Published in final edited form as:
Learn Disabil Res Pract. 2009 May ; 24(2): 69–80. doi:10.1111/j.1540-5826.2009.00281.x.

Highlights of Programmatic, Interdisciplinary Research on Writing

Virginia W. Berninger
University of Washington

Generation of Idea for Writing Research Program

From 1980 to 1983 my clinical responsibilities at Boston's Children's Hospital included assessment on interdisciplinary teams of infants, preschoolers, school-aged children, and adolescents. Through this experience, I sampled writing development in children with neurogenetic developmental disorders, brain injuries or diseases, or specific learning disabilities despite otherwise normal development: From infants and toddlers first learning to use crayons to leave a visible mark on the external world, to preschoolers using pencils to imitate adults writing visual symbols and copying these symbols, to school age children and youth writing alphabet letters, spelling words, and writing. Because the clinic director was skeptical about psychometric tests, we were encouraged to use informal tasks and observe the processes of children reading, writing, and doing math to determine where the bottlenecks in processing were for individual children. However, without age or grade norms, it was difficult to determine if an observed weakness was really a writing impairment or merely normal variation in writing ability. Moreover, different children had difficulty with different aspects of the writing process. By relying only on observed behaviors without controlled comparisons of tasks with different requirements, it was not certain exactly what was causing the bottlenecks in writing. What I observed stimulated my curiosity to do research on normal writing development to differentiate normal variation from disability in writing acquisition.

In keeping with the philosophy of the doctoral program in psychology at Johns Hopkins from which I received my Ph.D., I decided programmatic, interdisciplinary research was needed to address these issues. Programmatic research is designed to answer questions systematically, with the results of one study informing the research questions and design of the next study in a line of research that seeks comprehensive understanding of a phenomenon. Therefore, in planning programmatic research on writing, I drew on my interdisciplinary training in cognitive psychology, linguistics, psycholinguistics, developmental psychology, developmental psychobiology, and developmental neuropsychology at Johns Hopkins and my interdisciplinary clinical experience. I began by investigating writing in two contrasting populations—one clearly outside the normal range (nonspeaking and nonwriting due to brain injury) and one within the normal range (typically developing beginning writers).

Nonspeaking, Nonwriting Individuals Using Alternative Communication

In studies from 1984 to 1986 with children whose speech and hand function, but not intelligence, was abnormal due to severe cerebral palsy, we showed that, despite an abnormal sensorimotor period, these children developed Piagetian operational thought (Berninger, 1988a), had normal receptive aural language skills (Berninger & Gans, 1986a), and could use head wands to access keyboards and other alternative communication devices to learn and use written language (Berninger, 1986b; Berninger & Gans, 1986b). In a subsequent study, which

Requests for reprints should be sent to Virginia W. Berninger, 322 Miller, Box 353600, University of Washington, Seattle, WA 98195-3600. Electronic inquiries may be sent to E-mail: vwb@u.washington.edu.

NIH-PA Author Manuscript
NIH-PA Author Manuscript

included a comparison group of nonspeaking, nonwriting individuals with severe head injuries whose sensorimotor development had been normal, we showed that an abnormal sensorimotor period was more likely to impair nonverbal than verbal intelligence (Berninger, Gans, James, & Conners, 1988). Thus, impaired hand and mouth function alone was not sufficient to eliminate all communication through written language or necessarily impair cognition.

Longitudinal Study of Typical Beginning Writers from Kindergarten to First Grade

In the concurrent studies of normal variation in typically developing writers (and readers), children were assessed individually five times between the end of kindergarten and the end of first grade from 1984 to 1985. In the second, fifth, and eighth month of first grade, they participated in a computerized experiment with lexical decision, oral reading, and written spelling tasks. Normal variation was observed in the distribution of scores on all measures. Three findings were relevant to writing acquisition: Both spelling and orthographic coding (holding written words in memory while analyzing letter patterns in them) were very stable from end of kindergarten to end of first grade (Berninger, 1986a). Orthographic coding plus phonological coding (holding spoken words in memory while analyzing sound patterns in them) explained more unique variance in a normed, dictated spelling test than did either the orthographic or phonological coding alone (Berninger, 1986a). Ability to analyze all the letters in a word developed before the ability to analyze a single letter in the word, which developed before ability to analyze a letter group in the written word (Berninger, 1987). Until a child is able to analyze letter(s) in specific word positions, the child may not be able to apply phonics to spell a word.

On the computerized experiment (Berninger, 1988b), based on consistently correct responses on three trials to control for random guessing on lexical decision, children spelled and named real words that were completely predictable (e.g., ran) better than real words that were not completely predictable (e.g., two) in letter-sound correspondence, and were superior on real words compared to pronounceable nonwords (e.g., raf). However, on lexical decision, nonpronounceable letter strings (e.g., pte) were rejected more accurately than pronounceable nonwords, suggesting that sensitivity to regularities for letter sequences in words (one kind of orthotactic awareness acquired from print exposure) was acquired before grapheme–phoneme correspondence knowledge.

Pilot Study for Grant Application

A Royalty Grant from the University of Washington supported a pilot study during 1987–1988 that provided preliminary data for the National Institute of Child Health and Human Development (NICHD) grant application to continue studies of writing acquisition. A computerized experiment used to study levels of language in writing—choosing words, constructing sentences, and composing text—documented intraindividual differences in writers' levels of language in composing: Skill at the word level did not predict skill at the sentence or text level and skill at the sentence level did not predict skill at the text level (Berninger, Mizokawa, Bragg, Cartwright, & Yates, 1994). This study also generated a theoretical model for clinical assessment and treatment of writing disabilities, which emphasized that computer keyboards might be a bypass for handwriting but not for the language difficulties that underlie writing problems (Berninger, Mizokawa, & Bragg, 1991).

Cross-Sectional Study First Through Ninth Grades

Validating Predictors of Handwriting, Spelling, and Composing

For my first NICHD grant for writing research, I carefully selected 50 boys and 50 girls who were representative of the United States population in ethnicity and mother's level of education. Data were collected during 1989–1990 for first to third grade, 1990–1991 for fourth to sixth grade, and 1991–1992 for seventh to ninth grade.[1] Because of concern about widespread clinical use of tests that had only face validity, but not demonstrated concurrent or construct validity, for writing (or reading) assessment, we administered a large number of widely used measures as well as experimenter-designed ones to evaluate which met two criteria: (a) correlated at $p < .001$ with handwriting, spelling, or composing achievement outcomes; and (b) contributed unique variance to the same outcomes when other predictor measures were also included in multiple regression.

The correlation and regression analyses showed that the best predictors of handwriting were orthographic coding (Berninger, Yates, & Lester, 1991) and graphomotor planning for sequential finger movements (Berninger & Rutberg, 1992) in first through third grade (Berninger et al., 1992) and fourth through sixth grade (Berninger, Cartwright, Yates, Swanson, & Abbott, 1994). A test of visual-motor integration (copying nonletter, geometric forms) did not meet the criteria for concurrent or construct validity. Structural equation modeling, which evaluates whether predictor factors explain unique variance in outcome factors, showed that, from first through sixth grade, orthographic coding had a direct path to the handwriting outcome, whereas graphomotor planning for sequential finger movements had an indirect path via orthographic coding to handwriting (Abbott & Berninger, 1993). Based on more recent work, this orthographic coding-to-hand output is now thought to be the orthographic loop, which plays an important role in learning to spell (e.g., Berninger, Nielsen et al., 2008b; Berninger, Rutberg et al., 2006; Richards, Berninger, & Fayol, 2009). See Berninger (2007c) for pictorial representation of the orthographic loop from mental representations of written words and letters to hand (motor output via sequential finger movements) and assessment measures and instructional interventions for the orthographic loop.

The correlation and regression analyses showed that the best predictors of spelling were measures of orthographic coding, phonological coding, and vocabulary knowledge in first through third grade (Berninger et al., 1992) and fourth through sixth grade (Berninger et al., 1994). Structural equation modeling showed that orthographic coding consistently had a direct path to the spelling outcome from first through sixth grade, whereas the phonological path was direct in fourth to sixth grade (Abbott & Berninger, 1993).

The correlation and regression analyses showed that the best predictors of composition fluency (number of words within a time limit) and composition quality (based on independent ratings of typewritten versions of compositions with corrected spelling so that raters were not biased by the child's handwriting and spelling skill in judging content and quality of writing) were orthographic coding in the first three grades (Berninger et al., 1992) and orthographic coding and graphomotor planning for sequential finger movements in fourth grade and above (Berninger et al., 1994). Structural equation modeling showed that handwriting consistently had a direct path to both compositional fluency and compositional quality from first through sixth grade, whereas spelling did too, but not for all grade levels (Graham, Berninger, Abbott,

[1]Both our group and researchers at the University of Maryland (Graham and colleagues) and Florida State University (Silliman and Bahr and colleagues) have published studies based on the data collected. The last study, in progress at Florida State University, is examining the spelling errors during composing of narrative and expository texts, based on the same prompts, from first through ninth grade in typically developing writers.

Abbott, & Whitaker, 1997), despite the fact that both handwriting and spelling had been corrected by the research team to avoid bias in compositional quality ratings.

Relating Assessment to Writing Theory

According to the most influential model of the cognitive processes in skilled writing (e.g., Hayes & Flower, 1980), planning, translating, and reviewing and revising are key processes. The research focus was on two processes hypothesized to be related to translating from first through sixth grade: text generation at different levels of language (word, sentence, and text) and transcription (handwriting and spelling) (e.g., Berninger & Swanson, 1994). Whitaker, Berninger, Johnston, and Swanson (1994) documented intraindividual differences in levels of language in developing writers. Subsequent research showed that transcription affects translation in both children (Bourdin & Fayol, 1994, 2000) and adults (Bourdin & Fayol, 1996, 2002; Hayes & Chenoweth, 2003).

Spelling errors reflected children's attempts to use phonological, orthographic, and morphological knowledge in spelling words during composing from first through ninth grade (Silliman, Bahr, & Peters, 2006). A second-order factor underlying predictor measures of phonological, orthographic, and morphological awareness uniquely predicted spelling outcomes in both typically developing writers and children with dyslexia (Berninger, Raskind et al., 2008). Gender differences were found in *handwriting automaticity* in the primary grades (Berninger & Fuller, 1992) and *compositional fluency* (number of words within a time limit) in the intermediate grades (Berninger & Fuller, 1992; Berninger, Whitaker, Feng, Swanson, & Abbott, 1996). For both writing skills and developmental levels, boys were more impaired. A set of about 20 algorithms accounted for planning the next sentence in children's writing from first through sixth grade (Fuller's dissertation discussed in Berninger, Fuller, & Whitaker, 1996).

For seventh through ninth grade, the research focus was on all three cognitive proceses—planning, translating, and reviewing/revising—while composing a letter giving advice for foreign students who would be attending school in the United States (Berninger, Whitaker et al., 1996). Although all measures in the first to sixth grade studies were individually administered, those in seventh to ninth grade were group-administered because of practical issues in gaining access to students for research during the school day. Junior high students were randomly assigned to one of the six combinations of these conditions: guided or unguided planning; access or no access to planning notes during translating; and guided or unguided reviewing/revising. The guidance was in the form of specific written questions or checklists to which students could refer rather than in the form of teacher-led guidance. For the junior high writers, self-guided planning was superior to guided planning on quality of planning; access to prewriting written plans did not improve quality of translating; and quality of revision was not differentially affected by guided or unguided revision. However, when guided and unguided revisions were combined, the revised draft was better at all levels of language—word-choice level, sentence-level, and text-quality level in the junior high writers. The translating task, but not the planning or revising task, was correlated with an external validator of composing ability. Responses on a metacognitive understanding questionnaire were correlated to planning and revising. In contrast, intermediate grade writers benefited from guided revision (Whitaker et al., 1994); thus, self-generated revision may become important during the junior high grades.

The study of the cognitive processes was extended upward to adult writers learning to write psychological reports during their preservice training. Think-aloud protocols of graduate students showed that expert writers continue to develop their genre-specific planning and reviewing/revising skills needed for the workplace (Whitaker's dissertation discussed in Berninger, Fuller et al., 1996).

Working Memory

The initial studies, which relied greatly on sentence-span tasks, showed that working memory predicted unique variance in composing in developing writers in fourth through sixth grade (Berninger, Cartwright et al., 1994), seventh through ninth grade (Berninger, Whitaker et al., 1996), and elementary school (Swanson & Berninger, 1996a, 1996b). These results are consistent with other studies showing that working memory exerts constraints on written language production (e.g., Bourdin & Fayol, 2000; Hayes & Chenoweth, 2003). However, a more recent study that included word-level and subword level working memory tasks for spoken and written words showed that working memory at the word-level is related to many writing and reading outcomes in first to third grade (Berninger, Abbott et al., in press). Although much research on working memory has emphasized its capacity limitation, timing factors also contribute to working memory inefficiencies in writing (Berninger, 1999), which is why, in instructional studies discussed next and conducted from 1991 to 2007, we taught all levels of language close in time to overcome these inefficiencies.

Instructional Intervention Studies

After documenting the tremendous normal variation in the third-to-fourth grade transition study below, we conducted pretreatment assessments to identify children who met well-defined research inclusion criteria before inviting them to participate in the instructional studies. We never used samples of convenience (e.g., children in special education) because it is difficult to know how results might generalize to children with specific kinds of writing problems. In addition, we used assessment of response to intervention (RTI) for both groups and individuals to evaluate treatment effectiveness. Also, in the NICHD-funded Multidisciplinary Learning Disabilities Center, which was established in 1995 about the time these instructional studies in writing began, we conducted many parallel studies focused on reading (Berninger, 2008a; Berninger & Abbott, 2003). I began the instructional studies on writing from the unique vantage point of learning from a master teacher with considerable experience in teaching writing from kindergarten to high school.

Learning from Teachers

In 1990, I received an invitation to be a consultant and evaluate an innovative integrated writing-reading program, which Jennifer Katahira, a local teacher, had conceptualized and implemented in a kindergarten located in an inner city school that consistently scored in the lowest stanine[2] and served an ethnically diverse low-income population. I agreed to do the evaluation and what I observed was transforming and influenced the design of many subsequent instructional studies we conducted.

At the beginning of the school year, Katahira taught the children the “What I Think, I Can Say, What I Say, I Can Write” strategy. Then every day she began the school day by modeling it. First, she would tell a very simple story (initially a sentence but increasing to several sentences) and then record it on the chalkboard by having the children suggest letters to use to spell each of the sounds in each word in her story. To make their suggestions, children used a small “Sunshine Card” with a picture beside each of the 26 letters; the pictured word contained a consonant or short vowel that could be spelled with the letter. If what they proposed was not conventional spelling, Katahira matter-of-factly explained that in this word the sound was spelled this way and wrote that.

Next, children composed independently at their desks. They were encouraged to use the “What I Think, I Can Say, What I Say, I Can Write,” strategy and the Sunshine Cards. Invented

[2]Stanines are nine equal intervals in a normal distribution.

spellings were encouraged—the focus was on generating ideas orally and then translating speech into written words. The room was abuzz with productive talk as children thought aloud, then translated each word, sound by sound, into the letters they wrote on lined paper with space at the top to illustrate the ideas. After composing, they drew pictures to go with their stories and then took turns reading orally what they had written to classmates, their visible audience. During the year they revised their favorite stories over and over and illustrated them for the book the class published and showcased at the book celebration for the whole school at the end of the school year.

By end of kindergarten, all but one child was not only writing and enjoying writing but reading at the 90th percentile or above (the one exception was performing at the 70th percentile) (unpublished evaluation data). The first grade teacher the next year complained that the children did not want to go out to recess—they wanted to stay in and write and read together. Katahira's approach to integrated writing-reading may have worked because it began with Idea Generation, proceeded to Translation, with a tool to aid Transcription (spelling sounds for model letters), followed by Review (author reading written text to visible audience, classmates) and Revise (many times for final book publication). This teacher had included all the cognitive processes of writing in Hayes and Flowers' (1980) model.

During the 1991–1992 school-year, Katahira trained the first grade teachers in her school in integrated writing-reading (I-RW). For her dissertation research, Traweek compared I-RW with DISTAR, a direct instruction approach also begun in kindergarten that emphasizes phonics and reading but not writing, in a comparable school in the district. Reading achievement at end of first grade was comparable in both programs, but children in I-RW tended to create whole word and subword connections (rimes in word families and phonemes–graphemes in alphabetic principle), whereas those in DISTAR tended to create only subword connections for alphabetic principle (Traweek & Berninger, 1997). The instructional studies that followed showed that creation of multiple connections facilitates writing acquisition.

Third-to-Fourth Grade Transition

Because writing requirements in the curriculum increase dramatically in fourth grade and above, adults often become aware of children's writing problems for the first time in fourth grade. We recruited children at the end of third grade whose teacher noted that they had extreme difficulty in completing writing assignments. Careful assessment with a battery of measures previously validated in the cross-sectional studies, confirmed earlier clinical impressions of immense normal variation in why individual children struggled with writing (Berninger, Abbott, Whitaker, Sylvester, & Nolen, 1995, Table 2). Instruction was provided for all the cognitive processes of writing in current cognitive theory (planning, translating, transcription, and reviewing/revising) in individual tutorials.

During a brief[3] warm-up for transcription at the beginning of each session, children copied letter forms with numbered arrow cues (first half of lesson set) or wrote single letters from dictation (last half of lesson set) using procedures in Rutberg's dissertation in Berninger, Rutberg et al. (2006, Study 1). Then tutors provided explicit teacher modeling of planning, translating, reviewing/revising, followed by dialogue as the teacher guided students while they engaged in planning, translating, and reviewing/revising on a different engaging topic in each lesson. Children were also randomly assigned to additional phonological and orthographic coding treatment or extra practice in independent composing at the end of each session. The tutored children made significantly more progress than the no-treatment control group on

[3]Too much repetition causes habituation and the brain no longer attends to the task at hand and seeks novel stimuli or tasks to maintain attention over time.

automatic alphabet writing from memory at immediate posttest and 6-month follow-up and compositional fluency at immediate posttest and compositional quality at 6-month follow-up. The group given extra training in phonological awareness (segmenting spoken words into syllables and phonemes) and orthographic awareness (looking games for remembering all the letters or designated single letters or letter groups) made greater gains on the spelling probe than did the extra composing practice group (Berninger et al., 1995).

Persistently Poor Spellers and Readers

For her dissertation research, Hart recruited a sample of children whose reading and spelling was on average two standard deviations below the population mean and compared a single connection treatment aimed at teaching spelling-sound correspondences in phonics and a multiple connection treatment (whole word, word families, and phonics). Both growth curves for the group and individuals showed that the multiple connections treatment resulted in a faster growth on pseudoword reading probes (Hart, Berninger, & Abbott, 1997). More recently, Garcia's dissertation research (Garcia, Abbott, & Berninger, 2008) showed that a pseudoword reading predictor contributed significant and sizable variance to the outcome in a discrimination function that discriminated among poor, average, and superior spellers.

First Graders Without Legible Handwriting Automaticity

In a large-scale randomized controlled study in the schools we compared five ways to teach handwriting (copy from model, imitate teacher making motor strokes, numbered arrow cues, write from memory, and combined number arrow cues and write from memory) and a treated control (phonological awareness) for children whose initial handwriting was substantially below the population mean and their class means on legible and automatic letter writing (Berninger et al., 1997). After handwriting instruction, children always composed on a teacher-provided topic so that they could apply their handwriting (transcription) to translation of ideas into written text. The most effective method was clear even before statistical analyses, which confirmed that, compared to each of the other methods and the control treatment, the most effective method for teaching automatic legible letter writing was combined number arrow cues + writing from memory; this treatment transferred to improved compositional fluency (Berninger et al., 1997) and eliminated reversals (Berninger, Rutberg et al., 2006, Study 3, Brooke's dissertation research).

Low Achieving Second Grade Spellers

Because traditional spelling instruction emphasizing declarative knowledge (phonics rules) and segmenting words into cvcc or cvc syllables had not been effective in improving spelling in prior studies (e.g., Brooks, Vaughan, & Berninger, 1999), we evaluated other approaches. This work was inspired by Venezky (1995), who showed that American English spelling is generally predictable when relationships between phonemes and 2-letter (not only 1-letter) spelling units and a small set of alternations (possible spelling units for a given phoneme, which in English range from 2 to 4) are taught; when all spelling units are considered, words are never totally irregular. For the initial spelling instruction study for children who had completed second grade and met inclusion criteria for low spelling achievement, response to instruction (teaching the mind's ear and mind's eye to talk to each other, that is, make connections) showed that words of higher predictability (e.g, one letter corresponds to one phoneme) were learned faster than words of moderate predictability (e.g, one or two letter spelling units correspond to one of two phonemes), which were learned faster than words of lower predictability (e.g., one- or two-letter spelling units may correspond to one of three or more phonemes; or multi-letter units spelling units do not correspond to a phoneme) (Berninger, Abbott et al., 1998). However, spelling taught words of moderate and lower predictability explained unique variance in spelling achievement, but spelling highly predictable taught words did not.

Spelling achievement did not depend on whether pencils or keyboards were used for spelling instruction (Berninger et al., 1998). However, the poor spellers differed as to whether they also had poor handwriting. Those with poor handwriting were lower in spelling both before and after specialized spelling instruction, whereas children with good handwriting skills responded better to the specialized spelling instruction (Berninger, Abbott et al.).

We next conducted a large-scale, randomized, controlled experiment in the schools for at-risk second grade spellers who met research inclusion criteria for spelling significantly below the population mean and their class means (Berninger, Vaughan et al., 1998). In designing this study, I drew on three principles from child language, cognitive psychology, and written communication:

- **a.** Oral language is acquired in mother-infant bouts with frequent turn-taking and modeling; thus, alphabetic principle for spelling (phoneme-to-spelling direction) was taught as procedural knowledge with the teacher modeling, and the students imitating in fast-moving, turn-taking mode to avoid habituation[3]: key-word naming, phoneme production out of word context, and naming 1- or 2-letter spelling units for corresponding phoneme in alphabetic principle. For this process, children used a cue card with pictures of key words above 1- or 2-letter spelling units and were monitored for attention to the oral production of words and phonemes and to the visual letters, which they were also encouraged to touch. This cue card was an adaptation of that used by Katahira so that it included the most frequent phoneme-spelling unit correspondences in the high frequency words used in literacy instruction in the primary grades; the alternations were included side by side so that children learned strategies for alternate spellings for the same phoneme. All children completed this 5-minute warm-up activity[3] at the beginning of each session; only some correspondences were reviewed in any one session but all were introduced after a few sessions and reviewed several times in the course of the 24 lessons implemented twice a week over 4 months.
- **b.** Teaching for transfer facilitates application of knowledge. The teacher therefore modeled how to apply different units of spoken and units of written language to spell monosyllabic words orally and in writing. Only this component was experimentally manipulated so that the teacher modeled and students imitated the application of (a) phoneme-spelling unit (1- or 2-letter) correspondences; spoken and written rime units (part of syllable remaining after deleting onset phoneme/s); lexical strategy (naming the whole word and naming all constituent letters in spelling); combinations of two of these; combination of all three; or a treated control (phonological awareness).
- **c.** Before the independent composing part of each lesson, children were taught how to use Katahira's "What I Think I Can Say, What I Say I Can Write" strategy, which fostered transfer to translation at the word-, sentence-, and text-levels as children translated ideas into spoken words, spoken words into written words, written words into sentences, and sentences into written text. They were also taught how to use their cue cards to translate spoken words into written spellings. Both topics and a set of topic-related high-frequency words children use in writing were provided for the composing task. Children always read what they had written to their classmates; this sharing of the writing proved to be an important motivator for struggling writers to hone their composing skills.

The most effective treatment was a combination of whole word and rime strategies for learning to spell taught and transfer words (containing the same phoneme-spelling unit correspondences but in a different word context); but phoneme-letter(s) correspondences in alphabetic principle were most effective for spelling words correctly during composing at posttest (Berninger et al., 1998b). Growth mixture modeling showed that Rapid Automatic Naming (RAN) predicted correctly spelled words during the day-to-day composing lessons (Amtmann, Abbott, & Berninger, 2008). RAN assesses the phonological loop for time-sensitive coordination of phonological and orthographic codes in word spelling (Berninger, Abbott et al., 2006; pictorial representation in Berninger, 2007c). Half the sample reached grade level after these 24 lessons twice a week during second grade and maintained their gains during third grade; the other half reached grade level after another set of lessons at the beginning of third grade that focused on *polysyllabic* words and the *six syllable types in English* and maintained their gains at the end of third grade (Berninger et al., 2000).

Low Achieving Third Grade Composers

Children were recruited for compositional fluency significantly below the population and class means and taught alphabetic principle in the phoneme-to-spelling unit direction as in Berninger, Vaughan et al. (1998) and alternations for spelling (generating the alternations for corresponding 1- and 2-letter spelling units for each phoneme portrayed in pictures of target words on the cue cards). They were taught to apply the alternations as strategies for spelling content words (nouns and verbs that are more predictable in alphabetic principle) and function words[4] (prepositions, conjunctions, pronouns, articles that are less predictable in alphabetic principle). Compared to the alternative treatments or treated control, children who received this instruction improved significantly more in spelling both function and structure words (Berninger, Vaughan et al., 2002). Children in some treatments were taught explicit strategies for planning (e.g., using graphic organizers), translating, and reviewing and revising expository genre (informational and persuasive). Compared to alternative or treated control treatments, children who received this explicit instruction in the cognitive processes for composing improved significantly more in composing quality compared to alternative treatment or treated controls (Berninger, Vaughan et al.).

Writing-Readers

Most school assignments require integration of writing and reading. Children's executive function abilities for self-regulation of mental processes contribute to developing writers during middle childhood becoming writing-readers (Altemeier, Abbott, & Berninger, 2008; Altemeier, Jones, Abbott, & Berninger, 2006). Parents reported spending more time supervising homework activities in writing for children with than without researcher-identified executive function problems (Alston-Abel, dissertation research in progress). Integrated instruction in writing and reading improved children's performance on high stakes and psychometric writing tests (Berninger, Rutberg et al., 2006, Study 4) and improved the writing and reading skills of students with diagnosed learning disabilities (Berninger, Winn et al., 2008, Study 1). Children benefit from integrated reading-writing instruction that is specific to content domains in the curriculum (Berninger, Abbott, Abbott, Graham, & Richards, 2002).

Writing Problems in Children with Specific Learning Disabilities

Differential diagnosis of specific learning disabilities affecting written language acquisition has instructional implications (Berninger, 2008a; Berninger, O'Donnell, & Holdnack, 2008) and parents are often seeking diagnosis for this reason (Berninger, 2008b). See Berninger and Wolf (in press-a, in press-b) for instructional methods that can be implemented in general as well as special education. Just because a student responds to instruction it does not mean that the student does not have one of the following specific learning disabilities or that dysgraphia or dyslexia does not exist as parents are often told (Berninger, 2008b)—typically the vulnerabilities that are overcome resurface in different ways as curriculum requirements

[4]Function words, which have no meaning apart from their role in gluing together other words in sentence syntax, are sometimes called structure words.

change and increase over the course of education (Berninger, 2006a). These disabilities are invisible, in contrast to the students who were nonvocal and nonwriting with whom I first worked, but nevertheless real, as evidence from genetics, brain imaging, and assessment research around the world (for review, see Berninger & Richards, 2002) and in our family genetics study (for review, see Berninger, Raskind et al., 2008) has documented.

Dysgraphia

Some children have diagnosable motor problems and also related handwriting problems, but the larger number have dysgraphia (Greek word meaning impaired letter form production by hand), that is, handwriting problems despite motor function that falls within the normal range; see Berninger (2004) for further information on this distinction. The hallmark features of dysgraphia, a biologically based learning disability, are impaired orthographic coding and/or graphomotor planning for sequential finger movements, which together function as the orthographic loop (Berninger, Raskind et al., 2008). Individual differences (normal variation) can be observed in motor skills in handwriting related to placement of letters on lines of paper and maintaining consistency of letter size (Graham, Struck, Richardson, & Berninger, 2006), but the transcription skill that explains unique variance in the handwriting, fluency, and quality of composing of children with dysgraphia, whose motor development falls within the normal range, is automatic retrieval and production of legible letters (e.g., Berninger et al., 1992, 1994; Graham et al., 1997).

Ability to sustain handwriting over time and handwriting speed may also be important, especially as writing assignments become longer and more complex (Berninger, Rutberg et al., 2006). Research has not shown that good writers tend to use cursive rather than manuscript; individual differences in use of writing format have been observed (Graham, Berninger, & Weintraub, 1998).[5] Intellectually gifted children may have a specific learning disability related to transcription disability (TD) in handwriting and/or spelling (Yates, Berninger, & Abbott, 1994). Sometimes dysgraphia also affects math-specific writing skills such as automatic legible numeral writing, coding multiplace numerals in working memory (analogous to orthographic coding), and the visual-spatial placement of numerals during computation (see Berninger, 2007b).

Dyslexia

Although many think that dyslexia is a reading disorder, dyslexia is a writing and reading disorder in which spelling is the persisting feature (Berninger, Nielsen et al., 2008a) and the gender differences are related to the writing problems rather than the reading problems (Berninger, Nielsen et al., 2008b). The writing problems of children with dyslexia are underidentified and undertreated, especially in boys (Berninger, 2006a, 2006b; Berninger et al., 2008a). Dyslexia (impaired word-level decoding and spelling) is usually not evident until kindergarten when children struggle to learn names and sounds for letters; their oral language development during the preschool years falls within the normal range. The hallmark features of dyslexia are impaired phonological decoding (reading pseudowords) and the related processes of phonological coding of spoken words, orthographic coding of written words, RAN (phonological loop), and executive functions for inhibition and RAS (rapid automatic switching of attentional focus during naming) (Berninger, Abbott et al., 2006; Berninger, Raskind et al., 2008).

Even in children with dyslexia, but not attention deficit disorder, weaknesses in self-regulating attention may interfere with redirecting attentional focus to sequential letters in written words

[5]Children in the United States may not use cursive consistently because it is not taught until the third grade (age 9) in contrast to European schools (e.g., Italy and France) that teach cursive at the beginning of schooling and literacy instruction.

during the decoding process (Thomson et al., 2005); but pretraining in attention can significantly improve response to writing instruction for students with dyslexia (Chenault, Thomson, Abbott, & Berninger, 2006). Children with dyslexia who receive appropriate instruction in word decoding, which includes phonological, orthographic, and morphological awareness instruction, tend to have reading and listening comprehension commensurate with their verbal reasoning aptitude (Berninger, 2008a; Berninger, O'Donnell et al., 2008; Berninger, Raskind et al., 2008). Children with dyslexia may also have dysgraphia—handwriting disability—but not all do.

Oral and Written Language Learning Disability (OWL LD)

Some children have not only reading and writing problems but also oral language problems, which begin during the preschool years. As a result, they may have difficulty with listening comprehension and tend to have impaired real word reading, reading comprehension, and immature syntax in their written productions (as well as spelling) problems (Berninger, 2008a; Berninger, O'Donnell et al., 2008; Berninger, Raskind et al., 2008). Like the children with dyslexia they may also have dysgraphia and related handwriting impairments. However, the treatment needs of children with OWL LD are different from those of children with dyslexia. Those with OWL LD have both oral and written language impairment at levels of language involving the single word (e.g., finding words in semantic memory or morphological awareness especially of suffixes) and/or multiword units (e.g., syntactic awareness). Like the wise old owl, they may be very bright in nonverbal domains, but are not necessarily discrepant from their verbal aptitude (generally only if they are gifted in verbal reasoning). (See Berninger, 2008a; Berninger, O'Donnell et al., 2008; Berninger, Raskind et al., 2008.)

General Model of Working Memory Architecture for Diagnosis and Treatment Planning

Based on a synthesis of the programmatic research on assessment and instruction for individuals who were typically developing, low achieving, or learning disabled and on phenotyping (behavioral expression) and genotyping studies in families with multigenerational histories of learning disabilities, I proposed a unifying theoretical model that can be used for differential diagnosis and treatment planning (Berninger, 2007c, 2008a; Berninger, Abbott et al., 2006; Berninger, Raskind et al., 2008). The general model has storage and processing units for *three word forms* (phonological, orthographic, and morphological) (Berninger, Abbott et al., 2006; Berninger, Raskind et al., 2008; Richards, Aylward, Raskind et al., 2006), *two time-sensitive loop*s for cross-modality code integration (phonological and orthographic) (Berninger, 2007c; Berninger, Abbott et al., 2006; Berninger, Nielsen et al., 2008a; Berninger, Raskind et al., 2008; Berninger, Rutberg et al., 2006), and a *panel of executive functions* (inhibition, rapid switching attention, self-monitoring, etc.) (Berninger, Abbott et al., 2006; Berninger, Raskind et al., 2008) that operate within a capacity-limited and time-limited working memory architecture. Impaired orthographic coding results in dysgraphia, impaired orthographic and/or phonological coding results in dyslexia, and impaired orthographic, phonological, morphological/syntactic coding results in OWL LD (Berninger, Raskind et al., 2008). Individuals with each of the three specific learning disabilities affecting written language acquisition tend to have selective impairment in one or more executive functions and loops (Berninger, Raskind et al., 2008).

The theoretical model incorporates both (a) normal variation along a distribution of a single variable, and (b) profiles (constellations) of multiple variables in which the abnormality is not within a single dimension but in the patterning of the *relationships across the variable*s, which is not normal, along with associated, predictable impairment in phenotypes (behavioral markers related to genetic and brain variables) (see Berninger & Holdnack, 2008; Berninger, O'Donnell et al., 2008). When some of the variables in the learning profile are significantly underdeveloped compared to others, the brain/mind has difficulty orchestrating them in real time to learn specific academic skills, much as the orchestra makes noise if not all the musicians are able to play their instruments equally well and thus cannot play them in synchrony. As a result, fluency is impaired.

Although specialized reading or writing instruction normalized brain function during phonological, orthographic, and/or morphological tasks in children with dyslexia (Richards, Aylward, Berninger et al., 2006;Richards, Aylward, Raskind et al., 2006;Richards et al., 2005), the working memory impairment was not fully normalized. Only when both phonological loop (eye-to-mouth-to-ear connections between letters and phonemes) and orthographic loop (ear-to-hand-to-eye connections between phonemes and letters) were trained for children with dyslexia, did the functional connectivity in time appear to normalize for frontal brain regions linked to working memory and the related brain regions for components of the architecture, suggesting that all the components were orchestrated in time (Richards & Berninger, 2008).

Research into Practice

Assessment-Instructional Links

Most of the instructional studies have been translated into teacher-friendly lesson plans (see Berninger & Abbott, 2003; handwriting, Set 3; spelling, Sets 4, 5, 7, 8, and 10; composing, Sets 3, 4, 5, 7, 8, 10, 13, 14; and Berninger & Wolf, in press-b for Writing Workshops, Sets 2, 3, and 4). All instructional studies included assessment-intervention links (before, during, and after instruction) that can be applied, within the framework of the general theoretical model for a working memory architecture, to Tier 1 prevention, Tier 2 problem solving consultation, and Tier 3 differential diagnosis and treatment planning (Berninger, 2007a, 2007b, 2007c, 2008a; Berninger, O'Donnell et al., 2008). All tiers can be implemented in general education classrooms (Berninger & Wolf, in press-a, in press-b) to help (a) children with biologically based specific learning disabilities, (b) those who display weaknesses that are normal variation, and (c) those who are English-language learners (who also have responded to evidence-based writing instruction, see Berninger, Dunn, Lin, & Shimada, 2004). See Berninger and Fayol (2008) for teaching spelling that takes into account recent theoretical advances in understanding the language processes that are involved in spelling.

Response to Intervention

Children exhibited normal variation not only prior to treatment (Berninger et al., 1995) but also in response to treatment (e.g., Abbott, Reed, Abbott, & Berninger, 1997; Berninger & Abbott, 1992; Berninger et al., 1995; Hart et al., 1997). Although evidence-based instruction helps overcome learning problems related to lack of appropriate instruction (Berninger & Abbott, 1994) and assessment should always occur before, during, and after instruction (Berninger, 2007a, 2007c; Berninger & Abbott, 2003), RTI alone cannot identify biologically based learning disabilities. For diagnosis of specific learning disabilities, multigenerational histories of learning disabilities and characteristic profiles (constellations) of relative impairment in written or oral language skills and related phenotypes (behavioral markers) (Berninger & Holdnack, 2008;Berninger, O'Donnell et al., 2008) and language profiles (Berninger, Abbott et al., in press) are also relevant.

Longitudinal Studies First Through Seventh Grades

From 2001 to 2006, a longitudinal study with annual assessments of typically developing writers in first through fifth grade and third through seventh grade was conducted. Initial findings confirmed substantial normal variation in language profiles (intraindividual differences in listening, speaking, reading, and writing) (Berninger, Abbott, Jones et al., 2006). Spelling was the most consistent longitudinal predictor of writing and writing-reading connections from first to seventh grade (Abbott, Berninger, & Fayol, 2008), possibly because spelling is a bridge that translates ideas generated during planning into language at the word level by the scribe, that is, the orthographic loop (Richards et al., 2009). Sentence awareness does not emerge reliably until third to fourth grade (Berninger, Abbott, Augsburger, & Garcia, 2008). The most surprising finding was that, when writing by pen and by keyboard were compared on alphabet writing, sentence constructing, and text composing, children wrote more words and wrote words faster (Berninger, Abbott et al., 2008) and expressed more ideas (Hayes & Berninger, in press) when composing text by pen than by keyboard from second to sixth grade; but for letter writing and sentence constructing, the keyboard often showed advantages (Berninger, Abbott et al., 2008). Children with learning disabilities need explicit instruction in handwriting as well as keyboarding and both accommodations in the form of using a laptop and ongoing explicit instruction in all aspects of writing from planning to translating to reviewing and revising (Berninger, 2006a, 2008a; Berninger, Abbott et al., 2008).

Brain Imaging Studies

At the end of the 5-year longitudinal study, fifth graders who were right-handed and did not wear braces participated in functional magnetic resonance imaging (fMRI) studies. Children's brains were scanned while they generated ideas for a composition they wrote when they left the scanner. Differences between good writers and poor writers were observed during idea generation, especially in brain regions associated with working memory (Berninger et al., in press), and during spelling—both in temporary storage of novel words while letter patterns are analyzed in learning new words and in long-term storage of written words with links to other language codes (Richards et al., 2009). Of interest, good, but not poor, spellers activated in primary sensori-motor regions of the brain, consistent with the construct of a graphomotor envelope, analogous to intonational contours for spoken words, which may play an important role in learning to spell via word production (Richards et al., 2009).

During sequential finger movements, after controlling for motor movements, brain regions associated with cognitive, metacognitive, language, and working memory functions were robustly activated in good writers but not in poor writers (Richards et al., in press). Handwriting (requiring sequential strokes or key presses), spelling (requiring sequential letter production), and composing (requiring sequential word, sentence, and text production) were significantly correlated with the same five brain regions (left superior parietal, right inferior frontal orbital, right precuneus, and right and left inferior temporal) on this sequential finger movement task (Richards et al., in press), consistent with Lashley's (1952) claim that serial organization of behavior plays an important role in higher-order human cognition. On the fMRI tasks given to good and poor 11-year-old writers only one has been found to be associated with the gender differences—left inferior parietal region during planning of sequential finger movements, which was correlated with behavioral measures of handwriting and spelling. Boys underactivated compared to girls in left inferior parietal region. These and additional studies are extending knowledge of how the writing brain differs from the reading brain (see Berninger & Richards, 2002, Chapters 6 and 9).

Current and Future Directions

The research is being extended in both theoretical and practical directions. On the theoretical front, I am exploring these questions: What are ideas? How do ideas in implicit memory outside conscious awareness get translated into explicit memory in conscious awareness in working memory? Why do some students have difficulty translating ideas into language? What does grade-appropriate writing for different genre look like at the word, sentence, and text levels based on children's writing protocols rather than normed, psychometric tests? How can on-line experimental methods introduced by Fayol and colleagues inform our understanding of time-sensitive language production units (e.g., language bursts described by Hayes & Chenoweth, 2003)?

On the practical front, I struggle with these questions: How does understanding the writing brain lead to better assessment-intervention links for writing? How can research information be better shared with parents so that they can educate federal and state legislators of needed legislative change to ensure that instructional needs in writing are better met for all students including those with learning disabilities?[6] How can preservice education be transformed so that teachers are better prepared for teaching writing to diverse students who exhibit both normal variation and learning disabilities? How can we educate the business community, who called for accountability in education at a time when the current economic crisis indicates they should have focused on accountability in business rather than education, that school evolution not reform is needed so that schools evolve to optimize the achievement of a diverse[7] school population rather than impose an unrealistic homogeneous standard on all (Berninger et al., 2004)?[8] How can we reintroduce common sense and compassionativity (Berninger & Richards, 2002) into the equation for educational evolution that calls for respect for educators as well as students and parents as they work collaboratively to help all students express ideas in writing to the best of their varying[7] abilities?

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

I dedicate this article to Bernice Wong, Professor Emeritus, Simon Frazier University, for her pioneering and inspiring work to bring explicit and authentic writing instruction to students of diverse ethnic backgrounds and her many research, teaching, writing, and service contributions to students with learning disabilities. I also thank colleagues (in order of involvement in the writing research), Robert Abbott, H. Lee Swanson, Steve Hooper, Richard Venezky, Steve Graham, Todd Richards, William Nagy, Rick Wagner, Kenn Apel, Elaine Silliman, Michel Fayol, and Dick Hayes, for valued collaboration, Michael Dunn and Scott Beers for planned collaboration, and the 70 plus graduate students who assessed or taught research participants and often coauthored publications. Special thanks to Judith Rutberg Self, Dean Traweek, Theresa Hart, Dianne Whitaker Frances Fuller, Belle Chenault, Leah Altemeier, Noelia Garcia, and Nicole Alston-Abel whose dissertation research contributed greatly. I also thank Malt Joshi for his open-mindedness to the role of orthography in writing and reading. Finally, I thank my project officers at NIH—David Gray who helped me initiate the research, Reid Lyon who helped me sustain it, and Brett Miller who helped me complete it—and Charles Hughes, Editor, for inviting me to write about it.

Grants HD25858 and P50 33812 from the National Institute of Child Health and Human Development (NICHD) supported this research.

[6]The writing revolution, which arms parents with 95 evidence-based questions to ask of legislators, who are more likely to be able to make the needed changes related to writing than the writing researchers are, was launched in Seattle at the 2008 annual meeting of the International Dyslexia Association. For example, many schools are not providing explicit, systematic instruction in transcription skills and identifying students at-risk for transcription disabilities (TD); and special education tends to be more focused on reading than writing disabilities (Berninger, 2006a).

[7]Sources for this diversity and variability include (a) normal distribution of human traits and behaviors, (b) atypical profiles of human abilities due to genetic and neurological factors or injury or disease, (c) environmental variables ranging from cultural differences, family differences, personality differences, language differences, appropriateness and quality of instruction, and life experiences.

[8]Surely accountants have the numeracy skills to understand that human behaviors, including academic skills, distribute along normal curves; it is unrealistic to expect every child to be above the population mean. We need a no-fault understanding that learning to write is never solely the result of teachers alone or students alone but rather the product of complex interrelationships among educators (teacher knowledge), students (individual differences related to biology and environment), and parents (many of whom do not have financial or cultural capital or know-how to help their children with school learning).

References

Abbott R, Berninger V. Structural equation modeling of relationships among developmental skills and writing skills in primary and intermediate grade writers. Journal of Educational Psychology 1993;85 (3):478–508.

Abbott R, Berninger V, Fayol M. Longitudinal structural equation modeling of development of writing-writing and writing-reading connections at the letter, word and text levels in grades1 to 7. 2008Manuscript submitted for publication

Abbott S, Reed L, Abbott R, Berninger V. Year-long balanced reading/writing tutorial: A design experiment used for dynamic assessment. Learning Disability Quarterly 1997;20:249–263.

Altemeier L, Abbott R, Berninger V. Executive functions for reading and writing in typical literacy development and dyslexia. Journal of Clinical and Experimental Neuropsychology 2008;30:588–606. [PubMed: 18569253]

Altemeier L, Jones J, Abbott R, Berninger V. Executive factors in becoming writing-readers and reading-writers: Note-taking and report writing in third and fifth graders. Developmental Neuropsychology 2006;29:161–173. [PubMed: 16390292]

Amtmann D, Abbott R, Berninger V. Identifying and predicting classes of response to explicit, phonological spelling instruction during independent composing. Journal of Learning Disabilities 2008;41:218–234. [PubMed: 18434289]

Berninger V. Normal variation in reading acquisition. Perceptual and Motor Skills 1986a;62:691–716.

Berninger V. Comparison of two microcomputer-assisted methods of teaching word decoding and encoding to nonvocal, nonwriting, and learning disabled students. Programmed Learning and Educational Technology 1986b;23:124–129.

Berninger V. Global, component, and serial processing of printed words in beginning readers. Journal of Experimental Child Psychology 1987;43:387–418.

Berninger V. Development of operational thought without a normal sensorimotor stage. Intelligence 1988a;12:219–230.

Berninger V. Acquisition of linguistic procedures for printed words: Neuropsychological implications for learning. International Journal of Neuroscience 1988b;42:267–281. [PubMed: 3209379]

Berninger V. Coordinating transcription and text generation in working memory during composing: Automatized and constructive processes. Learning Disability Quarterly 1999;22:99–112.

Berninger, V. Understanding the graphia in dysgraphia. In: Dewey, D.; Tupper, D., editors. Developmental motor disorders: A neuropsychological perspective. New York: Guilford; 2004. p. 328-350.

Berninger, V. A developmental approach to learning disabilities. In: Siegel, I.; Renninger, A., editors. Handbook of child psychology, Vol IV, child psychology and practice. New York: John Wiley; 2006a. p. 420-452.

Berninger V. Research-supported ideas for implementing reauthorized IDEA with intelligent and professional psychological services. Psychology in the Schools 2006b;43:781–797.

Berninger, V. Process assessment of the learner, second edition. Diagnostic for reading and writing (PAL-II RW). San Antonio, TX: Psychological Corp; 2007a.

Berninger, V. Process assessment of the learner diagnostic for Math (PAL II-M). The San Antonio, TX: Psychological Corp; 2007b.

Berninger, V. Process assessment of the learner II user’s guide. San Antonio, TX: Harcourt/PsyCorp; 2007c. (CD format) Second Revision issued August, 2008

Berninger, V. Defining and differentiating dyslexia, dysgraphia, and language learning disability within a working memory model. In: Silliman, E.; Mody, M., editors. Language impairment and reading disability-interactions among brain, behavior, and experience. Guilford Press; 2008a. p. 103-134.

Berninger, V. Perspectives on language and literacy. International Dyslexia Association.; 2008b. Listening to parents of children with learning disabilities: Lessons from the University of Washington Multidisciplinary Learning Disabilities Center; p. 22-30.

Berninger V, Abbott R. Unit of analysis and constructive processes of the learner: Key concepts for education al neuropsychology. Educational Psychologist 1992;27:223–242.

Berninger, V.; Abbott, R. Redefining learning disabilities: Moving beyond aptitude-achievement discrepancies to failure to respond to validated treatment protocols. In: Lyon, GR., editor. Frames of reference for the assessment of learning disabilities: New views on measurement issues. Baltimore: Paul H. Brookes Publishing; 1994. p. 163-202.

Berninger, V.; Abbott, S. PAL Research-supported reading and writing lessons. Also Reproducibles. San Antonio, TX: Harcourt/PsyCorp; 2003.

Berninger V, Abbott R, Abbott S, Graham S, Richards T. Writing and reading: Connections between language by hand and language by eye. Journal of Learning Disabilities 2002;35:39–56. [PubMed: 15490899]

Berninger V, Abbott R, Augsburger A, Garcia N. Comparison of pen and keyboard transcription modes in children with and without learning disabilities affecting transcription. 2008Revised manuscript submitted

Berninger V, Abbott R, Jones J, Wolf B, Gould L, Anderson-Youngstrom M, et al. Early development of language by hand: Composing-, reading-, listening-, and speaking-connections, three letter writing modes, and fast mapping in spelling. Developmental Neuropsychology 2006;29:61–92. [PubMed: 16390289]

Berninger V, Abbott R, Rogan L, Reed E, Abbott S, Brooks A, et al. Teaching spelling to children with specific learning disabilities: The mind's ear and eye beat the computer or pencil. Learning Disability Quarterly 1998;21:106–122.

Berninger V, Abbott R, Swanson HL, Lovitt D, Trivedi P, Lin S, et al. Relationship of word- and sentence-level working memory to reading and writing in second, fourth, and sixth grade. Language, Speech, and Hearing Services in Schools. in press

Berninger V, Abbott R, Thomson J, Wagner R, Swanson HL, Wijsman E, et al. Modeling developmental phonological core deficits within a working-memory architecture in children and adults with developmental dyslexia. Scientific Studies in Reading 2006;10:165–198.

Berninger V, Abbott R, Whitaker D, Sylvester L, Nolen S. Integrating low-level skills and high-level skills in treatment protocols for writing disabilities. Learning Disability Quarterly 1995;18:293–309.

Berninger V, Cartwright A, Yates C, Swanson HL, Abbott R. Developmental skills related to writing and reading acquisition in the intermediate grades: Shared and unique variance. Reading and Writing: An Interdisciplinary Journal 1994;6:161–196.

Berninger V, Dunn A, Lin S, Shimada S. School evolution: Scientist-practitioner educators creating optimal learning environments for ALL students. Journal of Learning Disabilities 2004;37:500–508. [PubMed: 15586468]

Berninger, V.; Fayol, M. Encyclopedia of language and literacy development. London, ON: Canadian Language and Literacy Research Network; 2008. Why spelling is important and how to teach it effectively; p. 1-13.Available athttp://www.literacyencyclopedia.ca/pdfs/topic.php?topId=234

Berninger V, Fuller F. Gender differences in orthographic, verbal, and compositional fluency: Implications for diagnosis of writing disabilities in primary grade children. Journal of School Psychology 1992;30:363–382.

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

Berninger V, Gans B. Language profiles in nonspeaking individuals of normal intelligence with severe cerebral palsy. Augmentative and Alternative Communication 1986a;2:45–50.

Berninger V, Gans B. Assessing word processing capability of the nonvocal, nonwriting. Augmentative and Alternative Communication 1986b;2:56–63.

Berninger V, Gans B, St James P, Conners T. Modified WAIS-R for patients with speech and/or hand dysfunction. Archives of Physical Medicine and Rehabilitation 1988;69:250–255. [PubMed: 2965567]

Berninger, V.; Holdnack, J. Neuroscientific and clinical perspectives on the RTI initiative in learning disabilities diagnosis and intervention: Response to questions begging answers that see the forest and the trees. In: Reynolds, C.; Fletcher-Janzen, E., editors. Neuroscientific and clinical perspectives on the RTI initiative in learning disabilities diagnosis and intervention. New York: John Wiley; 2008. p. 66-81.

Berninger V, Mizokawa D, Bragg R. Theory-based diagnosis and remediation of writing disabilities. Journal of School Psychology 1991;29:57–79.

Berninger V, Mizokawa D, Bragg R, Cartwright A, Yates C. Intraindividual differences in levels of written language. Reading and Writing Quarterly 1994;10:259–275.

Berninger V, Nielsen K, Abbott R, Wijsman E, Raskind W. Writing problems in developmental dyslexia: Under-recognized and under-treated. Journal of School Psychology 2008a;46:1–21. [PubMed: 18438452]

Berninger V, Nielsen K, Abbott R, Wijsman E, Raskind W. Gender differences in severity of writing and reading disabilities. Journal of School Psychology 2008b;46:151–172. [PubMed: 19083355]

Berninger, V.; O'Donnell, L.; Holdnack, J. Research-supported differential diagnosis of specific learning disabilities and implications for instruction and response to instruction (RTI). In: Prifitera, A.; Saklofske, D.; Weiss, L., editors. WISC-IV Clinical assessment and intervention, second edition. San Diego, CA: Academic Press (Elsevier); 2008. p. 69-108.

Berninger V, Raskind W, Richards T, Abbott R, Stock P. A multidisciplinary approach to understanding developmental dyslexia within working-memory architecture: Genotypes, phenotypes, brain, and instruction. Developmental Neuropsychology 2008;33:707–744. [PubMed: 19005912]

Berninger, V.; Richards, T. Brain literacy for educators and psychologists. New York: Academic Press; 2002.

Berninger V, Richards T, Abbott R. The role of the hand in written idea expression. Proceedings for Writing in All Its States, University of Poitiers, Poitiers, France. 2009Submitted invited manuscript

Berninger V, Richards T, Stock P, Abbott R, Trivedi P, Altemeier L, et al. fMRI activation related to nature of ideas generated and differences between good and poor writers during idea generation. British Journal of Educational Psychology Monograph. in press

Berninger V, Rutberg J. Relationship of finger function to beginning writing: Application to diagnosis of writing disabilities. Developmental Medicine & Child Neurology 1992;34:198–215. [PubMed: 1559600]

Berninger V, Rutberg J, Abbott R, Garcia N, Anderson-Youngstrom M, Brooks A, et al. Tier 1 and Tier 2 early intervention for handwriting and composing. Journal of School Psychology 2006;44:3–30.

Berninger, V.; Swanson, HL. Modifying Hayes & Flower's model of skilled writing to explain beginning and developing writing. In: Butterfield, E., editor. Children's writing: Toward a process theory of development of skilled writing. Greenwich, CT: JAI Press; 1994. p. 57p. 81Reproduced in *The Learning and Teaching of Reading and Writing* (by R. Stainthorp). Wiley, 2006

Berninger V, Vaughan K, Abbott R, Abbott S, Brooks A, Rogan L, et al. Treatment of handwriting fluency problems in beginning writing: Transfer from handwriting to composition. Journal of Educational Psychology 1997;89:652–666.

Berninger V, Vaughan K, Abbott R, Begay K, Byrd K, Curtin G, et al. Teaching spelling and composition alone and together: Implications for the simple view of writing. Journal of Educational Psychology 2002;94:291–304.

Berninger V, Vaughan K, Abbott R, Brooks A, Abbott S, Reed E, et al. Early intervention for spelling problems: Teaching spelling units of varying size within a multiple connections framework. Journal of Educational Psychology 1998;90:587–605.

Berninger V, Vaughan K, Abbott R, Brooks A, Begay K, Curtin G, et al. Language-based spelling instruction: Teaching children to make multiple connections between spoken and written words. Learning Disability Quarterly 2000;23:117–135.

Berninger V, Whitaker D, Feng Y, Swanson HL, Abbott R. Assessment of planning, translating, and revising in junior high writers. Journal of School Psychology 1996;34:23–52.

Berninger V, Winn W, Stock P, Abbott R, Eschen K, Lin C, et al. Tier 3 specialized writing instruction for students with dyslexia. Reading and Writing. An Interdisciplinary Journal 2008;21:95–129.

Berninger, V.; Wolf, B. Teaching students with dyslexia and dysgraphia: Lessons from teaching and science. Baltimore, MD: Paul H. Brookes; (in press-a)

Berninger, V.; Wolf, B. Helping students with dyslexia and dysgraphia make connections: Differentiated instruction lesson plans in reading and writing. Baltimore, MD: Paul H. Brookes; (in press-b)Spiral book with teaching plans from University of Washington Research Program

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

Berninger V, Yates C, Lester K. Multiple orthographic codes in acquisition of reading and writing skills. Reading and Writing. An Interdisciplinary Journal 1991;3:115–149.

Bourdin B, Fayol M. Is written language production really more difficult than oral language production? International Journal of Psychology 1994;29:591–620.

Bourdin B, Fayol M. Mode effects in a sentence production task. Current Psychology of Cognition 1996;15:245–264.

Bourdin B, Fayol M. Is graphic activity cognitively costly? A developmental approach. Reading and Writing 2000;13:183–196.

Bourdin B, Fayol M. Even in adults, written production is still more costly than oral production. International Journal of Psychology 2002;37:219–222.

Brooks A, Vaughan K, Berninger V. Tutorial interventions for writing disabilities: Comparison of transcription and text generation processes. Learning Disability Quarterly 1999;22:183–191.

Chenault B, Thomson J, Abbott R, Berninger V. Effects of prior attention training on child dyslexics' response to composition instruction. Developmental Neuropsychology 2006;29:243–260. [PubMed: 16390296]

Garcia N, Abbott R, Berninger V. Discriminating poor, average, and superior spellers in grades 1 to 6 on set of phonological, orthographic, and morphological awareness measures. 2008Revised manuscript submitted

Graham S, Berninger V, Abbott R, Abbott S, Whitaker D. The role of mechanics in composing of elementary school students: A new methodological approach. Journal of Educational Psychology 1997;89(1):170–182.

Graham S, Berninger V, Weintraub N. The relationship of handwriting style and speed and legibility. Journal of Educational Research 1998;91:290–296.

Graham S, Struck M, Richardson J, Berninger V. Dimensions of good and poor handwriting legibility in first and second graders: Motor programs, visual-spatial arrangement, and letter formation parameter setting. Developmental Neuropsychology 2006;29:43–60. [PubMed: 16390288]

Hart T, Berninger V, Abbott R. Comparison of teaching single or multiple orthographic-phonological connections for word recognition and spelling: Implications for instructional consultation. School Psychology Review 1997;26:279–297.

Hayes, JR.; Berninger, V. Relationships between idea generation and transcription: How act of writing shapes what children write. In: Braverman, C.; Krut, R.; Lunsford, K.; McLeod, S.; Null, S.; Rogers, P.; Stansell, A., editors. Traditions of writing research. New York: Routledge; in press

Hayes JR, Chenoweth N. Is working memory involved in the transcribing and editing of texts? Written Communication 2006;23:135–149.

Hayes, JR.; Flower, L. Identifying the organization of writing processes. In: Gregg, LW.; Steinberg, ER., editors. Cognitive processes in writing: An interdisciplinary approach. Hillsdale, NJ: Lawrence Erlbaum; 1980. p. 3-30.

Lashley, KS. The problem of serial order in behavior. In: Jeffries, LA., editor. Cerebral mechanisms in behavior. New York: John Wiley; 1951. p. 112-136.

Richards T, Aylward E, Berninger V, Field K, Parsons A, Richards A, et al. Individual fMRI activation in orthographic mapping and morpheme mapping after orthographic or morphological spelling treatment in child dyslexics. Journal of Neurolinguistics 2006;19:56–86.

Richards T, Aylward E, Raskind W, Abbott R, Field K, Parsons A, et al. Converging evidence for triple word form theory in children with dyslexia. Developmental Neuropsychology 2006;30:547–589. [PubMed: 16925475]

Richards T, Berninger V. Abnormal fMRI connectivity in children with dyslexia during a phoneme task: Before but not after treatment. Journal of Neurolinguistics 2008;21:294–304. [PubMed: 19079567] Published on line by ScienceDirect for Elsevier 2007

Richards T, Berninger V, Fayol M. FMRI activation differences between 11-year-old good and poor spellers' access in working memory to temporary and long-term orthographic representations. Journal of Neurolinguistics. 200910.1016/j.jneuroling.2008.11.002

Richards T, Berninger V, Nagy W, Parsons A, Field K, Richards A. Brain activation during language task contrasts in children with and without dyslexia: Inferring mapping processes and assessing response to spelling instruction. Educational and Child Psychology 2005;22(2):62–80.

Richards T, Berninger V, Stock P, Altemeier L, Trivedi P, Maravilla K. fMRI sequential-finger movement activation differentiating good and poor writers. Journal of Clinical and Experimental Neuropsychology. in press

Silliman ER, Bahr RH, Peters ML. Spelling patterns in preadolescents with atypical language skills: Phonological, morphological, and orthographic factors. Developmental Neuropsychology 2006;20:93–123. [PubMed: 16390290]

Swanson HL, Berninger V. Individual differences in children's writing: A function of working memory or reading or both processes? Reading and Writing. An Interdisciplinary Journal 1996a;8:357–383.

Swanson HL, Berninger V. Individual differences in children's working memory and writing skills. Journal of Experimental Child Psychology 1996b;63:358–385. [PubMed: 8923751]

Thomson J, Chennault B, Abbott R, Raskind W, Richards T, Aylward E, et al. Converging evidence for attentional influences on the orthographic word form in child dyslexics. Journal of Neurolinguistics 2005;18:93–126.

Traweek D, Berninger V. Comparison of beginning literacy programs: Alternative paths to the same learning outcome. Learning Disability Quarterly 1997;20:160–168.

Venezky, R. The varieties of orthographic knowledge II: Their relation to phonology, reading, and writing. Dordrecht, The Netherlands: Kluwer Academic Press; 2005. From orthography to psychology to reading; p. 23-46.

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

Yates C, Berninger V, Abbott R. Writing problems in intellectually gifted children. Journal for the Education of the Gifted 1994;18:131–155.

Biography

Virginia W. Berninger (Ph.D. Psychology, Johns Hopkins University) has been a Professor of Educational Psychology at the University of Washington, Seattle since 1986. She teaches courses in school psychology, learning sciences, and educational neuroscience. She has been Director of the NICHD-funded Multidisciplinary Learning Disabilities Center and Literacy Trek. Her interests include basic and applied research (to clinics and schools).