiple tasks need to be executed simultaneously. When students are producing handwritten text, they must create the ideas for the text and engage in handwriting at the same time. Thus, if students need to focus attention on their handwriting, they cannot focus attention on other critical aspects of writing such as ideation, sequencing, and logical organization of text and pragmatic awareness. In order to execute multiple skills at the same time, subcomponents of complex tasks must be carried out without consuming attention by rendering those subcomponents automatic. Automaticity is the ability to execute skills accurately, quickly, and effortlessly (without consuming attention). From a theoretical perspective, in order to produce sophisticated text, writers must have handwriting available to them at an automatic level.

Graham et al. (1997) argued that the necessity to switch attention from higher-order processes to writing production processes can interfere with planning, which in turn may interfere with the quality of the content and organization of the written text. Moreover, switching attention from the composing process to handwriting may affect the coherence and complexity of written work (Graham & Weintraub, 1996). Additionally, Graham, Harris, and Fink (2000) suggested that the need to switch attention from the composing process to the demands of handwriting, for example, having to think about how to form a particular letter, may result in a writer forgetting his or her ideas or plans for the text.

PERSPECTIVES BASED ON RESEARCH FINDINGS

Relationship of Handwriting With Both Quality and Quantity of Written Text

In addition to the theoretical basis for the relationship between handwriting and written language, there is a growing body of research demonstrating that handwriting proficiency is essential for producing high-quality written text. Researchers have examined the impact of handwriting on both the quantity and quality of text that children can produce. Empirical findings show a strong and enduring relationship across a range of participant ages and methodological approaches between handwriting automaticity and amount of text produced. Research on handwriting and quality of written text is less consistent but nevertheless points to a critically important relationship.

Over three decades ago in 1976, Rice found that for students in Grade 2, the speed of handwriting predicted academic achievement as well as ability to complete written assignments. Biemiller, Regan, and Gang (1993), working with children in Grades 1–6, reported correlations of between .34 and .76 between fluency of handwriting and fluency in composition. Similarly, Meltza, Fenton, and Persky (1985) found correlations of .27 between speed of writing the alphabet and fluency in composition and .30 for quality of written text for students in Grades 4–9.

Berninger et al. (1992) showed that handwriting uniquely explained significant variance in composing in a primary grade sample (ages 6–8) representative of the U.S. population in mother's level of education and ethnicity. Graham et al. (1997) used structural equation modeling to examine the relationships among handwriting, spelling, and written composition. They found that transcription skills (spelling and handwriting), which support the translation of ideas into written language, accounted for 66% of the variance in compositional fluency (amount written within a 5 min time limit) in primary grades and 41% of the variance in compositional fluency defined the same way in intermediate grades. Transcription accounted for a smaller, but significant percent of variance in quality of text (based on two raters—evaluation of content and organization): 25% in quality of composition for primary children and 42% of the variance in quality of composition for intermediate children.

Jones and Christensen (1999), working with children in Grade 1 in Australia, found a much stronger relationship between speed and accuracy of handwriting and quality of written text than was observed in other studies, which typically did not control for reading ability. They found that when reading was controlled, handwriting accounted for 53% of the variance in written text.

Taken as a whole, correlational studies indicate that for normally developing children, the ability to produce letters automatically accounts for a remarkably large proportion of the variance in compositional fluency and, depending on the age of students, a large proportion of the variance in quality of written text. Other studies have demonstrated that handwriting has a significant impact on writing for children experiencing learning disabilities, a topic to which we now turn.

Handwriting and Students With Learning Disabilities

Gregg, Coleman, Davis, and Chalk (2007) examined the writing of students with and without dyslexia. They found that fluency in handwriting along with spelling and vocabulary accounted for more of the variance in scores of quality of composed text for students identified with dyslexia than for other students.

There is some evidence to suggest that handwriting difficulties may be particularly problematic for intellectually capable students experiencing specific writing disabilities. Yates, Berninger, and Abbott (1994) found that intellectually talented students often had transcription (handwriting and spelling) problems in elementary grades, which teachers did not identify or offer specialized instruction to overcome.

Impact of Interventions to Improve Handwriting

Although only a few studies examined the efficacy of handwriting interventions in improving written composition, they nevertheless have demonstrated that children experiencing difficulties in handwriting can gain significant benefit from a handwriting program. Brooks, Vaughan, and Berninger (1999) provided 17 Grade 4 and 5 students, experiencing learning disabilities in writing, with a program that covered both transcription (handwriting and spelling) and composition skills. They found that students improved in automaticity in handwriting as well as in their ability to compose text—and more easily than they improved in spelling.

Berninger et al. (1997) examined the efficacy of several different instructional strategies for handwriting. They assigned children in Grade 1 who had difficulty in handwriting to one of five treatment conditions:

1. Writing letters after seeing a teacher modeling the motoric production process for each letter
2. Writing letters after looking at a written model with numbered arrows to indicate the direction in which strokes should be made
3. Writing letters after looking at letters without the numbered arrow cues and holding them in the mind's eye with eyes closed for increasing duration
4. After studying the numbered arrow cues that show the component strokes and order in which to make them to form a letter, hold the letter in mind's eye with eyes closed and when prompted after increasing durations to open eyes, write the letter.
5. Looking at a letter without numbered arrow cues and then write it.

In addition to the experimental groups, a contact control group worked on phonological awareness with spoken words and no letters.

Children in all handwriting groups improved more in proficiency than children in the contact control group. Moreover, the group that both studied the letters with the visual guidance (numbered arrow cues for formation) and held them in memory for increasing times had better scores on a measure of fluency in writing text than the other treatment groups and the control group. Thus, it appears that an approach that provides both explicit guidance in the formation of letters and practice in memory storage and retrieval of letter forms is more effective than approaches that only model letter formation or that only require that children study a letter formation plan, practice memory storage and retrieval, or copy letter forms.

In a series of studies, Berninger et al. (2006) examined the relationship between an intervention in handwriting and children's ability to produce written text. Working with Grade 1 children, they compared an intervention that focused on orthographic-free motor activities such as tracing plastic letters, motor-free orthographic activities such as touching and naming letters on a keyboard, and direct instruction in handwriting. They found that the direct instruction handwriting program was more effective in developing automaticity in handwriting than either of the other activities. In a second study, they found that neither motor training nor orthographic training added to the impact of direct instruction in handwriting.

Jones and Christensen (1999) implemented a program with Grade 1 students that facilitated speed and efficiency of children's handwriting. Letter shapes were first modeled by the teacher. Modeling was followed by guided and independent practice. They found that the program significantly improved children's handwriting as well as the quantity and quality of compositions they could write. Likewise, Graham et al. (2000) found that teaching handwriting to become automatic also improved written composition.

Thus, existing research demonstrates that interventions to enhance handwriting in clinical interventions can lead to significant improvements in children's ability to produce written text. The current study extended these findings by examining the impact of teacher professional development in handwriting on young children's proficiency in handwriting and their subsequent capacity to create high-quality written text.

METHODS

Participants

Participants were 30 teachers and their students. Children were in their first year of schooling in 19 schools in a regional area in Queensland, Australia.

Teacher experience ranged from 2 to 20 years with a mean of 9.80 (SD 5.84). Most teachers had very limited training in handwriting instruction. At a preservice level, 21 teachers received no instruction in handwriting, 7 received less than 6 h training, and 2 attended a 1 week course.

More teachers received training as part of their ongoing professional development than they had at the preservice level. Eighteen teachers received up to 6 h training but 12 received no training.

Four hundred and twenty-five students in the 30 classes participated in pretesting at the beginning of the study. However, only 381 completed all posttest measures, and 275 completed delayed posttest measures. The mean age of students at commencement of the study was 5 years and 5 months. Ten percent of students came from an indigenous background and 22% were identified as having low socioeconomic background.

Measures and Materials

Handwriting was assessed using a measure modified from one developed by Berninger, Mizokawa, and Bragg (1991), which assesses automatic access, retrieval, and production of alphabet letters in the first 15 s of writing the alphabet from memory. The number of letters children could write in alphabetical order in 1 min was measured (also see Chapter 9, this book). Children were scored according to the number of legible letters they wrote in correct alphabetical order within that 1 min time limit.

Quality of written composing was assessed using a sample of independently generated text. Children were given a piece of paper with widely spaced lines and an illustration of a family and their pets watching television. Scores were given out of a possible 20 points. Initially, points were allocated as follows:

1 point—writing symbols or squiggles
2 points—writing random letters
3 points—writing letters with breaks to represent word boundaries
4 points—writing recognizable words
5 points—writing an understandable relevant phrase
6 points—writing an understandable sentence

Additional points were added depending on the number of sentences or thought units that the child wrote as well as for correct basic punctuation.

The *instructional strategy questionnaire* surveyed self-reported strategies teachers used to teach handwriting. It covered

How they taught letter sounds, names, and formations
How students' ability to write letters from memory was assessed
The individualized interventions that teachers used for students experiencing difficulties in handwriting
The timetable for introducing letters during the year
Use of lined paper to teach handwriting
Extent of use of commercially produced programs
Parent education in handwriting
Focus of handwriting lessons in terms of pencil control

The *instructional strategy observational checklist* was used to observe teacher classroom behaviors as they corresponded to issues covered in the *instructional strategy questionnaire.*

Teacher Professional Development Program

Two professional development programs were delivered to teachers. The control program provided teachers with information on how to enhance children's handwriting and written composition as it was specified by current curriculum guidelines for the state. These guidelines focused on prewriting activities that promoted correct pencil grip and fine motor control for writing. They suggested that lowercase letters should be introduced before uppercase but provided no timetable for their instruction. They indicated that uppercase letters should be introduced "as the need arises." Penmanship or copybook style of writing was encouraged and instructional strategies were provided that encouraged precise fine motor control and skilled pencil movement to write letters between specific lines. (Department of Education Queensland, 1984)

The written composition professional development program for control teachers focused on language experience and "guided writing." Shared and guided writing activities encouraged displays of environmental words and word banks for students to use in their writing. Teachers were encouraged to model writing sentences. Shared writing encouraged teachers to provide elements of stories such as introductions and conclusions and to discuss strategies that students could use in constructing their written language.

The professional development program for experimental teachers gave explicit advice on how best to teach handwriting to all young students regardless of fine motor skill development. It did not focus on aspects of teaching written composition (translation of ideas into written language). However, in reference to handwriting instruction, Graham suggested, "a reasonable balance between both meaning and form needs to be achieved" (1992, p. 2). Therefore, teachers in the experimental group were encouraged not to teach letter names, sounds, and formations in isolation. Instead, teachers were encouraged to model the writing of words and sentences daily so that students experienced the context of writing for meaning (Graham, Harris, & Larsen 2001). Strategies suggested to teachers did, however, focus on promoting fluent and efficient writing (Berninger, 1994; Kalat, 1998; Samuels & Flor, 1997).

The experimental professional development program suggested that children should be introduced to letter formations through teacher modeling and student practice using a variety of approaches such as writing in the air and on a desk, tracing on sandpaper, jumping around letter formations on the floor, and using finger-paint or paint brushes. When children were introduced to paper and pencil tasks, they worked with large, hollow ("bubble") letter shapes using directional arrows to guide pencil strokes. Starting and stopping points were marked by green and red dots (like traffic lights). Children used various colored crayons to write letters within the shapes.

When children had mastered the formation of each letter, they were provided with sufficient practice to attain automaticity. Initially, they practiced letters on unlined paper and then were encouraged to gradually reduce the size of their letters.

Finally, children were encouraged to use their handwriting skills to record their thoughts in written form. Teachers were told that children should be encouraged to attempt to write words and sentences to communicate their ideas, rather than to focus on copybook production of handwriting. That is, the professional development encouraged teachers to go beyond transcription only and to encourage the children also to translate their ideas into written language using their handwriting as a tool to do so.

PROCEDURE

Pretesting: All students in participating classrooms were given the handwriting and written language composing measures in the eighth week of school.

Handwriting: Initially, children were asked to sing the alphabet. They were then provided with an unlined piece of paper and given 1 min to write the letters in alphabetical order. They were asked to write the lowercase letters first and, if they had sufficient time, to write uppercase letters. They were scored according to how many letters they wrote in correct order.

Composing written language: This measure was also administered in whole class groups. The class discussed the given topic for 3 min and then children were asked to write their stories. They were told to make an attempt to spell any words on which they were unclear. Children were given 10 min to complete their writing.

Teacher professional development: Teachers within participating schools were randomly assigned to one of two groups. One group attended the control professional development and the other attended the experimental professional development. Professional development sessions lasted 1 h and were conducted in the 15th week of the school term.

Collection of information on instruction: Both the *instructional strategies questionnaire* and *observational checklist* were administered in the eighth month of the school year. Teachers were asked to complete the questionnaire. Teacher reports of handwriting instruction were then confirmed with observations and recorded on the checklist.

Student posttesting: Five weeks before the conclusion of the school year posttests were given. Students were assessed on handwriting and composing written language using the same measure as pretest.

Delayed posttesting: At the end of the subsequent school year, 1 year after initial posttesting, students were again assessed on the handwriting and written language composing measures.

RESULTS

Because classes represented intact groups, analyses of student performance in the first year of the study used whole class groups as the unit of analysis.

Pretest: Means and standard deviations for scores for classes on handwriting and written language composing are given in Table 7.1. There were no significant differences in the two groups of classes at pretest.

Posttest: Means and standard deviations for handwriting and written language composing at posttest are provided in Table 7.2. On measures of both handwriting

TABLE 7.1 Means, Standard Deviations, and Significance Testing at Pretest for Groups That Did and Did Not Get Professional Development

Measure	Group	*N*	Mean	SD	Range	$t_{(28)}$	*p*
Handwriting	Control	15	7.07	(2.35)	4–12	.30	.77
	Experimental	15	7.31	(1.97)	3–10		
Written language	Control	15	2.77	(0.66)	2–4	1.03	.31
	Experimental	15	3.03	(0.66)	2–4		

TABLE 7.2 Means, Standard Deviations, and Significance Testing at Posttest for Groups That Did and Did Not Get Professional Development

Measure	Group	*N*	Mean	SD	Range	$t_{(28)}$	*p*
Handwriting	Control	15	13.82	(1.16)	11–15	7.02	<.001
	Experimental	15	19.85	(3.11)	12–25		
Written language	Control	15	6.76	(1.45)	4–10	6.79	<.001
	Experimental	15	10.24	(1.34)	8–13		

TABLE 7.3 Means, Standard Deviations, and Significance Testing at Delayed Posttest for Groups That Did or Did Not Get Professional Development Training

Measure	Group	N	Mean	SD	Range	$t_{(28)}$	p
Handwriting	Control	108	23.84	(6.74)	8–48	11.84	<.001
	Experimental	167	33.43	(6.43)	15–52		
Written language	Control	108	10.25	(1.92)	4–14	12.55	<.001
	Experimental	187	13.02	(1.79)	9–19		

and written language composing, children who were in classrooms where teachers had 1 h of professional development on handwriting that emphasized fluency and proficiency, performed significantly better than children whose teachers had professional development on traditional approaches to teaching handwriting and written language.

The effect size for handwriting was 5.2 and for written language composing was 2.4. This result indicated that experimental classes had a mean that was 5.2 standard deviations higher than the mean for control classrooms in handwriting, and 2.4 standard deviations higher in written language composing.

Delayed posttest: Means and standard deviations for handwriting and written language composing taken 1 year following posttest are given in Table 7.3. At the beginning of their second year of schooling, students were allocated to a variety of classes and different teachers. These teachers had not completed either the control or experimental professional development. Thus, the unit of analysis at delayed posttest was an individual student.

Children in experimental classes in their first year continued to have significantly higher achievement in both handwriting and written language at the end of their second year. The effect size for handwriting was 1.42 and for written language composing 1.44. This finding indicated that in the second year after teachers had participated in professional development, the mean for students in experimental classes was higher than the mean for control classrooms on both handwriting and written language composing.

Teachers' instructional strategies: The number of teachers using various instructional strategies captured by the *instructional strategies questionnaire* and *instructional strategies checklist* is given in Table 7.4. Using chi-squared analysis, we found significant associations between responses on these and whether teachers received professional development in handwriting, with the exception of providing parents with information about curriculum and practices for teaching handwriting in the state.

To summarize, at pretest there were no differences between children in control and experimental teachers' classes on measures of handwriting or written language. However, children in experimental classrooms were significantly better on both measures at the end of the school year. These differences were sustained at delayed posttests conducted at the end of the following year. The questionnaire responses indicate that teachers who received professional development reported using different writing instruction practices than those who did not.

TABLE 7.4 Number of Teachers Using Observed Instructional Strategies in Handwriting and Significance Testing for Associations With Groups That Did or Did Not Get Professional Development

Strategy	**Control (n = 15)**	**Exp. (n = 15)**	$\aleph^2$	*df*	*p*
Focus on pencil control	15	0	30.0	1	<.001
Writing between specific line spaces	14	1	22.3	1	
Use of commercial text for practice	11	2	11.0	1	<.001
All letters taught by beginning of Semester 1	3	13	13.4	1	<.001
Individual screening and monitoring of letter names, sounds and retrieval of formations from memory	3	15	20.0	1	<.001
Early intervention so that all children mastered letter names, sounds, and formations	2	14	19.3	1	<.001
Providing parents information on handwriting instruction	14	14	.0	1	1

DISCUSSION

Existing research has established a strong relationship between proficiency in handwriting and students' ability to produce written text. For young writers, a number of studies have found a significant relationship between scores on measures of handwriting and quality and quantity of written text (Berninger et al., 1992; Graham et al., 1997; Meltza et al., 1985). In addition, interventions to improve children's handwriting have resulted in improvements in the capacity to produce written text (Berninger et al., 2006; Christensen, 2000; Graham et al., 2000; Jones & Christensen, 1999)

The current study is distinctive in two ways. First, it shows that training teachers to focus on handwriting instruction that emphasizes fluency and retrieval of letters from memory compared with training teachers on an approach adopted by traditional curriculum can have significant impacts on children's writing that can endure for at least 2 years.

These differences were quite remarkable. At the end of their first year, children in classrooms that focused on fluency and proficiency performed considerably better than children in classrooms that focused on neatness, fitting letters between preset lines, and precise pencil control.

At posttest, mean scores for the experimental group were 44% higher than control scores in handwriting and 51% higher in written language. These differences were sustained into the children's second year of schooling where mean scores were 40% higher in handwriting and 27% higher in written language. At posttest, the effect sizes were substantial: 5.2 for handwriting and 2.4 for written language. At delayed posttest they continued to be large: 1.42 in handwriting and 1.44 in written language.

In addition to differences in the means for the two groups, the range of scores indicated that the intervention had impact on all students including the poorest performers. The impact on low-achieving students is particularly important as these are the students most at risk of ongoing school failure.

At pretest, minimum scores (low achievers) were comparable for both experimental and control groups on measures of both handwriting and written language. With the exception of handwriting at posttest, the minimum scores for experimental group students were substantially higher than for control group students. At posttest, the minimum written language composing score for the experimental group was 100% higher than the control group. At delayed posttest it was slightly below 100% higher for handwriting and slightly above 100% higher for written language.

Standard deviations were fairly consistent for both experimental and control groups, suggesting that the intervention had impact on the high achievers as well as the poorest performing students. Posttest scores, particularly, demonstrated the impact on low achievers. The minimum score for the experimental group was slightly below the mean for the control group in handwriting and slightly below the maximum score but above the mean for the control group in written language. In other words, the lowest achiever in the experimental group performed close to, or above, the mean for all students in the control group. In the case of written language at posttest, the poorest performer in the experimental group performed nearly as well as the highest performer in the control group.

A similar pattern existed for composing written language at delayed posttest for which the minimum for the experimental group was slightly below the mean for the control group. However, it appears that although the mean for the experimental group was significantly above the mean for the control group, the minimum score fell below the mean for the control group in handwriting. This finding suggests that there may be a need for continuing practice in handwriting, particularly for children who are experiencing difficulties, and that other skills may also contribute to composing.

Although the intervention focused only on handwriting, its impact on written language composing was anticipated. At a theoretical level, the link between handwriting and written language composing is related to attentional limitations of working memory. Basically, beginning writers can focus attention on a limited set of tasks at a time. Writing has multiple sources of attentional demands. If a child needs to focus attention unduly on lower levels of tasks, then there is insufficient attention available for the most complex and sophisticated aspects of tasks. In writing, if a novice writer needs to allocate attention to handwriting, then insufficient attention is available for complex aspects of writing such as ideation, syntactic and pragmatic awareness, genre, and technical accuracy.

By enhancing children's proficiency in handwriting, more attentional resources were available for their written language composing. Consequently, their written language composing improved. Delayed posttest showed that improvements in handwriting in the first year of schooling had an enduring impact on children's ability to produce written text. Once automated, handwriting did not require attention over time. Thus, an intervention early in a child's schooling had a preventative influence on the potential for children developing writing difficulties. However, it should be noted that in the second year, the impact of the intervention on handwriting was slightly muted. Thus, there is a need for continued vigilance in ensuring that children continue to have sufficient practice in handwriting to maintain automaticity.

Children in the study learned manuscript. They would need to be taught cursive in the next few years. Thus, there is a need for ongoing focus on proficiency in handwriting as children learn new styles of handwriting, including keyboarding in the information age. Nevertheless, the data clearly show that children in the experimental group were significantly advantaged in learning to write in their early years.

The second distinctive aspect of the study was its focus on teacher professional development. The experimental intervention consisted of a 1 h professional development session that promoted teaching handwriting with a focus on fluency, proficiency, and retrieval of letter shapes from memory. The consequences of this brief intervention were quite dramatic. Not only did experimental children's handwriting demonstrate significant improvement in proficiency above control group children, but they also showed enhanced written language composing and the benefits were maintained at second year follow-up.

In addition to the direct impact on children, the intervention resulted in changes to teacher expertise and their subsequent practice. Compared to control teachers who were informed of current curriculum mandates, experimental teachers focused more on individual screening, analysis of handwriting, and early intervention. They also focused more on developing letter automaticity rather than skilled pencil control. They introduced all letters early in the school year and were less likely to use lined pages or commercially available programs to introduce children to handwriting.

It should be noted that, given the cost-effectiveness of the intervention (a total of 1 h for both teachers and presenter), the results for students were dramatic and enduring. Moreover, by focusing on developing teacher skills, professional development can be expected to lead to an ongoing change in teacher professional practice with its consequent impact on children's handwriting and written language.

The next research questions to pursue in extending this work include the following:

- What would be the immediate and long-range gains in writing achievement (handwriting and composing) if more extensive preservice teacher training in teaching manuscript, cursive, and keyboarding were provided?
- Would there be added advantage for the same outcomes if preservice teacher training also taught teachers a variety of explicit strategies for translating ideas into written language, which could be taught alone or in combination with strategies for teaching handwriting?

Much remains to be done to implement what we know from theoretical and empirical perspectives in writing so that professional development for teachers transfers to student writing outcomes in the classroom because teachers have become facilitators of translation of ideas into written language.

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8

Insights About Translation from Neuropsychology, Self-Talk Strategies, and Interventions

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Through both theoretical accounts and empirical studies, it is widely understood that writing is a complex process (Lienemann, Graham, Leader-Janssen, & Reid, 2006); therefore, determining effective instructional strategies for teaching writing and implementing writing instruction are challenges for many teachers. Nonetheless, writing is an important skill that all children need to develop. It is the primary tool for expressing knowledge and one of the main response outputs that teachers use to assess their students' educational performance (Graham & Harris, 2004). Because students use writing to collect and organize material, share and remember information and, ultimately, acquire and demonstrate knowledge, the academic development of students with writing difficulties is at risk (Graham & Harris, 2005).

Fortunately, researchers across disciplinary fields are examining written expression with particular emphasis on the associated neuropsychological processes and instructional approaches. Psychologists, educational specialists, and neuroscientists are all contributing to the scientific investigation of this multifaceted developmental process.

Even with an emphasis on written expression, the complexity of the processes involved has precluded researchers from forming a complete understanding of the cognitive and neurocognitive relationships inherent in written language. It is generally accepted that skilled writers use cognitive processes (i.e., planning, translating, reviewing, self-regulation) to manage the writing task (Graham & Harris, 1996). They are also fluent in text production processes (i.e., text generation and transcription) and knowledgeable about writing content, audience needs, and specific genres (McCutchen, 2006). In contrast, students with writing difficulties do significantly less planning and revising and frequently just write down any information that may be relevant to the topic, paying precious little attention to the intended audience or text organization (Graham & Harris, 2009). In addition, poor writers tend to produce text that lacks clarity as well as being shorter, poorly organized, and less interesting than good writers (Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002).

In this chapter, we provide an overview of the current literature regarding beginning writers, with a particular focus on the cognitive and neuropsychological research that has implications for the translation process during writing. This overview will highlight specific theories with direct relevance to translation during writing, as well as provide a discussion of self-talk procedures and how they can provide a "window" into the various aspects of the translation process. We also discuss several evidence-based approaches to the remediation of written language problems, with a particular focus on explicit instruction and strategy instruction, and their potential impact on translation. As the reader will note, these combined efforts have yielded significant findings with respect to our understanding of early translation processes in young elementary school children, but there remains a myriad of questions to be examined in this understudied yet critical aspect of written expression.

TRANSLATION DURING COMPOSING

In order to write, a person must have an idea, know the meaning of the symbols, translate the idea to symbols, and have the ability to form the symbols. Furthermore, the writer needs to comprehend the structure (i.e., sentence, paragraph, and text), content (i.e., ideas and their relationships), and purpose (i.e., writer's goals and audience) of the writing process (Collins & Gentner, 1980). In addition to these skills, a number of neuropsychological functions are considered important for the writing process including memory, attention, graphomotor output, sequential processing, higher-order cognition, language, and visual–spatial functions (Levine et al., 1993); however, the current literature does not fully account for the relationships among these processes and some necessary functions still remain undefined. If translation is a multidimensional process, as noted in Chapter 1, then a variety of neuropsychological functions will likely be involved in the unfolding of the translation process. For example, a number of studies have shown the importance of specific linguistic factors (e.g., semantics, grammar), along with academic functions such as handwriting and spelling, as key dimensions of written expression (Berninger & Rutberg, 1992; Hooper, Wakely, de Kruif, & Swartz, 2006; Sandler et al., 1992; Wakely, Hooper, de Kruif, & Swartz, 2006); however, how these functions contribute to the translation of ideas into text continues to require scientific examination. Further, the developmental process of writing and its associated cognitive underpinnings in young children is an area that has received relatively little attention (Hooper et al., 2006), but the application of these findings to the translational process may hold critical clues for increasing our understanding of this aspect of written expression. A better understanding of these relationships may also improve efforts to facilitate the translational aspects of written expression in young children.

SELECTED THEORETICAL MODELS

One of the primary theoretical approaches researchers have used is cognition. The origins of this approach can be traced to the Dartmouth Seminar, a multidisciplinary conference conducted at Dartmouth College in 1966 consisting of researchers who sought to examine writing using information emerging from cognitive psychology (see Hooper, Knuth, Yerby, & Anderson, 2009). This approach to writing research spawned key theories and studies of written expression, and provided clues for increasing our understanding of the translational process in writing. Cognitive process research, as applied to the understanding of the links among writing, thinking, and learning, has undoubtedly influenced the development of the process approach to writing (Hayes & Flower, 1980). Several theoretical models have been proposed to describe the cognitive functions involved in written expression (Berninger & Winn, 2006; Ellis, 1983; Kellogg, 1996; Roeltgen, 1985).

Hayes and Flower Model

The model proposed by Hayes and Flower (1980) over 30 years ago, and subsequently revised by Hayes (1996, 2000), has been one of the most influential in the broad field of written expression (see Chapter 2). It is considered the gold-standard cognitive model that includes planning, translating, and revising. Although the planning and revising aspects to this model have received attention, in conjunction with the goals of this volume, it is the translating process that has received less scientific scrutiny.

Hayes and Flower described a complex problem-solving process, operating within the task environment and the writer's long-term memory (Hayes, 1996; Hayes & Flower, 1980). It was developed based on research with adults, which posited that writing was ultimately a cognitive problem-solving task used to convey one's knowledge, opinions, and emotions to a potentially unknown or invisible audience. The model is presented as a problem-solving approach because the author must strategize and develop a number of solutions across all of the stages of the writing process—including translating—to create an effective final product. To engage in effective translating, the author has to (a) manage factors related to the task such as the topic, the audience, the amount of time available, and the quality of the text produced; (b) utilize the cognitive processes found to contribute to more understandable and coherent writing such as efficient retrieval of knowledge related to the assigned topic, understanding of the audience, and utilization of previously effective writing plans from long-term memory; (c) utilize planning strategies that facilitate goal setting and organization of ideas given the writing assignment; (d) effectively translate the ideas into written text—the text generation process; (e) engage in continuous self-monitoring and editing of generated text; and (f) perform postproduction revision and editing of the written text

(Hayes & Flower, 1980; also Chapter 2). The Hayes and Flower model and its subsequent revisions have been extraordinarily successful in generating much of the cognitively based research in written language over the past several decades, and it remains a key model for encouraging scientific efforts to understand the multidimensional aspects of translation in children's (Berninger & Winn, 2006) and adults' (Alamargot & Chanquoy, 2001) writing.

Not-So-Simple View of Writing

Based on the foundational work of Hayes and Flower (1980), Berninger and Winn (2006) provided a modified model applicable to children: the not-so-simple view of writing. The basic components of this model include transcription, executive functions, and text generation, with working memory supporting the translation process including the "cognitive flow." In this model, working memory may activate both long-term and short-term memory during the translating process. For example, long-term memory is activated during planning, composing, reviewing, and revising, whereas short-term memory is activated during reviewing and revising output. What is new in this model is the claim that externalizing cognition through writing and other activities may overcome some of the limitations of internal working memory. In addition, Berninger and Winn review evidence regarding word storage and processing units (i.e., orthographic, phonological, and morphological), a phonological loop, and executive supports (e.g., for managing supervisory attention including focus on relevant information while ignoring irrelevant information, changing attention between mental sets, and attention maintenance for staying on task). In addition, other executive functions may support conscious attention (e.g., metalinguistic and metacognitive awareness), cognitive presence, and cognitive engagement (Berninger & Winn; also see Chapters 3 and 5 in this book).

NEUROPSYCHOLOGICAL FINDINGS RELATED TO TRANSLATION IN YOUNG WRITERS

Translation during composition requires integration of a variety of neuropsychological processes (e.g., language, working memory, and attention/executive functions) that appear to be mediated by developmental constraints; however, most of the research to date has focused on the concurrent and predictive value of these processes, or how they can differentiate between groups of writers, as opposed to experimental studies of how these processes may directly or indirectly affect the translational processes (but see Chapters 3, 6, 7, 11 through 13 for an increase in experimental studies). For instance, Berninger and Swanson (1994) reviewed a series of studies of two subprocesses in children in grades 1–3 or 4–6: transcription and text generation. They found that speeded orthographic coding and motor integration uniquely predicted handwriting, and orthographic and phonological coding uniquely predicted spelling. In another study with a sample of grades 1–6, this research group used structural equation modeling to show that a handwriting factor consistently explained unique variance in composition length and quality, whereas a spelling factor did at some grade levels (Graham, Berninger, R. Abbott, S. Abbott, & Whitaker, 1997). Taken together, these investigators concluded that transcription may impose constraints on compositional quality. Intact handwriting and spelling may facilitate good translation of thought into text, but even individuals with good core handwriting and spelling skills may experience difficulties in translating their thoughts efficiently and effectively into text, perhaps secondary to other neuropsychological functions (e.g., planning) that may be developing more slowly and/or in a dysfunctional fashion (Graham et al., 2009; also see Chapter 5 in this book, for such evidence). In other words, good transcription does not guarantee good translation!

Although the predictive value of transcription functions is critical to our understanding of written expression of ideas, and in the prediction of writing trajectories (Hooper, Roberts, Nelson, Zeisel, & Kasambira-Fannin, 2010), other research has focused on the processes that contribute to transcription. For example, one function necessary for transcription into written word spelling is phonemic awareness. Phonemic awareness is essential in literacy acquisition (Edwards, 2003; Juel, Griffith, & Gough, 1986), that is, the development of both reading and spelling (Mehta, Foorman, Branum-Martin, & Taylor, 2005). Children will not acquire spelling-sound correspondence knowledge until a prerequisite amount of phonemic awareness is attained; moreover, such constraints due to lack of spelling-sound correspondence knowledge will likely place limitations on transcription and thus on a young writer's ability to translate ideas into writing (Puranik, Lonigan, & Kim, 2011).

Indeed, Abbott, Berninger, and Fayol (2010) found a relationship across adjacent grades from word spelling to text composition, suggesting that individual differences in spelling are related to individual differences in written composition, but this relationship was found consistently from spelling to text composition across grades 1–7 but only from text composition to spelling at some grade levels. Berninger, Abbott, Nagy, and Carlisle (2010) also provided longitudinal findings showing that phonological, orthographic, and morphological linguistic awareness undergoes growth (developmental change) in the first four grades, which has implications for spelling development, as shown with additional new analyses reported in Chapter 4 in this book. Research has also shown that task requirements in the curriculum change in the upper grades when children also have to integrate reading and writing during the translation process for writing (Altemeier, Abbott, & Berninger, 2008; Altemeier, Jones, Abbott, & Berninger, 2006). Considerable research points to the translation process for writing becoming more complex with increasing age (Caravolas, Hulme, & Snowling, 2001; Ehri, 1997; Foorman, Francis, Novy, & Liberman, 1991; Juel, 1988; Mehta et al., 2005; Shanahan, 1984).

In addition to transcription skills, core linguistic capabilities, and selected aspects of short- and long-term memory abilities, another critical set of neuropsychological functions that have been shown to influence written expression development is the various executive functions (Hooper et al., 2002; Repovš & Baddeley, 2006). Executive functions include multiple neurocognitive abilities such as planning/problem solving, inhibitory control, and set shifting, but also working memory (Hayes & Chenoweth, 2006; Swanson & Berninger, 1994). Research examining the role of executive functions in the writing process has indicated that poor writers in elementary school are less proficient in certain executive functions (Hooper et al., 2002). For example, Hooper et al. (2002) reported that children with writing problems experienced significantly greater difficulties in their initiation and set-shifting executive functions, functions that could be directly linked to their translation abilities, but not sustaining and inhibitory control abilities when compared to typical writing peers. Other research has studied the executive functions in integrating reading and writing during note taking and report writing in elementary school students (Altmeier et al., 2006). Inhibition and set shifting have longer developmental trajectories than other executive functions, but their contribution to written expression has only begun to be examined. Furthermore, it is important to remember that executive functions vary by grade and may be influenced by developmental level for other neuropsychological skills. For example, first and second grade students do not have as much automaticity with tasks as do their older counterparts, and consequently they will be in need of more external support for planning abilities than older students (Altemeier et al., 2006). How these various executive functions change over time, particularly in relationship to translation, remains an active topic of investigation.

The contributions of working memory to writing is well established (e.g., Lea & Levy, 1999; McCutchen, 2000). Whether working memory is poorly developed for an individual (Vanderberg & Swanson, 2007) and/or if there are increased demands placed on the working memory system by task requirements such as graphic execution and control (Bourdin & Fayol, 1994), studies of translation should examine working memory. The working memory systems underlie the active maintenance and simultaneous management of multiple ideas, the retrieval of grammatical rules from long-term memory, and the recursive self-monitoring that is required during the act of writing (Kellogg, 1999); thus, working memory undoubtedly contributes to the translation (Vanderberg & Swanson, 2007; Whitaker, Berninger, Johnston, & Swanson, 1994). More generally, working memory has been found to make both general and domain-specific (e.g., verbal versus visual–spatial) contributions to the writing process (Hooper et al., 2006; McCutchen, 1996; Swanson & Berninger, 1994). A breakdown in working memory may lead to problems with written output (Levy & Marek, 1999), perhaps secondary to its influence on translating ideas into text. A variety of studies have indicated that poor writers typically have reduced working memory capacity or inefficient working memory that could undermine the entire translational process. How developmental changes in this system contribute to deficits or facility in the translation process remains to be determined.

NORTH CAROLINA WRITING SKILLS DEVELOPMENT PROJECT

Our research team has focused on the relationships and developmental stability of specific neuropsychological functions hypothesized to be involved in writing expression (Hooper et al., 2011). Relatively few researchers have empirically studied these components simultaneously and over time, which is the goal of the North Carolina Writing Skills Development Project. The primary purpose of this study was to develop an empirical measurement model that encompassed the neuropsychological components that have been deemed as important to the development of written language. Once derived, could these neuropsychological components remain stable over first and second grades and would they show significant concurrent and predictive relationships with written expression?

The sample included 205 first grade students recruited from a single school district, some of whom were at risk for writing disabilities. We plan to track these students into the fourth grade, although our initial data analyses only report findings from students who were followed into the second grade. Measures were aligned with major neuropsychological components as extracted from key theoretical models of written expression, such as the Hayes and Flower, modified Hayes and Flower model, and the not-so-simple view of writing models, along with available empirical findings examining the neuropsychological contributors to writing in children. These included fine-motor speed, language, short-term memory, long-term memory, and targeted attention/executive functions including working memory. Using confirmatory factor analyses strategies and longitudinal structural equation modeling methods, we documented the three core latent traits that were stable at both grades 1 and 2: fine-motor, language, and attention/executive functions. These empirically derived factors were highly related to written expression and spelling at both grades 1 and 2, with the first grade latent traits accounting for 52% of the variance in second grade written expression and 55% for spelling. At both grades, the language and attention/executive functions latent traits were more highly associated with written expression and spelling than the fine-motor latent trait (Hooper et al., 2011).

This model provides a foundation for researchers who desire to examine the neuropsychological contributors to writing development in the early grades. We discovered that the impact of fine-motor, language, and attention/executive functions on written expression and spelling was stable from first to second grade. The language and attention/executive function abilities were likely to be particularly important mediators of the translation process in early writing.

SELF-TALK STRATEGIES AND TRANSLATION

Closely related to neuropsychological functions and translation are the connections between inner thoughts and written output and the related processes for making these connections, which are often studied using qualitative assessment strategies, such as self-talk and think-aloud strategies. Although the major cognitive models and associated neuropsychological findings provide significant clues with respect to *what* may be contributing to the translating process of writing, they do not necessarily inform *how* this process may be evolving during the actual writing task. Understanding the cognitive processes involved in writing and how they develop over time still leaves questions as to how the processes are effectively utilized during writing. Further, given known individual differences across nearly all cognitive abilities, it remains to be seen how students with differing skill levels of writing utilize these self-talk processes during the translational process, or even if they are aware of these processes.

Self-talk and think-aloud strategies also hold promise for increasing understanding of metacognitive functions, self-regulation, and self-efficacy (Graham et al., 1997; Graham & Harris, 2000; Graham, Harris, & Mason, 2005; Hooper et al., 2006; also see Chapter 5 in this book, for examples of oral think alouds for different cognitive processes in writing), all of which may play a role in the translation process. These strategies provide investigators and evaluators with a method to examine the process of translation during composing by directly engaging students in how and what they think before, during, and after the writing task. For these think-aloud strategies, students are asked to describe verbally their thought processes in detail as they move through a writing task, thereby providing a "window" into the translating process. Researchers have noted that the familiarity with the style of writing or prompt, the amount of structure and instruction provided, and the student's individual metacognitive ability are all factors to consider in evaluating this process (e.g., Englert, Raphael, Anderson, Anthony, & Stevens, 1991; Klein, 2000; Simpson, 1994a). Successful writers are aware of the writing process and the role of knowledge throughout the process (Englert et al., 2000). We suspect that their ability to articulate their underlying thoughts should increase our understanding of the entire writing process.

Early efforts (e.g., Mayer, 1987; Pressley & Levin, 1983; Wittrock, 1990) that examined learning strategies found that they could stimulate students to become more active learners, often having students generate an observable artifact to document their processing and progress. Less research has examined students' verbal productions as a measure of studying their text or utilized the notion that oral language, such as writing, might assist students in becoming more active learners. The notion here is that developing an inner speech or dialogue about one's writing, talking to others, and reflecting on one's writing throughout the task (Daiute, 1985) may assist children to activate and use metacognitive awareness and self-regulation strategies as they engage in the writing process. Inner speech is undoubtedly important in planning and regulating one's activity, based on the theoretical tenet that cognitive development results from social collaboration that, in turn, gives way to internal collaboration with oneself (Vygotsky, 1978). Successfully self-activating and regulating are essential to the development of a student's metacognition (Paris, Lipson, & Wixson, 1983), and mature writers have been found to engage in this type of inner dialogue (Daiute, 1985; Dyson, 1987). During writing, this internal egocentric speech becomes the invisible cognitive infrastructure for planning, drafting, and revising text. Understanding this aspect of translation, teachers presumably could model this "think-aloud" strategy and help scaffold the learner's development of new skills and abilities in the writing process.

Englert and colleagues (Englert, 2009; Englert & Raphael, 1980; Englert et al., 1991) documented results that supported the importance of instruction that makes the writing processes and strategies visible to the student through teacher–student and student–student dialogues. Under these conditions they found that students were able to internalize the dialogue (making it "inner dialogue"), which translated into gains in metacognitive knowledge and, ultimately, increased gains in writing. They based their study on previous research that suggested students would benefit from writing instruction that was focused on the mental processes and strategies that guide writers (Englert & Raphael, 1989), and that writing instruction needs to make the process of writing and the strategies for performing these processes visible to students (Raphael & Englert, 1990). Their research sought to provide scaffolding as an intervention through development and use of curriculum materials, and built upon the emphasis and movement toward a "process approach" to writing in the regular education classroom. In many respects, Raphael and Englert were visionary in their initial scientific efforts to make translation processes visible. Indeed, more contemporary efforts have supported these initial assertions, particularly from an instructional perspective (e.g., Harris & Graham, 2009).

Similarly, Simpson (1994b) modified a post-reading strategy called the "talk through." The term was originally coined by Nist and Diel (1990) and applies to a procedure where students rehearse important content concepts out loud as if they had an audience for their private speech. The strategy requires students to be involved in three general classes of study processes that have been determined to characterize successful independent learning: selective allocation, generation, and cognitive monitoring. *Selective allocation* includes the ability to encode key concepts (Einstein, Morris, & Smith, 1985). *Generation* involves students in transforming and reorganizing information using their own words and structures, and then elaborating or adding to what is being learned with their own images, examples, applications, or analogies (Day, 1986; Gagne, Weidemann, Bell, & Anders, 1984). Finally, *cognitive monitoring* occurs when students determine whether or not they understand what they have read, evaluate their state of memory and their strategy selection, and employ appropriate corrective action when failures of comprehension have been detected (Brown, Campione, & Day, 1981). Simpson found that these "talk throughs" were a successful form of active rather than passive learning because they allowed students to transform ideas into their own words and spontaneously elaborate upon ideas that, in turn, can enhance understanding and remembering. Students who were trained to conduct their own "talk throughs" improved their conceptual understanding and were able to demonstrate increased understanding through recognition or recall measures (Simpson, 1994a, 1994b).

Klein (2000) sought to examine the cognitive processes through which writing contributes to learning in a group of fourth through eighth grade students in their science classes. The students carried out science experiments, stated explanations about the phenomena that occurred, and then wrote journal style notes while thinking aloud. In this science task, the intervention contributed significantly to the likelihood of explanatory gains (i.e., the students' ability to explain and understand the phenomena as a measure of learning), whereas text production (i.e., amount of text produced) contributed marginally to these gains. Four aspects of the data were analyzed: writing operations, transitional sequences among writing operations, text features, and strategies for generating content. Analysis of the data yielded seven factors: producing, searching from experiment, brainstorming, elaborating genre, goal setting, searching from text, and reviewing beliefs; however, Klein found that most of the variance could be attributed primarily to three of the seven factors that significantly predicted learning during writing: brainstorming, searching from text, and searching from experiment. Klein noted that these three factors comprise the discrete strategies (rather than components of a single strategy or coordinated strategies) for developing goal-setting statements, explicitly reviewing the text for the purpose of generating ideas, and utilizing reflective selection to choose among the ideas—potentially key facets of translation in the writing process.

Finally, Green and Sutton (2003) investigated how providing support during writing, in the form of "think-aloud" strategies, to 600 11-year-old students contributed to improving the writing process. Students were asked to verbalize their thoughts as they planned a piece of writing, fill out planning sheets, and participate in a semistructured interview about the writing process. The goal here was to probe qualitatively children's thinking as they faced a writing stimulus and planned their writing, and to understand the children's own perceptions of their strengths and weaknesses as well as their strategies in planning their written work. Results suggested that writing performance improved when the students considered the audience and purpose of the writing task. These findings provided important clues to key components of the translation process during written language in children.

EVIDENCE-BASED INSTRUCTION FOR FACILITATING TRANSLATION

Several evidence-based efforts have been successful in improving the translation process for children at risk for writing problems. The overarching question here is whether translation of thought into text can be facilitated or improved by specific instructional strategies. And, if so, how does this occur? One basic comparison among treatment approaches differentiates those that rely primarily on explicit skill instruction versus those that primarily depend on strategy instruction, either of which can be implemented within a longitudinal efficacy design as explained in the section "Longitudinal Efficacy in Writing."

Explicit Writing Instruction

One evidence-based instructional approach aims at improving translation by improving transcription through explicit instruction (e.g., see Chapter 7 in this book). When transcription skills in children with low handwriting skills are improved, some transfer to improved composition has been observed (Berninger et al., 1997; also studies reviewed in Chapter 7). Improving transcription may improve translation in children by overcoming the "bottleneck" responsible for the struggle to get their ideas down on paper or on the computer screen, but these children may also benefit from explicit instruction in translation as well (Berninger, 2009; Berninger & Abbott, 2002). From a cognitive perspective, instructional approaches that improve the automaticity of transcription free-up working memory that supports the other ongoing processes during translation (see Chapter 7). Many schools are not providing explicit, systematic instruction in transcription skills, and those for whom this may be an impediment to their writing may experience associated problems during translation.

Other research is examining optimal transcription mode for individual writers, for example, handwriting or keyboarding. Although developmental research showed that second, fourth, and sixth graders wrote longer essays at a faster rate and expressed more ideas, much remains to be learned about tailoring optimal transcription mode to individual child writers during writing instruction. Children with transcription disabilities require not only accommodation but also specialized instruction.

Research has shown that for students with writing problems, explicit writing instruction appears to be essential (Berninger, 2009; Gleason & Isaacson, 2001; Hooper et al., 2009; Troia, 2002). In addition to improving transcription skills, explicit instruction has been shown to improve planning capabilities that, in turn, have produced increased length, better organization, and improved quality of students' compositions (Baker, Chard, Ketterlin-Geller, Apichatabutra, & Doabler, 2009; Graham & Harris, 2009; Harris & Graham, 2009). In general, the magnitude of the treatment effects has ranged from small (Berninger & Abbott, 2002; Hooper et al., 2011) to large (Englert et al., 2009; Graham & Perin, 2007), depending on the outcome variables used, instructional formats employed, the age of the students, and the specific interventions that were implemented. But see Berninger et al. (2000) for a double dose approach to getting all low achieving spellers up to at least average range for grade.

Longitudinal Efficacy in Writing

In *The North Carolina Writing Development Project*, we are conducting an ongoing evidence-based intervention for early elementary school students at risk for writing problems (Hooper et al., 2011). This study will provide us with some of the first longitudinal efficacy data in teaching writing skills. In general, longitudinal efficacy refers to following the same group of students over time after an intervention or series of interventions during this time period. Figure 8.1 depicts this longitudinal treatment design in which at-risk students are identified by a targeted screening at Time 1 and then randomly assigned to an explicit treatment versus

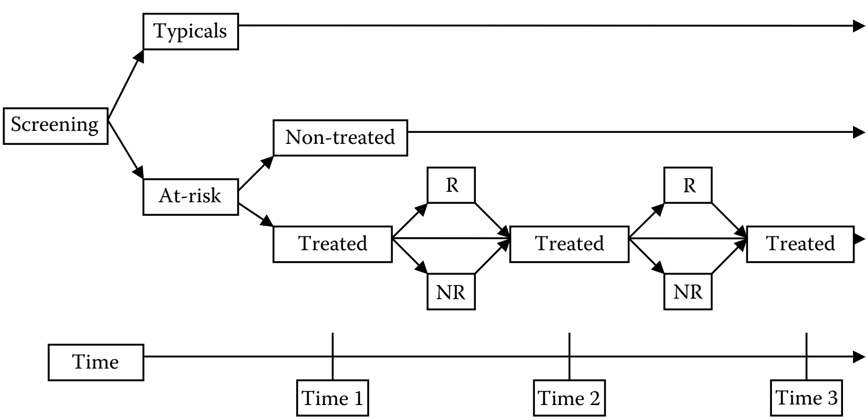

Figure 8.1 Longitudinal treatment design.

other (e.g., alternative treatment) and/or no treatment (e.g., business-as-usual) conditions. It is important to note that typical or nonaffected students are also identified by the initial screening. Although not a necessary component to treatment efficacy, this group allows for the comparison of learning slopes to typical, nonaffected students in an effort to determine if the intervention(s) can "normalize" a student's performance in a specific academic area. Once the groups are determined, students receive ongoing assessments (e.g., pretest and posttest) to determine who responds (R) and who does not respond (NR) to Time 1 treatment. Some longitudinal efficacy studies simply track students over multiple time points following the designated intervention; however, other studies track students over multiple time points following multiple interventions. In the latter condition, response-to-treatment then becomes a variable for inclusion in the next round of data analyses.

In the North Carolina Project, employing a randomized control trial design, students were identified as being at risk (n = 138) or typical (n = 67) in writing in grade 1, and the at-risk group was randomly assigned to treatment (n = 68) or business-as-usual conditions (n = 70) for grade 2. The writing intervention comprised Lesson Set 4 from the *Process Assessment of the Learner (PAL) Reading and Writing Lessons* for second graders with spelling problems (Berninger & Abbott, 2003), with the intervention occurring in small groups of 3–6 students twice a week over the course of 12 weeks during the spring of second grade. Our results indicated the overall rate of growth in writing skills significantly accelerated following the treatment for the at-risk treatment group when compared to the nontreatment at-risk group. Although the children in our studies were identified using different inclusion criteria (at risk in a variety of writing problems) than those in the studies on which the lessons were based, which included only second graders with spelling disabilities (Lesson Set 4 *PAL Reading and Writing Lessons*), improvement in translation could be inferred by the improvement in the writing products in our study. Of interest to how neuropsychological functions interact with treatment, we did not uncover any significant moderator effects from our neurocognitive variables (fine-motor, language, executive functions). However, the findings suggested that examination of these types of interactions could yield important findings in future studies, particularly with respect to response-to-intervention methods (also Figure 3.1 is relevant to this claim). Following the longitudinal efficacy design, our students have now completed the third grade intervention using Lesson Set 7 in the *PAL Reading and Writing Lessons*, and a fourth grade intervention is planned, and findings from those interventions are forthcoming.

To summarize, the findings from the North Carolina Writing Development Project suggest the need for ongoing exploration of evidence-based treatments in writing, particularly with respect to longitudinal efficacy, and support further ongoing examination of possible neuropsychological moderators for effective treatment in samples with a variety of writing or writing-related problems rather than a specific one. Further research is needed to determine whether explicit instruction has to be related to specific diagnosed writing deficits to be optimally effective in improving the translation process.

Self-Regulated Strategy Instruction for Translation

The self-regulated strategy approaches develop a schema to move students through the translation process in an efficient and effective fashion. To date, there have been a number of strategy-based interventions proposed and studied to address the text generation needs of students who may be at risk for writing problems. Many of these interventions have been devoted to the higher-order aspects of composing, such as planning and revising (Wong, Butler, Ficzere, & Kuperis, 1997), organization and self-monitoring (Isaacson, 1995), and metacognition and self-regulation strategies (Englert et al., 2009; Therrien, Hughes, Kapelski, & Mokharti, 2009). In this regard, the work of Graham and Harris (2009) provides an excellent example of these evidence-based, strategy interventions.

The self-regulated strategy development (SRSD) model is a multifaceted instructional framework that integrates self-regulation and cognitive skills to improve writing skills. The SRSD model was designed as a framework to facilitate the development of self-regulation and associated cognitive skills to improve written language. Specifically, this model was developed to address the written language needs of children with learning disabilities (Graham & Harris, 2009) and, more recently, emotional disabilities (Lane et al., 2008), and it has been studied with children from middle elementary school to high school. In this model, written language is considered a problem-solving process that involves planning, knowledge transfer, and various skills (Harris et al., 2008) and focuses on three areas: (1) explicit writing instruction, (2) explicit instruction in self-regulation strategies, and (3) development of positive self-efficacy about writing (Graham & Harris, 2009; Harris & Graham, 2009). The SRSD model has a well-founded scientific basis with research evidence from over 40 single-subject studies (Rogers & Graham, 2008), a number of small group studies (Graham & Harris, 2003), and several key meta-analyses documenting the effectiveness of this model (Graham, 2006; Graham & Perin, 2007; Rogers & Graham, 2008). The evidence demonstrating a positive impact of SRSD on written expression is clear and compelling (Graham & Perin, 2007).

With respect to translation, the SRSD model provides an avenue to understand how strategies facilitate text production. The SRSD model provides a clear algorithm for translating thoughts into an organized text. This algorithm provides the vehicles for the execution of clear and specific strategies designed to facilitate the infrastructure for written output such that the written output is genre specific and appropriate for a specific audience. In this fashion, the SRSD model addresses many of the key facets comprising translation and provides an evidence-based intervention for students who may be struggling with a specific written task. Although it is unclear how variability in specific neuropsychological functions, or specific learning impediments, will interact with the scaffolding provided by this model, efforts to date have demonstrated its educational utility for students in regular education and special education settings (Graham & Harris, 2009; Harris & Graham, 2009).

Based on the cumulative findings from the SRSD model, Graham, Olinghouse, and Harris (2009) have asserted 12 evidence-based recommendations for writing instruction (e.g., teach strategies for planning, revising, and editing; set clear and specific goals for what writers are to accomplish in their writing product) that have evolved from use of the SRSD model. Taken together, these strategies have helped students improve five main areas in writing: the genre needs in writing, the quality of the written output, the knowledge of writing, the approach to writing, and a student's self-efficacy for writing. Improvements have also been reported in core components of writing such as planning, revising, content-specific messages, and mechanics. Maintenance and generalization of these skills have been demonstrated across genres, students with different needs, and educational settings (Harris & Graham, 2009). Furthermore, the teaching of strategy development with students in late elementary school and beyond coincides with what is known about development of the prefrontal cortex and associated brain functions at this developmental time period (Hooper et al., 2002).

As well, there is a strong match between the ascendance of executive functions with respect to their importance to writing as children age, and the use of instructional strategies that capitalize on their capabilities to learn and deploy such strategies. The instruction that occurs via the SRSD approach for specific strategies is directly tied to the writing process as well as the writing product. The specific features of each strategy not only relate to how the students will change their approach to the writing task but also have an effect on how they move through the writing process, including the translational phase. Consequently, this evidence-based intervention likely holds significant promise for modifying the translation process during written expression in positive ways.

CONCLUSIONS

In accordance with the focus of this volume, more research is needed on the translation process during composing. Cognitive models have provided many key components that are needed to engage in successful and consistent translation, but more remains to be learned. The not-so-simple view of writing encourages the field to investigate how writing supports externalizing cognition, that is, access to thoughts and thinking by producing products of translation which can be visibly inspected and reinspected, thus overcoming limitations in internal working memory from which stored contents may disappear and not be readily accessed over time. In this chapter, we emphasized the theoretical models and empirical support for neuropsychological functions critical to the translation process in the written language of young elementary school children. Key among these are neuropsychological functions for language, executive functions, and working memory. These processes may not only predict translation during composing across development but also may be influenced by developmental changes in translation and can inform instruction. Moreover, these neuropsychological processes may be the window on individual differences that may place qualifications on all the other models and frameworks—how translation works may be influenced to some degree by individual differences in an individual writer's neuropsychological processing.

Although these models provide some necessary components for translation, the talk-through and self-talk strategies are promising assessment strategies designed to provide the "how" of the translation process. The self-talk strategies provide an intriguing avenue for increasing our understanding of the translation process. Although these efforts can be labor intensive, and perhaps hindered by language impairments or problems with theory of mind, they also appear to hold significant explanatory potential with respect to our understanding of the translation process in young students. Their interaction with many of the neuropsychological functions important to the writing process also warrants scientific inquiry. Although the field of written language has forged ahead with a number of evidence-based approaches for improving written language composing, whether the effect on translation is direct or indirect remains to be determined. Knowing that the translation processes involved during composing can be structured, nurtured, and actually "repaired" for young students struggling with the text production component is encouraging, but the effects of these intervention approaches on translation still requires research investigation.

In this chapter, we highlighted some findings related to the translation processes in composing of beginning and developing writers. We underscored neuropsychological and metacognitive findings, including self-talk approaches, as well as evidence-based instructional approaches related to translation. Hopefully, this chapter and volume will inspire further research on these topics.

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9

Multivariate Assessment of Processes in Elementary Students' Written Translation

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In this chapter, we first describe the historical context of how researchers became aware of the importance of transcription and text generation at multiple levels of language during translation in writing for both developing and skilled writers. We then explain the importance of both automatic and flexible transcription processes in writing development. Next, we discuss development of transcription and text generation, interrelationships between transcription and text generation, and developmental changes and instructional needs for transcription and text generation. Then, we consider the implications of this line of research on transcription and text generation on the need for group assessment for early intervention to prevent writing disability. Finally, we discuss our research contributions, including new findings, to make the case for more classroom writing assessment that can inform instructional decision making.

HISTORICAL CONTEXT FOR RESEARCH ON TRANSCRIPTION AND TEXT GENERATION

In 1980, Hayes and Flower proposed a model of the cognitive models of writing that has been very influential in stimulating further theory building as well as empirical research. That model included recursive planning, translating, and reviewing/revising processes that had been identified while adult, skilled writers thought out loud and explained what they were doing and why as they composed.

During the last decade of the twentieth century, in order to investigate how the model might be used to explain writing development, a series of interdisciplinary, multivariate assessment studies were conducted with children (50 boys, 50 girls) in grades 1–9 (ages 6–14) in a sample representative of the United States at that time based on mother's level of education and ethnicity. Initially, multiple regressions were used to identify which of the multiple neuropsychological and language measures uniquely predicted specific writing outcomes in handwriting, spelling, and composing in the primary grades (1–3) (Berninger, Yates, Cartwright, Rutberg, Remy, & Abbott, 1992), intermediate grades (4–6) (Berninger, Cartwright, Yates, Swanson, & Abbott, 1994), and junior high grades (Berninger, Whitaker, Feng, Swanson, & Abbott, 1996).

Structural equation modeling was then used to demonstrate that handwriting, spelling, and composing are separable constructs even though all three are functionally interrelated during the composing process (Abbott & Berninger, 1993). Specifically, transcription skills (handwriting and spelling) were related to composing in each grade 1–6, with handwriting explaining unique variance in the length and quality ratings (based on content and organization), even though the compositions had been typewritten to avoid bias due to the quality of children's actual handwriting (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997).

Additional studies based on the same sample showed reliable intraindividual differences in children's relative text generation ability related to word choice (lexical diversity), sentence construction, and quality of text composed (Whitaker, Berninger, Johnston, & Swanson, 1994). Other studies showed that planning and reviewing/revising skills were emerging but often more evident before or after composing than during (summarized in Berninger & Swanson, 1994) as had been the case with the adults in the Hayes and Flower's (1980) study. Collectively all these findings, reviewed in Berninger and Swanson (1994), supported the conclusion that both transcription (handwriting and spelling) and multiple levels of language in text generation were supporting the translation process in Hayes and Flower's model, whereby thoughts are transformed into written language (Berninger & Swanson, 1994).

At the same time that these studies of English-speaking developing writers in the United States were being conducted, a parallel line of research was being conducted in France, which also showed the importance of transcription skills in developing the text generation skills for translating thought into written language. The French writing researchers (Fayol and his students and colleagues) applied the experimental methodology of online experiments in real time rather than multivariate assessment methods used by U.S. researchers but reached similar conclusions. Transcription skills demand greater amount of resources for children than for adults (Bourdin & Fayol, 1994; King & Rental, 1981). Children's compositions improved when they were asked to dictate their compositions to adults (Bourdin & Fayol, 1994), which King and Rental (1981) had found earlier and Reece and Cumming (1996) subsequently replicated. However, text generation can only be functional once children achieve a certain level of automaticity in transcription skills. That is why children show better performance on oral composition compared to their written compositions (Fayol, 1991; Simon, 1973). After transcription skills become sufficiently efficient, "text generation can steadily graduate from single words to grammatical clauses, then to paragraphs combining several sentences" (Alamargot & Fayol, 2009, p. 27).

De La Paz and Graham (1995) also documented that transcription was important in written text generation. Graham and Harris (2000) showed that individual differences in transcription skills predict writing achievement not only in the early grades, but also in the middle school grades, just as Berninger et al. (1992, 1994, 1996) had found. Singer and Bashir (2004) also called attention to the multiple levels of language that have to be coordinated, such as juggling several balls in the air, during text generation that requires the activation and coordination of a complex array of linguistic and metalinguistic skills, including phonology, semantics, syntax, morphology, pragmatics, and orthographic knowledge.

Thus, it is not surprising that Hayes' most recently revised model of writing development included not only a translation component but also a transcription component for both developing and skilled writing (Hayes & Berninger, 2010). This current model also calls attention to two transcription modes that are both important in the twenty-first century, handwriting and keyboarding, and showed that these can exert differential effects on the translation process itself: Children in grades 2, 4, and 6 expressed more ideas when writing essays by pen than by keyboard.

AUTOMATIC VERSUS FLEXIBLE TRANSCRIPTION

On the one hand, automatic transcription can have benefits for text generation during translation. Canonical correlations identified an automaticity dimension and a linguistic dimension in the complete multivariate battery of measures given to primary grade writers (Berninger et al., 1992). Unless automatic, the transcription processes can exert so many demands on working memory that they interfere with other higher-order writing processes required for writing, such as planning and reviewing (Bourdin & Fayol, 1994, 2002; McCutchen, 1996; Olive & Kellogg, 2002). Underdeveloped, inefficient transcription processes constrain the fluency and quality of composing (Bourdin & Fayol, 1994, 2002; Bourdin, Fayol, & Darciaux, 1996; Olive & Kellogg, 2002).

On the other hand, flexibility of strategy use is also important. Beginning and developing writers use a variety of strategies, sometimes flexibly combining basic and more complex strategies to write based on the demands of the task at hand (Rittle-Johnson & Siegler, 1999; Siegler, 1996). Evidence for flexible strategy use can be found as early as preschool (Puranik & Lonigan, 2010). For example, children could spell their name perfectly or use initial and final letters when spelling basic CVC words (a relatively easy task); however, these same children could resort to writing random letters when writing a sentence (a more advanced task). The proclivity to use a variety of strategies may be a developmental phenomenon, not occurring until a child has reached a certain level of proficiency in the translation process, and thus dependent on experience and instruction.

DEVELOPMENTAL ISSUES IN TRANSCRIPTION AND TEXT GENERATION

Broad patterns can be observed as children's transcription and text generation develop. Virtually, every parent of a young child has turned the household refrigerator into a museum, adorned with art and notes, for example, for Mother's Day and Father's Day. Even seemingly meaningless scribbles are an early precursor to the written word. Children's early scribbles may seem completely random to the untrained eye, yet contain writing-specific features indicating that general knowledge of writing (Ferreiro & Teberosky, 1982; Puranik & Lonigan, 2010; Tolchinsky, 2003) and the patterns of the specific writing system to which they are exposed (Pollo, Treiman, & Kessler, 2008) are beginning to develop. In preschool, children often attempt to write their names and spell words before they enter kindergarten and receive any formal writing instruction. Children's early spellings are not random either, but go through stages where they use the letters of their names to spell other words (Both-de Vries & Bus, 2010; Levin, Both-de Vries, Aram, & Bus, 2005; Treiman & Broderick, 1998), but tend to spell correctly the initial, then the initial and last letter of words, before being able to spell conventionally.

Past the emergent writing phase in preschool and kindergarten, research on writing has raised the possibility of two critical periods in writing acquisition, analogous to that identified by Chall (1983) for reading: Initially during the first three grades (ages 6–8) children are *learning to write*—to form letters, use invented and conventional spelling, and use those transcription skills to compose text alone and in social contexts. Then, during a critical transition from third to fourth grade (ages 9 and 10) when the writing requirements of the curriculum increase exponentially, the focus changes to *writing to learn* and integrating reading and writing. This is the period when children are learning to become proficient in the translation process of writing.

INTERRELATIONSHIPS OF TRANSCRIPTION AND TEXT GENERATION

At least three lines of research provide evidence to support the claim that transcription skills influence writing achievement. The first line of evidence includes multivariate assessment studies that examine the amount of variance a predictor or independent variable explains in a dependent or outcome variable in children's writing. Findings from these studies indicate that transcription skills account for varying but a substantial amount of variance in text generation (e.g., Graham et al., 1997; Jones & Christensen, 1999; Juel, 1988; Puranik & Al Otaiba, 2011). For example, transcription skills (spelling and handwriting fluency) accounted for 25% of the variance in compositional quality and 66% of the variance in compositional fluency (number of words in text produced under timed conditions) in the primary grades (Graham et al.).

The second line of evidence includes studies that examined the effects of transcription skills on written output when the demands of transcription skills are removed. In Glynn, Britton, Muth, and Dogan's (1982) study, college students were asked to write persuasive reports without worrying about spelling and punctuation. Students showed an increase in the number of arguments included in their compositions when the demands of transcription skills were eliminated. Transcription skills demand greater amount of resources for children than for adults (Bourdin & Fayol, 1994; King & Rental, 1981), and children's compositions improved when they were asked to dictate their compositions to adults (Bourdin & Fayol, 1994; King & Rental, 1981; Reece & Cumming, 1996). Olive and Kellogg (2002) reported that, unlike adults, third-grade children were unable to alternate attention between higher-level composing tasks and lower-level transcription tasks. McCutchen (1996) suggested that young emergent writers resort to a knowledge telling strategy when lower-level transcription skills are not yet automatic, leaving little to no resources for higher-order composing processes in text generation. Reducing the processing and production demands of transcription skills has a positive influence on the quality and amount of written text produced (De La Paz & Graham, 1995; Glynn et al., 1982).

Finally, the third line of evidence for the role of transcription skills in writing includes treatment studies. Treatment studies, which provide one kind of evidence for making causal inferences, have shown that improving handwriting automaticity or spelling improves children's text generation and composing quality (Berninger et al., 1997, 1998; Graham, Harris, & Chorzempa, 2002; Graham, Harris, & Fink, 2000; Jones & Christensen, 1999). Jones and Christensen showed that instruction aimed at improving first grader's letter formation and handwriting fluency improved both handwriting and their ability to generate text. Graham et al. (2000) showed that the composing gains, as a result of teaching handwriting, were maintained 6 months later.

DEVELOPMENTAL CHANGES AND INSTRUCTIONAL NEEDS

Some children struggle with becoming fluent handwriters throughout schooling (Berninger, 2008; McCutchen, 2006). For everyone, handwriting may never become so effortless that it does not cost cognitive resources (McCutchen). Although handwriting is a unique predictor of text generation from the early grades to the middle school grades, handwriting may not be as strong a predictor in the upper as in the lower grades (e.g., Berninger & Swanson, 1994; Graham et al., 1997; Medwell, Strand, & Wray, 2009). Children's spelling abilities also in general improve with age (Berman & Verhoevan, 2002; Puranik, Lombardino, & Altmann, 2008), but some children, especially those with written language deficits, may continue to struggle with spelling throughout their school years (Bishop & Clarkson, 2003; Mackie & Dockrell, 2004; Nelson & Van Meter, 2002; Puranik, Lombardino, & Altmann, 2007; Treiman, 1997), which in turn compromises their ability to compose text. In a longitudinal study with overlapping cohorts from first to fifth grade and from third to seventh grade, spelling was found to be the most consistent longitudinal predictor of composing across adjacent grades (Abbott, Berninger, & Fayol, 2010). Thus, all students might benefit from greater attention to screening for transcription problems and ongoing teaching of transcription skills as they relate to the grade-appropriate writing curriculum requirements.

Graham and Weintraub (1996) proposed four ways in which handwriting skills can interfere with ability to compose text. First, if handwriting is not automatic, children slow down and may forget their ideas and plans before they produce their translated written language. Second, switching attention from planning to handwriting and back again to planning may affect the coherence and sophistication of written text produced. Third, competing attention demands may interfere with the writer translating thoughts into writing. Finally, when children struggle with lower-order writing transcription processes, they feel less motivated and inclined to write. Because writing requires the management and coordination of multiple cognitive–linguistic processes simultaneously (Berninger, 2008; Moats, 2005–2006), writing is often thought to be more difficult than reading (Juel, 1988) and requires explicit, systematic, and sustained instruction for its mastery (cf., National Reading Panel, 2000; Snow, Burns, & Griffin, 1998), especially in transcription skills (Graham & Harris, 2000).

Handwriting Automaticity

When young children are learning to write, they must exert conscious control to form alphabet letters. Research over the past two decades has shown that handwriting requires the integration of orthographic codes (letter forms and written words stored in working memory) and sequential finger movements (Abbott & Berninger, 1993). Thus, handwriting is a linguistic act or "language by hand," not just a motor act (Berninger, 2000). Graphonomics research, such as writing development research, indicates that once children can write letters, they also have to develop handwriting automaticity to free up precious cognitive resources for higher-order writing processes (Medwell & Wray, 2008; Tucha, Tucha, & Lange, 2008). To develop handwriting automaticity, handwriting instruction should include strategies for using numbered arrow cues to form letters, writing the letters from memory after storing them in the mind's eye where they are visualized, and naming the letters as verbal retrieval cues (Berninger, 2008; Berninger et al., 1997). Direct instruction for accurate and automatic letter formation can also promote handwriting fluency, which is the ability to sustain letter writing over time throughout composing (Jones & Christensen, 1999).

Spelling

Like handwriting, spelling is not simply a motor process or a visual process (Berninger et al., 2006); instead, it involves making multiple connections among representations of spoken words (phonological awareness), written words (orthographic awareness), bases and affixes in spoken and written words (morphological awareness), and vocabulary (semantic meaning) (e.g., Apel, Masterson, & Niessen, 2004; Cassar, Treiman, Moats, Pollo, & Kessler, 2005; Moats, 2005–2006; also see Chapter 4).

Spelling develops in a somewhat predictable fashion for most typically developing children, although theoretical perspectives vary from stage theory (Ehri, 1997;

Templeton, 1991; Treiman & Bourassa, 2000a) to overlapping waves model (Rittle-Johnson & Siegler, 1999; Siegler, 2000; Treiman, 1998; Treiman & Bourassa, 2000b), to the connectionist model or statistical learning (Foorman, 1994; Pollo et al., 2008; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Ziegler & Goswami, 2005). In addition, children simultaneously use multiple processes for accurate spelling such as phonological, orthographic, and morphological knowledge based on students' representations of particular spelling patterns (Cassar & Treiman, 1997; Deacon & Bryant, 2005, 2006; Treiman, Cassar, & Zukowski, 1994; Walker & Hauerwas, 2006).

The speech-to-print translation process is challenging unless children can analyze spoken words into smaller units of sounds (i.e., phonological awareness). It is not uncommon that children fail to spell consonant clusters such as spelling "had" for *hand* (Treiman, 1993), and "set" for *street* (Bruck & Treiman, 1990) because it is difficult to discriminate those sounds in word context. Children with poor phonological awareness may omit letters for less salient phonemes, especially those that occur in internal locations and in unstressed syllable (e.g., pat for past), reverse letters (e.g., flod for fold), and spell distinct vowel sounds with same letter (e.g., bet and bit both spelled bet).

Children also need orthographic knowledge to spell words accurately. Some phonemes in English have multiple possible spellings, and many times the position of the phoneme in the word determines conventionally correct spelling. For instance, certain letters in English are more prone to being doubled than others (e.g., *e*, *l*, but not *u* or *h*) and have positional constraints (e.g., the *ck* pattern occurs in the middle or end of words but not in the beginning). Studies with English-speaking children have shown that children are sensitive to these orthographic patterns, even in first grade (Hayes, Treiman, & Kessler, 2006; Treiman, 1993). For example, *ck* was rarely found in the initial position of words in first graders' writings (Treiman, 1993). Children are also sensitive to more sophisticated orthographic patterns such as the vowel context in determining a final consonant, preferring *thull* over *thul* and *thool* over *thooll* (Hayes et al., 2006). Children who have weak orthographic knowledge may use illegal substitutions (e.g., cas for catch) or use phonemically possible spellings that violate rules (e.g., rane for rain).

Children further use morphological coding and semantic relations in their spelling. The English writing system is a morphophonemic orthography such that morphological information, as well as phonological information, is represented in conventionally correct spelling of words. Thus, the conventional spelling for the word, *health*, makes sense given that health is related to *heal* although *helth* is a correct phonological representation. Studies have shown that children use morphological information in their spelling fairly early on, and their ability to use morphological knowledge in spelling develops over time. As an example, first-grade children rarely missed /n/ in a two-morpheme word like *tuned* compared to a single morpheme word *brand* (Treiman & Cassar, 1996), indicating that the existence of a root word (e.g., *tune*) helps children to represent the sound /n/. Derivational morphology information in spelling is more challenging than inflectional morphology (e.g., Deacon, 2008), perhaps because of often considerable differences in pronunciation in the derived word and base word. Spelling *sign*, for example, is challenging for many students in upper elementary grades unless the child is aware of the word's relation to *signal* (Waters, Bruck, & Malus-Abramovitz, 1988). Children who have weak morphological knowledge are likely to show phonemic spelling of morphemes (e.g., walkt for walked) or fail to spell the inflected or derived form (e.g., assension for ascension from ascend).

The fact that spelling requires coordination of multiple processes (phonological, orthographic, and morphological codes) has at least three implications for instruction. First, it is important to employ a multipronged approach to spelling instruction (Berninger, 2000, 2007; Graham et al., 2002; Henry, 2010; Moats, 2005–2006; Nunes & Bryant, 2006, 2009). In other words, it is important for teachers to attend to phonological, morphological, and orthographic principles of spelling rather than a single aspect. Such multifaceted instruction indeed benefits students. For example, Graham et al. provided spelling instruction based on lexical knowledge (i.e., memory for the spelling of specific words, see Ehri, 1986) and letter–sound combinations, phonological segmentation, and orthographic patterns to second-grade children with spelling difficulties, and this approach results in improved spelling as well as writing.

Second, distributed practice across the week is more effective than daily drill in spelling (Rice, 1897). Third, it is critical to document carefully children's spelling development in terms of their correct *and* incorrect spellings (Masterson, Apel, & Wasowicz, 2006). In particular, children's spelling errors reveal a great deal of information about children's spelling development and linguistic (i.e., phonology and morphology) and orthographic processes they draw on for spelling, and their linguistic processing breakdowns. Recent research has clearly shown that children have diverse experiences with language and literacy skills and thus effective writing instruction should match students' needs with tailored instruction rather than a one-size-fits-all approach (Connor, Morrison, & Katch, 2004; Connor et al., 2009). Careful spelling error analysis reveals specific patterns of misspelling and helps teachers identify sources of breakdowns that interfere with children's spelling (e.g., phonological awareness, orthographic knowledge, and morphological and semantic knowledge). Teachers then can plan systematic, differentiated instruction or intervention tailored to individual students to address the specific needs and sources of difficulty (Apel et al., 2004; see, e.g., SPELL and SPELL-2 software assessment programs by Masterson, Apel, & Wasowicz, 2002; Masterson et al., 2006).

Text Generation

Writing acquisition requires the generation and sequencing of increasingly larger units of written language—from letters in words, to words in sentences, to sentences in paragraphs, and finally to paragraphs in written discourse. However, children do not necessarily develop comparable proficiency in all levels of language—word, clauses, sentences, paragraphs. Intraindividual dissociations can occur across levels of language in writing samples showing relative strengths at some levels of language and relative weaknesses in other levels of language (Whitaker et al., 1994). For example, a child struggling with handwriting can be skilled in generating ideas or a child lacking the ability to combine simple sentences into more complex forms can be proficient in spelling. Thus, any comprehensive writing intervention protocol should target skills at the word, sentence, and text levels.

Individually Tailored Instruction

The aforementioned findings do not imply that children develop text generation skills in a hierarchical sequence either. Mastery of a lower language level (e.g., words) is not necessary for proficient performance at a higher level (e.g., sentences). In fact, research with beginning writers—preschoolers, kindergartners, and first graders—has shown that children are able to use invented spelling to compose sentences from very early on in their writing careers (Chomsky, 1979, Puranik & Lonigan, 2010; Traweek, Cartwright, & Berninger, 1992 as cited in Berninger, 2009). What this line of research indicates is that intraindividual differences across levels of language exist within individual writers and instruction must be tailored to take into account these relative strengths and weaknesses related to text generation. Some children may need to have their attention drawn to writing words, whereas some children may need help with idea generation to construct syntactically acceptable sentences or to create coherent texts.

We emphasize that breakdowns in spelling, capitalization, and punctuation are not merely mechanical errors but rather clues to how instruction might be individually tailored. Not only level of spelling achievement but also spelling errors should be analyzed at specific grade levels to identify how errors reflect the various ways children struggle with the phonological, orthographic, and morphological aspects of the spelling system (see Apel & Masterson, 2001; Silliman, Bahr, & Peters, 2006). Analyzing breakdowns will allow for differentiating instruction tailored to meet individual student needs. Similarly, text generation skills should be facilitated by integrating all levels of written language—word, sentence, and text, with a focus on the child's instructional level.

IMPLICATIONS OF TRANSCRIPTION AND TEXT GENERATION RESEARCH FOR ASSESSMENT

Now that considerable research has identified effective writing instruction during the primary grades (ages 6–8 or 9 in the United States) (e.g., Berninger et al., 2002; Hooper, Knuth, Carlson Yerby, & Anderson, 2009; Morris & Mather, 2008; Troia, 2009) and upper elementary grades (ages 9–12 in the United States) (e.g., Berninger et al., 1995; Graham & Harris, 2005; Harris, Graham, Mason, & Friedlander, 2008; Hidi & Boscolo, 2006; Troia, 2009) to prevent writing disabilities, group assessments are needed that can be administered in general education classroom to identify students who would benefit from early intervention or supplementary instruction at these grade levels. Given the complex nature of writing, the assessment of writing is also riddled with unique challenges as well as possibilities. We consider alternatives currently available.

CURRICULUM-BASED WRITING ASSESSMENT

Curriculum-based measurement (CBM) (Deno, 1985; Deno, Marston, & Mirkin, 1982; Deno, Mirkin, & Masterson, 1980; Videen, Deno, & Marsten, 1982) is one approach to assessing and monitoring growth in behavior or skills over time by administering multiple probes of equivalent difficulty over time. The time-series data obtained from these repeated measures, which provide a snapshot of a student's progress, can be used by classroom teachers to establish a baseline, monitor progress, identify areas of strengths and weaknesses, inform instruction, and measure growth. CBM-W (CBM for writing) measures have been gaining ground (Tindal, Marsten, & Deno, 1983; Tindal & Parkar, 1991). However, Peverly (2006) has pointed out that CBMs may be misnamed because they are not really linked to the curriculum in the classroom of an individual student; they may be useful educationally but more appropriately named time-series probes.

The CBM-W involves students' writing in response to a prompt for 3–5 min. Variables commonly calculated from writing samples include total number of words written, correctly spelled words, and correct word sequences. In a recent review of 28 studies on CBM-W, McMaster and Espin (2007) summarized reliability and validity data for writing assessments. Overall, their review indicated that CBM-W can be used as reliable and valid indicators of writing proficiency for secondary school students but reliability and validity data for elementary school students was a little less convincing (see McMaster & Espin for a review of studies). Other researchers are attempting to address some of these issues related to the technical adequacy of CBM-W and ascertaining the best prompts and variables to assess writing (e.g., McMaster, Xiaoqing, & Petursdottir, 2009; Ritchey, Coker, & McCraw, 2010). For example, in a study using CBM-W with first graders, McMaster et al. reported good reliability and validity for writing measures using sentence copying, and sentence and story writing using photo and story prompts. Likewise, Coker and Ritchey (2010) reported good reliability and validity for the following variables: total number of words written, correctly spelled words, and correct word sequences for kindergarten and first-grade children. Assessment of spelling using CBM has shown to be particularly promising for beginning writers (Coker & Ritchey; Lembke, Deno, & Hall, 2003; Ritchey, 2006).

LINGUISTICALLY INFORMED ASSESSMENT OF WRITING SAMPLES

Writing samples can be analyzed with an almost limitless number of variables, ranging from precise analyses of latencies captured via monitoring of keyboard keystrokes to qualitative ratings of overall writing quality. The sheer number of possible variables that are available and may be relevant makes it difficult to identify key foci for assessment and potential targets for instruction and remediation. On the one hand, researchers in the cognitive and linguistic traditions develop multidimensional coding schemes and assess interrater reliability for a coding scheme for quality based on content and organization applied by multiple raters (e.g., Berninger et al., 1992, 1994; Graham et al., 1997). On the other hand, perhaps the most widely used method of scoring writing samples for school assessment is often holistic scoring in which writing samples are given an overall rating (Huot & Neal, 2006).

Other approaches to developing writing assessments analyze relationships among multiple measures (e.g., correlations or covariances) in order to identify a smaller number of underlying factors or dimensions. If we can identify a smaller number of underlying factors that account for individual or developmental differences in writing, it may be possible to develop scoring systems that reflect these factors, which may have application to tailoring interventions individually.

Exploratory Factor Analysis of a Written Retelling Task

Puranik et al. (2008) explored the factor structure of writing using a retelling paradigm in which students in grades 3–6 wrote what they remembered from a story that was read to them. This approach separates the transcription process from the idea generation process related to text generation—in that the students only had to reproduce not construct the text. The researchers coded variables by transcribing the writing samples into a database using the *Systematic Analysis of Language Transcript* (SALT) conventions (Miller & Chapman, 2001). They carried out an exploratory factor analysis and interpreted a three-factor solution as representing the factors of productivity, complexity, and accuracy. Total number of words, *t*-units, and clauses comprised the productivity factor. Mean length of *t*-unit and clause density comprised the complexity factor whereas percentage of grammatical *t*-units, proportion of spelling errors, and proportion of correct punctuation comprised the accuracy factor. Children's performance of each of these measures showed improvement with age with some measures showing a statistically significant improvement.

Confirmatory Factor Analyses: Five-Factor Model

Wagner et al. (in press) used confirmatory factor analysis to compare models of the factor structure of writing samples provided by first- and fourth-grade students. Their study replicated and extended the Puranik et al. (2008) study by (a) analyzing writing to a prompt as opposed to story retelling, (b) using confirmatory factor analysis to test alternative models including one suggested by the results of the initial exploratory factor analysis, (c) adding a measure that represented the macrostructure of text (text organization and overall cohesion), and (d) incorporating the construct of handwriting fluency, that is sustained letter writing over time.

Writing samples were obtained from 208 first- and fourth-grade students by asking them to write about choosing a pet for their classroom. In addition to obtaining writing samples, handwriting fluency was measured by asking students to write the letters of the alphabet in order as quickly and carefully as possible for 60 s, and by asking them to write the sentence "The quick brown fox jumps over the lazy dog" as many times as possible for 60 s.

Ten variables (labeled 1–10) were coded from the writing samples and entered into SALT. The variables were chosen to represent four constructs that were evaluated as possible factors. The construct of *macro-organization* was represented by coding: presence or absence of a topic sentence (1), rated logical ordering of ideas (2), and number of key elements present (i.e., main idea, body, and conclusion) (3). That is, macro-organization was an index of translation of ideas into written language. The construct of *complexity* was represented by mean length of *t*-unit (4) and clause density (5). That is, complexity refers to linguistic complexity. The construct of *productivity* was represented by total number of words (6) and number of different words (7). Thus, a factor underlying composition fluency (total words) and lexical diversity (number of different words), both defined on the basis of words and widely studied in the writing research literature, was included in the model. Finally, the construct of *spelling, capitalization, and punctuation* was represented by number of spelling errors (8), number of capitalization errors (9), and number of punctuation errors involving correct placement of a period (10). In addition to these four constructs measured using the obtained writing samples, the construct of *handwriting fluency* was represented by having students write the letters of the alphabet in order for 60 s and to copy a sentence for 60 s.

To examine the magnitude of differences in scores between the first- and fourth-grade samples, effect sizes (Cohen's *D*) were calculated. The magnitudes of the effect sizes varied by construct. Large effect sizes ranging from 1.65 to 2.48 were found for variables associated with the productivity and handwriting fluency constructs. Moderate effect sizes ranging from 0.56 to 0.94 were found for variables associated with the macrostructure organization and complexity constructs. Small and nonsignificant effect sizes ranging from 0.16 to 0.28 were found for variables associated with spelling, capitalization, and punctuation construct.

Confirmatory factor analyses of the writing sample and handwriting fluency variables were carried out to test alternative models of the underlying factor structure of writing. Three results are of special interest. First, the best-fitting models consisted of five factors that represented the constructs of macro-organization, complexity, productivity, spelling and punctuation, and handwriting fluency. Models that posited fewer factors, such as a general factor model for which individual differences in writing can be explained by a single factor analogous to the *g*-factor of general intelligence, produced a significantly poorer fit to the data, consistent with a model in which multiple processes contribute to the complex writing process. The second result of special interest was that the best-fitting models were identical for the first- and fourth-grade samples. Given the considerable development in writing that takes place between first and fourth grade, it is surprising that the factor structure remains invariant. The implications of this finding are that the same domains (constructs) should be assessed from grades 1 to 4 even though children will improve over time in each of the skills contributing to the measurement of the construct. The third result of special interest was the strong correlation between handwriting fluency and factors beyond productivity. That there should be a strong correlation between handwriting fluency and productivity is not surprising: If you can write more fluently, you are likely to write more. What is more surprising is the magnitude of the correlation between handwriting fluency and macro-organization. This correlation was 0.32 ($p < .05$) for first graders and a sizable 0.81 ($p < .001$) for fourth graders. The sizable relationship can probably be explained by handwriting fluency reflecting sustained processing over time in working memory, which has been found to be related to idea generation (Hayes, 2008, as cited in Hayes & Berninger, 2010).

Correlations of comparable magnitude have been found by other investigators, even when handwriting measures reflected automatic retrieval of alphabet letters in a 15 s interval. One possible explanation for strong relations between handwriting fluency (sustained retrieval and production over time) and composition is that both automatic and fluent handwriting free up attentional and other executive resources that can be applied to planning and translating (Alves, Castro, Sousa, & Stromqvist, 2007; Chanquoy & Alamargot, 2002; Christensen, 2005; Connelly, Campbell, MacLean, & Barnes, 2006; Connelly, Dockrell, & Barnett, 2005; Dockrell, Lindsay, & Connelly, 2009; Graham et al., 1997; McCutchen, 2006; Olive, Alves, & Castro, in press; Olive & Kellogg, 2002; Peverly, 2006; Torrance & Galbraith, 2006). The ability to juggle many processes contributing to writing in working memory, as discussed earlier in this chapter, then is likely contributing to the quality of the composing at the macrolevel.

The factor structure we have described of macro-organization, complexity, and productivity also reflects the multiple levels of language underlying text generation (Abbott et al., 2010; Whitaker et al., 1994) reported in earlier writing research already discussed. The macro-organization factor draws on text-level language, the complexity factor draws on sentence-level language, and the productivity factor draws on the word level of language. The concordance of these factors with the levels of language in text generation adds converging validity for the current factor structure. The remaining factors appear to be related to transcription. So the reliable five-factor solution nicely accounts for all the relevant text generation and transcription processes during translation. Thus Wagner et al.'s (in press) results can be explained conceptually within alternative, cross-disciplinary frameworks, lending convergent construct validity to the findings.

As with many complex processes and application of multivariate data analysis procedures, results often depend on what and how many measures were employed, which may vary with different research aims. Finding that five factors was needed to account for composition and handwriting fluency may appear to contradict an interesting multilevel confirmatory factor analysis of reading, spelling, writing, and verbal ability reported by Mehta, Foorman, Branum-Martin, and Taylor (2005), but the current study did not include reading or verbal ability measures. Mehta and colleagues scored writing samples by rating them on (a) addressing the prompt, (b) unity and logical organization, (c) vocabulary usage, (d) sentence completion, (e) grammar usage, (f) use of capitalization, (g) use of punctuation marks, and (h) spelling conventions. These ratings were then combined into a single writing ability estimate. The data were modeled both at the level of the individual student and at the classroom level, as is appropriate when data are nested within two different levels. At the student level, there were two highly correlated ($r = .7$) yet distinct factors: A literacy factor that consisted of word reading, passage comprehension, phonological awareness, writing, and spelling, and an oral language factor that consisted of vocabulary and two verbal subtests from an IQ test. At the classroom level, a single factor accounted for both the literacy and oral language factors.

At both the individual and classroom level, literacy in the form of writing and reading was determined to be a unidimensional construct. Comparison of the two models shows that from a system perspective when different constructs are included in a system, the organization of the constructs may vary somewhat.

There were also measurement differences across the two studies. Mehta et al. (2005) combined eight aspects of writing into a single writing score instead of analyzing different latent factors. This writing score was included with measures of word reading, phonological awareness, reading comprehension, and spelling as indicators of a single construct of literacy. The fact that the model fits for both studies was adequate and suggests that there is a fair amount of common variance at this level of analysis, which has been a common finding when reading and writing are compared (Shanahan, 2006). Another potentially important difference between the two studies is that Mehta et al.'s writing score was a composite of quality ratings (0 = poor to 4 = excellent) of the eight aspects of writing they coded. The writing variables, modeled by Wagner et al., were not limited to quality ratings but included quantitative variables.

The instructional implications of the Puranik et al. (2008) and the Wagner et al. (2011) study are that in addition to assessing students' written products globally using quality ratings or holistic scoring systems, educators should consider strengths and weaknesses at each language level. This scheme for examining dimensions of writing is consistent with previous research regarding intraindividual differences or processing breakdowns at three levels of language—word, sentence, and discourse level (Whitaker et al., 1994)—and adds instructionally relevant information. Children with written language deficits especially those that also have concomitant oral language difficulties can struggle with different levels of language. Furthermore, similar to analyzing writing at different levels of language, analyses of transcription errors should include not only handwriting and spelling, but also capitalization and punctuation.

ALTERNATIVE: COH-METRIX ANALYSIS OF WRITING SAMPLES

Coh-Metrix is a computational tool that generates 60 indices that describe the linguistic and discourse representations of text. Its primary usage has been to analyze the coherence and readability of professionally written texts. We sought to explore the use of Coh-Metrix for analyzing the first- and fourth-grade writing samples that Wagner et al. (in press) analyzed using SALT. Because we were interested in the ability of Coh-Metrix to expand our previous analysis of the characteristics of the words contained in the writing samples, *we corrected misspellings before applying Coh-Metrix*.

Using Coh-Metrix to analyze writing samples has a number of potential advantages compared to the SALT-based coding used in the prior study. First, Coh-Metrix is a computer scoring system and for that reason is much more efficient. In the prior study, writing samples were hand coded and the data were then imported into SALT for analysis. In addition to being time consuming, considerable training is required to obtain sufficiently reliable coding of writing samples. Thus, a

TABLE 9.1 Coh-Metrix Variables Used in Comparison of First- and Fourth-Grade Writing Samples

1. READNW. Number of words in the writing sample
2. READNS. Number of sentences in the writing sample
3. READASW. Average number of words per sentence
4. TYPTOKc. Type–token ratio for all content words
5. SYNNP. Mean number of modifiers per noun phrase
6. SYNHw. Mean number of higher-level constituents per word
7. SYNLE. Mean number of words before the main verb of main clause in sentences
8. FRQCRacw. Mean frequency of content words
9. WORDCacw. Concreteness mean for content words
10. HYNOUNaw. Mean hypernym values for nouns
11. HYVERBaw. Mean hypernym values for verbs
12. LSApssa. Mean sentence-to-sentence LSA value for all combinations of sentences
13. CREFC1u. Content-word overlap
14. READFRE. Flesch reading ease score
15. READFKGL. Flesch–Kincaid grade level

second advantage of Coh-Metrix over using SALT is improved reliability. Because no human judgment is required, Coh-Metrix approaches perfect reliability when used to score writing samples. A third advantage of Coh-Metrix is that it provides a richer set of variables that characterize the macrostructure of text compared to the variables used in the prior study. A fourth advantage is that Coh-Metrix provides a set of indices that characterize words with respect to variables such as frequency and concreteness. A fifth and final advantage is that Coh-Metrix provides several readability indices that could prove useful indices of "writability."

The Coh-Metrix variables used in the present study are listed in Table 9.1. Most of these variables are self-explanatory. The type–token ratio for all content words is created by dividing the number of unique words (i.e., types) by the number of instances of each word (i.e., tokens). Each unique word is considered a type, and each instance of that word is considered a token. Content words are nouns, adverbs, adjectives, and verbs. More complex sentences typically have more modifiers (i.e., adjectives and adverbs) per noun phrase. Number of higher-order constituents per word is an index of the structural density of sentences. Concreteness was defined as the mean concreteness value of the content words in the writing samples using the MRC Psycholinguistics Database (Coltheart, 1981) to determine concreteness values. Hypernym refers to the number of levels in a conceptual taxonomic hierarchy. Abstract words have fewer distinctive features and attributes compared to concrete words, and therefore abstract words are lower in hypernym than are concrete words. Latent semantic analysis (LSA) refers to the similarity among all possible pairs of sentences, with similarity quantified by the cosine of the angle between vectors in latent semantic space. Higher cosine values denote greater relations and cohesion among sentences in the sample. Content-word overlap refers to the proportion of content words in adjacent sentences that share common content words. Flesch reading ease is a readability formula that

TABLE 9.2 Descriptive Statistics, Effect Sizes, and Significance Tests of Developmental Differences Between the First- and Fourth-Grade Writing Samples Based on Coh-Metrix Analysis

	First Grade	Fourth Grade	Cohen's	
	M (SD)	*M* (SD)	*D*	*t*
1. Number of words	43.65 (18.28)	113.88 (42.36)	2.09	14.9***
2. Number of sentences	5.38 (2.31)	9.57 (4.55)	1.16	8.0***
3. Words per sentence	9.05 (4.79)	12.85 (3.87)	0.87	5.9***
4. Type–token ratio	0.77 (0.12)	0.75 (0.10)	−0.18	−2.5*
5. Modifiers/noun phrase	0.56 (0.33)	0.59 (0.17)	0.11	0.9
6. Higher-level constituents	0.80 (0.08)	0.79 (0.04)	−0.16	−0.9
7. Words before main verb	2.03 (1.27)	2.64 (1.13)	0.51	3.4**
8. Content-word frequency	5498.24 (2780.80)	4284.42 (1738.81)	−0.52	−3.5**
9. Concreteness	401.81 (43.42)	391.45 (27.11)	−0.29	−1.9
10. Abstractness of nouns	5.76 (1.09)	5.69 (0.69)	−0.08	−0.6
11. Abstractness of verbs	1.32 (0.35)	1.49 (0.26)	0.55	3.7***
12. All sentences LSA	0.23 (0.14)	0.18 (0.09)	−0.42	−2.8**
13. Content-word overlap	0.20 (0.15)	0.12 (0.08)	−0.67	−2.7*
14. Flesch reading ease	96.9 (6.3)	90.7 (6.2)	−0.99	−6.7***
15. Flesch–Kincaid	1.62 (1.96)	3.77 (1.62)	1.20	8.1***

*** $p < .001$, ** $p < .01$ or less, * $p < .05$ or less.

is based on average sentence length and average number of syllables per word. Scores range from 0 to 100, with lower scores indicative of greater difficulty of the text. The Flesch–Kincaid grade-level formula converts the reading ease score to a metric that corresponds roughly to grade levels in the United States. Higher grade levels are indicative of greater difficulty of the text.

Descriptive statistics, effect size differences, and *t*-test values and their significance for differences in Coh-Metrix values between the first- and fourth-grade writing samples are presented in Table 9.2. The largest differences were found for variables that reflected productivity in terms of numbers of words and sentences contained in the writing samples. Large differences were also found for sentence length and for the two Flesch readability indices that are based in part on sentence length.

Moderately large differences were found in word-level variables with fourth-grade writing samples characterized by words that were less frequent. There were differences between grades in the abstractness of the verbs used but not in the abstractness of the nouns used. The sentences of the first-grade writing samples were more overlapping and highly related compared to the fourth-grade sentences, based on the LSA and content-word overlap variables. Fourth-grade writing samples were characterized by more words occurring before the main verb, and a smaller type–token ratio. Finally, no differences were found in terms of the number of modifiers per noun phrase or higher-level constituents.

In general, Coh-Metrix appears to be a promising new tool for analyzing writing samples. Most of the Coh-Metrix indices examined differentiated the first- and fourth- grade writing samples and the differences were in the expected directions. Coh-Metrix provides a richer set of indices than those analyzed in our prior study. There are, however, a couple of disadvantages of Coh-Metrix. First, it does not provide a qualitative analysis of spelling errors and second, it does not provide a measure of handwriting fluency: two important measures of transcription. In future work, we intend to compare the factor structure of writing samples using Coh-Metrix analyses to that obtained in the prior study.

FUTURE DIRECTIONS

Schools in the twenty-first century face enormous challenges creating universal writers who meet grade-level standards in writing. Progress has been made in the United States, but many still write below the grade school level according to the 2007 National Assessment of Educational Progress (NAEP). With the call in the United States by the National Commission on Writing (2003) and the Common Core State Standards Initiative (2010) for every state to teach writing based on best writing practices, there has been an increased focus on writing research recently. In this section, we discuss some avenues for future research with a focus on the translation process of writing. It is our hope that this research effort will include increasing collaboration among United States' writing researchers and writing researchers across countries for a truly global effort in creating universal writers (see Chapter 1).

One area for future writing research involves researchers being clearer about which dimension of handwriting they are assessing in a particular research study and why. Although the fields of cognitive psychology and graphonomics had worked out nomenclature for dimensions of handwriting, as many other disciplines have begun doing handwriting research, they have adopted their own terms without paying attention to the terms used in already established in other lines of research. Thus, for a start, we need to develop consistent use of terminology.

Ways of assessing handwriting also vary from study to study and across disciplines. In studies with elementary school children, various measures of handwriting have been used, ranging from children (a) copying as many letters as they can in 1 min (e.g., Olinghouse & Graham, 2009) to (b) writing as many letters in the alphabet from memory as they can in 1 min (Hudson, Lane, & Mercer, 2005; Jones & Christensen, 1999; Wagner et al., 2011) to (c) writing the alphabet in order from memory (scored for number of legible letters in alphabetic order in first 15 s, total legibility, and total speed), copying a sentence with all the alphabet letters (scored for same outcomes as the previous task), and copying a short story in 90 s (e.g., Berninger et al., 1992, 1994, 2007; Berninger & Rutberg, 1992; Swanson & Berninger, 1996) to (d) copying their compositions (Olive & Kellogg, 2002).

These dimensions differ not only in name but also in underlying transcription constructs (speed, legibility, and fluency) and how they are related to text generation (e.g., Richards et al., 2009). For example, research has shown that it is automatic alphabet letter writing in the first 15 s, which Graham, Harris, and Fink (2000) also used, is a hallmark diagnostic feature of dysgraphia (Berninger, 2007), but sustained copying on a copy task proved to be a very good screen for early intervention (Berninger et al., 2006). There is a growing evidence that multiple dimensions are involved in handwriting and should be assessed with interpretation of results restricted to which dimension was measured. A similar case can be made for assessing and interpreting the multiple dimensions of spelling and composing.

The second area for future research pertains to the importance of large-scale classroom assessments at the two critical developmental periods in writing development—school entry (learning to write) and third- to fourth-grade transition when writing to learn (Berninger et al., 1995; Klein, 1999). The research measures discussed in this chapter have promise in this regard. For example, the macrostructure, sentence complexity, and lexical diversity factors have been shown to be valid and are instructionally relevant (Puranik et al., 2008; Wagner et al., in press). Individual children are likely to vary in whether they have relative weaknesses or strengths in each of these constructs, which could be assessed before, during, and after intervention during the learning to write period and also the writing to learn period. Quick, comprehensive, and efficient language-sampling procedures are needed to detect these difficulties with several aspects of writing. The scheme for examining dimensions of writing at various language levels could be very relevant for educators and clinicians interested in classroom writing assessments and evaluating response to intervention through progress-monitoring procedures. Clearly as indicated in the section "Curriculum-Based Writing Assessment," research is also needed to validate specific curriculum-based writing measures at specific times in writing development and specific educational applications, for example, which indices are most sensitive to capturing growth in student writing and are most related to curriculum in place in a local school district or specific state's high stake standards. The macrostructure factor used in our previous research may be a promising approach to assessing the quality of the translation process.

Another area for potential future research is whether and if so how spelling varies when the writer focuses only on spelling dictated words compared to when spelling while composing. Spelling, whether using standardized assessments or using researcher-generated tasks, is generally assessed by having children spell single words to dictation (e.g., Both-de Vries & Bus, 2008; Lombardino, Bedford, Fortier, Carter, & Brandi, 1997; McBride-Chang, 1998; Ouellette & Sénéchal, 2008). Spelling words during text composition while juggling a host of other writing goals such as choosing words, formulating sentences, reviewing and monitoring yields important assessment information.

Finally, one transcription skill that appears to be sidelined and has not received adequate attention is punctuation (Hall, 2009). Researchers have suggested that beginning writers are generally poor at punctuation, either just forgetting to punctuate or typically confining their use of punctuation to the most basic punctuations (Ferreiro & Kucchermaglio, 1996; Simone, 1996). Overall, future research should build on the seminal work begun by Fayol (in press, for review) on how children come to understand and use punctuation (Hall). This research is needed because punctuation marks where translation during a written language burst ends (see Chapter 2), marking a complete thought or separate but related ideas, are embedded within a larger syntactic structure composed during translation (Fayol, 1997).

ACKNOWLEDGMENTS

Support for carrying out this research was provided in part by grant P50 HD052120 from the National Institute of Child Health and Human Development and by a Postdoctoral Training Grant R305B050032 and grant R305A080488 from the Institute of Education Sciences. The opinions expressed are those of the authors and do not represent views of the funding agencies.

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10

Facilitating Children's Translation of Ideas Into Written Language Through Combining Art Activities and Self-Regulated Strategy Instruction for Writing

MICHAEL DUNN

The results of the National Assessment of Educational Progress (2007) indicated that about 40% of fourth-grade students in U.S. public schools had difficulty demonstrating proficiency with writing at a basic level. State assessments for writing also reflect this national profile (e.g., Washington State's Assessment of Student Learning, 2009). The underlying question is why writing would pose more difficulty for children than other literacy domains such as reading. A plausible reason is that writing is a more complex activity in that it requires other skills in addition to writing that have to be integrated with writing. For example, writing may require reading source material and writing a final draft requires not only generating a text but also reading it to make edits for a publishable copy (Fletcher, Lyon, Fuchs, & Barnes, 2007). Even with proficient reading skills, writing can pose additional challenges.

Struggling writers (Troia, 2008) often have not developed a means to manage writing tasks (Baker, Chard, Ketterlin-Geller, Apichatabutra, & Doabler, 2009). Choosing a story topic, organizing the story's structure (i.e., beginning, middle, and end; Donovan & Smolkin, 2006), spelling words for phrases and paragraphs (Saddler, Behforooz, & Asaro, 2008), and then reviewing multiple drafts to produce a publishable copy are often overwhelming for these children (Shanahan, 2006).

Their written product tends to be shorter than that of typically-achieving peers, lacking in detail, with poor penmanship, spelling, and syntax, and missing a plot or progressive theme (Hooper, Swartz, Wakely, de Kruif, & Montgomery, 2002). Students who struggle with writing need to be taught how to manage, that is, self-regulate (e.g., Graham & Harris, 2005; Harris, Graham, Mason, & Friedlander, 2008), the text-generation process.

NEED FOR STRATEGY INSTRUCTION AND HOW TO TEACH IT

Mnemonic-strategy instruction (MSI) provides a step-by-step process for teachers to explain, model, and offer feedback to students in managing a task such as writing (Graham & Harris, 2005; Scruggs & Mastropieri, 1992). One example is *Plan, Organize, and Write* (POW; Graham, Harris, & Mason, 1992) where students are first taught to plan their story, organize their ideas, and then write their text. Graham and Harris created a formative process for teaching strategies to students, which they named *self-regulated strategy development* (SRSD). Teachers sequentially present the following components: (a) review and develop a student's background knowledge about a task such as story writing (e.g., What is a story you have written or read? How do you start to write a story?), (b) discuss the strategy and attain the student's commitment to learning and using it for story writing, (c) introduce the teacher modeling the strategy with verbalization of all thoughts in working through the sequential story-writing steps, (d) ask the student to memorize the strategy's steps to internalize its components, (e) provide teacher-guided practice, and (f) have student demonstrate independent use of the story-writing strategy. SRSD helps children to improve an area of weakness such as story writing by combining academic strategies with procedural instructions. Teachers can employ established scaffolding (e.g., organizational) techniques to help children in this process.

Once students have chosen a story topic, they need to consider what the related content should be. Graham and Harris (1989) created the WWW, W = 2, H = 2 cue questions so that struggling writers could focus their story writing on key content. Each W and H specifies a question for what should be included in a story: Who is in the story? Where does the story take place? When does the story take place? What do the characters do? What do the other characters do? How does the story end? How do the characters feel? Saddler, Moran, Graham, and Harris (2004) found that six students' use of WWW, W = 2, H = 2 resulted in their producing more elaborate story content—from doubling baseline performance to including all seven WWW, W = 2, H = 2 cue questions. After students have pondered the applicable content to their story's topic, they then need a means to note their ideas for later generating the actual first draft of text. Noting WWW, W = 2, H = 2 answers with words and phrases written on paper is one way to generate the first draft, but that translation of thoughts into written symbols requires skills that are typically difficult for struggling writers: handwriting and spelling. A notation method, which represents the writer's story ideas, but without words that need to be transcribed, might help.

RATIONALE FOR ART

One of the themes of this book is that translation is a cross-domain communication process, which in the case of writing is translation of ideas into writing or construction of new ideas through writing (see Chapter 1). Inherent in the translation process is gaining access to ideas, that is, cognitive representations of many kinds. That alone may pose challenges for some struggling writers. Once ideas are accessed, some beginning or struggling writers who are still learning to translate ideas into the syntax of language (Berninger, Nagy, & Beers, 2011) may have difficulty not only accessing and/or generating their thoughts but also transforming them into language. Cognitions reside in a nonlanguage domain of the mind (see Tables 3.1 through 3.5).

Thus, struggling writers who have difficulty in accessing their cognitions, generating them, and/or expressing them in language might benefit from art activities during the writing process. Art activities, such as drawing or painting or modeling with clay, may help struggling writers access ideas coded in nonverbal formats in mind, generate ideas that may be more easily expressed nonverbally than verbally for that writer, and transform ideas, which are first expressed in a nonlanguage format, into the syntactic or narrative structures of written texts. The art activities may stimulate the flow of ideas (Kellogg, 1994), that is nonstrategic idea generation, as much as thinking aloud may, or may assist with the strategic planning via nonverbal imaging. For example, in a longitudinal study when beginning writers were asked to think aloud and generate ideas about specific topics before writing about the topic, some coded categories were language based but most were not and included cognitive representations as easily expressed via art as words (Berninger et al., 2009). Moreover, when the brains of good and poor child writers were scanned during idea generation prior to composing outside the scanner, they differed in a brain region associated with working memory. Art may externalize cognition in ways that overcome limitations of working memory in supporting idea expression via written language (Berninger & Winn, 2006). Thus, art activities may facilitate idea expression in writing (Dunn, In press, submitted [b], in preparation [a], in preparation [b]; Dunn & Finley, 2008, 2010) for many reasons, ranging from stimulating idea generation to providing support for strategy planning and implementing, and facilitating the transformation of ideas into written language during the translation process. However, the art activities may facilitate word generation or narrative schema rather than syntax construction, which is a uniquely language function.

Explicit instruction and ample practice with a variety of writing strategies improves composition in writers beyond the initial stage of writing acquisition (Donovan & Smolkin, 2006). For example, Deschler, Warner, Schumaker, and Alley (1984) introduced the components of the ask reflect text (ART) strategy based on the WWW, W = 2, H = 2 questions. While pondering their responses, students printed, wrote, or illustrated story ideas, characters, settings, and events, and then practiced this ART strategy with controlled materials. Graham and colleagues (e.g., Graham and Harris, 1989) further developed and validated the

WWW, W = 2, H = 2 strategy for narrative story writing by employing it with students in the upper grades. These struggling writers benefited from orally verbalizing during discussion and then memorizing all those steps of the strategy to apply on their own to self-regulate the story-writing process. Other studies have reported evidence of the effectiveness of the ART strategy for planning and translating (e.g., Bender, 2002; Dunn & Finley, 2008). Although most studies including story planning with art were with students fourth grade and above, research by Dunn and colleagues included first graders (Dunn & Finley, 2008), second graders (Dunn, In press; Dunn & Finley, submitted), third graders (Dunn, in preparation [b]), and fourth graders (Dunn, in preparation [a], in preparation [b]; Dunn & Finley, 2008, 2010).

The author's research (Dunn, In press, submitted [b], in preparation [a], in preparation [b]; Dunn & Finley, 2008, 2010) documents evidence for the benefits of adding art activities to writing strategy instruction. Dunn and Finley reported evidence for incorporating art media in the ART strategy (WWW = 3, W = 2, H = 2 strategy). The strategy referred to the treatment that teaches a strategy for planning and text generation: participants *ask* themselves WWW, W = 2, H = 2 questions, then *reflect* about what they wanted to include in their answers while creating their own aesthetic representation of their answers to the WWW, W = 2, H = 2 questions, and finally use this story plan to generate their *text*. Adding art activities (e.g., watercolor paints, colored markers and pencils, playdough) to the ART writing strategy offered an alternative nonverbal channel for generating ideas that does not require transcription but may benefit the quality of ideas expressed in writing (Danko-McGhee & Slutsky, 2007; Dunn & Finley, 2008; Fu & Shelton, 2007).

Writing paper in K-1, which is unlined at the top for artwork and lined on bottom half for written language, may benefit dual channels for idea expression. Text and visual images on the Internet complement each other through webpage themes, key words, and story ideas that illustrate the message(s) of the text (Fleckenstein, Calendrillo, & Worley, 2002; Flood & Lapp, 1997); thus, complementary generation of visual images and written text may benefit the writing process. Images are more compact and efficient storage units relative to words early in the writing process (Hobson, 2002).

Children's art is an important research tool for observing children's cognitive development, but art may also facilitate their cognitive development (Gardner, 1980). Although Goodnow (1977) reported that children's drawing and writing follow separate developmental trajectories beginning at age four, developing writers continue past age four to integrate written words and nonverbal drawing in some fashion for idea expression during composing. Both declarative and procedural knowledge are expressed in children's drawings (Fayol & Barrouillet, 1995). Some struggling writers, with oral language syntax problems, produced a mix of art and text to express their ideas and were visibly upset if asked to produce only text (Berninger et al., 2009). Combining art and oral language to express ideas during planning may benefit idea expression during composing without having to engage transcription processes simultaneously with planning.

COMPARISON OF PRE- TO POST-INTERVENTION ART, STORY CONTENT, AND STORY QUALITY

The author assessed participants' change in story quality and content in four single-subject design studies (Dunn, In press [fall 2008 project], submitted [b] [spring 2009 project], in preparation [a] [fall 2009 project], in preparation [b] [spring 2010 project]). The fall 2008 study included nine second-grade students who demonstrated low story-writing ability based on an initial probe assessment. The author had attained an external grant to fund the project that included the objective of helping as many children as possible with the provided funds; one 25 session project with three groups, each with three children, was the best balance with the funded intervention assistant and classrooms' schedules.

The first step was to define which students would be good candidates for the intervention. Using any already-learned strategies, the students were asked to write an initial probe story about a simple cartoon picture that had no text balloons; students could illustrate their story if they so chose. Students who demonstrated little to no story-writing ability were asked to participate with parental permission. They were grouped by classroom to facilitate scheduling. After each group's baseline phase, the participants learned the ART strategy. They then completed additional probes in follow-up sessions to demonstrate their change in story-writing ability.

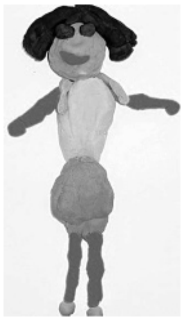
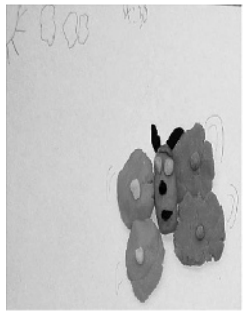
In reviewing participants' pre- to post-intervention art and story products, the children demonstrated some practices that the author had expected and others that were unexpected. During baseline, students wrote very little text and what they wrote was often more of a description about the cartoon-picture prompt, as opposed to what would constitute a basic story. Having reviewed their initial probe to define their eligibility for participating in the intervention, the author expected that they would produce little text. In contrast, he thought that students would use their allotted 10 min for using art media to illustrate their text by creating play dough or watercolor pictures, for example; instead, they often chose to use pencil crayons to color the cartoon-picture prompt. Table 10.1 contains two examples of students' self-generated art during the baseline phase.

Lara's baseline art media was a girl made of playdough. In Lara's story, she proceeded to write what other project participants did: a description about the art. Blake's art media, a colored drawing, and associated text provided the beginning of a story's ideas and prose. The picture has two characters from the text talking to each other in reference to the component of voice/quotes included in the text. One character holds a cookie as indicated in the story.

After the participants learned the ART strategy, the author thought that their art products would be a direct reflection of the WWW, W = 2, H = 2 questions. Instead, there was not that much difference. In Dunn's spring 2009 study (under review), the three fourth-grade participants attained 100% nonoverlapping data for story content (i.e., addressing the WWW, W = 2, H = 2 questions), but improving story quality was a challenge given their similar pre- to post-intervention scores.

To this author, it is understandable that the participants had more difficulty with story quality. Improving sentence ideas, spelling, and prose takes ongoing effort and practice (Shaywitz, 2003). To be a better writer, a person needs to

TABLE 10.1 Example of Participants' Pre- and Post-ART Aesthetic Story Plans and Text

Lara Spring 2010		Blake Spring 2009	
Pre	Post	Pre	Post
			
What do the hearts look like? The colors of the heart are white and red. The color of a heart is red. The heart is medium sized. Mr. Smarts has a moustache and a green bowtie.	Emily is a pop star. She looked like a fabulous girl. All the boys want her. She is waking on the stage and the boys say, "I love you." The time is 11:00. The boys stay at night to see her. It is at the Super Star Fashion Show. She went into her room where she got makeup. She was happy because the boys said, "I love you." The boys were glad to meet Emily. They she went to bed. The boys went home. They told each other they will be back tomorrow.	Bob, Fred, and Betty were carrying cookies. Fred took the first two bites. He raised his arm with the cookie. Then Bob took a bit, but Betty did not. Betty eats yours. She ate it all in one bite. "Nice," said Bob and Fred. So Bob and Fred tried to eat all in one bite but they got a big stomach ache. So they went to the doctor's office. The doctor said to drink a lot of water.	A buffalo and a girl were getting married at 2:00 a.m. It is at a party. So they dance, but little people always get mad at them. Look at this hole! A hand grabs her. She screamed. You'll be ours, said the small people. They put her in a trap. Wooo! She screamed. Somebody give me a hammer. I'm going in. Somebody gave the buffalo a hammer. Crash went the floor. he jumped in. The small people ran away. He grabbed the girl, and they lived happily ever after.

read continually other writers' published stories so as to review and analyze good examples (MacArthur, 2011). About 10 min of each 45 min session was devoted to reading published trade books as well as an analysis of the text (e.g., each sentence begins with a capital letter; review how the story/setting is introduced). More extended practice over a long period of time could prove more beneficial. During the 2 days of ART strategy training as well as follow-up sessions, the intervention specialist provided multiple solo and interactive examples for participants to apply how to write a good story. Students demonstrated in their story products that answering the WWW, W = 2, H = 2 questions was an attainable objective but managing improved story quality in the process was more of a challenge.

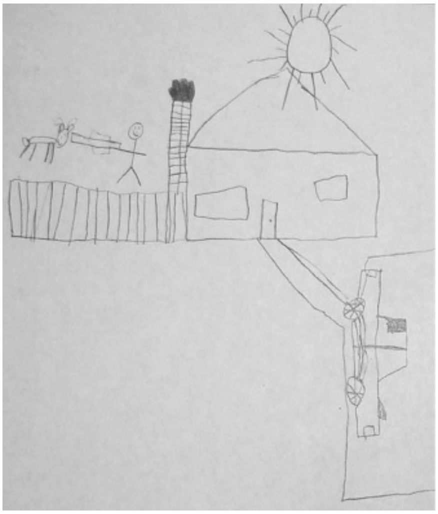
With the intent of the ART strategy being to help students generate more elaborate text including story quality, this author was curious to analyze in the fall 2009 project how students' provision or nonprovision of art media would impact their story products. He employed an alternating-treatments design. Phase A consisted of baseline performance in which children employed already-learned strategies for story writing. The intervention specialist then provided each of the four fourth-grade participants with two sessions of training in the ART strategy (Phase B). Following three Phase C sessions with art media (e.g., watercolor paints, playdough), students completed Phase D's four consecutive sessions with a paper and pencil. The remaining sessions of the 25 session timeline for the project included art media tools (as in Phase C).

The results indicated that the more elaborate and consistent a student's story content and quality scores were following the two sessions of intervention training, the less likely the withdrawal or art media tools rendered lower story content and quality scores. The data from this project indicated that ART and art media in particular provided a means to help students who struggled most with writing stories. Their story content improved as well as some gain in story quality. Ben's story products (see Table 10.2) from Phases D back to C illustrated the differences in a story product without and then one with art media.

Ben's session 17 story did not answer where the story took place nor how the characters felt at the end. Ben's art clearly indicated the location, but he chose not to state it in his text. His session 18 story addressed all of the WWW, W = 2, H = 2 questions, had more total words written, and provided a simple conclusion. Ben included a house and mouse in his painting as well as a sun to identify the daytime. Based on this author's experience in doing the six ART projects to date, Ben's case again illustrates that the more a child struggles with a skill such as writing, the more beneficial MSI can be. Reviewers of Ben's story products could infer that his use of paints helped him to generate more ideas for his prose. The use of color provided for a more vivid picture and this may have helped him to translate his ideas to his text.

The spring 2010 project offered ART to second-, third-, and fourth-grade students with a known learning disability in writing. With the premise that the more students struggle with writing, the more beneficial ART would be for them, the 2010 study's results affirmed this hypothesis. There was 100% nonoverlapping data for both story content and quality for all four children.

TABLE 10.2 Ben, Session 17 (Without Provision of Art Media) and Session 18 (With Provision of Art Media)



One day me and my dog were playing tug of war. My dog made me fall down. We played all day and then went to bed. The next day, we played tug of war again and he made me fall again. So we went inside. We ate and went to sleep again.

One day two mice wanted cheese. So they went out of their mice hole and looked for cheese. After looking for hours, they saw a whole lot of cheese. So they got on the counter and took a lot of cheese. They made their way down and back to the mice hole. They ate the cheese and felt good. They went to sleep until the next day.

As a concluding component of the spring 2010 project, the intervention specialist interviewed each of the four participants about their thoughts in using and ideas for changing the ART strategy. They commented that they found using the strategy to be fun. The students liked the use of art materials as it helped them to visualize their ideas. They stated that they did use the strategy for tasks outside of the intervention sessions such as for nonfiction writing. For example, the WWW, W = 2, H = 2 questions could be replaced with questions for doing a book report: What was the central argument/topic of the book? As a reviewer, my thoughts about the book are …?

Students did not report that they thought the ART strategy's components should be changed. They found the sequence of a guide for writing elements (i.e., ask and the WWW, W = 2, H = 2 questions; reflect while noting answers with illustrations and art media; and text with printing/handwriting/computer keyboarding) helpful.

CONCLUSIONS AND FUTURE RESEARCH

Writing is a challenging task. For narrative writing, a person needs to have a sense of what the story will be about (ideas to express in it), what a good story entails (metacognitive and metalinguistic awareness of narrative), knowledge of language (word choice, syntax, and grammar skills, discourse structure), transcription skills (spelling and handwriting or typing), reading ability to manage reviewing of drafts, and revising and editing expertise so as to produce an acceptable or publishable text. With writing drawing on so many processes, many of them potentially occurring at the same time or nearby in time, a weakness in one or more of these areas can make the writing process very difficult. Adding art activities to the writing process may seem like one more process to be juggled or may have facilitative effects on the writing process, for example, the generation of ideas and translation of ideas into a nonlinguistic format prior to transforming that format into written language.

More research is needed to address these issues. On the one hand, art may benefit the narrative writing of struggling writers, but the national assessments showing that 40% of the nation's children are below proficiency in writing include mostly expository (essay) writing—for example, informative (descriptive), compare and contrast, or persuasive (take and defend a position or opinion) essay writing (National Assessment of Educational Progress, 2007). On the other hand, art may also benefit writing in the content domains of the curriculum, such as science and social studies, if combined with teaching strategies for domain-specific writing in the content areas of the curriculum. Art activities in the form of drawing architectural and other geometric designs might also facilitate some aspects of math learning. Art might not only strengthen the quality of ideas represented but also access to them nonverbally as well as verbally.

Based on the results of the ART studies completed to date for struggling writers or those with specific learning disabilities, a continuing challenge is how to promote more growth in writing quality. Students' management of ideas when transforming them to express them in written text is a nonobservable black box until translated into visible representations. The mental processes individual children use in producing their final written texts remains somewhat of a mystery. Only rarely did participants follow the intervention specialists' example of illustrating the answer to each WWW, W = 2, H = 2 question. Even with repeated examples and demonstrations of how to make sentences more elaborate with adjectives and adverbs, modeling alone was seldom sufficient for students to compose stories with more adjectives and adverbs contributing to more elaborate sentences.

Future research could explore how children internalize practice with reading and modeling their writing on published stories, with and without illustrations of the ideas in both art and text. Devoting a portion of each intervention session to having students explain their thinking as they see a demonstration of a writing process, combine sentences into one, and write a story or text of another genre should facilitate greater understanding to the verbal processes involved in generating written texts. Systematically, adding art activities to these think alouds as a way of thinking through nonverbal expression might also demystify the translation of ideas into other domains. Demystifying students' thinking and translating processes could help intervention providers offer more differentiated writing instruction tailored to where the translation process is breaking down in individual writers.

ACKNOWLEDGMENT

The author would like to thank the Lematta Foundation for its support in the ART intervention projects discussed in this chapter.

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Part IV

Experimental Methods for Studying Translation in Real Time in Adults and Children

11

Contributions of Online Studies to Understanding Translation From Ideas to Written Text

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The ultimate goal of written composition research is to understand how we normally compose texts and the mental processes that are involved in such a complex task. A cognitive perspective has the goal of determining the what, when, and where for different kinds of thoughts related to the text as they become available and can be transcribed. A developmental perspective introduces the necessity to study the evolution of the different dimensions involved in composing, from idea generation to graphic transcription. An educational perspective adds to the two previous kinds of research regarding what dimensions can be modified, and to what extent, by direct or indirect interventions.

There are two avenues toward understanding processes of text production, its development and its modification through education. The first one is to use corpus analyses of texts composed in natural situations: A number of texts are collected, some key dimensions are carefully studied through linguistic analysis that can be supplemented by using more sophisticated tools (e.g., pause and writing rate [WR] recording) and through correlational and regression analyses in order to bring to the fore the main determinants of written composition performance. Until recently, linguistic analyses have been extensively used with adults, often combined with verbal protocols of people having to comment on what they were thinking about when they prepared to write (Fayol, 1997b). By contrast, the recording of pauses and WRs was rarely used until recently, mainly because technical devices were lacking or very difficult to use. Such devices are now available and offer new perspectives to study written composition in real time (Alamargot & Chanquoy, 2001; Alamargot, Chesnet, Dansac, & Ros, 2006).

The second avenue is to design experimental studies by carefully controlling for some aspects of the situations, material, and instructions. Of course, experimental research is a better source of data if the goal is to make inferences about cause and effect to understand causal mechanisms. However, experiments often lead to elaborate, artificial situations and thus introduce difficulties in the interpretation of data or in the generation of results with ecological validity. As a consequence, the best way may be to combine correlational and experimental approaches and thus benefit from both the authenticity (generalization to the real world) of corpus analyses of written production *and* the careful design of experiments and manipulation of variables to evaluate cause–effect relationships. That is what we tried to do in a series of studies from 1990 to 2010 that combined writing protocol analyses and controlled experiments to study correlational and causal relationships.

FIRST STEP: ANALYZING ONLINE PROCESSING IN WRITTEN COMPOSITION

Combining Developmental and Experimental Research Methods

Two research programs were initiated at the end of the 1980s. The first one aimed at studying the development of written composition in real time in second and third graders, when handwriting is known to be not fully mastered and still difficult for some students (Berninger & Swanson, 1994; Fayol, 1991c; Simon, 1973). The second one used experimental design to determine the impact of different variables on the online management of written composition of short text endings (Chanquoy, Foulin, & Fayol, 1990). In the two studies, the main dependent variables were the variations of pause durations (or latencies) and, to a lesser extent, the variations of WR (or writing duration) (Foulin, 1995).

From a descriptive point of view, pauses as well as WRs imply a deviation from a continuous and entirely linear process of written transcription unfolding in real time (Schilperoord, 2002): Pauses correspond to moments of scribal inactivity (Matsuhashi, 1981, 1982; Piolat, 1983); WR changes correspond to variations in the speed of transcription. A number of correlations have been reported regarding variations in pauses in speech as well as in written composition and several other variables (Espéret & Piolat, 1991): (a) Butterworth (1980) observed that pauses occur at important discourse breaks and separate idea units; (b) Cooper, Soares, and Reagan (1985), Danks (1977), Ford (1984), Ford and Holmes (1978), and Kaufer, Hayes, and Flower (1986) described regular associations between pauses and syntactic structures that followed; and (c) Daiute (1981, 1984) reported that pauses were linked to the previous part of the text. Fewer data were available regarding variations in WR. In any case, the main question had to do with the interpretation of the variations.

Composing in the Framework of Limited Capacity Theories

There is general agreement that text production draws on at least four types of cognitive processes: (a) retrieving and organizing information from memory, that is, planning text content; (b) formulating information that is retrieved; (c) monitoring the text produced so far; and (d) rereading and repairing already produced text (Flower & Hayes, 1980; Hayes & Flower, 1980). Researchers dealing with study of speech production or written composition tried to relate variations in pause duration and production rates with these processes.

On the one hand, composing is a complex task, which requires the efficient online coordination of both lower-level processes, such as graphic transcription, lexical access, syntactic frame construction (Bock & Levelt, 1994; Levelt, 1989), and higher-level processes, such as elaborating ideas and conceptual relations, thematic processing, maintaining coherence and cohesion, and respecting text-type constraint processes (Berninger & Swanson, 1994; Fayol, 1991a, 1991b, 1997a). Researchers assume that all these processes have a cognitive cost, even very slight.

On the other hand, human beings have a limited pool of general cognitive resources (including attention and working memory) that must be flexibly allocated to accommodate the real-time needs of the processing system (Fayol, 1999; McCutchen, 2006). Using auditory probes and verbal categorizations to examine how college students allocated their time while composing texts, Kellogg (1987b) reported that one-half of their time was devoted to *translating*, and the rest to *planning* and *reviewing*. The time required for planning decreased over the composition session while the time spent reviewing increased. Translating remained approximately constant throughout composition and required less cognitive effort than planning or reviewing.

To better assess the cognitive effort involved in the different cognitive processes described in the Hayes and Flower's model, Kellogg measured interference between composition and a secondary task. College students were asked to detect randomly presented tones (the secondary task) while they were composing a text (the main task). Kellogg assumed that attentional resources not dedicated to the primary task would remain available to writers who could use them to process the secondary task: The more time it took to identify the tones, the more demanding the composition task was. The cognitive processes of planning, translating into text, and reviewing required more cognitive effort than many other human tasks, for example, playing chess or reading simple and complex texts. Kellogg (2001a) compared the cognitive effort expended while composing narratives, expository, and argumentative texts. By measuring RTs on secondary tasks and examining verbal retrospections, he concluded that planning, translating, and reviewing competed for common memory resources. He also noted that the cognitive effort was larger when producing expository and argumentative texts than when composing narratives. Finally, Kellogg (2001b) showed that RTs on secondary tasks were reliably lower for high domain-knowledge writers compared to those with low domain knowledge (Kellogg, 1987a, 1987b). High domain knowledge reduced the transient effort required for planning, translating, and reviewing. Moreover, variations in writers' domain knowledge and verbal ability independently affected students' performance.

Pause and Writing Rate Variations in a Capacity Theory of Composing

Composing is thus both a multicomponent activity, involving several costly cognitive processes that operate at different levels of representation, and an integrative activity. It is necessary not only to describe and study the processes involved in written composition and analyze the shiftings between these processes, but also to explain how they are orchestrated in the limited-capacity cognitive system (Levy & Ransdell, 1995). One objective of written composition research is thus to analyze the online management of written composition (Fayol, 1999), that is, to determine how the different processes are activated, and how they succeed or not without exceeding the limits of capacity. In this perspective, variations in pauses and WRs (or writing durations) are worth studying because they provide objective cues to follow the online management of written composition. The main assumption is that variations in pause durations (or latencies) and in WRs (or writing durations) may be interpreted in terms of differences in processing load: The longer the pause, the slower the WR, the heavier the load (Schilperoord, 1996, 2002).

At any moment during composing, people have to deal with the management of several subcomponent skills. Improvement of this management can be obtained by automating some skills (graphic transcription, spelling, lexical access), by increasing the knowledge and processing of some highly stereotyped situations (story schema, chains of anaphoric references; Fayol, 1991b; Fayol & Lemaire, 1993), and by having a well-structured knowledge base about the topic dealt with in the text (Kellogg, 2001a). When dimensions of written composition can be more or less automated, such automation reduces capacity demands, and thus increases the ability to carry out concurrent tasks. In contrast, some other dimensions persist as problem-solving tasks. For example, in accessing and organizing ideas, as one must do during translation, the writers must exert a conscious and careful control over what they are doing. The cost of such higher-order activities can only be slightly reduced through practice. To cope with such costly situations, writers have to develop adaptive strategy choices (Siegler, 2005), that is, vary their choices of procedures in response to problem difficulties (Are they highly knowledgeable about the topic?) or evaluate their own competencies (How costly are transcription and spelling?) or task instructions (Is it important to focus on spelling?) and so on. Studying the modifications of the online management of written text production in children—how they modulate their pause durations and WR and whether they simultaneously write and plan ahead part of what they have to report—provides insights about the way automation and strategies help improve text production.

First Study

Employing such a perspective, Foulin and Fayol (1988) compared the production of two types of texts—a narrative and a report—in second and third graders. Children were video recorded when they were composing their two texts (the order was counterbalanced) and the production process was analyzed through computing the frequency and duration of pauses between and within main linguistic units (sentences and clauses) and the WR (including the within-clause [WC] pauses) of the same linguistic units. As expected, the authors observed that from the second to the third grade, the texts became longer, the mean pause duration decreased (but the frequency of pauses remained stable), and the WR increased. Third graders composed longer texts by writing faster and pausing less time than second graders. At each school level, the between-clause (BC) pauses were significantly longer than the WC pauses. Pauses were longer following punctuation marks and preceding connectives, giving some indications regarding the way successive clauses are related to each other.

In a later study, Foulin (1998) analyzed the distribution and duration of the initial pauses as a function of syntactic units (paragraph, sentence, clause, and phrase) in second and third graders and adult students composing a report about a personal tour (which enabled to control for the knowledge of the topic). At each level, in adults as well as in children, initial pause duration was consistently longer than intra-unit pauses. Moreover, the pause duration varied as a function of the level of language of the pause location: The higher the language unit of the pause location, the longer the pause. These results are in compliance with previous data regarding both speech production (Goldman-Eisler, 1972; Holmes, 1995; Piolat, 1983) and written composition (Matsuhashi, 1981, 1982; Nottbusch, 2010; Schilperoord, 1996, 2002). However, these results neither permit disentanglement of the roles of conceptual complexity or lexical selection from that of syntactic complexity (Grosjean & Dommergues, 1983) nor take into account processes of revision and control: Only latencies supposed to be related to planning were considered. Moreover, only pause durations were analyzed, and no attempt was made to study their relation to WR and to determine whether participants were able to conduct several activities (e.g., transcribing and accessing the lexicon) in parallel.

NEXT STEP FURTHER: EXPERIMENTING WITH WRITTEN COMPOSITION

At the end of the 1980s, it was clear that the familiarity with the content (i.e., the knowledge base of the writer), the type of text (narrative versus expository versus argumentative, Fayol, 1991b), and less clearly the complexity of syntactic structures have an impact on the quality and quantity of texts produced by adults (or adolescents). Far less was known about the processing in real time of the cognitive operations leading to such differences. Almost unexplored also were the evolution of text production and the online involvement of the cognitive operations. One way to deal with these questions was to plan an experiment using a simplified composing situation enabling better control for the different variables assumed to impact written composition. For that, we adapted the Holmes' (1984) paradigm of text completion (Chanquoy et al., 1990).

Experiments With Composing Text Endings

Adults, third graders, and fifth graders were asked to compose written endings from oral text beginnings, which were either narrative (e.g., Mary goes to the restaurant. She reads the menu. She goes in) or expository (e.g., It's a car. It is parked in the car park. It's shining). All participants were required and trained to produce endings that were either highly predictable (script-like endings) or unpredictable. The endings had to consist of three (for the adults) or two (for the children) events (in the narratives) or states (in the expository texts). The adults had to formulate the endings in either one or three sentences, whereas the children had to use either one or two sentences. To adapt the difficulty and duration of the task to the participants, the children produced eight endings (four narrative and four expository; one- or two-sentence long; four predictable or four unpredictable), whereas the adults produced 16 endings (eight for each condition). All the participants, but especially the children, were trained before performing the task.

The participants were video recorded when composing and their production behavior was analyzed using a videotape recorder. Three dependent variables were analyzed:

1. The time lapse between the end of the instructions and the beginning of transcription (i.e., the prewriting [PW] duration).
2. The time lapse between the end of the *n*th clause and the beginning of the (*n*+1)th clause; that is, the BC pause duration: BC—the adults had two BC pauses (between clause 1 and clause 2, and between clause 2 and clause 3), whereas the children had only one BC pause (between clause 1 and clause 2).
3. The mean duration for the transcription of one character between the beginning and the end of the same clause, that is, the WC WR (in seconds per character). This WR includes both the writing duration and the duration of the WC pauses.

Three findings are of interest. First, there was a significant increase in WR and a significant decrease in BC pause duration as a function of age and/or school level. Moreover, the PW latency was significantly longer in the adults than the children. Second, familiarity with the content impacted the PW pause duration in the three groups, as well as the BC pause duration and the WR in adults and fifth graders but not in the third graders. The text type (narrative versus expository) had no effect on pauses or WR. Third, the WR of the adults and fifth graders increased in the last clause (i.e., the third or the second, respectively), thus suggesting that its management imposed a lower load on the participants. Overall, these results show that the speed and the flexibility of composing increase as a function of age or school level: The oldest participants made shorter pauses, wrote more quickly, and modulated more the speed of processing of the different dimensions of composing (familiarity with the content and syntactic complexity). The same trends have been reported elsewhere using slightly different methodologies (Van Dell, Verhoeven, & Van Beijsterveldt, 2008; Verhoeven & Van Hell, 2008). This finding suggests that, with increasing age and experience, people become both more skilled at dealing with the low-level components of writing and more able to distribute strategically the management of the other components of composing. However, no precise data are available regarding the processing of the low-level dimensions of composing: The WR provided only a rough indicator of the processing of transcription.

To summarize, using a text-ending paradigm, we were able to provide evidence of some online production effects in adults as well as in fifth graders: The more predictable the endings are, the shorter the initial and the BC latencies and the faster the WR. These effects did not appear in third graders, maybe because children mainly devote their attention to the management of transcription and therefore have fewer resources available for dealing with the higher dimensions of text production (Bourdin & Fayol, 1994, 1996, 2002). To test this hypothesis, another experiment was planned.

Comparing Composing and Recalling Text Endings

What emerged from the previous study is that the temporal parameters of composing became more differentiated between the age of 8 years and adulthood. However, the data remained difficult to interpret, especially regarding the third graders. As written composition involves many components, variations in pause duration and WR cannot be attributed to one process only. Moreover, these variations are themselves dependent on age or school level. Berninger (Berninger & Swanson, 1994; Berninger et al., 1997, 1998) and Graham (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997) have shown that spelling and handwriting skills are important determinants of composition performance and that their cognitive cost decreases with age. One possibility would be that the cost of handwriting is so high and writing so slow in young children that it is only during pauses they are able to deal with other dimensions (Alamargot & Fayol, 2009).

To test this hypothesis, we compared the written composition and the written recall of the same text endings in the same children and adults. The written recall of a linguistic text fragment is a much simpler task than composition because the content, the syntactic frames, and the lexical items have already been selected. The task merely consisted of writing down a series of strings of linguistic elements from working memory. As a consequence, the cognitive load associated with conceptual and linguistic processing could be measured by comparing the pauses and WR associated with each linguistic segment in written composition and transcription after rote learning.

A new population of children and adults listened to the beginning of stories and were asked to compose a two-action ending for each beginning. The endings had to be either predictable or highly unpredictable, and the two actions had to be inserted in either one or two separate sentences. After training, each of the participants (third graders and adults) produced four endings each. After composing, participants had to read every ending and memorize it thoroughly until they could write it down again by rote. The participants were video recorded while composing and recalling the text endings. The same temporal parameters as in the previous experiment were analyzed relating to both composition and recall: initial PW pause duration (in composition only), BC pause duration, WC pause duration, and WR.

We provide an overview of the main results. As in the previous experiment, the PW latency was significantly longer with unpredictable than with predictable endings in adults (9.27 versus 4.86 s, respectively) but not in children

(8.36 versus 8.34 s, respectively). Recalling the text endings was always faster than composing the same texts, in both adults and children. There were dramatic decreases between the composition and the recall durations and rates: in BC pause duration −5.55 s (−69%) in children and −1.76 s (−72%) in adults; in WC pause duration −0.56 s in children (−39%) and −0.15 s in adults (−33%); and in WR −0.13 s/car in children (−14%) and −0.04 s/car in adults (−10%). The decrease was approximately of the same magnitude in children and in adults. This unexpected result suggests that the *relative* cost of graphic transcription is approximately the same in children and adults and cannot therefore explain the differences in composition patterns between children and adults. However, the pause durations and word transcription times were far higher in children than in adults. It is possible that the length of the pauses and the time required for transcription prevent children from retaining and/or from retrieving from memory the information that they need in order to generate and organize ideas.

Another important result emerged from the two previous experiments. In the first one (Chanquoy et al., 1990), the WR of the last clause of narratives relating unexpected endings (but not any aforementioned endings) was faster than the WR of other previous clauses (note that adults had to produce three-clause endings). The second one (Fayol & Stephant, 1991) confirmed this result—the last clause of such endings was composed as fast as it was recalled in the second part of the experiment, which means only that remained to manage the cost of graphic transcription. Moreover, the WC pause duration when recalling (1.28 s) was shorter than when composing (1.7 s), and the difference was more important with the first (0.58 s) than the second (0.26 s) clause. These two observations suggest that, in the next to last clause of narratives, the WC pause duration was lengthened and the WR was slowed down by the preparation and/or the maintenance of information regarding the next (and last) clause. By contrast, the semantic content and most aspects of the linguistic dimension of the last clause had been selected before the production onset of this clause. This result suggested that writers, at least adults, manage several activities in parallel when composing. As already reported by Ford and Holmes (1978) regarding the production of oral discourse, planning processes may occur outside of pauses, that is, along with speaking or writing. The main question is to try to determine what representations and what procedures can be activated in such cases.

LEVELS OF LANGUAGE: FROM TEXT PRODUCTION TO WORD PRODUCTION

From Oral to Written Production During Translating

Online studies of written text composition have used two main paradigms: verbal protocols associated with secondary tasks and analyses of temporal parameters, especially pause durations, assuming that pause durations reflect the cost of planning the next segments (but see Daiute, 1981, 1984; Kaufer, Hayes, & Flower, 1986). In all cases, WRs have rarely been taken into account, as if no modulation occurred of this dimension. This lack of analyses of WRs is probably due to the fact that models on composing texts focused on high-level dimensions, especially planning and revising and did not deal with the translation process and the written output processes of writing (Fayol, 1991a; but see Berninger & Swanson, 1994). At best grammatical encoding was studied, especially clauses, because clauses are the interface between conceptual and linguistic processes (Schilperoord, 1996, p. 115). Words were almost systematically ignored in text production models despite their fundamental role in language production model and their extensive study by psycholinguists. The results from a number of experiments dealing with the oral production of single-word or multiword utterances have been collected since the end of the 1980s (Levelt, 1989, 1999). They provide theoretical frames, empirical data, and clever methodologies to investigate word production; they might also provide guidelines to study the written composition processes and representations.

Producing Single Oral Words

Over the last 10 years, researchers have focused their work on investigating the production of single words, mainly nouns. Most of the theories of speech production distinguish four main levels of processing: conceptual preparation, formulation (i.e., grammatical encoding and phonological encoding), and articulation. There is also general agreement that lexical access in speaking can be subdivided into a phase that is concerned with the retrieval of semantic and syntactic characteristics (i.e., lemma) and a phase that involves access to the phonological properties of the intended word (i.e., lexemes) (Garrett, 1982; Levelt, Roelofs, & Meyer, 1999; Schriefers, Meyer, & Levelt, 1990). Evidence from speech errors (Astell & Harley, 1998; Harley, 1993; Levelt, 1989), neuropsychology (Kinsbourne & Warrington, 1964), and experimental studies on normals (Schriefers, 1990, 1992) suggest that semantic representations related to the concept-to-be-named are first activated. Experimental evidence comes mainly from the picture–word interference paradigm, in which participants have to name a picture target (generally eliciting the production of nouns, e.g., *a cat*) while ignoring distractors related or not to the target (e.g., *a dog*, presented in the oral or in the written modality). Semantic distractors presented auditorily (or visually) at 150 ms (but not later) before picture onset (i.e., –150 ms stimulus onset asynchrony [SOA]) delay spoken picture naming compared to unrelated controls (Schriefers et al.). A picture of a *cat* is named more slowly when accompanied by the related word *dog* than by the unrelated word *nut*. This inhibition effect from semantic distractors occurs also with visual distractors.

The situation is less clear concerning phonological (or orthographic) encoding, especially regarding how the lemma level and the lexeme level relate to each other. Discrete two-step models assume that speaking proceeds in a serial manner (Schriefers et al., 1990); cascaded models propose that speaking proceeds from one to the other level in a gradual fashion such that semantic retrieval need not to be entirely finished before the beginning of phonological access (Dell, 1986). Again, using a distractor while naming a target noun enabled inferences about the representation(s) activated: For instance, the target was *cat* and the phonologically related distractor was *cap*, a phonological neighbor that could be presented at different SOA (–150, 0, and +150 ms). The naming of *cat* was facilitated (speeded up) when *cap* was presented either simultaneously (0 ms) or shortly after (+150 ms) the picture onset. The interpretation of this result was subject to numerous criticisms that are not relevant for the current chapter (see Bonin & Fayol, 2002a, 2002b for an extensive discussion).

The results from most studies thus confirm the relevance of distinguishing in spoken production between a semantic and syntactic lemma level and between a phonological morphemic and lexical level. The lexeme is the locus of the classical word frequency effect (WFE). Naming objects takes more time when the lexical labels are rare than when these labels are frequent (Levelt, 1989). Jescheniak and Levelt (1994) provided the first clear evidence supporting the lexeme locus of the WFE in speech production. This very robust WFE explains at least part of the variation in between-word pauses and hesitations in oral production.

Several problems are related to the previous result. The first one is that the latencies in picture naming do not provide definite evidence that the WFE alone does affect spoken or written responses. WFE is strongly correlated with age of acquisition (AoA): Frequent words are learned earlier in life than rare ones. WFE is also correlated with length (the word length effect [WLE]): Short words tend to occur more often than longer ones and to be learned earlier than long ones. In most previous studies, AoA was not controlled for, but when AoA was controlled for, the WFE did not emerge easily as a significant predictor of word naming latencies (Bonin, Fayol, & Chalard, 2001; Bonin, Chalard, Meot, & Fayol, 2002).

Another problem concerns the WLE: Longer words should take longer to prepare. Regarding speech production, this question concerns the degree to which speakers plan ahead at the phonological level (i.e., the number of syllables) before they initiate a response. Theories and data differ about the role and span of phonological planning. The empirical results are mixed. In a majority of studies, the WLE is not a significant predictor of the latencies in picture naming: Only the first syllable would be prepared before the word onset whatever the length of the word. Using a picture-naming task associated with a priming of the second syllable of the target words, Damian, Bowers, Stadthagen-Gonzalez, and Spalek (2010) reported a faster production of the words, attesting that the entire word was planned at the phonological level despite the absence of the WLE. Speakers could plan long phonological chunks (one utterance at least) but the (oral) response could be initiated as soon as the first syllable is placed into the articulatory buffer.

The last problem concerns the articulatory duration. Most of the time, researchers have only taken into account latencies in picture naming, that is, the time between the picture presentation and speech onset. Thus they implicitly assumed that the whole phonological information was available from the response onset and that no retrieval occurred during articulation. As an articulatory response unfolds over time, its duration (the time interval between onset and offset of an utterance) could vary as a function of the processing of the previous cognitive operations, for example, lemma selection or lexeme retrieval. Only Kello, Plaut, and MacWhinney (2000) found that when task demand increased in a Stroop naming task, lengthening occurred in both naming latencies and response duration. However, Meyer (1990), Schriefers and Teruel (1999), and Damian (2003) could not replicate this finding. All reported effects on response latencies, but response duration was never affected by the experimental manipulations of semantic and phonological relatedness. However, all these experiments dealt with isolated words and not more or less long utterances. By contrast, Ford and Holmes (1978), using a detection task along with an oral monologue production, observed that reaction times increased significantly toward the end of clauses. They interpreted this increase as an index that some planning concerning a next clause might take place before the current clause had been completed. Planning processes might thus occur along with speaking.

In spoken word production, a word is selected from among all of the words in the mental lexicon to express a particular concept. This representation is mapped onto the sound shape of the word. Current models of word production assume that there is automatic activation of the target word but also partial activation of other related representations that share properties with the word candidate (Dell, 1986). These representations compete with each other and the best fitting candidate is ultimately selected from the set of activated representations. The selection of the phonological representation of a word is modulated by the number of words in the lexicon that share sound properties with it (Dell & Gordon, 2003), resulting in a cascaded effect on its articulatory implementation. Reaction time latencies for naming pictures of words, which have many phonological neighbors, are faster than that for naming words, which have few phonological neighbors (Vitevitch, 2002).

To summarize, the study of oral word production led to observing several signatures of the processes involved in such production: the relevance of the distinction between a semantic and syntactic lemma level and between a phonological morphemic and lexical level; the occurrence of a frequency effect (WFE) difficult to disentangle from the AoA and the length effect (WLE); a robust neighborhood effect; and the absence of two expected effects—the length effect and the impact of all the variables previously evoked onto the articulatory duration. From the end of the 1990s, several researchers began to determine whether these effects would appear when word production is conceived as part of utterance production involving at least two words.

Producing Multiword Spoken Utterances

When turning thought into oral language during translation, speakers need to convert a preverbal message into a linear sequence of words. Key questions are how far ahead speakers do plan in this process and whether advance planning differs at different representational levels. These questions can be raised as concerns for both each word of a clause or a sentence *and* the whole clause or sentence. For example, in referring to the lemma/lexeme distinction it is worth considering whether all lemmas and lexemes from the same utterance are activated before the onset of articulation or whether only some of them are activated and thus how and when the others are planned and articulated. Questions about latencies (i.e., pauses between words) and articulatory durations must be considered in this new perspective.

At first evidence with respect to phonological advance planning in multiword utterances came from the analysis of speech errors. Garrett (1980) contrasted word-exchange errors and sound-exchange errors. In word exchanges, words from the same syntactic categories exchanged places and spanned over different syntactic phrases; this observation suggests a relatively large degree of advance planning (Fromkin, 1971). Sound exchanges occurred over short distances, generally within a phrase. Because speech errors obey different constraints, they are thought to arise at different levels of encoding and different representational levels, respectively, grammatical encoding and phonological encoding.

More recently, advance planning was addressed by applying the picture–word interference task: Participants produce utterances in response to picture(s) while ignoring distractor words. Meyer (1996) was the first to study experimentally the oral production of multiword utterances. The participants named two simultaneously presented objects (pictures of, e.g., the bag/the arrow) either by noun–phrase coordination (the bag and the arrow) or by a simple sentence (the bag is next to the arrow). Semantically related distractors to the first as well as to the second noun slowed down naming speed (inhibition effect), providing evidence that both lemmas have been selected before the speech onset. Phonologically related distractors to the first noun had facilitation effects (the latencies were shorter); those related to the second noun showed a small inhibition effect: The phonological form of the second noun became a competitor for the phonological form of the first noun (see also Smith & Wheeldon, 1999).

Several studies have been conducted to understand better the extent, the levels of representation, and the processes of advance planning in dealing with sentences but not texts. They concentrated on phonological advance planning. The results seemed to converge toward a unified conception strongly related to the picture–name interference paradigm. For example, Jescheniak and Schriefers (2001) asked German speakers to produce bare nouns or noun phrases (Det + noun) while phonological distractors were presented related to or not related to the noun. They found substantial facilitation with bare nouns, but reduced facilitation with noun phrases. In Italian speakers, Miozzo and Caramazza (1999) found similar facilitation for bare nouns and for determiner plus noun phrases. In English and in Spanish, Costa and Caramazza (2002) reported facilitation on the noun describing colored objects by using determiner plus adjective plus noun, suggesting that speakers had encoded the phrase up to its final element before the articulation onset. Damian and Dumay (2007) replicated these results even when a deadline response was used to increase the demand of the production task (but see Schriefers & Teruel, 1999). Schnur, Costa, and Caramazza (2006) observed faster latencies when their participants produced intransitive sentences such as *the girl jumps* and *the orange girl jumps* with a distractor phonologically related to the verb.

Jescheniak (Jescheniak, Schriefers, & Hantsch, 2003; Oppermann, Jescheniak, & Schriefers, in press) proposed a theory able to accommodate most of the previous empirical results. The assumption is that the phonological forms of the successive words receive a graded pattern of activation before articulation is initiated. The subsequent words differ with respect to their activation level, decreasing from left to right, such that activation strength varies as a function of their position (i.e., rank) in the utterance. Elements outside the phonological advance planning scope have an activation of zero. Any distortion of this graded activation pattern leads to interference during phonological encoding. As a consequence, primes that enhance the activation of the utterance-initial element speed the encoding process without cost. By contrast, primes that enhance the activation of noninitial elements disturb the graded activation pattern such that the primed element moves to a wrong (i.e., too early) position, hence production errors such as those described by Fromkin or Garrett. Oppermann et al.'s (in press) results are in line with this conception. The participants viewed pictures of simple scenes involving an agent performing a simple action on a patient (e.g., a mouse eating cheese) along with sentences describing these scenes (e.g., the mouse eats the cheese). During the test, only the picture of the agent was presented (mouse) and participants were asked to describe what the agent has been doing using SVO or SOV sentences elicited by sentence fragments. Distractors phonologically related or not to the subject or to the object of the sentence were presented at three SOA (0, 150, and 300 ms). There was facilitation from distractors related to the noun in the initial utterance position and interference from distractors related to the object appearing in the second phrase in SOV and to the subject in the second phrase in VSO production (i.e., in noninitial position). However, when sentences used a nondominant word order, the increased processing demands led to smaller grammatical planning.

At the moment, most results having to do with the oral production of multiword utterances bear on short phrases or clauses. An integrative model suggests that in such cases all lemmas are selected before speech onset but only the initial lexeme of the utterance is activated. This conclusion cannot be extended without caution to sentences and (small) texts. Moreover, no data are available regarding the online processing of lexemes in the course of the utterance articulation: When are the successive words retrieved? Is the corresponding process cost free or does it require variable latencies to reactivate the target words? Are all lexemes activated after the previous one has been articulated or are some of them retrieved in parallel with articulation to ensure the fluency of production? At the moment none of these questions is answered, and most of them are not approached or tackled.

Producing Written Utterances

The study of written composition benefits from the previous studies, results, and theories from oral production, which may draw on common as well as unique processes during translation of ideas into language that can be produced orally through mouth or graphically through hand. In a number of cases, researchers tried to use the paradigms and replicate the results in the written modality that have been used and reported in the oral modality. Most of the time, the researchers were successful.

To begin with, it is useful to transfer the question approached in the oral production to the written production of utterances. In written word production, a word is selected from among all of the words in the mental lexicon to express a particular concept. This representation is then mapped onto the phonological and orthographic form of the word, and these abstract representations are in turn mapped onto articulatory implementation of oral or written processes that provide information to the articulators of mouth or finger movements of hand about the ultimate realization of the word. Most theories assume that there would be an automatic activation of the target word but also a partial activation of other related representations (Dell, 1986), leading to a competition until the selection of the target word. This competition leads to interferences in some cases (with increasing processing difficulties entailing increases in latencies) and to facilitation in other cases (enhanced processing leading to decreased processing time).

As the selection of the phonological representation of a word, that of the orthographic representation is expected to be modulated by the frequency, the AoA, and the number of words in the lexicon that share form properties with it. This modulation would have a cascaded effect on the articulatory implementation, in the written modality as well as in the oral modality. Reaction time latencies for words, which have many phonological and/or orthographic neighbors, would be faster than that for words that have few neighbors (Vitevitch, 2002). The influence of lexical neighbors on articulatory processes would reflect the cascading effects of lexical activation and selection processes on articulation. The main difference has to do with the articulation phase, that is, how abstract cognitive representations coming from phonological–orthographical encoding are transformed into articulatory motor program (Damian, 2003). One important question concerns the possibility of an impact of this cascaded effect onto the modulation of written rate, that is, the duration of transcription. Indeed, handwriting is far slower than speaking, leaving potential room for modulations of the production rhythm, and making it possible to control for through reading the forms already produced.

Research devoted to writing isolated words provided evidence that there are no fundamental differences between oral and written word production regarding the different levels of representations and the time course of their activation: The lemma level is common to both modalities, whereas in writing, the lexeme level includes both phonological and orthographic information (Bonin & Fayol, 2000). The same semantic interference effect showed up in the written production of isolated words with the same SOA (–150 ms), suggesting that the same representation level (lemma) and the same time course in written picture naming as in oral picture naming (Bonin & Fayol). Extending the picture–word interference paradigm to the production of written words, Bonin and Fayol used a factorial combination of semantic and phonological relatedness and two SOAs (0 and –150 ms). Phonologically related distractors facilitated written production (latencies decreased) as compared to phonologically unrelated distractors. However, semantic and phonological relatedness interacted: Semantic interference was observed with phonologically unrelated distractors, but disappeared with phonologically related distractors. The latencies observed with the semantic interference and that observed with the phonological interference were not additive, as expected by the strict serial conception. These results replicated the interaction between semantic and orthographical/phonological relatedness reported by Starreveld and La Heij (1995).

Comparing the oral and written naming of frequent and rare nouns on the basis of pictures depicting well-known objects, Bonin, Fayol, and Gombert (1997, 1998) observed significant frequency effects in both writing and speaking from pictures. Using an homophonic picture-naming task in which participants had to speak aloud or write down homophonic words (e.g., *verre* = glass, high frequent word, versus *ver* = worm, low frequent word, the common pronunciation of which is /vEr/), Bonin and Fayol (2002) reported that written latencies were longer than spoken latencies, but less time was necessary to produce high than low frequency words under both modalities. This result confirmed that the differences in naming time were related to lexical properties, here frequency. However, as in the oral modality, the latencies in picture naming do not provide definite evidence that the WFE alone does affect spoken or written responses: Again, WFE correlated with AoA and length (WLE). When AoA was controlled for, the WFE did not emerge easily as a significant predictor of word naming latencies (Bonin, Fayol, & Chalard, 2001; Bonin et al., 2002). However, WF remains one of the main and most robust variables in studies of written language, in reading as well as in writing.

Things are clearer regarding the neighborhood effect. Roux and Bonin (2009) have studied the impact of orthographic neighborhood on spelling. Adult participants were required to spell orally words with dense or sparse orthographic neighborhood. The dependent variables were oral spelling latencies and error rates. As expected, oral spelling latencies were shorter with words having a dense orthographic neighborhood and longer with words having a sparse orthographic neighborhood. The authors interpret the facilitatory effects (60 ms) of dense neighborhood by considering that words with such neighborhoods receive activation from many similar words.

Moving from orthography (spelling) to handwriting production necessitates programming of the number of letters, their sizes, and directions (Van Galen, 1991). Van der Plaats and van Galen (1990) provided evidence that the longer the word to write (i.e., the number of letters), the higher the latency. However, the increase as a function of the number of letters was slight, which led the authors to conclude that a large part of the letters was programmed online. Because processing capacities are limited, handwriting proficiency requires that letters are grouped into chunks in order to facilitate motor programming. As a consequence, people use syllables and graphosyllables as units for chunking information on the letter string to write words and pseudowords. Interestingly, this chunking process leads to an increase of pause duration at the syllable boundaries (Kandel, Alvarez, & Vallée, 2006). Copy tasks have shown that the number of syllables affected latencies for pseudowords, but not words when items were copied once. However, when the same items were copied several times, the number of syllables impacted on latencies of both words and pseudowords from the second copy onward. It is as if the participants stored the items in a phonological buffer that delivered information to the articulatory program sequentially, syllable by syllable (Lambert, Kandel, Fayol, & Esperet, 2008).

In addition, handwriting proficiency was optimized through grouping letters into chunks in order to program efficiently the motor outputs. In French, these chunks integrate both phonological and orthographical information: Orthographic syllables (similar to the graphosyllables of Caramazza & Miceli, 1990) and bigram frequencies are used as processing units separated by boundaries

(Kandel, Grosjacques, Peereman, & Fayol, submitted; Kandel, Hérault, Grosjacques, Lambert, & Fayol, 2009). Results are thus mixed regarding the phonological WLE, and are few in number concerning the graphemic dimension (i.e., number of letters). Nevertheless, it is impossible to disregard the number of letters as a potential variable impacting on latencies and on writing duration (or WR).

The possibility of parallel processing, for example, planning occurring while articulating, seems more likely in written composition because writing is slower than speaking. Few data are available. Chanquoy et al. (1990) observed that the WR of adults and fifth graders increased in the last clauses of narratives, and Fayol and Stephant (1991) showed that the pause before and the WR of these last clauses were, respectively, as short and as fast as when people were recalling them, suggesting that their management imposed a lower load on the participants than when they are producing the clauses. Unfortunately, the collection of data did not allow the authors to determine whether the variations affected the pauses within clauses and within words or the speed of transcribing words and letters. Another set of data was clearer regarding this last question.

Delattre, Bonin, and Barry (2006) used a spelling-to-dictation task to compare the written production of regular (consistent) versus irregular (non-consistent) French words matched on a number of dimensions (word frequency, bigram frequency, etc.). They replicated Bonin, Peereman, and Fayol's (2001) finding that latencies in the initiation of written production were reliably longer for irregular than for regular words matched for frequency and several other variables. More importantly, the writing duration was also significantly longer for irregular than for regular words matched for length and bigram frequency. The authors interpreted these results within a cascaded model of written word production: Spelling irregular words should trigger some central conflict between sublexical processing (i.e., using phoneme–grapheme associations) and lexical processing (i.e., access to the word-specific orthographic form). Resolving this conflict would both delay the latency and slow down the writing duration of the words, thus suggesting that the conflict is still not resolved when writing begins. The results obtained by Bonin et al. (1997, 2001) and Delattre et al. (2006) clearly show that the written production of isolated words is sensitive to both the frequency and consistency of these words and that these dimensions impact on both latencies (pause duration) and writing duration (WR) in isolated word production. Unfortunately, the authors did not report the value of the correlations between these two variables.

Regarding the production of written multiword utterances, Bonin, Fayol, and Malardier (2000) replicated Meyer's (1996) results using the same paradigm with the written modality. Both lemmas were activated. Both activated their lexical and sublexical units but the first one activated its units more strongly than the second. Latencies were shorter when the distractors were related to the first noun (facilitation effect) and longer when the distractors were related to the second noun (inhibitory effect). Subsequent studies showed that the variables that contribute to the naming latencies were similar in the two production modes, oral and written (Bonin, Malardier, Méot, & Fayol, 2005). The processes involved in the written production of two nouns from pictures are thus coordinated in the same way as in speaking despite that written latencies were longer than speaking latencies.

To the best of our knowledge, none of the experiments devoted to the study of clause or sentence production have been replicated in the written modality. However, there is no theoretical reason to consider that the representations involved and the time course of their activation would differ from that of the oral modality. The main differences between the oral and the written modalities have to do with (a) the slowness of graphic production, which could facilitate both planning and reviewing of what has been already produced and (b) the difficulties related to spelling: Word writing demands spelling processing, the difficulty of which differs between spelling systems, depending on the consistency of the phoneme-to-grapheme correspondences (Lété, Peereman, & Fayol, 2008). Phonology-to-orthography consistency refers to the level of variability in the orthographic codes that can be assigned to a particular phonological unit. For example, phoneme-to-grapheme consistency is lower when a number of different graphemes can be mapped to a particular phoneme (e.g., /o/ in French is spelled o in "mot" [word], au in "saut" [jump], and eau in "oiseau" [bird]) than when a single grapheme is always associated with a particular phoneme (e.g., again in French, /u/ is always spelled "ou" as in the words "fou," "cou," and "bijou"). Bonin et al. (2001) found longer latencies for irregular than for regular French words, providing evidence that consistency has an impact on the online management of isolated written word production. In a spelling-from-dictation task, Lété et al. (2008) found that phoneme-to-grapheme consistency and word frequency had independent effects on spelling accuracy scores in the primary grades of learning to read.

Whereas the consistency contribution (indicating a sublexical procedure to spell words) remained high across grades, the impact of word frequency (indicating a lexical lookup procedure) exhibited a massive jump between first and second grades. People producing written sentences or texts have thus to manage the specific difficulties related to spelling. One important question concerns when such difficulties are managed. Two possibilities are worth considering. First, spelling difficulties can be perceived and solved before the writing onset, words being directly retrieved and transcribed from memory. Second, as suggested by Delattre et al.'s (2006) results, some difficulties could remain unresolved when transcription begins. In such cases, these difficulties could be tackled either when pausing within word, for example, before an earlier part of the word, or when writing through parallel processing of transcribing and planning the sublexical part of the current or the next word.

As previously noted, studies dealing with the oral production of isolated words have reported that no variable impacted the articulatory dimension. The situation is quite different regarding sentence or clause production. To repeat, at least two observations suggest that adults and children at the end of elementary school can both transcribe sentence fragments and prepare or review other parts of their writing (Chanquoy et al., 1990; Fayol & Stephant, 1991). The remaining question is to determine when and how they proceed to conduct these different activities.

SUMMARY AND CONCLUSION: FROM TEXT PRODUCTION TO WORD PRODUCTION AND BACK TO INTEGRATE BOTH

The previous review makes clear that we have two current trends in written production research. The first one deals with texts as wholes and analyzes the management of the higher-level components through verbal protocols, linguistic analyses, secondary tasks experiments, and global studies of pauses and (rarely) WRs. The corresponding results attested that the knowledge of the content evoked within the texts, the rhetoric organization (e.g., narrative, expository), and the phase of the composition process (e.g., planning before onset, translating, reviewing) impact on the online management of written composition. In addition, the strategies of the writers change as a function of age or schooling: Elementary school children tend to produce according to a knowledge-telling strategy (Bereiter, Burtis, & Scardamalia, 1988); they formulate their utterances as the corresponding knowledge is accessed. By contrast, older writers compose their texts using a knowledge-transforming strategy (Bereiter et al.). Researchers adopting that perspective rarely take into account the role of lower-level variables such as the complexity of handwriting, the orthographic form of words, or the syntactic structure of sentences (but see Berninger, Fuller, & Whitaker, 1996; Berninger & Swanson, 1994; Graham et al., 1997).

The second trend focuses on lower-level processes, most of the time the production of isolated words generally in the oral modality (Levelt, 1989). However, more recently, the research paradigms used to study oral production have been extended to the study of oral phrases, clauses, and even sentences, and to that of written word and multiword utterances, making clear that the first steps of the production process (i.e., conceptual and the lemma) are the same whatever the modality. Regarding the following steps, even if the word forms differ (phonological versus orthographic), the same variables impact on latencies: frequency, AoA, and neighborhood. Some differences appear with the impact of spelling and with the mapping of the lexeme representation onto the articulation process. Contrary to what has been reported with the oral modality, in the written modality, the impact of frequency, neighborhood, and consistency could have cascaded effects on the articulatory implementation, leading to variations in both latencies and handwriting durations.

For some time, the focus of study was how written word production unfolds when words are included in texts. Until recently, the production of words has mainly been studied using isolated words or, at best, pairs of words as if producing isolated words was enough to understand how words are processed in larger context, that is, texts. Moreover, the main chronometric measure was latencies, implicitly assuming that pauses are devoted to planning the next word and that writing duration (or rate) is not relevant.

Following researchers working on the study of reading in real time (Kliegl, Nuthmann, & Engbert, 2006), we envision the question of word production within texts through new glasses. First, as we are studying written composition, we propose considering both latencies (i.e., pause lapses) before words and within words.

Indeed, online analyses reported in the section "First Step: Analyzing Online Processing in Written Composition" showed that adults and children often stop writing within words for a while. We also suggest taking into account the WR (or duration) of written words. At the moment, it is impossible to disregard the possibility that handwriting speed can be modulated by variables such as frequency, neighborhood, and consistency. As a heuristic approach, it could be worth studying the correlations among these three dependent variables. Previous results attest that latencies (at least before isolated words) are sensitive to the previously mentioned variables. If there is no variation in writing duration, no correlation will appear. By contrast, if some variations occur, it will be relevant to determine whether they are highly or slightly, positively or negatively, correlated with latencies (a high correlation would mean that the two variables index the same processes). Previous data regarding the production of text endings (Chanquoy et al., 1990; Fayol, Foulin, Maggio, & Lété, in press) showed that the correlations were weak (−0.10), justifying that latencies and WR are treated as independent indexes in separate analyses. The reasoning is thus that each of the three dependent variables is worth studying because each of them provides information about specific aspects of word production.

Second, until now, the implicit assumption regarding the relationship between latencies and word production was that the pause before any word was indexing processes related to this word, or at most, to the two or three following words. We refer to that conception as the *immediacy* assumption. It can be extended to within-word pauses and to writing duration or rate: The variations affecting these variables should be exclusively related to the processing of the current word at time n. However, another conception is worth considering. As evidenced by researchers working on the dynamics of reading, we hypothesize that some words are not totally processed when they have been transcribed (Daiute, 1981). As a consequence, some cognitive operations would still be devoted to their processing (n−1) when the next word is being processed, a matter of *delayed effect*, the impact of which could affect the following pause (i.e., the latency relative to the next word) or the written duration of the next word. Reciprocally, a writer engaged in the transcription of a current word n could begin processing the next word (n+1) (e.g., computing its consistency), either when pausing within the word n or when transcribing it: an *anticipatory effect*.

To summarize, we suggest studying the online written word production in the context of text production through the use of chronometric measures, taking into account three dependent variables and three moments of production: the current word n, its predecessor (n−1), and its successor (n+1). We are expecting both *immediacy effects* (e.g., the impact of consistency), *delayed effects* (e.g., frequency), and *anticipatory effects* (e.g., neighborhood). Such research is currently in progress (Maggio, Lété, Chenu, Jisa, & Fayol, in preparation). The most salient results to date include the following: First, as reported in previous attempts to take into account both latencies and writing duration, the correlation between these variables (and the within-word pause duration) was significant but weak, suggesting that the variations were relatively independent. As a consequence, each of them was indexing some specific aspects of the dynamics of written composition.

Second, a brand new result was that the rank of the words in the text exerted a systematic facilitatory effect upon the three dependent variables: The further the word in the text, the faster the WR, and the shorter the before and the within pauses. Third and contrary to the general assumption, the pause preceding word *n* was only sensitive to delayed effects from some characteristics of the previous words (*n*–1). Fourth, the WR variations were associated with immediacy (e.g., consistency of the spelling of *n*) and anticipatory (e.g., the frequency of (*n*+1)) effects. Fifth, the within-pause durations were mainly sensitive to immediacy effects (e.g., syllable frequency).

Overall, analyzing the processing of words in the context of written text composition brings to the fore the dynamics of production. Obviously, things appear far more complex than has been previously expected. When composing, people are concurrently writing down parts of their texts, finishing the processing of data from already transcribed words (delayed processing), solving current problems about some specific difficulties (e.g., spelling), and thinking ahead about other aspects related to the characteristics of the next word(s) (anticipatory processing). This dynamic management of composing is not yet completely understood, but it is worth studying because it opens new avenues in understanding why written composition is so complex and why it is so hard to learn and manage.

The next step in this line of research will undoubtedly make the writing process appear to be still more complex because it will be necessary to integrate in a unique model components from higher and lower levels involved in written composition online in time.

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Montluçon (France) December, 2010

12

Using Eye and Pen Movements to Study the Writing Process

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This chapter discusses the advantages and limitations of using handwriting pauses as indicators of the dynamics of text composition. We explain how the joint analysis of eye and pen movements can provide a more heuristic framework for interpreting pauses, by giving researchers a means of identifying the different functions of reading in the course of written composition. As an illustration, we report the results of four experiments exploring the eye movements of writers in situations where they either had to compose texts from documentary sources or transcribe sentences requiring careful handling of the subject–verb agreement. In our conclusion, we discuss the need to adjust the interpretation of eye movements (saccades, fixations, smooth pursuit, and microsaccades) to take account of the specific context of handwriting production.

ASSESSING THE DYNAMICS OF WRITING PROCESSES

Research on text production has undergone considerable change since Hayes and Flower first proposed their groundbreaking model in 1980 (Hayes & Flower, 1980), not only in the kind of issues it addresses but also in the methods it uses to do so. Composition has come to be seen as a dynamic and complex cognitive activity with its own final production. As a consequence, experimental studies no longer simply sketch out the workings of the main processing components (planning, formulation, and revision), but instead probe all the individual processes involved and the ways in which they are implemented (for a review, see Alamargot & Chanquoy, 2001; Chanquoy & Alamargot, 2002). Note that translation is sometimes referred to as formulation.

This shift in outlook has been made easier by improvements in the tools and techniques used to conduct experimental investigations, in particular real-time paradigms (for a review, see Olive & Levy, 2002; Piolat & Pélissier, 1998). These paradigms involve matching the activity's temporal characteristics with the semantic and linguistic features of the final product, in order to investigate the engagement and/or cost of writing processes. Verbal protocols (Hayes & Flower, 1983), double- and triple-task methods (probe reaction time; Kellogg, 1987; Levy & Ransdell, 1994), and the analysis of pauses and rates in the course of handwriting (Chanquoy, Foulin, & Fayol, 1996; Matsuhashi, 1981) are the three real-time analysis paradigms used to study written production: verbal protocol, the double-task paradigm, and the pauses and rates paradigm. Although they investigate different aspects of the writing processes, they all complement each other.

The verbal protocol paradigm, widely used in the literature, consists of recording and interpreting the writers' verbal description of the processes in which they are engaged (Hayes & Flower, 1983). As such, it is a useful method for exploring the conscious implementation of the different components of text composition (Gufoni, Fayol, & Gombert, 1994). The double-task paradigm provides a means of comparing the attentional resources that are allocated to different processes in the course of composition. Based on the postulate of additivity, the analysis of variations in performances on a secondary task (generally the time it takes to respond to a bleep) allows researchers to make deductions about variations in the attentional resources allocated to the primary task. When this method is supplemented by verbal protocol collection, the double task becomes a triple one and makes it possible to put a name to the processes whose cost is being assessed (Kellogg, 1987; Levy & Ransdell, 1994; Piolat & Olive, 2000). The last of the three—the pauses and rates paradigm—involves recording variations in writing speed (graphomotor execution) throughout the course of production and in inferring the nature of the processes that are engaged from the duration and location of the pauses. The advantage of this paradigm is that it is totally nonintrusive: It does not cause any interruptions (unlike the double or triple task) or generate any additional mental activity (unlike the verbal protocols). Rather, it allows the writing processes to be freely implemented and their time course to be monitored continuously. Its main shortcoming is that the analysis is restricted to pauses and rates, which may not be enough to ascertain the nature of the underlying processes. If verbal protocols are not used in conjunction with it, the temporal data therefore have to be analyzed in relation to the linguistic context in which they occur.

ANALYZING HANDWRITING MOVEMENTS: PAUSES AND RATES

Tools for Recording Pauses and Rates

Researchers studying written production first started to analyze variations in handwriting speed, and thus the associated pauses and rates, in the 1980s (Gould, 1980; Matsuhashi, 1981). This paradigm had originated from research on oral production (Goldman Eisler, 1958) and its adaptation to written production. Although the verbal protocol, the double-task paradigm, and the pauses and rates paradigm investigate different aspects of the writing processes, they all complement each other. There are currently two different methods for recording pauses and rates, corresponding to two different modes of written production: typewriting and handwriting.

For the last 20 years or so, the so-called "spyware" has been used to study the dynamics of typewriting by recording the time associated with the depression and release of the keys. Programs used today include Recording WordStar, developed by Sirc and Bridwell-Bowles (1988), Real-Time Replay (Ransdell, 1990), S-notation (Severinson & Kollberg, 1994), and ScriptLog (Ahlsén & Strömqvist, 1999). Despite their speed, these programs nonetheless have their limitations. For instance, many of the pauses they record are liable to be influenced by the writer's expertise—or lack of it—in handling a computer keyboard. In the case of novice users and unorthodox use (e.g., typing with two fingers), pauses inherent to the graphomotor programming and execution of the message and/or visual checking of the keyboard may thus be unduly long.

Handwriting remains the most widespread production mode in society and the most widely used one in schools. The increasing use of styli and touch screens (PDAs, tablet PCs, etc.) means that handwriting once more plays a key data entry role. For many years, the only way of identifying pauses and rates for handwriting was to pore over video recordings of writing activity image by image (Chanquoy, Foulin, & Fayol, 1990). Furthermore, this laborious mode of analysis afforded only limited temporal accuracy (in the order of a tenth of a second). Now, however, a digitizing tablet can be linked up to a computer to record a range of handwriting parameters, including the spatial and temporal coordinates of the pen tip (tip moving across the tablet's surface) and the pressure exerted on it. This system was used as early as 1987 by Kelly to record pauses made by deaf participants writing short texts (Kelly, 1987). In the early 1990s, Pynte, Courrieu, and Frenck (1988) and Passerault (1991) systematized this recording method and extended its capabilities. It was henceforth possible not only for each "pen press" and "pen lift" to be recorded, but also for each point sampled in the course of production to be spatially and temporally localized. Researchers started to use software such as G-Studio (Chesnet, Guillabert, & Espéret, 1994) and OASIS (De Jong, Hulstijn, Kosterman, & Smits-Engelsman, 1996) to digitize the entire handwriting production activity. They could now perform accurate and flexible analyses of writing speed and any variations in that speed. The unit of measurement was no longer the number of letters produced within a given space of time, as it is in typewriting studies (number of characters per minute), but the sample point. Systems such as this, notably OASIS, made it possible to detect relatively minor accelerations and decelerations and to consider the stroke as the smallest unit of graphomotor production (De Jong et al.).

UNDERSTANDING HANDWRITING PAUSES: ADVANTAGES AND LIMITATIONS OF THE HIERARCHICAL MODEL

Handwriting pauses are of no significance in themselves, their psychological interpretation depending on their duration and on the semantic, linguistic, and even graphical context in which they occur. This covariation between the length and the linguistic—and semantic—localization of a pause has been described on many occasions, in both oral and written production, in individuals of different ages and for different types of text and discourse (for a review, see Foulin, 1995). Convergent results show that the higher the level of the linguistic unit (word, phrase, grammatical proposition, sentence, or paragraph), the longer the pause. The interpretation of this hierarchical distribution is based on the postulate that the length of a pause reflects the number and/or complexity of the processes being implemented within it (Foulin, 1998). Accordingly, we can assume that several processes will be taking place during a pause that precedes a paragraph: (a) planning the paragraph's overall content, (b) generating the propositional and semantic structure of the sentences that will go to make up that paragraph, (c) generating the syntactic structure of the paragraph's first sentence, (d) retrieving the lexical items required at the beginning of that sentence, (e) ensuring the correct lexical and grammatical spelling of those first words, and (f) undertaking the graphomotor planning required to launch the actual handwriting of the paragraph. Interword pauses are generally short, by comparison, reflecting the time it takes physically to mark the space between the previous word and the next one, and the time needed to complete the lexical, orthographic, and graphomotor processing of the new word, if these processes are still ongoing.

Given this extensive empirical evidence, the hierarchical model for interpreting pauses would appear to offer a valid means of investigating the distribution of the processes involved in elaborating a whole text, a paragraph, a sentence, or a single word. Three major criticisms can, however, be leveled at it.

Hierarchical Model for Pauses Cannot Tell Us How Much Time Is Spent on One Particular Process During a Pause

Several processes may follow on from each other in the space of a pause, whatever that pause's hierarchical position. Even though we can assess the amount of time required by one particular process by experimentally manipulating its occurrence (e.g., asking the participant either to pay attention to the spelling or else to disregard it and measuring the effect of this instruction on pause length), carrying out a fine-grained description of all the processes activated during a pause remains a difficult undertaking in the absence of any additional indicators of the writer's mental activity during that period of graphomotor inactivity. This difficulty is compounded by the fact that the degree of automation of certain processes (especially orthographic processing) differs according to the writer's degree of expertise, resulting in variations in pause duration. As a consequence, the hierarchical model can only offer us a global approach to the orchestration of writing processes and cannot give an account of the diversity of processing strategies adopted by writers during pauses.

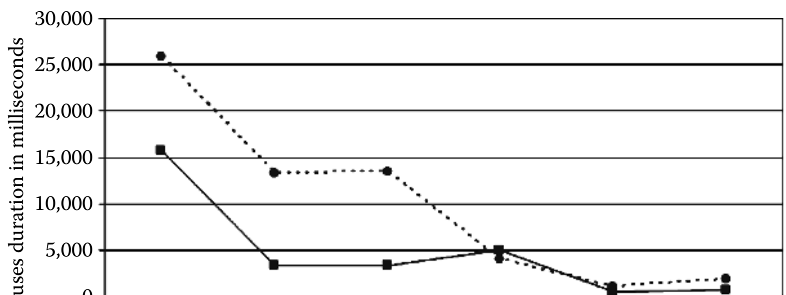
Hierarchical Model for Pauses Cannot Tell Us Anything About the Processes That Take Place in Parallel With the Graphomotor Execution

The hierarchical interpretation of pauses is based on the postulate that controlled processes are necessarily implemented during handwriting pauses, in contrast to the automated process of graphomotor programming, which can be engaged during the handwriting period following the pause. Although this sequential model is well founded, it does not mean that controlled processes never take place in parallel with graphomotor execution (Chanquoy et al., 1990; Foulin, 1998; Olive & Kellogg, 2002). Although variations in writing rates and speeds may attest to fluctuations in the number and/or attentional cost of these parallel processes, we still have to describe and model the conditions governing their sequential or parallel organization.

Hierarchical Model for Pauses Fails to Take the Specificities of Writing Process Management Into Account

Unlike oral production, which generally works on the "just-in-time" principle (especially in the case of dialogues and speeches), handwriting can be interrupted at any time. The permanent presence of the written trace enhances this relative freedom in process management (Fayol, 1997). In theory, a writer can engage in the (re)reading of the text-produced-so-far, either to review or to continue it, at any time and for any length of time. Here, once more, the hierarchical model is ill-suited to predict the location and length of these breaks in handwriting.

Alamargot, Chesnet, Dansac, and Ros (2006) demonstrated the limitations of the hierarchical model by scrutinizing the distribution of handwriting pauses recorded while two adults composed a procedural text from a documentary source. The pauses were categorized according to their linguistic location, in the following hierarchy: prewriting, interparagraph, intersentence, interpropositional (grammatical proposition), interword, and intraword. For instance, by contrasting the performances of two adults (as extracted from an experiment conducted by Alamargot, Caporossi, Chesnet, & Ros, in revision), it can be shown the same hierarchical distribution of pause durations according to their location. This initial finding therefore replicated most previous ones: the higher the level of a linguistic unit, the longer the mean duration of the preceding pause (Figure 12.1).



	Pre-writing	Inter-paragraphs	Inter-sentences	Inter-propositions	Inter-words	Intra-words
●···· Participant 6	25,860	13,205	13,384	3,998	920	1,750
■— Participant 10	15,704	3,375	3,265	4,943	539	692

Pauses location in the text

Figure 12.1 Mean duration of pauses according to their locations in the text. Participants 6 and 10.

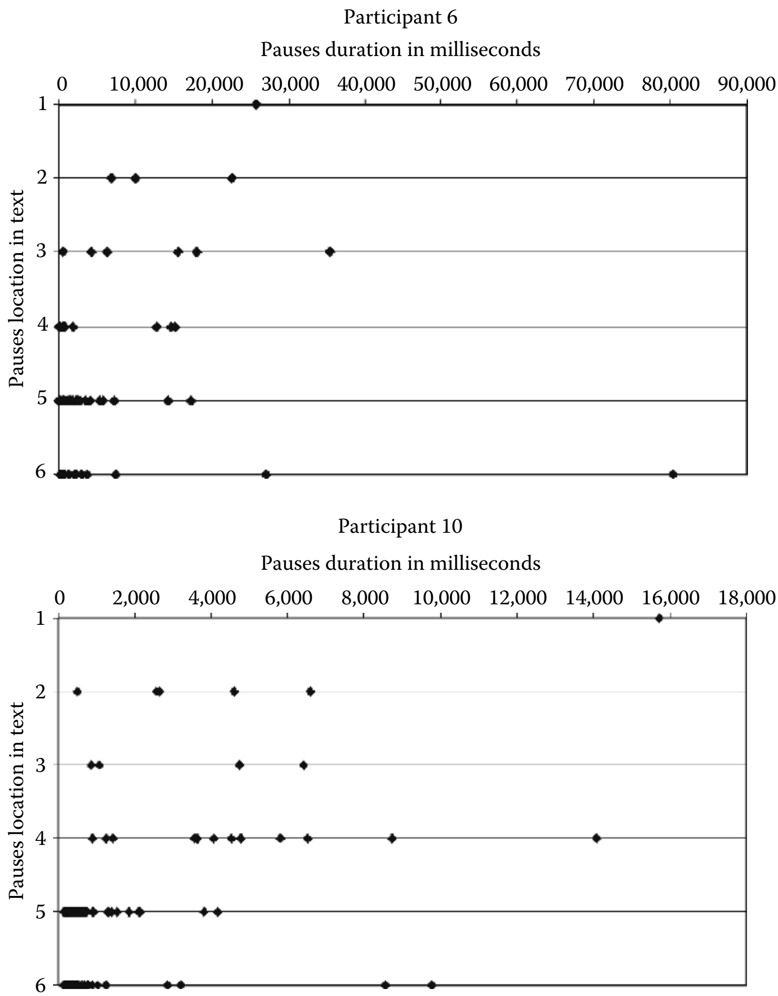


Figure 12.2 Distribution of pauses according to their duration and their position in the text (1: prewriting, 2: interparagraphs, 3: intersentences, 4: interpropositions, 5: interwords, 6: intrawords).

As this result could also stem from the fact that pauses between lower-level linguistic units were not only shorter, but also more numerous, the authors looked at the distribution of all the pauses and discovered that the longest pauses did not systematically occur before the highest level units (Figure 12.2).

Each of the hierarchical positions in the text proved to have a broad spectrum of pause durations. Some of the pauses occurring in the middle of a word, for instance, lasted between 20 and 80 s. The presence of long pauses within or between low-level linguistic units may have been a consequence of the specific nature of writing process management referred to earlier (fewer time constraints and permanence of the written trace). This possibility raises the question of how to undertake the real-time identification and description of the writing processes that the model cannot predict. The answer may lie in the combined analysis of eye movements and pause durations.

ADDITION OF EYE MOVEMENT ANALYSES

The pauses and rates paradigm analyzes the "output" of written production, that is, the temporal characteristics of graphomotor execution (writing and pausing periods). Its heuristic power can be augmented by analyzing the "input" of written production, too—in this case, the processing of visual information gleaned from the text-produced-so-far and/or documentary sources.

Visual activity was first studied at the beginning of the last century (Dearborn, 1906), but it was not until the 1970s and 1980s that research really started to take off, profiting from new technical and technological advances (see, e.g., O'Reagan, 1975). The past two decades have seen an increasingly diversified approach, with eye movements being investigated both as a subject in their own right and as indicators of cognitive processes. The former involves (a) defining the relevant ocular parameters, including saccades, and fixations (Inhoff & Radach, 1998) and (b) determining the physiological, cognitive, developmental, and environmental factors liable to influence these parameters (Katsanis, Iacono, & Harris, 1998). In this context, we cite research on saccade control, the role of attention in this control, and the visual perception of images or scenes (Rayner, 1995). For the latter, eye parameters are interpreted as indicators of processes whose implementation and orchestration rely on representations constructed from visual information. In this context, eye movements can be used to identify reasoning and problem-solving strategies, describe how human–machine interfaces are used, and investigate reading processes—as potential indicators of decoding and/or comprehension (for reviews, see Kennedy, Radach, Heller, & Pynte, 2000; Rayner, 1998; Underwood, 1999).

In written production, systematic and repeated studies using the simultaneous recording of visual and graphomotor activity were initially only conducted in situations of copy typing. Inhoff and Gordon (1998), for instance, investigated the visual, motor, and lexical constraints that modulate the duration and location of saccades and fixations when typists look at the text, which is being copy typed, the screen, the keyboard, or their fingers. The characteristics of the "eye–hand span," that is, the distance that is expressed in the number of character spaces between the fixation of the letter and its graphomotor execution, have also been described and discussed.

Although research on copying explores the nature and/or function of visual activity during handwriting, it only looks at one specific situation of written production. We also need to investigate the nature of writers' visual activity when they are composing a text of their own, together with the nature of the writing processes that are rooted in this visual processing.

We can assume that writers' visual activity varies according to the nature of the processes in which they engage. For Hayes (1996), text composition is a composite task, which elicits a variety of cognitive activities, including reasoning, reading (written trace or documentary sources), information searching (in the environment or in memory), and graphomotor execution control (hand or pen movements). These activities play a variety of roles in the three main writing components (planning, formulation, revision). For example, (re)reading the text-produced-so-far may be triggered not only for the purposes of revision (reading to assess the quality of the text), but also for planning (reading to determine future content) and formulation (reading to establish a link between two sentences). Four of the activities involved in written production have a strong visual component. They are (1) reading comprehension, (2) information searching, (3) graphomotor control, and (4) monitoring of graphomotor output. In all probability, these four activities each make different demands on the visual component and therefore give rise to four specific patterns of eye behavior, in terms of fixations, saccades, and perceptual span.

By synchronously recording eye and graphomotor activities, *Eye and Pen* software (Alamargot et al., 2006; Chesnet & Alamargot, 2005) can provide evidence for the presence of each of these four activities during pausing and handwriting periods, and descriptions of the corresponding oculomotor behavior. Findings on the behavior elicited by reading comprehension, target and anomaly detection, and eye–hand coordination (e.g., aiming) tasks represent a valuable theoretical and empirical resource and a useful point of comparison for pinpointing the specific features of the visual component of writing.

Reading Comprehension of One's Own Text

Reading comprehension is an integral part of text composition. Writers put themselves in the place of the reader, in order to assess the rhetorical, pragmatic, and linguistic qualities of their message (Hayes, Flower, Schriver, Stratman, & Carey, 1987). Studies of the eye parameters associated with this type of (re)reading (fixations, regression, and refixation saccades) can draw on the findings of standard reading research (Just & Carpenter, 1980).

This possibility raises the question of how the semantic and linguistic representations, which writers already have of their writing, influence eye movement behavior. When a text is read for the first time, its meaning is gradually extracted and integrated into a situation model, but in the case of written production, this model is present at the very outset. For this reason, the situation in classic research that most closely resembles the conditions in which writers find themselves when rereading their texts is the one where readers are asked to read a text for the second time round. In this situation, Millis, Simon, and TenBroek (1998) found that rereading speedup was greatest at sentence boundaries and that fewer cognitive resources were allocated to proposition assembly in the second reading than in the first one, going instead to text-level integration. We can infer from these results that there is an even greater difference between the modalities of reading an unknown text for the first time and those of reading one's own text. We can assume that reading what one has written relies less heavily on content integration processes than reading a new text, and therefore results in different oculomotor behavior, with modifications in the duration and frequency of fixations and regression saccades. However, this type of comparison requires sophisticated methodological reasoning and has seemingly yet to be undertaken.

Information Searching for the Purposes of Text Production or Revision

Visual searches for a particular item of information during text composition may concern either the text-produced-so-far or any documentary sources that are available. This searching makes it possible to (a) encode from source an item that is needed in order to continue composing the text, (b) check whether the portion currently underway is consistent with the source and/or the text-produced-so-far, and (c) detect a mistake or anomaly that occurred earlier in the text.

Numerous studies have shown that the oculomotor behavior patterns associated with information searching are different from those that characterize reading comprehension. For example, Inhoff, Topolski, and Wang (1992) compared the relationship between fixation duration and saccade size in three different activities: (1) copy typing of different series of sentences, (2) reading comprehension of those sentences, and (3) the detection of individual letters ("t" or "f") in the course of reading comprehension. Results showed that saccades following short fixations (50–150 ms) were larger (in terms of character spaces) during letter detection than during reading comprehension. Moreover, although there were frequent long fixations (>450 ms) in letter detection, there were none at all in reading comprehension. Adopting a rather similar approach, Rayner and Fischer (1996) compared the characteristics of fixations and saccades according to whether participants had to understand a text containing either frequent or less frequent words or scan it to detect a particular letter. Compared with scanning, reading comprehension was found to generate shorter fixations, larger saccades, and more numerous refixation saccades. Low-frequency words only increased fixation duration in reading comprehension. These two experiments show just how far oculomotor behavior is dictated by these activities (reading, searching, detecting, copying, etc.), in terms of the demands of their inherent processes and the shifts of attention they require.

Writers may need to consult documentary sources to select information for inclusion in their own texts, in which case their gaze will alternate between these sources (information uptake) and the text-produced-so-far (transcription of the information that has just been perceived). There are several possible patterns of oculomotor behavior, depending on whether the task requires a major transformation of the information or straightforward copying. The notion of "eye–hand span," defined by Inhoff and Gordon (1998) in the context of copy typing (see previous paragraph), can be adapted and operationalized here with *Eye and Pen*, in order to study what can be termed as the "writing from source" span. Alamargot, Dansac, Chesnet, and Fayol (2007), for instance, explored variations in the distance between the fixation point and the tip of the moving pen as a potential indicator of source consultation in parallel with handwriting (see the following).

Information searches are not necessarily restricted to documentary sources. Writers may also look for information within their own text, with a specific objective in mind (e.g., correcting an error spotted earlier, looking for an antecedent to resolve an anaphor, or reactivating the memory trace of previously formulated content). This strategic uptake of visual information is probably guided by both (1) the task objective (Dore-Mazars, 1999) and (2) the visuospatial representation that the writers have constructed of their environment in the course of their activity (Rao, Zelinsky, Hayhoe, & Ballard, 2002). Unlike reading research (Baccino & Pynte, 1998), writing research has yielded very few data about the way in which the visuo-spatial representation of the text-produced-so-far is elaborated and the role this representation plays in guiding searches for information within it (Heurley, 1994).

Graphomotor Control

Two complementary modes of handwriting control are generally described in the literature (Graham & Weintraub, 1996; Zesiger, 1995). First, the proactive, "feedforward" control of graphomotor execution relies on internal knowledge and consists of the retrieval of a generalized motor program or schema, its parameterization (e.g., adapting handwriting size), and the implementation of the now specific program (Van Galen & Teulings, 1983). Second, the retroactive graphomotor control relies on visual and tactile/kinesthetic feedback from the written trace being formed. According to Smyth and Silvers (1987), this retroactive control can be exproprioceptive and/or proprioceptive. Exproprioceptive control is the means by which the handwriting is fitted into the "writing space," through the positioning of the text on the page, the words on the lines, and the letters in the words (topokinetic characteristics of the handwriting). Proprioceptive control concerns the formation of the handwriting (morphokinetic characteristics of the handwriting). The content of a motor buffer is continually updated by recording the letter strokes that have just been produced or are about to be (Van Galen, Smyth, Meulenbroek, & Hylkema, 1989). The recording of eye movements during graphomotor execution provides an accurate means of exploring the mechanisms subtending exproprioceptive and proprioceptive control, as it enables us to identify the visual information that is processed during the formation of the letters and/or their constituent strokes.

To begin with, during the act of writing, the pen has to be moved in order to go from one unit to the next, start a new line, or return to a section of the text that has already been written. In all probability, the pattern of oculomotor behavior triggered by the exproprioceptive control of these movements is similar to that observed in nonlinguistic pointing tasks (Helsen, Elliott, Starkes, & Ricker, 2000). In written production, if the point where the handwriting is to be resumed lies outside the parafoveal visual field, the writers have to make a saccade to fixate that point, all the while guiding their hand in order to position the pen tip. The synchronized recording of eye and graphomotor movements, such as that performed by *Eye and Pen*, allows researchers to identify the exact point at which the saccade is made and the nature of the visual activity needed to guide the hand toward the new location (e.g., regression and/or refixation saccades). The digitizing tablet can be used to examine the impact of the writing medium on this oculomotor behavior, by manipulating the page format, the number of columns, the presence and spacing of lines, and so on.

In addition, unlike exproprioceptive control, which may be solely episodic (shifts from one location on the page to another are discrete events), the proprioceptive control of handwriting continues throughout the writing process and requires continuous synchronization of hand and eye movements, especially in novice writers (Chartrel & Vinter, 2006, 2008; Zesiger, 1995). This type of synchronization has been studied using a variety of nonlinguistic, sequential tasks. Ballard, Hayhoe, Li, and Whitehead (1992) asked participants to copy spatial configurations made up of colored blocks by moving a separate set of blocks around with a mouse on a computer screen. When the authors analyzed fixations on the different elements of the environment (model to be copied, blocks to be moved, copy underway), they found that instead of being constant, the synchronization of the eye and the mouse cursor was strategically regulated to meet task demands. In particular, they observed numerous instances of desynchronization, temporarily precluding visual retroactive control. Pelz (1995) replicated these results, administering the experiment in a naturalistic setting where the blocks were physically handled. For their part, Miall and Tchalenko (2001) observed similar phases of hand–eye desynchronization in an artist drawing a portrait. Using *Eye and Pen*, we, too, have detected and described this phenomenon in text production from sources (see the following; Alamargot et al., 2007).

These phases of desynchronization obviously raise the question of the complementariness of visual and tactile/kinesthetic feedback in the retroactive control of graphomotor execution. Although hand movement control can apparently "make do" with tactile/kinesthetic information in the absence of visual feedback, we have yet to find out exactly how long this dissociation can be maintained and identify the circumstances under which resynchronization becomes necessary. *Eye and Pen* provides a means of carrying out the appropriate investigations.

Monitoring of the Written Product

Butterfield, Hacker, and Albertson (1996) stressed the importance of distinguishing between control and monitoring. The purpose of control is to pilot graphomotor execution, whereas that of monitoring is to look for possible discrepancies between the trace that has just been produced and the writer's intentions and/or production norms. The monitoring system informs the writer of any errors that have been made. If the system fails to detect an error immediately after it has been produced, this error will only be picked up if the writer subsequently searches the text-produced-so-far for information.

Visual activity obviously plays a key role in monitoring. As the quality of the trace has to be analyzed as to when it is produced, the corresponding fixations should logically be located downstream from the writing point. However, uncertainty still surrounds the exact size of the monitoring span, the nature of the information that falls within this attentional focus, and the types of processes that are engaged, in particular, the possible relationship between monitoring and the visual component of retroactive control. *Eye and Pen* can answer some of these questions by analyzing the distances between fixation and writing points. This capability allows researchers not only to characterize the monitoring span in terms of the number of character spaces or linguistic units, but also to elucidate the nature of the processes that take place within it. Presumably, if the writing point lies outside the parafoveal visual field, handwriting control has to rely solely on tactile/kinesthetic information and it is the monitoring system that benefits from the visual information. If, on the other hand, the writing point lies inside the parafoveal visual field but is not the fixated object, monitoring takes place downstream from the writing point and retroactive control is based on both parafoveal and tactile/kinesthetic information. These relatively fine-grained investigations should yield important findings on the way in which graphomotor execution and local revision processes are implemented.

Conclusion: Research on Reading During Handwriting

In the previous sections, we describe four of the activities involved in written production that have a visual component. The synchronized study of handwriting and eye movements now makes it possible to test novel hypotheses about specific processes that rely on visual information fixated during pausing and handwriting periods, which should ultimately improve our understanding of the different roles played by reading during handwriting. Research on the role of reading during handwriting was previously largely descriptive. Adopting the verbal protocol paradigm, McCutchen, Francis, and Kerr (1997) demonstrated the effect of varying levels of text composition skills on fifth graders' ability to detect and diagnose linguistic and semantic errors in texts. Similarly, Van den Bergh and Rijlaarsdam (1999) highlighted the relationship between (re)reading the text-produced-so-far and content elaboration. Regarding documentary sources, researchers were mainly interested in the effect of writers' reading comprehension skills on the quality of the texts they produce (for the selection of relevant information: Spivey & King, 1989; for source use strategies: Kennedy, 1985).

Although this research underscored the importance of reading during handwriting, the methods it used did not allow for fine-grained analysis, and without accurate descriptions of the different forms of reading, it is impossible to grasp their impact on the finished text. To remedy these shortcomings, Hyönä, Lorch, and Kaakinen (2002) recorded writers' eye movements as they read through documentary sources for the first time in order to summarize them. An analysis of these eye movements (fixations and saccades) revealed four source-reading strategies, each one characterizing a different group of writers: (1) "fast linear readers" did not return to sentences they had already read, (2) "slow linear readers" reinspected each sentence before moving to the next one, (3) "nonselective reviewers" reread sentences but had no particular strategy for deciding which sentences to choose, and (4) "topic structure processors" used the sources' headings to decide which sentences to reread. According to these authors, it was the fourth reading strategy, characteristic of participants with the greatest working memory (WM) capacity (as measured by reading span test, see Daneman & Carpenter, 1980), that resulted in the most accurate text summaries.

The fourth reading strategy was an interesting study because it featured a particularly fine-grained analysis of source reading, illustrating the methodological usefulness of collecting oculometric data to describe the different forms of reading and their respective consequences. Nonetheless, by imposing a single reading phase prior to writing, the authors eluded the central question of the interplay between the two activities (reading–writing) in the course of text composition. It was from this perspective that the *Eye and Pen* software was developed.

Eye and Pen simultaneously records eye movements (fixations and saccades, recorded by an oculometer) and pen movements (pauses and rates, recorded by a digitizing tablet). By synchronizing these two signals, we can accurately describe and analyze how writers process visual information available in the task environment while pausing or handwriting. We set out in the following the results of four experiments in which we used *Eye and Pen* to elucidate the role of reading during handwriting and, more specifically to assess the impact of cognitive resource availability in WM on its implementation.

The first three experiments were designed to describe the characteristics of documentary source reading during text composition in adults (Experiments 1 and 2) and from a developmental perspective (Experiment 3). Experiment 4 sought to determine whether (re)reading the beginning of a sentence containing the subject whilst producing the verb helps to ensure correct subject–verb agreement.

EXPERIMENTAL EVIDENCE

Experiment 1: Impact of Working Memory Capacity on the Dynamics of Source Reading During Handwriting

The purpose of this experiment (Alamargot et al., 2007, 2011; Alamargot, Dansac, Ros, & Chuy, 2005) was to explore the influence of WM capacity, looking at how often and for how long participants consulted a documentary source either during handwriting pauses (first analysis) or in parallel with graphomotor execution (second analysis). Graduate students were asked to produce a procedural text (assembling a model turbine) based on documentary sources in the form of captioned pictures of the turbine parts, the assembly steps, and the related vocabulary. *Eye and Pen* recorded their eye and pen movements throughout the course of composition. Their abilities were assessed in a series of tests measuring WM span (written production span; adaptation of the test developed by Daneman & Green, 1986); lexical fluency in writing (number of words produced within a limited space of time and referring to a specific category); graphomotor automation (writing the letters of the alphabet and one's first name and surname as many times as possible within a limited space of time); and skill at assembling the model (domain expertise), measured in the amount of time taken to complete the turbine.

We conducted an initial analysis to gauge the influence of WM capacity on (a) handwriting pause duration and (b) the frequency of documentary source consultation during these pauses (number of forward and backward movements between the text-produced-so-far and the sources during each pause). In line with capacity theory (McCutchen, 1996), we expected the high-span writers to make shorter pauses, as their greater storage and processing capacity would mean that they did not need to consult the sources as often to process the information they contained. However, the results were quite the reverse. High-span writers made longer handwriting pauses because they consulted the sources more frequently during these pauses. In the course of these consultations, they also fixated a greater variety of information items in the documentary source (photos of parts, steps, associated lexicon). This appears to have been due to more complex planning of the text, based on a pragmatic analysis of the reader's needs. This was reflected in the presence of more "reader supports" in the texts, designed to steer the reader carefully through the turbine assembly process. Thus, as well as reading the sources to determine the content of their texts (reading to compose), as the low-span writers did, the high-span writers appeared to use their residual resources to undertake additional pragmatic processes, constructing a representation of the reader and maintaining this representation in WM until the task had been completed.

The twofold aim of the second analysis was to (1) identify the periods when the writers read the sources in parallel with graphomotor execution and (2) demonstrate that the frequency and duration of these periods depended partly on their WM capacities. "Parallel reading" was defined as the fixation of an item of information sufficiently far from the moving pen for the latter to move outside the parafoveal visual field (distance of ~4 cm). Results revealed that all writers frequently engaged in parallel reading, either of the sources or of distant portions of the text-produced-so-far. For the group of graduate students described here, the mean duration of these periods was 543 ms and their summed duration represented ~10% of total writing time (excluding pauses). Multiple regression analyses showed that variations in the duration and frequency of these periods were partly accounted for by variations in performances on the tests measuring participants' abilities. Thus, the greater their graphomotor automation and lexical fluency, the longer and more numerous these periods were. Conversely, the smaller their WM span and domain expertise, the more likely the parallel reading periods were to end in a handwriting pause. In other words, modest resources and a lack of referential knowledge forced writers to halt their parallel processing and make a handwriting pause. Without this pause, they could not properly read the sources or the text-produced-so-far.

Experiment 2: Impact of Text Type on Reading During Handwriting

Whereas the first experiment investigated the production of a procedural text from documentary sources, in this second experiment, we manipulated the nature of the text that had to be produced from sources (see Alamargot & Quinlan, 2005). Adult writers (engineering students) were divided into two groups according to their performances on a WM span test (adaptation of Reading Span Test, see Daneman & Carpenter, 1980). Both groups had to (a) copy, (b) summarize, and (c) merge technical documents. The order of the tasks and the documents' topics was counterbalanced. Oculomotor and graphomotor movements were recorded with *Eye and Pen*.

We expected that the increase with task complexity (Copy < Summarize < Merge) in the amount of time taken to read the documentary sources (in terms of number of fixation per word) would be even steeper for writers with low WM capacity. Results confirmed this hypothesized interaction. Contrary to our expectations, however, the composition task that elicited the highest number of fixations per word was not the merging task (1.46 fixations per source word) but the summary (2.7 fixations per word). The copy task only generated 1.07 fixations per source word. It was also in the summary task that WM span had a significant effect. A second, more in-depth analysis of the reading strategies implemented in these three tasks (in terms of first and second passes—reading/rereading) revealed a strong similarity between the copy and combination tasks, indicating that when the writers had to combine information contained in different source documents, they read these sources through for the first time as though they simply had to copy them out. Only after this initial reading phase did they embark on content elaboration, based on the information they had memorized, hence the greater summed duration of handwriting pauses (60% of composition time for combination versus 34% for copy). We can thus conclude that different types of text elicit different modes of documentary source reading. Content elaboration in the summary task began during the (intensive) source reading phase and continued during the composition phase. When participants had to combine information contained in different sources, the reading phase resembled that of the copy task (straightforward extraction of information) and the composition phase (lengthier processing) that of the summary task. To sum up, text elaboration processes take place mainly during source reading (immediate source analysis) and/or during formulation (delayed source analysis), depending on the goal of the composition and the type of text.

The results of these two experiments are interesting for several reasons. As well as enhancing our knowledge of writing processes, they demonstrate, as Hyönä et al.'s (2002) study did, the benefits of subjecting reading during handwriting to a fine-grained analysis. It was the accuracy of the oculomotor indicators, together with their synchronization with the handwriting pauses and rates, that allowed us to account for some of the apparently paradoxical or counterintuitive temporal data. The finding that participants with greater WM capacity made longer handwriting pauses, for instance, contradicted the predictions of capacity theory. Only by analyzing eye movements during these pauses did we realize that this increase in duration was, in fact, due to more complex planning, which only the high-span writers were capable of undertaking. Similarly, it was the dual analysis of fixations and handwriting pauses that enabled us to show that the similarity of reading strategies in copy and combination tasks did not mean that subsequent processing, based on the information that had just been read, would be equally similar. Last, but not least, oculomotor and graphomotor indicators are obviously extremely sensitive to variations in WM capacity. This discovery is encouraging, as it means that analyzing variations in these indicators could shed useful light on differential and/or developmental strategies for text production that have yet to be examined with any degree of accuracy. We explored this issue in our third experiment.

Experiment 3: Impact of Expertise Development on Reading During Handwriting

In this experiment (Alamargot, Plane, Lambert, & Chesnet, 2009), we used eye and pen movements to trace the development of writing expertise—or, more specifically, of reading during handwriting—by comparing five writers with different levels of expertise. The consequences of learning and practice for writing processes are twofold: (1) the automation of low-level processes such as graphomotor execution and orthographic procedures and (2) more complex high-level processes, as they shift from local to overall planning and revision. According to capacity theory (McCutchen, 1996), these two effects are linked. The automation of low-level processes frees up resources that can then be allocated to high-level ones, which, in turn, become increasingly complex (Fayol, 1999). As a consequence, writing expertise is subtended by two contrasting temporal patterns: (1) an acceleration in execution and formulation (adults can write and spell faster and more easily than children) and (2) an increase in the amount of time dedicated to planning and revision (adults use more complex strategies to build more highly structured texts and spend more time on composition than children).

This study set out to clarify our understanding of the relationship between low-level (execution and formulation) and high-level processes (planning, revising), the way it changes in the course of development, and the impact it has on the characteristics of written output. A dual description of writing processes was undertaken, based on (1) the respective time courses of these processes, as assessed by analyses of eye and pen movements and (2) the semantic characteristics of the writers' scripts. In order to gain a more accurate description of processing strategies, we chose to adopt a "case-study" approach, whereby a comprehensive range of measures was used to assess processes in a seventh, ninth, and twelfth grader, a graduate student, and a professional writer. The task was to write a story as the continuation of an excerpt from a source document (incipit).

Results confirmed the principles underlying the general developmental hypothesis, showing a steady acceleration in the time course of both low-level processes (short pauses, writing speeds) and high-level ones (long pauses), and a steady reduction in "reading density" for the text-produced-so-far (expertise-related decrease in fixation frequency and duration). A closer look at the data revealed some interesting features. Fixation frequency and duration for source reading underwent an initial rise in students and a subsequent fall in adults. The twelfth grader proved to occupy a pivotal position in this developmental trend. The adults gave the incipit a rather cursory reading, partly during the composition phase. This finding was especially true of the author, who stood apart from the others not because she had developed novel controlled processes, but because she performed the normal high-level processes remarkably rapidly, as revealed by a temporal analysis of her eye movements and graphomotor activity. The speed of these processes suggests that they had undergone a considerable degree of proceduralization, as a result of practice. This proceduralization reduced the cost of processing, by allowing the author to retrieve procedures from long-term memory and to fire several different processes at the same time. The consequences were twofold. First, the author was able to quickly elaborate the text's overall plan, maintain this plan in memory, and thus spend less time consulting the incipit, both before and during composition. Second, she could also consult the incipit and the text-produced-so-far without interrupting her handwriting. She did this more frequently than the graduate student, despite the fact that both adults displayed the same levels of graphomotor automation and formulation (similar writing speeds and shorter pauses).

Experiment 4: Impact of Reading During Handwriting on the Control of Subject–Verb Agreement

The combined analysis of oculomotor and graphomotor movements constitutes a new paradigm for research on spelling, providing an opportunity to distinguish between automatic and controlled processes without interfering in their time courses. This fourth experiment (Alamargot, Leuwers, Caporossi, Pontart, O'Brien-Ramirez, Pagan, et Fayol, 2011) represented one of the very first attempts to integrate real-time measures into the study of grammatical processes—more specifically, subject–verb agreement in written production. Simple N1 N2 V-type sentences (*Le chien des voisins mange* [the dog belonging to the neighbors is eating]) can be used to elicit attraction errors in adults (*Le chien des voisins mangent* [The dog belonging to the neighbors are eating]), providing that their cognitive resources are partially siphoned off by a secondary task (see, e.g., Fayol, Largy, & Lemaire, 1994). This result, which has often been replicated (for a review, see Largy, Cousin, & Dédéyan, 2005), points to the presence of a two-level process: the agreement rule is automatically triggered by the presence of a plural N2, but the error is averted through "pregraphic control," whereby the agreement process is reiterated. When cognitive resources are scarce, this control cannot take place and the attraction error is not inhibited. Furthermore, when the number of N1 is not maintained in WM for some reason (see the following), pregraphic control relies on the reinspection of the words that have just been written (here, the subject of the verb). We therefore hypothesized that (re)fixating N1 while V was being produced would help to inhibit the error and/or activate the correct verb.

The experiment we carried out to check this hypothesis involved the production of simple sentences with a relative ("who") clause (*La mamie qui montre les papis lance une balle* [The granny who points to the grandpas is throwing a ball]), where a number mismatch between the local noun (*les papis* [the grandpas]) and the head noun (*la mamie* [the granny]) could potentially trigger an attraction error in the main verb (*lance* [is throwing]). We chose to administer a classic dictation task, instructing the participants to write out the prerecorded sentences they were played. Online production times were recorded using a digitizing tablet, with parallel recording of eye movements, in order to discover whether the participants inspected their previous production, and if they did, (a) when, (b) what information did they look at, and (c) how long did they look at it for?

The combined analysis of writing speed (slowing down, pauses) and of the visual activity associated with graphomotor execution (smooth pursuit eye movements [SPEMs], fixations, and saccades; Gowen & Miall, 2006) allowed us to identify the phases where automatic processes, characterized by a faster writing rate and eye–pen synchronization (SPEMs), gave way to controlled ones (fixations, saccades). We expected to observe two types of oculomotor behavior when writers encountered a problematic sentence, such as the one cited earlier. First, if the representations of N1, N2, and V were all activated, the agreement would be worked out in WM (N1–V agreement, inhibition of N2) and the gaze would remain close to the pen tip, "pursuing" the word being written. Second, if, on the contrary, N1 was deactivated in WM, one or several regression saccades would be needed to bring N1 back into the attentional focus. There are several reasons why an N1 representation may cease to be maintained in WM, including (a) the syntactic distance between N1 and V (*Les mamies qui arrosent les papis cueillent une fleur* [The grannies who water the grandpas are picking a flower] versus *Les papis menacent la mamie qui porte un sac* [The grandpas are threatening the granny who carries a handbag]), especially if the N1 noun phrase is augmented (e.g., SS relative) and (b) the number of N2, as a plural requires stronger inhibition (SP: singular N1 and plural N2).

The main results showed that ocular parameters, particularly saccades and, to a lesser extent, SPEMs, are sensitive to the grammatical configuration of sentences requiring immediate written recall. When a sentence is liable to trigger an attraction error (e.g., singular N1 and plural N2), the writer's eye movement is modified, giving rise to larger saccades to N1, and to longer SPEMs, punctuating more rapid production.

These initial encouraging results underscore the benefit of analyzing eye movements to elucidate the nature of the pregraphic control required in subject–verb agreement and the conditions under which it can be performed. Additional investigations are nonetheless needed to determine its exact time course. By matching handwriting pauses and rates to the different components of the sentence, especially at the point where the verb is inflected, it should prove possible to elucidate the nature of the processes that are engaged in the course of production.

CONCLUSION

The combined study of oculomotor and graphomotor movements showed three complementary advantages. First, the recording of eye movements during handwriting did not modify the time course of the writing processes in any way. The exploration of pauses remained entirely nonintrusive, but at the same time allowed for the continuous analysis of writing processes. Second, by analyzing fixations and saccades, we could achieve a particularly fine-grained spatial and temporal description of the processing of visual information retrieved from the task environment (documentary sources and/or text-produced-so-far). This description can tell us about the workings of the visual component and, by so doing, shed further light on the characteristics of the different writing processes that rely on this component and, more particularly, on the multiple roles of reading during handwriting. Third, the categorization of visual information uptake, according to whether this information comes from sources or from the text-produced-so-far, and whether uptake takes place during pauses or graphomotor execution, provided a means of overcoming the three limitations inherent to the hierarchical model associated with the pauses and rates paradigm.

Eye movement parameters such as saccades and fixations, which have been widely studied in reading research, can be successfully adapted to research on writing, although their meaning and validity as indicators of writing processes cannot be taken for granted and need to be confirmed. The study of regression and refixation saccades during handwriting (returning to the text-produced-so-far) is a particularly promising area, as these eye movements could provide clues to information selection, just as they do in reading tasks. In this case, we would expect fixation durations to be similar to those measured in classic reading task studies (Rayner, 1998). It is this behavior (regression and refixation saccades) that is mainly targeted in studies of subject–verb agreement, for example. The specific context of writing may also give rise to a specific set of oculomotor behavior patterns, which have yet to be studied. For instance, when handwriting is ongoing, the gaze frequently "follows" the slow motion of the pen tip (6°–10°/s). The use of classic fixation or saccade calculation algorithms based on distance, speed, and/or acceleration criteria results in an overestimation of fixation durations and prevents the accurate identification of their exact location (i.e., their barycenter), as a sequence of short and relatively stationary fixations is interpreted as a single fixation. These slow eye movements accompanying the pen therefore need to be characterized and analyzed to ascertain the nature of the information being processed.

Our more in-depth analysis of eye movement signals has revealed two slow-motion modes during handwriting, depending on pen kinetics: SPEMs and microsaccades, which gradually shift the fixation location (Alamargot et al., in press; Caporossi, Alamargot, & Chesnet, 2004). In order to elucidate the as yet unidentified role of SPEMs and microsaccades during handwriting, four indicators need to be simultaneously taken into consideration (fixations, SPEMs, saccades, and microsaccades). Gowen and Miall (2006) studied saccades and SPEMs in drawing and tracing tasks, whereas Miall, Imamizu, and Miyauchi (2000) demonstrated that microsaccades take place during handwriting. Several functions can be assigned to slow eye movements. From the graphomotor standpoint, we can assume that the gaze is necessary for the morphokinetics of letter formation. However, in the case of adults, this formation would appear to rely on motor program execution (proactive control). For instance, removing visual feedback therefore has no effect on letter formation, apart from an increase in pen pressure (Chartrel & Vinter, 2006). Gowen and Miall's results (2006) show that pen pursuit is more frequent when the task has a low cognitive cost. Thus, pursuit can be regarded as the simple topokinetic control of the written trace formation. From a psycholinguistic standpoint, one alternative hypothesis is that while the eye is slowly following the pen, it could also monitor the unit being produced, at spelling level, for instance.

Although it is methodologically prudent to undertake further investigations before generalizing the use of ocular indicators recorded during handwriting, the four pilot studies described here suggest that the combined analysis of eye and pen movements represents a particularly heuristic method for undertaking fine-grained analyses of the nature and dynamics of the processes involved in written production.

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13

Why Use a Copy Task to Study Spelling in Handwriting?

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The aim of this chapter is to show that even though the copy task is used less frequently than the dictation task, it is just as relevant for understanding how the spelling process works, especially *when the real-time approach is adopted*. In the case of languages with a deep orthography, such as English or French, which are also morphophonemic orthographies, learning how to spell—defined here as the process involved in retrieving or working out the sequence of graphemes in a word (Steffler, 2001)—is time consuming, frequently difficult, and sometimes problematic for schoolchildren (Graham, Harris, & Chorzempa, 2002; Manesse & Cogis, 2007).

Yet spelling is a vital component, not just of orthography but also of text composition. For beginning writers, spelling is cognitively costly, because of their lack of knowledge about orthographic forms and rules and limited automation of the phoneme-to-grapheme conversion processes. According to the capacity theory of writing (McCutchen, 1996, 2000), cognitive resources therefore have to be allocated to spelling, which may in turn exert influences on other processes (e.g., organizing ideas or searching for vocabulary). Thus, it is not surprising that individual differences in spelling and in composing are significantly related across adjacent grades in the first 7 years of schooling (Abbott, Berninger, & Fayol, 2010), and poorer spelling may result in poorer composition performances (Graham, 2000; Juel, 1988). When children are freed of orthographic constraints, for example, by being allowed to dictate their texts or use invented orthographies, they do indeed produce longer and sometimes better quality texts (Scardamalia & Bereiter, 1986). Similarly, the positive impact of a program for teaching spelling to poor spellers in second grade was found to extend beyond orthographic accuracy and to improve text production, with an increase in the length of the texts they produced (Berninger et al., 1998). It is therefore important to investigate spelling, not simply to elucidate its own processes, but also to design programs for teaching text composition to developing children and adults who still have spelling problems.

Up to now, researchers have mainly studied spelling via dictation tasks, often featuring single words. Although this dictation paradigm has resulted in significant scientific advances (Alvarez, Cottrell, & Afonso, 2009; Delattre, Bonin, & Barry, 2006; Martinet, Valdois, & Fayol, 2004; Sprenger-Charolles, Siegel, & Bonnet, 1998; Treiman & Kessler, 2006), a number of its shortcomings have gradually come to light. Foremost among these is the fact that a dictation task makes it hard for researchers to control the sequences of letters that are actually produced, thereby hindering comparisons of participants or items. The same limitation applies to the picture-writing paradigm (writing a word prompted by a visual stimulus) (e.g., Bonin, Fayol, & Gombert, 1997).

Possible variations in the sequences of letters used to write the items become an even greater problem when researchers wish to take advantage of the recent advent of software specifically designed to record the writer's activity in real time (for a review, see Chesnet & Alamargot, 2005). This software provides a means of supplementing and refining the results yielded by examination of the finished texts. However, these fine-grained online analyses work on the assumption that participants' productions will all be identical, so that none of the temporal variations that are observed are caused simply by differences in letter sequences between participants. In this context, the copy task offers a useful alternative to the dictation task, in that it lends itself particularly well to real-time investigations. The copy task provides participants with a model that serves as the input for their writing activity, whether it is handwriting (Kandel, Alvarez, & Vallée, 2006) or typewriting (Inhoff, Briihl, Bohemier, & Wang, 1992). This model may either disappear as soon as pen is put to paper (Lambert, Kandel, Espéret, & Fayol, 2008) or else remain visible until the task is completed (Kandel, Herault, Grosjacques, Lambert, & Fayol, 2009). In the latter case, researchers can analyze the number of lookbacks to the model while it is being copied (Lambert, Alamargot, Laroque, & Caporossi, 2011; Transler, Leybaert, & Gombert, 1999). It is also possible to analyze graphomotor activity in real time, using the indices that are classically considered in other writing situations such as dictation (latency, speed, and fluency; Delattre et al., 2006; Kandel et al., 2009) and text production (writing pauses and rates; Chanquoy, Foulin, & Fayol, 1990; Dansac & Alamargot, 1999). This analysis of graphomotor activity can now be supplemented by an analysis of oculomotor activity (Alamargot, Chesnet, Dansac, & Ros, 2006). The model's presence makes the copy task particularly relevant, as it can tell us when and where the orthographic representation needs to be reactivated, by allowing us to distinguish between fixations on the model and fixations on the text-produced-so-far. Last but not least, the copy task facilitates the study of written production in young children or struggling writers (Humblot, Fayol, & Lonchamp, 1994; Kandel et al., 2009), as the provision of a model makes the writing task easier.

After describing the major off-line studies of the spelling process, we describe the contributions that online studies have made, using dictation and picture writing. We then look at how the copy task can help us to probe the spelling process.

OFF-LINE STUDIES OF THE SPELLING PROCESS

Orthographic processes are usually studied by means of either spelling-to-dictation tasks (Alvarez et al., 2009; Delattre et al., 2006; Martinet et al., 2004; Sprenger-Charolles et al., 1998; Treiman & Kessler, 2006) or picture-writing tasks (Bonin & Fayol, 2002; Bonin, Peereman, & Fayol, 2001). In the case of spelling to dictation, the task of choice for researchers to find out how the phonological representations of words or pseudowords are translated into orthographic representations has been to assess spelling skills via variations in the letter sequences that are produced. When only real words are used, the analysis is based on orthographic errors, according to a range of criteria. Success or failure may concern either whole words (Martinet & Valdois, 1999; Martinet et al., 2004) or specific parts of words (Treiman & Kessler, 2006). Errors can also be classified on the basis of their phonological characteristics, according to whether the written word is phonologically accurate (PA) or inaccurate (PI) (Alamargot, Lambert, Thébault, & Dansac, 2007; Leybaert & Alegria, 1995). For example, Burt and Tate (2002) cited the orthographic errors made by adults in a dictation task as evidence that a single orthographic lexicon serves visual word recognition and spelling production.

The dictation task has also been used to assess children's spelling acquisition and level of expertise (Plaza & Cohen, 2003; Sprenger-Charolles et al., 1998; Treiman & Kessler, 2006). In order to identify the predictors of successful spelling acquisition, Landerl, Thaler, and Reitsma (2008) followed a group of 115 German students from grades 1 to 8. The prediction measures (letter knowledge, phonological short-term memory, phonological awareness, rapid automated naming, and nonverbal IQ) were assessed at the beginning of first grade. Spelling performances were probed by means of a dictation task that featured high-frequency words in first grade, words of different frequencies in fourth grade, and both words and sentences in eighth grade. Results showed that phonological awareness for spelling was a better specific predictor than all the others (letter knowledge, phonological short-term memory, rapid automated naming, and nonverbal IQ). Moreover, children who still had difficulty translating spoken words into phonologically plausible letter sequences at the end of first grade developed problems with orthographic spelling later on. Word dictation is often used to investigate levels of orthographic knowledge in both children and literate adults. When the dictation task features pseudowords, the different orthographies adopted for the same pseudoword shed light on the underlying processes. For example, the way that a vowel is transcribed in French depends on the preceding consonant (Pacton, Fayol, & Perruchet, 2005), demonstrating that this particular language has a conversion system that is based on a larger unit than the phoneme. The use of pseudowords also tells us about the link between assembled and addressed phonology. Using a dictation task, Barry and de Bastiani (1997) showed that even in the context of a regular orthography such as Italian, adults use lexical representations to work out the orthography of pseudowords and do not rely wholly on conversion rules.

Other methods for studying spelling involve orthographic decision-making tasks (Chalmers & Burt, 2008; Richards et al., 2005). On these, participants are offered the choice between different orthographic forms for the same word, all of which are pronounced the same, and having to select the one that is the correct word-specific orthographic spelling. Pacton, Perruchet, Fayol, and Cleeremans (2001) administered a task featuring pseudowords to French first graders, who had to choose between two forms that are more or less frequent in the French language. The authors found that the first graders were already aware of the statistical regularities of their orthographic system. For example, they preferred words that had a double consonant in the middle (e.g., *tummar*) rather than at the beginning (*ttumar*). By showing that children acquire orthographic regularities implicitly and almost at the outset, this result undermines the notion that acquisition takes place in a series of steps, with orthographic knowledge necessarily emerging after phonological knowledge, and instead favors a more interactive conception whereby orthographic knowledge appears at a very early juncture in acquisition. Orthographic decision-making tasks are useful because they make it possible to conduct investigations with very young children who are not yet able to perform a dictation task, which requires many processes, including graphomotor processes and processing of the whole grapheme sequence.

Finally, dictation and orthographic decision-making tasks are centered on individual performances as individuals deal with variations in the word forms across experimental conditions and complete production or selection. Although these variations allow some conclusions about how stimulus properties and task requirements affect processing outcomes, they are not readily adaptable to real-time analyses of processing during the course of writing. Moreover, investigations that focus on success or failure in the retrieval of orthographic information (or the choice of graphemes, in the case of translation) do not always supply sufficient information to test different models of the spelling process. For example, participants may arrive at a correct orthographic spelling in a dictation task even though they have not necessarily implemented the same processes to do so. A real-time analysis can provide additional information in the form of temporal data about the graphomotor execution.

ONLINE STUDIES OF THE SPELLING PROCESS

The real-time analysis of writing offers researchers a means of studying spelling via temporal variations in production and not simply the end product of processing. In the following text, we provide an overview of studies that have applied a real-time approach to dictation and picture-writing tasks. Temporal variations are studied essentially in terms of latencies, writing speeds, pause durations, and writing fluency.

Writing Latency

Latency can be defined as the time that elapses between the presentation of the stimulus, in either oral (dictation task) or picture (picture-writing task) form, and the start of production. It is probably the most frequently used indicator. Many studies have looked at the effects of orthographic regularity and lexical frequency on latency. By dictating single words, Delattre et al. (2006) were able to show that latency is influenced by both orthographic regularity and frequency. This twofold influence on the initiation of production (and thus on the retrieval of orthographic information) occurs independently of the mode of production, as it has also been demonstrated using an oral spelling task, where participants spell the words out loud (cf., Kreiner, 1996, who demonstrated a double effect of familiarity and orthographic regularity on latency in adult participants). The influence of regularity and frequency has also been reported in tasks where the stimulus is not an orally presented word but rather its pictorial representation. In picture writing, latency is the time that elapses between the appearance of the drawing on the screen and the first press of the pen. Bonin et al. (2001) found longer latencies for irregular French words than for regular ones. More specifically, results indicated that initial inconsistencies affected latency, whereas inconsistent units in the middle or at the end of the words did not. Similarly, Bonin and Fayol (2002) found that latencies were longer for rare items than for frequent ones. Finally, Bonin and Méot (2002) used picture writing to highlight the frequency × regularity interaction, which had already been observed in word recognition via the naming task. They showed that the irregularity effect was larger for low-frequency words than for high-frequency ones. In conclusion, analyses of latency in three different types of tasks involving the spelling process (dictation, oral spelling, and picture writing) yield convergent results as to the combined influence of orthographic regularity and lexical frequency and support a spelling process based both on an orthographic lexicon and on phonological-orthographic conversion rules.

Writing Speed

One recent methodological advance has been to supplement latency measures with the recording of writing speed or duration. This refinement of real-time indicators has been made possible by improvements in the software used to record and analyze writing, which supports a digitizing tablet (e.g., NeuroScript, OASIS; De Jong, Hulstijn, Kosterman, & Smits-Engelsman, 1996). Modulations in speed in the course of production can be regarded as the "signature" of the cost of the processes activated in parallel with graphomotor execution, as demonstrated by Fayol and Stephant (1991). In the spelling of single words to dictation, Delattre et al. (2006) conducted a combined analysis of writing latency and duration in order to investigate the dynamics of the spelling process. This study was concerned with the relationship between spelling and graphomotor processes in French adults. More specifically, it investigated how difficulties engendered by irregular words might affect peripheral processes in writing. To this end, they used a dictation task in which participants were required to write each target word out three times. Latencies, the writing duration for each word, and the interval between successive writings of the same words were recorded. Results showed that latencies were reliably slower for irregular words than for regular ones. Moreover, the regularity effect was greater for low-frequency words than for high-frequency ones. Writing duration was also longer for irregular words, but only low-frequency ones. Presumably, the spelling process had not been completely resolved by the time participants started to write the word and therefore continued while the latter was actually being written. Delattre et al.'s (2006) study therefore confirmed that the spelling process can be engaged in parallel with graphomotor execution and yielded support for a cascade model, in which spelling and graphomotor processes can be activated in parallel.

The real-time analysis of writing, via pause duration and writing speed, is increasing our understanding of the spelling process, by supplementing findings on variations in the finished product and taking them one step further.

The use of digitizing tablets also provides a means of conducting fine-grained explorations of the temporal dynamics of writing, via the analysis of velocity and acceleration (Thomassen & Van Galen, 1992). For instance, single letter strokes (i.e., the smallest relevant units of the handwriting process) are formed by open loop movements characterized by a velocity profile that has a single peak and a bell-shaped course. In the assessment of kinematic data, the maximum velocities of both ascending and descending strokes can be measured, along with maximum acceleration and deceleration. These analyses of temporal writing profiles have been made possible by the development of dedicated software such as POET (Rosenblum, Parush, & Weiss, 2003a) and, more recently, Ductus (Guinet & Kandel, 2010). Fluency is calculated according to the number of velocity peaks per letter (Meulenbroek & Van Galen, 1989). Smooth movements have few velocity peaks, but when the cognitive system is overloaded, movement becomes less smooth (i.e., dysfluent), resulting in an increase in the number of velocity peaks. Research has shown that fluency is sensitive to the cost of processes imposed by the writing task, such as the number of units to be processed in the course of writing (Kandel et al., 2009). It is also an indicator of automation, as it increases with the acquisition of writing skills (Chartrel & Vinter, 2008). Changes in fluency may signal the presence of one of the pathologies that can affect writing (Teulings, Contreras-Vidal, Stelmach, & Adler 1997; Tucha, Mecklinger, Walitza, & Lange, 2006).

Finally, when dictation and picture-writing tasks are associated with the real-time analysis of writing latencies, speed, and fluency, they can prove extremely useful for studying the spelling process. Indeed, they have prompted researchers to rethink the dynamics behind the elaboration of the orthographic representation and acknowledge that processes may be engaged in parallel with graphomotor execution. These two tasks nonetheless have several drawbacks, as we have already pointed out. It is particularly difficult to ensure beforehand that all the participants will produce exactly the same sequence of letters, especially in the case of pseudowords and/or child participants, and that possibility in turn hinders fine-grained comparisons of temporal patterns. The copy task allows us to sidestep this problem.

USING THE COPY TASK TO STUDY THE SPELLING PROCESS IN REAL TIME

Assessing the Mechanisms of the Spelling Process

In a copy task, adult or child writers are asked to reproduce a visual model in writing. Copying can be performed either in the participant's normal handwriting (Lambert et al., 2008) or in another case, such as block capitals (Kandel et al., 2006).

It can also be done on a keyboard (Inhoff, Briihl, Bohemier, & Wang, 1992). The model can either remain visible throughout the copy task (Kandel et al., 2009) or disappear at the first pen press, thus preventing participants from returning to it once they have started the copying (Lambert et al., 2008). The main advantage of this visual model is that it considerably reduces the number of incorrect copies, thereby yielding identical productions for comparison. Moreover, the copy task allows for the inclusion of highly unfamiliar words without the attendant risk of orthographic errors (Lambert et al., 2011) and makes it easier to study the acquisition of the spelling process in young writers (Kandel et al., 2009). Finally, the copy task enables researchers to investigate the "literal" writing of pseudowords, controlling the production of the grapheme sequence without the risk of variations between participants. As we indicated earlier, although pseudowords are sometimes included in dictation tasks, their analysis is necessarily restricted to the choices of letter sequence made by the writers, according to the item's linguistic characteristics (Pacton et al., 2005). If researchers also wish to measure temporal variables, they must ensure that all the participants' productions are identical.

One of the earliest studies in which a copy task was analyzed in real time in order to explore spelling was conducted by Zesiger, Mounoud, and Hauert (1993). They used this paradigm to study the influence of lexicality and the frequency of letter sequences on the temporal aspects of letter sequence production. French 8–12-year-olds and adults were asked to write words (e.g., CAB-ANE), pseudowords ending with a frequent trigram (e.g., CAB-URE), and pseudowords ending with a nonfrequent trigram (e.g., CAB-ODE). The aim was to see how the presence of a word in the orthographic lexicon influences the temporal pattern of writing and to show that writers start to program the writing of the second trigram while they are still writing the first one. The analysis therefore focused on the first shared trigram, for which duration, trajectory length, average velocity, and dysfluency were recorded. The results for the adult participants showed that the first trigram was written more quickly, with greater fluency and a shorter trajectory when it belonged to a real word. Furthermore, both its duration and its trajectory length were influenced by the frequency of the second trigram, arguing in favor of the anticipatory processing of the second trigram. In the children, no clear effect of lexicality or trigram frequency was observed, thus suggesting sequential processing with no overlapping. In this experiment, the copy task made it possible to control the letter sequences that were written and ensure that the first trigram was always copied the same way.

The use of pseudowords in the copy task, associated with an analysis of temporal indicators, can help us identify the spelling processing units used in handwriting. The question of processing units is an important one. As in reading studies, the definition of these units determines the way we construct our models of writing. Thus, data indicating that processing depends on the frequency of a letter sequence (bigram or trigram) support connectionist models. Zesiger et al.'s (1993) results suggested that the spelling process relies on the trigram, with one trigram being programmed while the preceding one is still being written. Their study also showed that these processes overlap to a considerable degree, in line with cascade models. In Van Galen's (1991) model of handwriting, the spelling process may be engaged while the previous word is still being written and may not end until after the individual has started writing the target word. In this model, however, the processing units are not trigrams but whole words, although their representations are said simply to contain information about the identity and order of the letters (Teulings, Thomassen, & Van Galen, 1983). Several studies have suggested that this conception of orthographic representations is too simplistic, as words cannot be considered as mere linear sequences of letters.

Research on how the processing unit in the spelling process is determined points to the syllable as a likely candidate and not only letters. Some case studies of patients with acquired dysgraphia have suggested that orthographic representations encode not only the identity of the graphemes and their respective positions, but also information about the word's syllable boundaries (Caramazza & Miceli, 1990; Miceli, Capasso, Ivella, & Caramazza, 1997). Experimental studies using the delayed copying paradigm have yielded empirical evidence that syllable-sized units regulate handwriting production (Zesiger, Orliaguet, Boë, & Mounoud, 1994). French adults wrote words that began with identical trigrams but differed in the position of the syllable boundary. For example, *pa.role* has an initial CV syllable, whereas *par.don* has an initial CVC syllable. Although the results were nonsignificant in handwriting, a syllable effect did emerge in typing, in that interkey times were longer at syllable boundaries than within syllables. For their part, Kandel et al. (2006) did find evidence of syllable effects in handwriting. Participants were asked to write words in upper-case letters and to lift the pen between each letter. The authors measured the interletter times, predicting that syllable boundaries would be characterized by longer interletter times. In the first experiment, French adults wrote words that had the same initial letters but different syllable boundaries (CA.RAFE vs. CAR.TON). For words comprising a phonologically simple initial syllable, either CV or CVC, the results were not statistically significant in the item analysis. By contrast, the second part of the experiment used syllables starting with a consonant cluster such as CCV and CCVC (e.g., *TRA.CEUR* and *TRAC.TUS*), and here the syllable effect was significant, with longer interletter times at the between-syllable positions (between *a* and *c* in *traceur*) than at the within-syllable positions (between *a* and *c* in *tractus*).

Although these studies provided evidence in favor of the syllable as a processing unit in handwriting, as opposed to the word or the trigram, the participants did not use their habitual handwriting, as they were required either to use a keyboard or to write in capital letters. The syllable effect could therefore have been an experimental artifact arising from nonautomated graphomotricity.

Lambert et al. (2008), however, did highlight an impact of the syllable in a copy task with French adult participants who used their habitual handwriting. The authors used a new paradigm whereby words or pseudowords that appeared on a computer screen had to be copied out three times in quick succession on a digitizing tablet. The item disappeared from the screen as soon as the pen tip touched the tablet. The participants could only see what they were currently writing. Three latencies were measured: between the visual presentation of the item and the start of handwriting (L1), between the end of the first word copy and the beginning of the second one (L2), and between the end of the second word copy and the beginning of the third one (L3). The hypothesis was that these three latencies would not all involve the same processes. L1 would encompass both visual encoding and spelling activation and movement programming, while L2 and L3 would only involve spelling and graphomotor processes.

In Experiment 1, when the participants had to copy two- and four-syllable words (*fonction—activité*) and pseudowords (*coutrait—covinima*), L2 and L3 were longer for the four-syllable items than for the two-syllable ones, irrespective of the item's lexicality. This showed that writing movements are indeed modulated by syllabic units. The number of syllables did not appear to influence L1, but its effect may actually have been masked by the additional time needed to recognize the words and prepare for the graphomotor execution. Experiment 2, which featured high-frequency and low-frequency words and each category included both two- and three-syllable words, replicated the results of Experiment 1.

Experiment 3 was designed, through the use of a delayed copy paradigm, to dissociate the encoding process from the spelling activation process and movement programming. Participants could only start to write the stimulus after a delay, meaning that encoding could be dissociated from the spelling and movement preparation undertaken before the start of handwriting. To compare the three latencies, the writing of the two subsequent word copies was also delayed. The participants could only start writing the item for the second or third time after an auditory signal. The results of Experiment 3 revealed that despite the dissociation of the visual encoding process from the spelling and motor processes, L1 remained significantly longer than the other two. It was still determined by the item's lexicality, and the number of syllables only had an effect with pseudowords.

Finally, Experiment 4 introduced short and long delays before the signal preceding the third word copy. There was no significant lexical effect when this delay was short, as in Experiment 1. When it was long, however, there was a lexical effect in L3. All these results provide supplementary information about the way in which syllables modulate the written production of words and pseudowords. The words' syllable structure constrains the time course of handwriting. The storage of orthographic information in the graphemic buffer—once lexical access has occurred for words and chunking has taken place for pseudowords—seems to be achieved via a rehearsal process, which is sensitive to the processing load, measured in the number of syllables.

The use of the copy task was absolutely the key to success in this study. For a start, a way had to be found of getting participants to write words and pseudowords in order to compare the effects of the number of syllables according to lexicality. Moreover, in order to analyze and compare latencies, all the participants had to produce identical copies, in terms of the number of letters written for the pseudowords. Based on a triple copy task, this paradigm made it possible to highlight the influence of syllables in adults without forcing them to modify their usual handwriting.

Assessing Acquisition

We cannot study spelling acquisition unless we understand how the relevant processes gradually develop and, in particular, how the processing units, especially the syllabic unit, evolve. It is therefore vital to analyze pupils' written production at different stages of learning. As we have seen, by controlling the production of letter sequences, the copy task makes it possible to use pseudowords, and in the case of children, it may prove a methodological necessity for real words too. Because of children's lack of orthographic knowledge, dictation remains a complex task that precludes the production of equivalent copies by participants.

In a sample of French first graders, Kandel, Soler, Valdois, and Gros (2006) examined whether the graphemic structure of words modulates the timing of handwriting production during the acquisition of writing skills. They assumed that, at the beginning of handwriting acquisition, children would write words as sequences of single letters, but would gradually come to rely on the grapheme unit, once they had realized that a group of letters—a complex grapheme—represents a single phoneme. Accordingly, to write the word *look*, the child would first activate /luk/, then break it down into its phoneme–grapheme units /l/ = L, /u/ = OO and /k/ = K, and finally "unwrap" the OO grapheme into its letter constituents for serial production. To test the shift from the letter unit to the grapheme unit, the authors asked first graders to copy words of varying graphemic complexity, such as cris.tal ([kRis/tal]) and chan.son ([ʃa~/so~]), on a digitizing tablet. In French, these words have four and two graphemes, respectively, in the first syllable. The authors analyzed movement duration and dysfluency, paying particular attention to the grapheme and syllable boundaries. Grapheme and syllable effects were found for both types of measures. The duration and dysfluency distributions revealed that the children processed the first syllable of each word grapheme by grapheme, irrespective of the number of letters they contained. This result would appear to confirm the hypothesis that graphemes serve as processing units at the very start of learning.

Kandel et al. (2009) went on to study the influence of syllables in handwriting in third and fifth graders. They sought to show that children learning to write eventually graduate to the orthosyllable processing unit. Most research on spelling acquisition supports the idea that written language is, in fact, the transcription of phonologically elaborated messages (Luria, 1970). An alternative approach suggests that written language production is relatively autonomous with respect to speech (Bonin et al., 2001). This approach states that the processing units involved in written language production do not derive exclusively from oral language. At the beginning of writing acquisition, the letter chunks are elaborated on the basis of phonological processes because the child is more proficient in speech than in the not-yet-mastered written language. However, with the acquisition of handwriting and repeated exposure to frequently associated letter groups, which respect graphotactic constraints, spelling units gradually become independent from phonological ones. Accordingly, the syllable used in writing processes becomes increasingly subject to orthographic rather than phonological constraints. For example, the French word *case* is phonologically monosyllabic [kaz], but orthographically bisyllabic, comprising two orthosyllables (ca.se).

Kandel et al.'s (2009) study exploited the French final e—as in *case*—to find out whether children use orthographic or phonological syllables as processing units in handwriting production. French third, fourth, and fifth graders copied words on a digitizing tablet. Half the words ended in -e and were phonologically monosyllabic (*barque* = [baRk]) but orthographically bisyllabic (e.g., *bar.que*), henceforth referred to as the "with e" condition. These words were matched with words that were both phonologically and orthographically bisyllabic (e.g., *bal.con* = [bal.kõ]), henceforth referred to as the "without e" condition. The authors analyzed the time it took the children to write each letter and the number of velocity peaks per letter (fluency). For the third, fourth, and fifth graders, results on mean letter-stroke duration and movement fluency values revealed significant peaks at the syllable boundaries for words that were bisyllabic both phonologically and orthographically ("without e" words), as well as for words that were phonologically monosyllables but orthographically bisyllables ("with e" words). These data support the idea that the processes for segmenting written words become relatively autonomous with respect to spoken language at a very early stage in the acquisition process and rely on orthosyllabic units.

Kandel, Peereman, Grosjacques, and Fayol (2011) recently examined the theoretical controversy over the impact of syllables and bigrams in handwriting. Results indicating the role of the syllable as the processing unit in spelling are based on the fact that syllabic boundaries mark breaks in the time course of the word writing. However, these boundaries often coincide with low-frequency bigrams. The increase in writing duration at syllable boundaries could, therefore, also be explained by a simple effect of letter sequence frequency. French third and fourth graders were asked to write words that differed in the distribution of their bigram frequencies. Bigrams either coincided with the words' syllable boundaries ("same" condition) or else were located within their initial syllables ("different" condition). Bigram durations were longer in the same condition, where the bigrams straddled the syllable boundaries, than in the different condition, where they were intrasyllabic. Results suggest that syllable boundaries and bigram frequencies both contribute to the online processing of letter sequences.

None of these studies could have been conducted without recourse to the copy task. In every case, duration and fluency could only be measured if all the children produced exactly the same sequences of letters. Moreover, the visual model of the copy simplified the task and made it possible to conduct investigations in even the youngest writers (as early as first graders). Results for these copy tasks showed that spelling acquisition initially relies on letter-by-letter processing, with children gradually graduating to larger units such as the grapheme and, ultimately, the orthosyllable. These changes in the nature of the processing unit undoubtedly free up cognitive resources, as well as increasing processing speed.

Study of Eye and Pen Movements During a Copy Task

One of the characteristics of the copy task is that the model can remain visible throughout. It can be regarded as an external memory aid helping to support short-term memory and also to correct the copied letter sequence, if necessary. The number of times the model is (re)inspected during the copying, as well as the copy span (i.e., the size of the unit written between two inspections) are both useful measures of spelling performance, as they reflect the need to reactivate the word's memory trace. The precise location of these reinspections in the model can also shed light on the spelling process. For example, it can confirm the nature of the processing unit, assuming that reinspections are primarily located at the boundaries of such units. This variable can also help us to track the shift from the letter unit to the syllable one.

Rieben, Meyer, and Perragaux (1991) analyzed reinspections of the model during a word copy task performed by French first graders. A text featuring new vocabulary was written on a board and studied in the classroom. The children had to produce a new text while referring to the one on the board that served as a dictionary. The authors analyzed the places in the reference text where the children searched for lexical information. Results confirmed that the use of syllabic strategies precedes whole-word copying. To look in greater depth at spelling acquisition and the "upgrading" of the processing unit, Humblot, Fayol, and Lonchamp (1994) asked first and second graders to copy bisyllabic words of varying regularity and familiarity. As the words were placed behind the children, they had to turn their heads in order to see the words, thus allowing the researchers to record the number of times they looked back to the model. Results showed that copying familiar and regular words required fewer lookbacks than copying less familiar and irregular words. The syllable seemed to become the unit of information transfer in the middle of the first grade. These two studies yielded consistent results, in that they showed that the syllable boundary was the main locus of reinspection in the model. Similar investigations have been conducted with deaf writers, for whom the copy task represents an alternative to the dictation task, which, for obvious reasons, is problematic. Transler et al. (1999) asked deaf and hearing children (mean age 10 years 6 months) matched on word recognition level to copy written words and pseudowords. The number of lookbacks to the model, copying duration, and locus of the first segmentation were all recorded. Results showed that the syllable boundary was the main focus for lookbacks in both groups of participants. Nonetheless, the hearing children very probably relied on phonological information to spell the words, whereas the deaf children depended more heavily on letter sequence frequency. This hypothesis was confirmed by an analysis of copy errors, as the hearing children made phonologically plausible errors, whereas the deaf children made errors that only respected letter sequence legality.

This research relied on the number of lookbacks to the model and their locus to elucidate the mechanisms of the spelling process. However, the methodology that was adopted made a distinction between the information uptake and writing phases, meaning that the writing process was regarded as sequential, alternating strictly between handwriting and lookbacks. It is nonetheless entirely plausible that writers in a more ordinary writing situation, where the model and the writing zone are close together (e.g., on the same page), adopt a parallel processing mode, inspecting the model while continuing to write some parts of the word. One means of studying these episodes of parallel processing and the conditions in which they occur is to analyze the movements of both the eye and the pen together (Alamargot, Dansac, Chesnet, & Fayol, 2007; Alamargot, Plane, Lambert, & Chesnet, 2009). These authors sought to analyze the visual searches, either in the text-produced-so-far or in documentary sources, which take place in parallel with graphomotor execution. Alamargot et al. (2007) demonstrated that searches (either of sources or of the text-produced-so-far) during the composition of a text based on documentary sources can indeed occur in parallel with graphomotor execution. The authors deemed parallel processing to take place each time the writer fixated a unit of information that was sufficiently far from the moving pen for the latter to be beyond the parafoveal visual field. Results indicated that, on average, information searches occurring in parallel with writing occupied 10% of graphomotor execution time. This demonstration was only made possible by the combined analysis of visual and graphomotor activity.

Eye and Pen software is the ideal tool for conducting this type of investigation in handwriting production (Alamargot et al., 2006; Chesnet & Alamargot, 2005). By its very nature, the copy task involves the spatial and temporal dissociation of the spelling process (reading the word to be copied in one place) and the graphomotor execution process (writing out the copied word in a different place). Visual searches focusing on the model to be copied while graphomotor execution is going on elsewhere can be assumed to be indicative of parallel processing. Furthermore, recording eye movements allows researchers to identify the locus of lookbacks with considerable accuracy. In the past, they had to use a methodology that forced writers to turn their heads so that none of the lookbacks went unnoticed. The recording of eye movements does away with this constraint and participants can thus perform the copy task in a more ecological setting. The other advantage of this system is that it tells us not only the exact location of these lookbacks to the model in the course of graphomotor execution but also their duration.

Lambert et al. (2011) studied the engagement of spelling processes in parallel with the graphomotor execution of several different words, in order to clarify the roles of frequency and regularity in determining the extent of this parallel processing in French adults. According to the cascade model (Van Galen, 1991), the spelling process may be engaged while the previous word is still being written and may not end until after the individual has started writing the target word. In order to highlight possible instances of anticipatory processing, the target word (varying in frequency and regularity) was inserted into a series of four words. The spelling of the target, consistently placed in third position, might occur during the execution of word 2 (i.e., in anticipation) and/or continue beyond the writing latency (i.e., the pause between word 2 and the target). In this study, the target's latency and writing duration were measured, and by combining the copy task with an analysis of eye and pen movements, it was possible to conduct a more fine-grained analysis of these two classic variables. Latency can mask several types of parallel processing, especially anticipatory effects. In a bid to shed further light on possible process overlap, the authors calculated a so-called parallel latency. The latter began not when the writing of the previous word had ended but as soon as the processing of the target began, that is, at the start of the first fixation on the target. This first fixation might occur either during the pause between the two words or during the writing of the previous word. If the writer fixated the target before he or she had finished writing the previous word, this behavior would obviously signal the start of a word recognition process and thus the parallel implementation of the spelling process. The authors analyzed both the number of these lookbacks and their duration.

One of Lambert et al.'s (2011) main findings was that latency, as it is classically defined in research on the production of single words, does not reflect the entire extent of the spelling process initiated prior to writing. In this study, classic latency (i.e., the prewriting pause) was only sensitive to frequency. However, when the anticipatory spelling process engaged in parallel with the graphomotor execution of the previous word was included in the measure of latency (starting with the first fixation on the target), results changed. This parallel latency was sensitive not just to frequency but also to spelling regularity, as the two factors interacted. These results therefore confirm that the spelling of one word may be engaged during the writing of the previous word, in the case of successive words, and illustrate the importance of taking this anticipatory process into account.

In summary, when the copy task is associated with an analysis of graphomotor and oculomotor indicators, a fine-grained analysis can be performed of the spelling process and its dynamics in the course of writing. This approach makes it possible to highlight processes that are activated in parallel and does away with the need for cumbersome methodology, such as recourse to the dual-task paradigm.

CONCLUSIONS AND FUTURE DIRECTIONS

Spelling is one of the central processes in written production and involves the processing of a chain of graphemes, which is specific to written language. Achieving a comprehensive understanding of spelling mechanisms and their acquisition is the key to the broader study of how written production takes place. The most popular method consists of analyzing the finished product of dictation tasks—essentially the analysis of orthographic errors for words and choices of orthographic sequences for pseudowords—and has brought considerable scientific advances, including evidence in favor of a process based both on an orthographic lexicon and on phonological-orthographic conversion rules. The real-time recording of graphomotor activity, hitherto impossible, is now enabling researchers to refine the results of these time-honored analyses. The coupling of real-time measures with a copy task brings particular benefits, as it allows pseudowords to be used while ensuring that all participants produce identical copies. This feature allows fine-grained analyses to be conducted of the time course, safe in the knowledge that all the letter sequences will be exactly the same. Research on pseudoword copying has already enabled us to confirm that the syllable is the processing unit for spelling in adults (Lambert et al., 2008). We have also been able to show that beginning writers at the start of spelling acquisition take single letters as their processing units. Information searches in the word being copied can be investigated through the combined analysis of oculomotor and graphomotor movements. It is in this context that the spelling processes undertaken in parallel with graphomotor execution have been uncovered (Lambert et al., 2011).

These methodological advances are relatively recent and further studies are required to address two issues in particular. First, we need to validate the various temporal indicators used to bring underlying processes to light. Although researchers classically rely on speed, fluency, pause duration, and latency, these indicators have not yet been sufficiently and clearly defined. For example, the notion of pause remains ambiguous, as it can be defined as either the raising of the pen while it is still moving (pen lift) or the immobilization of the pen while it continues to press on the writing surface (pen pause). Likewise, the meaning of eye movements in the context of writing needs to be defined, especially for fixations on the text-produced-so-far (cf., Alamargot et al., 2006; Caporossi, Alamargot, & Chesnet, 2004). Second, and this issue is connected with the first issue, researchers need to find ways of more accurately modeling the spelling process. Up to now, modeling has mainly been undertaken in neuropsychology and it is vital to check that it can be extended to "normal" individuals in the field of cognitive psychology. In this context, the links between spelling and graphomotor processes remain largely unknown in normally developing individuals. Investigating these links could be a fruitful and productive next step for cognitive researchers.

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Part V

Reflections on Past, Present, and Future of Translation Research

14

Translation in the Context of Theoretical Writing System Research

MARTIN NEEF

STUDY OF LANGUAGE USE VERSUS THE STUDY OF THE LANGUAGE SYSTEM

The editors of this book refrain from relating their study to a specific field of linguistic research, presumably because they have quite a broad perspective on the subject of translation. However, because I am invited to comment on this book from the perspective of theoretical linguistics, I dare to subsume the preceding chapters under a unifying notion. Psycholinguistics or cognitive linguistics may be sensible terms to use to cover the study of producing, understanding, processing, learning (with or without education), and losing language. Commenting on this book from the perspective of theoretical linguistics demands a reflection on the relation between these two kinds of linguistics, especially because a number of linguists assume a closer relation between cognitive psycholinguistics and theoretical linguistics than I do, especially linguists working in the paradigm of generative linguistics. This entanglement of theoretical and cognitive linguistics was manifestly introduced in the linguistics discourse by Chomsky's conception of an "ideal speaker–listener" (Chomsky, 1965: 3). The notions "speaker" and "listener" refer to a setting of language use by individuals in specific contexts. At the same time, the "ideal speaker–listener" is an abstraction of everything that characterizes an authentic speaker or listener in a specific situation, like being affected by "grammatically irrelevant conditions like memory limitations, distractions" or the like. In effect, it is a "counterfactual idealization" (cf., Botha, 1989: 65) that underlies the generative paradigm as an axiom. Counterfactual idealizations may be regarded as "methodologically expedient" (Newmeyer, 1983: 75) by supporters of a scientific paradigm, but differently from outside.

I prefer to regard the invention of the ideal speaker–listener an attempt to kill two birds with one stone (and it was an effective one, given the unquestionable success of generative linguistics). What Chomsky tried to establish is that theoretical linguistics is concerned with "knowledge of language" (a formulation already present in the 1965 passage referred to earlier and later in 1986 used by Chomsky as a book title). Consequently, generative linguistics has been taken as part of cognitive linguistics, claiming that cognitive linguistics and theoretical linguistics are essentially the same (e.g., Bierwisch, 1987). Non-generative linguists, on the other hand, may argue that each bird deserves its own stone. Knowledge of language is one thing, but language itself is something else.

Cognitive linguists, in a narrow sense, care about the cognitive aspects of language use, like using language in speaking, understanding, thinking, and, of course, learning or losing a language. Their subject of study is the individual language user, and they generalize upon small samples of inquiry. Cognitive linguistics is interdisciplinary in nature, and it works with empirical methods, arriving at results that are either right or wrong, relative to the empirical world. Unlike Chomsky, a cognitive linguist in this sense does not have to presuppose that a typical language user knows his language perfectly; there may well be differences in the knowledge of language between individual language users. Language as such, however, is the same, however perfect or imperfect the individual's knowledge of this language may be.

Cognitive aspects are one part of the area of language use. Other parts concern communication and text production, as well as speaking and hearing as physical actions. These aspects of language use as well need empirical methods to be studied. Characterizing the sides of linguistics touched upon so far collectively as the study of language use implies that there is something that is being put to use and that can be studied by abstracting from aspects of use. This something is what may be called the language system. The language system, thus, is an abstract object (cf., Katz, 1981). The study of the language system is not empirical, at least not in the first place. Language system linguistics is a theoretical science approaching an abstract system that neither exists in any human being's head nor in any book but is the virtual base or the point of reference of these aspects of knowledge. The study of the language system is axiomatic. Linguistic axioms, however, target an independent system that exists prior to the model describing it. In this sense, theories of the language system are empirical after all (cf., Falkenberg, 1996).

A central property of language systems is that they are not fully regular, which is closely related to the fact that they change over time. A linguistic item, however, does not indicate in itself whether it is irregular. Irregularity is determined by comparing any item to a norm, and axiomatic theories supply such a norm by constructing a system of rules (or something similar) to reconstruct the language system under discussion. Rules can be assumed with good or less good arguments (whereas phenomena of concern in the study of language use can be observed). The English verb *to go* constitutes a relatively undisputed case of irregularity. The reason for why this verb can be classified as irregular is rooted in the English language system. English, like other languages, has a large class of verbs that show formal behavior that can be explained by a set of rules. In many cases, however, linguists disagree about whether some linguistic item has to be classified as regular or irregular. For example, there is no such notion as "irregular noun" in the

German linguistic tradition, although German nouns show a diverse formal behavior. Because linguists working on German noun morphology have not yet arrived at a consensus of what to regard as regular, to date, the irregular class is inevitably also undetermined.

Axiomatic linguistic theories have to be consistent. Such theories of the language system are either sensible or not. Sensible theories cover a broad range of data, but given that language is an open system, it is not consequential to value one theory superior to another simply because it seems to classify more data as regular. Other factors of theory conception play an important role as well, and, to some extent, this role depends on the current predominant fashion of theorizing. Such fashions concern the decision between diachronic and synchronic approaches, between language-specific and language-universal approaches, and between derivational and declarative approaches, among others.

The aforementioned denial of a crucial borderline between a language system and language use is not a historic residue but widespread in current thinking, as illustrated by the introductory argumentation in Honda and O'Neil (2008), who define what they regard as the actual way of thinking linguistically. After outlining the diversity of linguistic questions in a sensible way, they state that at the core of linguistics lies the examination of the structure of language. All of a sudden they equate the notion of structure with that of knowledge of language, quite in the spirit of Chomsky. As the central linguistic questions with respect to some aspect of knowledge they establish the following: "How do we know this? In fact, how did we come to know this?" (Honda & O'Neil, 2008: 1). Consequently, they equate "grammar" with "mental grammar." Studying the language faculty is a notable field, but there is no reason to assume that this studying will lead to a theory of the language system. On the contrary, I regard knowledge of language and acquisition of language as aspects of language use, hence as aspects that may lead to theories that are empirically assessable and testable. The language system itself, however, is something else, and there can be no external evidence presented in favor of some theory of this system.

STRUCTURE OF THE LANGUAGE SYSTEM

In my view, the core of linguistics is the analysis of the language system. Language system linguistics, or in short theoretical linguistics, is not interdisciplinary in nature; the language system is exclusively the object of linguistics. Based on, or related to, theories of the language system, the use of this system can be studied. These statements are meant as neutral descriptions, not as valuations to favor one field of linguistics over another. The theoretical approach advocated for in this chapter has certain connections to structural linguistics but shall in general be seen as belonging to a post-structuralist paradigm as well as to a post-generative one. To give this approach to linguistics a name, I call it a declarative grammar (Neef, 1996). Whether or not sketching such an axiomatic concept is sensible can only be answered with an in-depth analysis of specific language systems. The results of such an analysis are sensible if they yield a deeper understanding of the language system.

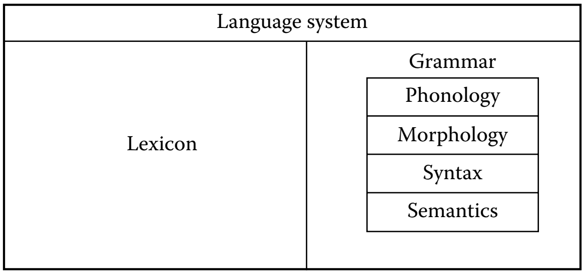

Figure 14.1 Structure of a language system. (From Neef, M., *Die Graphematik des Deutschen*, Tübingen, Germany, Niemeyer, 2005a (=*Linguistische Arbeiten* 500).)

A language system as an abstract object can be reconstructed in terms of the diagram in Figure 14.1.

The task of a theoretical linguist who studies a specific language is to conceive a formal model that captures a significant subset of linguistic data. This formal model may employ different modes of explanation like rules or constraints. In a declarative grammar, only constraints are employed for this task. The set of these rules or constraints together form the grammar of a language. Data that conform to grammar are regular or grammatical. Thus, the linguistic theory determines the borderline between regularity and irregularity. In the eyes of the linguist who evaluates the theory at hand, this borderline is either convincing or not, but there can be no proof with regard to its empirical truth, because there is no such truth. Data that do not conform to grammar are either ungrammatical, that is, wrong, or irregular, that is, conventionally licensed. All kinds of irregularities are captured in the component of the language system called lexicon. This characterization of the term lexicon relates to a structuralist conception, most clearly expressed in Bloomfield (1933), but can occasionally also be found in generative approaches like Di Sciullo and Williams (1987).

The component of syntax contains constraints to determine the well-formedness of phrases and sentences, whereas morphology deals with regular aspects of words and lexemes. All these linguistic units show regularities in their combination of form and meaning. Meaning aspects are covered in the semantics subcomponent. For the subject of translation of ideas into written forms, the most important component of grammar is phonology. This component involves units that have formal properties but do not bear meaning, a feature that makes language highly flexible to express an infinite set of meanings with a small set of basic units. More precisely, the basic units of phonology (usually called phonemes) have the potential for distinguishing meaning, a definition that also goes back to Bloomfield (1933: 136) (but cf., also Neef, 2005b).

In this conception, the language system contains a phonology module but not a module of phonetics. The distinction between phonetics and phonology is a persistent topic in theoretical linguistics. In line with the preceding considerations, I argue for a phonology that is principally autonomous from phonetics (Neef, 2005b). Whereas phonetics is part of the study of language use, phonology is part of the study of the language system; phonetics is the act of producing, transmitting,

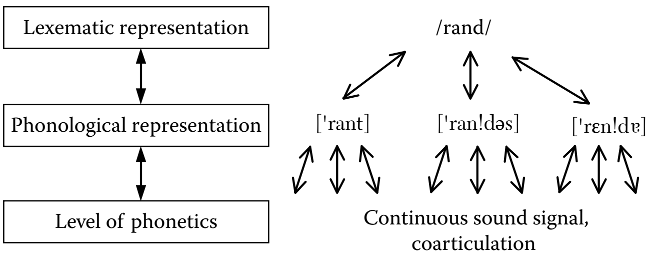

Figure 14.2 Phonological representations and related levels. (From Neef, M., Linguistische Berichte, 202, 207, 2005b.)

and receiving sounds, whereas phonology is a module of the abstract language system. The relation of phonology and phonetics as well as between phonology and stem representations of lexemes can be illustrated as in Figure 14.2.

The phonological representation is the central level in this diagram. Phonological representations contain all and only symbols for those units that have the potential to distinguish meaning in a specific language. The three phonological representations given are meant to belong to the phonology of German. The notation implies that word stress and syllable boundaries, among the language-specific set of phonemes, are phonologically relevant. The symbols of the phonemes are given in a different font than the regular text of this chapter to indicate the different level of representation. This level resembles surface representations in generative approaches, but at the same time significantly differs from phonetic transcriptions (cf., Vennemann & Jacobs, 1982: 36).

There are many different ways to realize phonetically a specific phonological representation, some of them being more typical than others. For example, the sound signal is different from the standard version when the speaker talks with full mouth, but this is irrelevant as long as the speaker means his sound string as a realization of this specific phonological representation and as long as the hearer is able to understand this intention. Uttering a phonological representation is a type of translation in the sense of the notion supported in this book: One form is converted to another form; an abstract representation is given physical reality by speaking. This kind of translation, thus, belongs to language use.*

A speaker not familiar with German may be able to pronounce the three phonological representations given in Figure 14.2 in a comprehensible way (although the sound signal may show a foreign accent). He may not be able to note, however, that the three forms represent existing words in German and, moreover, that these three words belong to one and the same lexeme (the first word is the nominative singular, the second the genitive singular, and the third the nominative plural of the lexeme Rand "edge"). An in-depth analysis may show that for this lexeme a constant representation can be assumed, based on the general regularities of the phonology of German. This lexematic representation resembles underlying representations in generative phonology. Its units are of a fundamentally different

* cf., Chapter 1, p. 10 and Chapter 4, p. 23 for a similar view of the relation of phonology and phonetics, though in slightly different terms.

type than the ones on the phonological level, indicated in the figure by bold print. Again, the relationship between lexematic representations and phonological representations can be regarded as an instance of translation, this time a translation inside the abstract language system. Both types of translation mentioned, of course, can proceed in both directions, indicated by the two arrowheads.

MODULAR APPROACH TO WRITING SYSTEMS

The study of writing systems is far less established in theoretical linguistics than the one of the language system. As a consequence, there are quite few competing theories in this field. Venezky (1970, 1999) proposed a derivational approach for the perspective "from letter to sound," while Bierwisch (1972), Nunn (1998), Sproat (2000), and Rollings (2004) are among the most important theoretical contributions of the opposite perspective, namely, "from sound to letter." Carney (1994) gave a comprehensive survey of rules of both directions in the English writing system. To try non-derivational conceptions, some linguists have applied optimality theory on fragments of the German writing system (e.g., Geilfuß-Wolfgang, 2002; Sternefeld, 2000; Wiese, 2004).

In Neef (2005a), I have suggested a different framework for the theoretical study of phonographic writing systems (with the example of the German writing system). In this approach, I distinguish three different submodules that are related to a writing system (Figure 14.3).

The modular approach to phonographic writing systems rests on the observation that among the spellings that are wrong according to the prevailing orthographic norm, specific spellings are less wrong than others.

In Figure 14.4a, the spelling is conventionally correct. The spelling in Figure 14.4b is incorrect for this word, as it would be for any other word in English. In Figure 14.4c, the spelling is incorrect as well although it looks like a spelling of an English word. The spelling in Figure 14.4d is also incorrect but it looks like a more promising candidate because it allows the derivation of the correct pronunciation. In other words, if the letters of this spelling are converted into a phonological representation by rule, the result is the same as it is for the spelling in Figure 14.4a <fight>. Thus, spellings in Figure 14.4a and d are both correct according to the component of writing systems that I call graphematics,[*] but only the former is also correct according to what I call conventional orthography.[†]

a. Graphematics
b. Systematic orthography
c. Conventional orthography

Figure 14.3 Modules related to phonographic writing systems. (From Neef, M., *Die Graphematik des Deutschen*, Tübingen, Germany, Niemeyer, 2005a (=*Linguistische Arbeiten* 500).)

[*] In German linguistics, the expression "graphematics" is also used to refer to a different, though related, concept, something like the natural base of orthography (cf., e.g., Eisenberg, 2006).

[†] A similar distinction, though in different terms, is given in Garcia et al. (2010: 6) when they state that "early spellings of young children are often phonologically plausible, but not orthographically correct."

a. <fight>
b. <qngs>
c. <vaid>
d. <fite>

Figure 14.4 Imaginable spellings of the English word fight.

Graphematics is the component of a writing system that allows relating written units to the grammar of the basic language system. In phonographic writing systems, the relevant level of grammar is the phonological level. Therefore, an analysis of the phonology of the language in question is a prerequisite for an analysis of graphematics. It is worth stressing that graphematics in this conception is not related to phonetics but to phonology (cf., also Chapter 4, p. 23); the reference point is not the continuous sound (as a matter of language use) but the discrete phoneme (as an element of the abstract language system). The graphematic component comprises the means that allow the derivation of the phonological form of a word from its spelling. The transformation (or translation) of a spelling into a phonological form is what I call "recoding." From this notion, the specific graphematic theory developed in Neef (2005a) obtains its name "recoding model." The term "recoding" is well established in psycholinguistics, but it is meant here strictly as a term pertaining to the theoretical writing system research.

Any phonographic writing system needs to have a graphematic component in order to function. If there are no regularities in the way a written form is mapped onto a phonological form, the system is useless or not even worth being called a system. Graphematics is related to reading, but less so to writing. Obviously, a complete analysis of a writing system also has to say something about the perspective "from sound to letter." In fact, graphematics is enough to allow the systematic spelling of units of language as well. This is because any spelling that affords the regular recoding of the phonological form of the unit in question is a regular graphematic spelling of that unit. The number of such graphematically possible spellings (called the "graphematic solution space") may be large; graphematic spelling is therefore characterized by variation within the limits of graphematics. On the early stages of the development of a writing system, writers typically follow a graphematic system and use different possible spellings for a word.

RECODING MODEL AS A THEORY OF GRAPHEMATICS

In my analysis of the graphematics of German, the basic units are letters. Since the set of letters is small and finite, it is possible to define the set of letters of the German alphabet, which is based on the Latin script, by giving a complete list, as in Figure 14.5.

<a>, <b>, <c>, <d>, <e>, <f>, <g>, <h>, <i>, <j>, <k>, <l>, <m>, <n>, <o>,
<p>, <q>, <r>, <s>, <t>, <u>, <v>, <w>, <x>, <y>, <z>, <ä>, <ö>, <ü>, <ß>

Figure 14.5 List of letters of the German alphabet.

Letters are units of abstract writing systems; they can be made visible by several graphic means. For the most part, this variation is irrelevant for questions of graphematics. Only few conditions have to be observed. Letters (at least those of the Latin script) are pairs of uppercase and lowercase variants. Therefore, a font realizing the German alphabet has to supply 59 different forms, 30 for lowercase letters and 29 for uppercase letters (the letter <ß> comes without an uppercase version). The relation between uppercase and lowercase variants of one letter is conventional throughout. From the viewpoint of graphematics, the only necessary condition on letter shapes is that the form of the umlaut letters <ä>, <ö>, and <ü> makes use of the form of the non-umlauted letters <a>, <o>, and <u>, adding a trema on top of it (and this condition holds for both uppercase and lowercase variants).

In the present approach, the central, defining property of a letter is that it corresponds to phonological units, prototypically to a phoneme. Therefore, each letter of an alphabet needs to have a rule capturing its correspondences to phonological units. These correspondences are specific for each writing system (though writing systems based on the same script show close relations). In the extreme case, the correspondence may be zero for few letters of a writing system like for the soft sign and the hard sign in Russian or the letter <h> in both Italian and French. Different types of correspondence rules have to be assumed, ranging from simple to quite complex, as illustrated in the list in Figure 14.6; combinations of different rule types may lead to even more complex rules for individual letters.

The rule in Figure 14.6a is most simple. A number of linguists claim that an isomorphic relation between letters and phonemes is the ideal of a graphematic system, advancing the predominance of a so-called phonological principle (cf., Venezky, 2004: 141). Although unambiguous context-free correspondence rules may well be regarded as the prototypical instance of a correspondence rule, it is hard to find arguments why they should be the only existing type. In the Recoding Model, at least, other types play a significant role as well. In German, only 8 of the 30 rules for single letters are of this type; in Italian, the ratio is 4 out of 21 (Neef & Balestra, 2011: 116 and 128).

The rule type in Figure 14.6b is typical for the German writing system in that it captures underdetermination: The letter <o>, for example, corresponds to the tense vowel [o] in <Mond> "moon" and to the lax vowel [ɔ] in the structurally similar spelling <Gold> "gold." The German writing system has some means to make the recoding unambiguous, namely, lengthening and sharpening. In general,

a.	Unambiguous context-free		<m>	→	[m]		
b.	Underdetermined		<o>	→	[o] ∨ [ɔ]		
c.	Inherently ordered	i.	<d>	→	[d]		(primary)
		ii.		→	[t]		(secondary)
d.	Context-dependent	i.	<u>	→	[v]	/	<q>—[VOK]
		ii.		→	[u] ∨ [ʊ]		(primary)

Figure 14.6 Types of correspondence rules. (From Neef, M., *Die Graphenmatik des Deutschen*, Tübingen, Germany, Niemeyer, 2005a (=*Linguistische Arbeiten* 500); Neef, M., & Balestra, M., *Typology of Writing System*, Special issue of *Written Language and Literacy*, 14, 109, 2011.)

however, a core characteristic of German graphematics is underdetermination: In many cases, one and the same spelling relates to more than one phonological form. Of the 30 letters of German, 16 show underdetermination, while only 5 of the 21 Italian letters do so (Neef & Balestra, 2011: 133–138).

The rule type in Figure 14.6c shows a case when a rule has more than one default. Then phonology decides which option is to be chosen, namely, the primary one if that results in a phonologically well-formed representation and the secondary one otherwise. In the spelling <Hunde> "dogs," the letter <d> corresponds to a voiced [d], giving the phonological form [hʊn.də]. In the spelling <Hund> "dog," however, the letter <d> must not correspond to a voiced [d] because due to the phonological rule of final devoicing voiced obstruents are not permitted at the end of a word. Therefore, the letter <d> activates its secondary default, the voiceless [t], resulting in the phonological form [hʊnt].

The last rule type is given in Figure 14.6d, showing that some letters have context-dependent correspondences. The context is on the level of written language because it concerns the context of a letter that is to be recoded. In the spelling <Qual> "agony," the letter <u> is recoded as a consonant, as indicated by the phonological form [kval], whereas in the written minimal pair member <Dual> "dual," it is recoded as a vowel, the phonological form being [du.'al].

Given a spelling like <Lamm> "lamb," however, it is clear that the letter rule for <m> is not fully correct. In a case like this, only one of the instances of the letter <m> is recoded according to the rule whereas the other is recoded as zero. There are different options for dealing with the fact that in this case only one of the letters <m> corresponds to a phoneme. I use a constraint on sequences of identical letters (cf., Figure 14.7) to handle data of this kind in a general fashion. Thus, constraints constrain the scope of letter rules.

Sequences of identical letters serve a specific function in the German writing system: They help to minimize underdetermination that is introduced in the system by rules of type (Figure 14.6b). In particular, if the letter <o> precedes a sequence of two identical consonant letters, it can only correspond to a lax vowel while the correspondence to a tense vowel is ruled out. Therefore, the spelling <fromm> "devotional" cannot be recoded as *[fʀom] but only as [fʀom]. This phenomenon is called "sharpening." The following constraint gives a formulation in terms of the recoding model (a related constraint for English is given in Neef, 2004: 221) (Figure 14.8).

In a sequence of identical letters, all non-initial ones may be recoded as zero.

Figure 14.7 Constraint on the recoding of sequences of identical letters. (From Neef, M., *Die Graphenmatik des Deutschen*, Tübingen, Germany, Niemeyer, 2005a (=*Linguistische Arbeiten* 500).)

A vowel letter does not correspond to a tense vowel or to schwa if it is immediately followed by a sharpening marker. A sharpening marker is a sequence of identical consonant letters as well as <x>, <ck>, and <tz>.

Figure 14.8 Constraint on the recoding of vowel letters in front of sharpening markers simplified; (From Neef, M., *Die Graphenmatik des Deutschen*, Tübingen, Germany, Niemeyer, 2005a (=*Linguistische Arbeiten* 500).)

The graphematic component of a phonographic writing system is, thus, reconstructed as consisting of a set of letter rules and a set of constraints. A detailed analysis of the graphematics of German is given in Neef (2005a).

TOWARD SYSTEMATIC ORTHOGRAPHY

In principle, a phonographic writing system is ready to function if it consists of a graphematic component only, as indicated in the final remark of paragraph 3 above. Typically, in the development of writing systems, however, a second component is introduced that leads to fixed spellings of specific morphological units like roots, morphemes, or words. This second component is systematic orthography. In the present theoretical conception, graphematics and orthography are not of equal relevance (in contrast to Carney, 1994), but graphematics is the main component of a writing system whereas orthography is both dependent on graphematics and optional in general.

In the modular framework to writing system research, a graphematic theory has been fully developed with the Recoding Model. A theory of systematic orthography is only sketched as yet (Neef, 2005a: Chapter 6). The respective theory works with constraints for the spelling of words. The base of the system is the graphematic solution space as supplied by graphematics. The graphematic solution space for a specific phonological form may be quite large. The list in Figure 14.9 is meant to illustrate this feature for the English writing system.

Spellings (e) and (f) in Figure 14.9 look weird but may be adequate as spellings of interjections. Words of this class may even have more than two identical letters in a row, which means that the graphematic solution space for the phonological form [ʀaɪt] is actually larger than that given in Figure 14.9. Interjections allow more structural diversity of their spellings than do other word classes. Hence, constraints that rule out certain structural properties of spellings are sensitive to levels of the vocabulary, distinguishing native words from foreign words, proper names, interjections, and the like. Native words that are neither interjections nor proper names are subject to the highest number of constraints, compared to the other relevant classes of the vocabulary. It is unlikely, however, that the interplay of constraints leads throughout to the reduction of possible spellings to exactly one case. Spellings (a) and (b) in Figure 14.9, for example, may be equally suited as spellings of the said type. This possibility means that the analysis of systematic orthography leads to fixing the number of orthographically possible spellings to a small number but not necessarily to one. This possibility is unsatisfying for the

a. right
b. rite
c. write
d. wright
e. rightt
f. wrightt
g. ...

Figure 14.9 Graphematic solution space of the phonological form [ʀaɪt] in English.

needs of conventional orthography that rejects variation. The fact that the English lexeme RITE is spelled <rite> and not <right> is eventually a matter of convention and not the outcome of a systematic analysis. Hence, there is an insurmountable distinction between systematic orthography and conventional orthography.

In the regular case, conventional orthography picks one spelling of the graphematic solution space and declares it to be the conventionally correct spelling. It is also possible that the conventional spelling does not belong to the graphematic solution space. The English spelling <xmas> for <Christmas> is a case of this type. In contrast to systematic orthography, conventional orthography is located outside the writing system, it may deviate from graphematics, and it may be changed at will by responsible institutions. A linguistic theory of systematic orthography is conceivable, whereas a theory of conventional orthography goes beyond theoretical linguistics to include limiting factors such as socioeconomic needs and political power.

TYPES OF TRANSLATION

In the preceding paragraphs, I have sketched a declarative model of the analysis of language systems as well as a modular theory of writing systems that is compatible with the former model. The base of this conception is a strict distinction between questions of language use and those of the (language or writing) system. In this paragraph, the concept of translation has to come to the foreground, addressing the following questions: What types of translation emerge from the theoretical conception proposed? What are the relations between these types of translation and the aspects of translation alluded to in the preceding chapters?

The present book rests on a broad definition of translation that I will assume as well, of course. Translation, thus, is "to change or convert from one form, function, or state to another" (Chapter 1, p. 2). The specific type of translation addressed in the book is the transformation of ideas into written language. A straightforward question is: Is this a translation in one step or in more than one?

A first and most compelling distinction of types of translation that results from the theoretical conception is the one between translation as an aspect of a system and translation as an aspect of the use of a system. The former should be studied within system linguistics, the latter within language use linguistics, each with their appropriate methods. There may be crucial differences between the way a system functions according to a theoretical analysis and the way aspects of language are put into use. This difference can be made clear by comparing graphematics and reading.

According to the modular writing system theory formulated in this chapter, the graphematic component of a phonographic writing system takes written representations as inputs and derives phonological representations as outputs via the application of correspondence rules (plus constraints, under specific circumstances). This abstract relation is called recoding in the present approach. Recoding, thus, is a type of translation, in particular one of the systematic type. The analogue on the level of language use is reading. Reading could proceed in a way similar to the theoretical analysis given. A graphematic reader would relate one letter after another to the appropriate phoneme, taking both the letter context and relevant aspects of the morphological structure into account. Beginning readers may behave like this, partly depending on the teaching method chosen, but this way of using written language is in two ways ineffective: First, strictly graphematic reading takes time. Second, reading in this way may lead to ambiguous results because in many cases one and the same spelling relates to more than one phonological form. In the actual vocabulary, cases like these are rather infrequent, but they exist in both German (the spelling <Weg> relates to both "path" with a tense vowel and "away" with a lax vowel) and in English (<read> is a relevant example). Cases abound in the potential vocabulary. Based on both these qualifications, the process of reading may be more efficient when the relation of full written words to their counterparts in the language system is learned by heart, taking spelled words as holistic units. This may be the core of fluent reading, but neither way of reading affects the structure of graphematics.

For the scope of the present book, the process of reading is largely irrelevant (though in Chapter 3, p. 29, translation is defined as a bidirectional function, covering both reading and writing), but graphematics is not. This is because graphematics in principle suffices to define written representations for words; any member of the graphematic solution space of a specific phonological representation is a graphematically licensed spelling (cf., Figure 14.9). Not only for writing systems can it be assumed that they go through a graphematic phase in their development, but the same holds for individual writers. This is by and large what in Chapter 5 is called "phonological spelling"* as a phase of writing development and which is contrasted to "orthographic spelling." The notion of "phonological spelling," however, is somewhat misleading since it gives the impression of referring to a part of phonology. A truly phonological spelling could be a phonological transcription (a notion akin to the traditional term "broad phonetic transcription") in which any phoneme is represented by a constant written symbol in an isomorphic way. The kind of spelling meant, however, includes correspondence rules between graphemes and phonemes (or letters and sounds) with their possible underdetermination, inherent ordering, and contextual dependence (cf., Figure 14.6). A superior term could be "graphematic spelling," a term that also suits better to "orthographic spelling" in that both make clear to refer to aspects of the written language.

Children who are able to produce graphematic spellings have already learned a relevant part of the writing system,† but orthography still waits to be learned. Because I define orthography as assigning constant written forms to specific morphological units like words or morphemes (depending on the specific writing system), orthographic spellings and morphological spellings as distinguished in Chapter 5 would be virtually the same. Venezky's (1970, 1999) classification of the writing system of English as "morphophonemic" is hardly meaningful under this conception because any developed writing system that has a component of

* In Chapter 8, p. 13, a closely related notion seems to be addressed in the formulation of "phonemic spelling of morphemes."

† This level of knowledge is also referred to in Chapter 9, p. 6: "Children's early scribbles may seem completely random to the untrained eye, yet contain writing-specific features indicating that general knowledge of writing [...] are beginning to develop."

systematic orthography besides the obligatory graphematic component shows influences of both phonological and morphological properties of the respective language. Thus, any writing system of this type is "morphophonemic."

Although graphematics is conceived as a theory based on correspondence rules that relate given letters to phonemes, the theory of systematic orthography does not work with a parallel of such rules, namely, correspondence rules relating given phonemes to letters.* This theoretical conception, however, does not imply that users working with a writing system do not have knowledge of possible relations between phonemes and letters, keeping in mind that questions of language use are in the current approach strictly delimited from questions of the language system.

It holds even more for orthography than for graphematics that the modeling of their systematic properties demands rote learning in situations of using the writing system. That is because the component of systematic orthography shows a higher degree of underdetermination than graphematics. As argued earlier, there is, for example, no systematic reason for the English lexeme RITE to prefer the spelling <rite> over <right>. This theoretical conception leads to the expectation that writers do not apply phoneme–grapheme conversion rules when attempting to write the word *rite*. Instead, they have eventually learned this spelling by heart. Learning of this type is supported and facilitated by the graphematic base of the orthography.

The theoretical conception of structural properties of writing systems discussed so far leads to the following model of translation: When trying to translate an idea into a written word, the writer first searches the adequate word for his idea (disregarding here for the sake of simplicity larger linguistic units like phrases and sentences, as well as relations between the word and the lexeme). This is a matter of translation between the levels of cognition and language system, and it is essentially meant as what is characterized as the translator in Chapter 2. Then, the writer converts this word into an adequate spelling, something that in Chapter 2 is attributed to the transcriber, but which is conceived here in a slightly different way. The spelling is either selected from the writer's mental lexicon directly or, if no spelling is available there, it is generated by means of knowledge of the writing system. A prerequisite for this generation is the selection of the phonological form of the word in question. This phonological form is then translated into a spelling by invoking available knowledge of properties of the writing system. This knowledge comprises the graphematic solution space, constraints of systematic orthography, and general phoneme–grapheme relations, as well as an analogy to the spelling of similar phonological forms.

A spelling as a mental representation can be materialized as a written form by several mechanisms like handwriting or typewriting, which is again a process of translation. This last step, however, lies outside the cognitive ←→ linguistic translation process as the main focus of this book (although in Chapter 4, transcription

* A basic difference between orthography and graphematics is also assumed in Chapter 4, p. 14, although in different terms, namely, with reference to the alphabetic principle: "In English the alphabet principle in the reading direction is not identical to the alphabetic principle in the spelling direction." Based on the modular theory of writing systems, the difference does not lie in specific versions of an alphabetic principle but has a more fundamental nature.

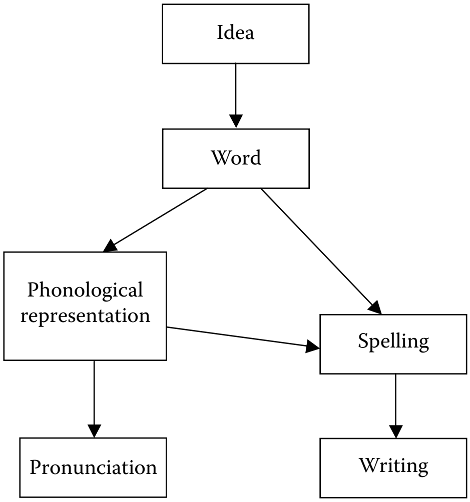

Figure 14.10 Model of the process of translation of ideas into spoken and written forms.

skills are defined as comprising the materializing skill of handwriting as well as linguistic knowledge like spelling and punctuation, which appears to be a heterogeneous class of skills, though). Thus, the translation of an idea into a written form is a process of several distinct steps. Figure 14.10 depicts this conception, including the alternative way of materializing an idea by speaking.

This model calls into question one of the central tenets of this book, namely, that "translation is the fundamental cognitive process of writing [. . .] Writing always requires, as a minimum, some translation (transformation of one or more cognitive representations into written language)" (Chapter 1). Translation, of course, is always involved in the writing process, of course, but only in relating a word to an idea. This word is the base for both writing and speaking. Therefore, it can be said that the writing process proper only starts after the word has been fixed. The choice of the spelling of this word can be based on translation, but it can also be based on selection only (if these two processes are sensibly distinguished) if the spelling is a learned entity. Moreover, phonemic awareness as mentioned in Chapter 9 is relevant for the graphematic phase of literary acquisition but less so for skilled writers (and readers) who can make recourse to a rich inventory of full forms in their mental lexicons.

CONCLUSION

In this chapter, I have tried to frame the topic of translation in the context of theoretical linguistics. The base of a theoretical reflection of the translation of an idea into a written form is a conception of a writing system. A phonographic writing system consists of a language system and graphematics plus optionally of systematic orthography, added by a specific script. Since the language system is a constituting part of a writing system, a prerequisite of writing system research is sound knowledge of the language system. For this purpose, I have outlined a declarative model of language system linguistics, insisting on a strict distinction between the language system on the one hand and the use of a language system on the other hand. The distinction of phonology and phonetics, for example, mirrors this basic distinction. Several types of translation can be tied to this theoretical conception, but given the assumption that conventional orthography lies outside the scope of theoretical linguistics, the actual process of translating ideas into written forms may have additional features that go beyond the realm of a theoretical analysis.

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Afterword

This book offers an invitation to continue, in both research and practice, to address issues raised about translation, defined in Chapter 1 (Introduction) as bidirectional cognitive ← → linguistic transformation during writing. These cross-domain transformations may involve multiple mechanisms, depending on the writer's state of mind, writing task at hand, level of writing development, and individual or other differences: nonlinear to linear flow; strategic plans for selecting, organizing, and adapting or revising content; construction of new knowledge or modification of existing knowledge; and/or other options yet to be discovered. In contrast to past approaches to translation, in this book, we introduce a view in which text generation and transcription are not equated with translation but rather reframed as processes that support the translation process in which representations/operations in one domain are transformed into another domain.

As discussed in Chapter 1, recent evidence indicates that such translation dates back to prehistoric times, and translation by hand (writing) may have developed as early as translation by mouth (speech). In Chapter 2, the case is made that translation does not occur in isolation of the other cognitive and language processes involved in writing but results in language bursts punctuated by pauses in writing. In Chapter 3, the complexity of processes involved in understanding and investigating translation is acknowledged. These include the nature of cognitive representations that may be translated, alternative mechanisms for accessing and operating on cognitions, and multiple ways in which cognitions are transformed into language. How translation occurs in time is also complex. To date, online translation has been studied based on production in real (linear) time. However, just as non-Euclidean space is multidimensional, so is time. Contemporary cognitive neuroscience is developing new ways to study and model timing mechanisms in the human brain that regulate its multilevel processing across space and time. Future writing research may make increasing use of some of these methods and models. Also of great importance are individual differences in the writer, emanating from genetic and environmental variations and their interactions, which influence translation processes. Future research on translation should integrate the study of individual differences in writers and experiments that manipulate instructional and/or writing task conditions.

The different levels of language into which cognitions can be translated—word, sentence, and text—are considered in Part II. In Chapter 4, a developmental model is introduced in which translation at the word level proceeds from oral naming of objects to oral naming of written words to writing of spoken words to writing (and reading) written words alone with links to many other language codes. Design and interpretation of future translation studies should take into account a writer's developmental level in these word-level code transformations. In Chapter 5, longitudinal case studies are presented for 20 children across the first five grades in which the developmental trajectory for translation skills is tracked and shown to be dynamically variable within and across individuals, and the construct of self-regulated translation bouts supported by cycles of working memory is introduced. Future research might investigate the relationships among language bursts marked by relatively brief pauses in production and cessation in self-regulated translation, which does not resume without prompts from others or intervening nonwriting activity. In Chapter 6, the focus is on the individual, cultural, language, and socioeconomic differences that can influence how teachers and students interact in teaching and learning, respectively, in the process of translation. Much remains to be learned about these interactions, all of which are timely topics for both practice and research in writing.

Part III focuses on the role of educators in developing translation processes. In Chapter 7, the results of a randomized controlled study show that students of first-grade teachers given explicit instruction in teaching handwriting excelled in translation during writing compared to students whose teachers did not receive this instruction. In Chapter 8, initial results of a longitudinal efficacy study are presented. This paradigm will hopefully be employed in future translation studies in which children followed across multiple school years are compared according to whether they did or did not receive specific kinds of writing instruction. Also, a neuropsychological model of fine motor skills, word and subword level language skills, and executive functions is shown to have longitudinal stability across the first two grades. In Chapter 9, a validated model of comprehensive classroom assessment of writing, informed by theoretical models of levels of language and transcription that support translation, is presented. This model has important implications for the value of classroom assessment of writing for purposes of differentiated writing instruction. Research relevant to the value of using technology in classroom assessment of writing skills is also reviewed. In Chapter 10, single case studies are reviewed that show translation during writing benefits from supplementing writing strategies instruction with art activities for low-achieving child writers. Cognitions may be transformed not only into written language but also into nonlinguistic formats that include expression through art by hand. Much remains to be learned about the most effective ways to (a) prepare teachers to teach translation during writing, (b) assess in the classroom individual writer's translation and translation-related processes in writing, and (c) teach writers who do not show normal or typical patterns of writing development ways to improve their translation during writing.

Part IV provides an overview of the pioneering and ongoing programmatic research employing online experimental studies of translation products in real time and related processes. In Chapter 11, the results are synthesized from a series of studies from 1990 to 2010 that combined writing protocol analyses and controlled experiments to study correlational and causal relationships in the development of translation. This synthesis provides an overview of what is currently understood about translation from this programmatic research and as such serves as a valuable reference point from which to design future research and interpret the significance of the resulting findings for advancing knowledge of translation. In Chapter 12, new technology is described that supports joint analysis of eye and pen movements to study how pauses reflect different processes involved in translation. Four experiments are described that apply this technology to explore the eye movements of writers as they compose texts or transcribe sentences requiring subject–verb agreement. Interpretation takes into account both eye movements (saccades, fixations, smooth pursuit, and micro-saccades) and the specific linguistic context of handwriting production. In Chapter 13, an innovative application of this new eye and pen technology is described which employs a copy task rather than a conventional dictation task to study spelling when translation per se is not required. The new insights gained about transcription without translation will hopefully stimulate future research to tease apart the many complex processes involved in translation and related processes during writing.

Part V is the culminating part of this book that serves as a transition to the future of translation research. In Chapter 14, readers are reminded that we will gain a complete understanding of translation only when we gain full understanding of the language system. Both cognition and language are complex systems supporting our mental worlds. Further research is needed on the (a) nature of the cognitive system and the nature of the language system, each of which has a different brain architecture; (b) the processes by which the cognitive and language systems learn to communicate with each other bidirectionally and transform each of their unique kinds of representations into representations in the other domain; and (c) the processes by which the internal language representations that result from the translation process are further transformed via hand and fingers into written language in the external world. Translation, that is, cross-domain transformation, is a fascinating, not fully understood, process about which much remains to be discovered. Multiple methods, including instructional studies, experiments, investigations of various kinds of writing-related technology, and assessment of individual and other kinds of differences among writers, which may be used alone or in combination, may contribute to this discovery process. This book will have accomplished its intended purpose if readers participate in this discovery process about the fundamental nature of translation during writing.

The Co-Editors

Glossary

Académie Française: Guardian of the French language, which regulates the words that can be used in French (see Chapter 1).

Articulatory suppression: Condition in which speech is not allowed, which interferes with the phonological loop of working memory (see Chapter 2).

Automatic: Performed quickly without conscious effort (see Chapters 7 and 11).

Balance versus trade-off: Processes equally developed versus one process developed more than another process (see Chapter 6).

Buffer: Storage unit (see Chapter 2).

Case studies: Individuals studied in depth with multiple measures and/or assessment modes (see Chapter 5).

Categorical variable: Discrete or nominal variables as opposed to continuous variables (see Chapter 3).

Category: Set of related concepts (see Chapter 3).

Circadian rhythms: Sleep-wake cycles (see Chapter 3).

Cognitive psychology: Science of the nature of cognitive (mental) representations in thoughts and of the processes in thinking (see Chapter 3).

Cognitive systems: Sets of cognitive representations and operations and have structural and functional organizations (see Chapter 3).

Confirmatory factor analyses: Evaluate the degree to which multiple indicators (measures) of a factor are represented in one or more separate factors (see Chapters 3 and 9).

Controlled processing: Application of strategies (can be slow and effortful or fast and fluent) (see Chapter 3).

Conscious: In state of awareness (see Chapters 1 and 3).

Consciousness: State of awareness (see Chapters 1 and 3).

Continuous: Vary in degree along a scale (see Chapter 3).

Continuum: Continuous variable (in contrast to a discrete or categorical variable) (see Chapter 3).

Correlational research: Relationships between two variables or among multiple variables (also multivariate methods such as regression or structural equation modeling) (see Chapter 3).

Cross-code scribe: Integrating in writing two or more codes (e.g., phonological and orthographic) (see Chapter 4).

Cross-code talker: Integrating in speech two or more codes (e.g., orthographic and phonological) (see Chapter 4).

Decoding: Oral reading to transform written words into spoken words (cross-code talking) (see Chapter 4).

Descriptive research: Using coded variables with or without quantification to describe phenomena (see Chapter 3).

Dichotomous variables: Two variables (see Chapter 3).

Double-task paradigm: Two tasks are given, one of which interferes with the performance of the other (see Chapters 2, 11, 12, and 13 and articulatory suppression).

Dysgraphia: Specific learning disability in handwriting and/or spelling in individuals whose development is otherwise in the normal range (see Chapter 5).

Dyslexia: Specific learning disability in word decoding and/or spelling in individuals whose development is otherwise in the normal range (see Chapter 4).

Encoding: Spelling to transform spoken words into written words (cross-code scribe) (see Chapters 4, 8, 9, 10, 11, and 13).

Executive function(s): Self-regulation (mental government) (see Chapters 4, 5, and 8).

Lower order: Supervisory attention of working memory.

Higher order: Working memory supports planning, translating, reviewing, and revising.

Experimental: Comparison of manipulated conditions to which participants are randomly assigned (see Chapter 3).

Filled pause: Place holder (e.g., um, hmm) during a momentary breakdown in the self-regulated translation bout (see Chapter 5).

Growth-curve modeling: Assessing change over time (see Chapters 4 and 8).

Handwriting: Forming letters by hand (see Chapters 5, 7, 8, 9, 11, 12, and 13).

Interindividual differences: Differences among individuals (see Chapters 5, 6, and 9).

Intraindividual differences: Differences within individuals (see Chapters 5 and 6).

Invisible text: Written product under conditions in which the writer cannot view the text written so far to review it visually (see Chapter 12).

Jung's four mechanisms of consciousness: Perception of through senses, feelings (affect), intuition (sensed but not easily articulated), and thinking (active and concerted effort to understand) (see Chapter 3).

Language burst: Production of written language marked by brief pauses when translation ceases momentarily (see Chapter 2).

Language system: A theoretical framework for understanding language as a construct rather than language use (see Chapter 14).

Lemmas: Morphology (base word that can be transformed to express grammatical variations of a common semantic meaning) or abstract conceptual form selected for utterance in early stage of speech production before speech sounds are attached to it (see Chapters 13, and 14).

Levels of language theory: Language is a complex process that can be analyzed at different units—subword, word, syntax/sentence, and text—as separable levels that are related but not in a 1-to-1 way; the separable levels also may work in concert in functional systems (see Chapters 1, 3, 4, and 5).

Lexical: Refers to words (see Chapters 4, 9, and 11).

Linguistics: Science of language (see Chapter 14).

L1: One's first language (see Chapter 6).

L2: One's second language (see Chapter 6).

Mapping: Creating connections across domains at corresponding units or levels of analysis in each domain (see Chapter 4).

Meaning versus form: Ideas expressed versus structures used to express ideas (see Chapter 6).

Meta-analyses: See Chapters 3 and 8.

Metacognition: See Chapters 2, 5, and 11.

Morphological: See Chapters 4, 5, 6, and 11.

Multiple constraints: Meeting multiple writing demands (see Chapters 11, 12, and 13).

Multiple regression: Evaluating if each of a set of predictor variables is significantly related to outcome variables (see Chapter 3).

Neuropsychology: Inferring cognitive processing within a conceptual framework of brain from behavioral tests given clinically (see Chapters 3, 4, 5, and 8).

Online processing: Inferring cognitive and language processing that result in written productions in real time (see Chapters 11, 12, and 13).

Online production: Studying participants' production of written language in real time in contrast to reaction time studies of response time to contrasting stimulus conditions (see Chapters 11, 12, and 13).

Online studies: Studies of writing processes and products as they occur in real time (see Chapters 11, 12, and 13).

Oracle: Naming with voice concepts and/or language units as in learning oral language in early childhood (see Chapter 4).

Orthographic: Referring to the written word and its parts (see Chapters 3, 4, 5, 11, 12, 13, and 14).

Orthographic loop: Working memory component that integrates mental representations of written words and parts (orthographic codes) and motor output codes through the hand and fingers (handwriting) (see Chapters 4 and 5).

Pattern analyzer: Detects regularities in words (see Chapter 4).

Pauses and rates paradigm: Assessing pauses before written language production and rate of writing during written translation outcome (see Chapters 11 and 12, also Chapter 2).

Phoneme: Abstract sound segment that makes a difference in meaning and corresponds to alphabet letters (see Chapter 14).

Phonetics: Continuous speech production (co-articulated phones within words) (see Chapter 14).

Phonological: Refers to sound storage and processing (see Chapters 4, 5, 6, 8, 9, 11, 13, and 14).

Phonological loop: Working memory component that integrates mental representations of written words and parts (orthographic codes) and motor output codes through the mouth or covert speech (phonological codes) (see Chapters 4 and 5).

Profiles: Patterns of relative level of development of skills within a domain and across domains (see Chapter 5, Appendix B).

Prompt: (1) Other regulation in the form of provided topic for initiating the self-regulated translation bout and (2) other regulation in the form of tester/teacher prompting writer when translation ceases for a long pause with verbal encouragement to write more (What else can you think of?) (see Chapter 5).

Qualitative research: Descriptive research using methods of observing, interviewing, ratings on questionnaires, etc., that code categories in data without employing quantitative analyses; sometimes mixed methods of quantifying coded variables (see Chapters 3 and 10).

Quantitative research: Using numbers to evaluate research findings (see Chapter 3).

Quasi-experimental: Compare conditions (e.g., grade levels) to which children are not randomly assigned (see Chapters 3 and 9).

Regression: Evaluate the relationship between a single predictor or multiple predictors and outcomes (see Chapter 3 and Multiple regression).

Reticular activating system: A brain system for regulating the awareness of the brain to incoming messages from the environment (see Chapter 4).

Satisfice: A decision process in which the decision maker chooses a "good enough" alternative rather than insisting on the best alternative (see Chapter 2).

Self-regulation: Mental self-government for controlling mental processing and behavior.

Self-talk: A kind of self-regulation in verbalization (talking) is used to guide or mediate learning or behavior (see Chapter 8).

Semantic(s): Meaning (any kind of cognitive representation) (see Chapters 3, 4, 6, 9, and 14).

Silent orthographer: Written word spelling with links to phonology, morphology, and semantics that can be accessed in the mental dictionary (lexicon) (see Chapters 4 and 11).

Silent portal of mind: Links between spelling and concepts and other semantic representations in the cognitive system (see Chapter 4).

Structural equation modeling: Evaluating the statistical relationships among predictor factors and outcome factors in structural models (multiple variables) (see Chapter 3).

Sublexical: Level of language for units of language smaller than the word but contained in the word (see Chapters 4, 5, and 11).

Surface structure: Encoded oral or written language (see Chapter 14).

Syntactic: Clause units with subject and predicate and other word parts (see Chapters 3, 5, 6, 9, 11, 12, and 14).

Think aloud: Self-generation of ideas and strategies (plans and revisions) (see Chapters 2, 5, and 8).

Transcription: Mode of output that supports the expression of the outcome of the translation process, for example, speech for oral output (see Chapters 1, 2, 4, and 5), or pictographs (see Chapter 1), handwriting (letter production by pen or keyboard) (see Chapters 5, 7, and 9), or written word spelling (see Chapters 4, 5, 9, 11, 12, 13, and 14) for written output.

Translation: Act of transforming from one kind of representation into another kind of representation, for example, cognition to language or language to cognition (see Chapters 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, and 12).

Translation bout: Self-regulated cognitive ← → linguistic transformation with no other regulation except prompt provided for topic (see Chapter 5) or cognitive ← → nonverbal art transformation (see Chapter 10).

Unconscious: Outside of awareness (see Chapter 3).

Unconsciousness: The state of being outside of conscious awareness (see Chapter 3).

Verbal protocol method: See Think aloud (Chapters 2, 5, and 8).

Visible text: Written product that a writer can see in the text written so far (see Chapter 12).

Working memory (WM): Mechanism for holding cognitions and language in temporary memory for purposes of conscious processing (see Chapters 1, 2, 3, 4, 5, 11, and 12) that has four components (see the following text and Chapters 4 and 5):

WM word form storage and processing units

WM syntax storage and processing unit

WM loops for integrating language codes and motor output codes

WM supervisory attention/executive functions for self-regulation

Working memory cycle: Period of time in which sustained working memory supports a self-regulated translation bout, which may cease periodically but continues with the support of a subsequent working memory cycle (see Chapter 5).

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