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Evidence-Based Diagnosis and Treatment for Specific Learning Disabilities Involving Impairments in Written and/or Oral Language

Virginia W. Berninger1 and Maggie O’Malley May1

Abstract
Programmatic, multidisciplinary research provided converging brain, genetic, and developmental support for evidence-based diagnoses of three specific learning disabilities based on hallmark phenotypes (behavioral expression of underlying genotypes) with treatment relevance: dysgraphia (impaired legible automatic letter writing, orthographic coding, and finger sequencing), dyslexia (impaired pseudoword reading, spelling, phonological and orthographic coding, rapid automatic naming, and executive functions; inhibition and rapid automatic switching), and oral and written language learning disability (same impairments as dyslexia plus morphological and syntactic coding and comprehension). Two case studies illustrate how these differential diagnoses can be made within a conceptual framework of a working memory architecture and generate treatment plans that transformed treatment nonresponders into treatment responders. Findings are discussed in reference to the importance of (a) considering individual differences (diagnosis of impaired hallmark phenotypes) in planning and evaluating response to instruction and modifying instruction when a student is not responding; (b) recognizing that teaching may change epigenetic gene expression at one stage of schooling, but not the underlying gene sequences that render individuals still vulnerable as curriculum requirements increase in nature, complexity, and volume in the upper grades; and (c) using evidence-based diagnoses of specific learning disabilities that are consistent across states for free and appropriate education K to 12 and for accommodations throughout higher education and professional credentialing.

Keywords
Evidence-based diagnosis, differential diagnosis and treatment, dysgraphia, dyslexia, oral and written language learning disability (OWL LD)

All good teachers use both assessment and instruction to foster student learning. They may assess (a) current knowledge before introducing a lesson or unit and (b) response of individuals to instruction at the end of a lesson, a set of lessons, or major unit of study. They may take the results of these assessments into account in planning the next goals in teaching for the group as well as for individuals. This article was invited at a time when different perspectives exist as to how teachers should respond when a student shows persistent struggles in responding to instruction.

On the one hand, some focus on formal assessment to identify students with educationally handicapping conditions, who from birth to 21 have a civil right under federal law for free and appropriate public education (FAPE). Federal law is translated into legal code in each state for deciding which students are eligible for FAPE. However, each state has legal code that specifies procedures for implementing these eligibility criteria in different ways. In some states, eligibility is based on an arbitrary formula (e.g., discrepancy between Full Scale IQ and achievement on a cluster score, averaged over subtests, in a specific academic domain like reading, written expression, or math). However, research has not validated one and only one way to calculate discrepancy or amount of discrepancy or use of cluster scores within an academic domain in computing discrepancy. For example, pseudoword reading may be more diagnostic than the average of pseudoword reading and real word reading, and writing fluency may be more diagnostic than the average of writing samples (written expression) and writing fluency (see Berninger, 2006, 2008a).

On the other hand, some advocate a response-to-intervention (RTI) approach, which has three advantages. First, RTI focuses school professionals on the value of early intervention for prevention. Second, RTI can be applied to a wide
range of struggling learners, which include children from low socioeconomic (SES) and/or low literacy homes and English language learners as well as children who have biologically based educationally handicapping conditions or children who have learning problems to which both environmental and biological variables may contribute. Third, RTI may identify a variety of children with instructional and learning needs within general education. The current economic challenges call attention to the fact that schools cannot afford to send all children who fail to respond to instruction to special education. The disadvantage of RTI is that it does not pinpoint, that is, diagnose why an individual failed to respond to instruction and identify how any teacher in general or special education might adapt instruction so that the individual begins to respond to instruction.

In this article we propose and illustrate an alternative approach, which is grounded in 20 years of National Institute of Child Health and Human Development (NICHD) funded research. First, we advocate for FAPE for all students, not just those with specific learning disabilities. Educational professionals do not violate federal special education law by proactively providing appropriate and evidence-based instruction for all students, including those from low SES or low literacy homes and/or those who are learning English as a second language. Berninger and Wolf (2009b) offer guidance for how general education teachers can organize their classrooms to provide evidence-based differentiated oral language, reading, and writing instruction within group settings. Such an approach, if initiated in the early grades (K to 2) for beginning literacy skills, with follow-up in the upper elementary and middle school grades, and with grade-appropriate universal screening for a few developmentally appropriate target skills and RTI assessment, should increase the number of children who succeed in school, are promoted to the next grade, graduate from high school, gain access to higher education, and do not drop out of school, especially during elementary and middle school (e.g., Berninger, 2007).

At the same time, we acknowledge that some individuals have biologically based specific learning disabilities, which are best understood in reference to three conceptual models. The first model is the learning triangle (Berninger, 2007; Berninger, Stage, Smith, & Hildebrand, 2001; Berninger & Winn, 2006). According to this model, the base of this triangle—curriculum and instruction at one corner and instructional materials and tools at the other corner—supports the learning process, which is mediated by the individual differences in the learner (Berninger & Richards, 2009) at the topmost pinnacle of the learning triangle.

Curriculum is the set of grade-appropriate content to be taught and the sequence in which to teach it. Under ideal circumstances, this curriculum is evidence based and developmentally appropriate, that is, organized according to developmental stepping stones in achieving age- or grade-appropriate goals in specific academic domains. Some school systems have a well-articulated curriculum with scope and sequence outlined at each grade level. Others have standards or desired goals with little guidance as to what should be taught, when, how to achieve these standards, or which alternative approaches to use for differentiated instruction that meets individual differences in instructional needs. In addition, teacher conceptual knowledge about domain-specific content and pedagogical knowledge about teaching procedures for implementing curriculum in specific content domains also influence whether students meet standards or pass high-stakes tests.

Instructional materials and tools can also influence the effectiveness of teaching and student learning outcomes. In some school systems, textbook adoptions by the district determine which instructional tools (commercially purchased) and instructional strategies can be used. In others, teachers are given varying degrees of professional autonomy in choosing which textbooks and instructional tools to use. These may include classroom libraries, graded sets of instructional activities in a box, lessons for differentiating instruction, technology tools, or teacher-created lesson plans and instructional materials.

However, curriculum and instruction in one corner of the learning triangle and instructional tools and materials in the other corner of the learning triangle do not alone determine the student learning outcomes. Individual differences in the learner, which influence how a student responds to instruction, also contribute to learning. Individual differences in learners result from environmental and biological variables and nurture–nurture interactions as learners construct knowledge as they interact with the physical and social environments and respond in varying ways to the same instruction (e.g., Berninger & Abbott, 1992; Berninger & Chanquoy, 2009; Berninger & Richards, 2009). The educational implication is that a national list of “what works,” even if based on research, is unlikely to work with all students. Such a one-size-fits-all approach violates two general principles based on teaching experience: (a) Students vary greatly in their instructional levels at entry to each grade, and (b) students learn most effectively when taught at their instructional level (within which they experience mostly success but have room to grow). Evidence-based instruction must also deal with differentiated instruction—meeting the needs of all individuals in a classroom—and respect educators’ professional autonomy in choosing among evidence-based alternatives (Berninger & Richards, 2002; Berninger & Wolf, 2009b).

The second model is based on multidisciplinary research showing that hallmark phenotypes can be identified for biologically based, specific learning disabilities in children whose cognitive, language, motor, attention and executive function, and social emotional development fall within the normal range: That is, developmental disabilities
of the five developmental domains falls outside the normal range) and other neurogenetic disorders can be ruled out. Table 1 summarizes the hallmark phenotypes for three specific learning disabilities, which were identified based on behavioral assessment, family genetics, brain imaging, and treatment research. See the references in Table 1 for the details of the methods and findings for the representative studies. Phenotypes are behavioral markers of the expression of underlying genotypes.

Some children had only handwriting problems (dysgraphia), some had only reading and spelling problems (dyslexia), and some had oral language and written language problems (OWL LD) (Berninger, 2008a). Each specific learning disability had different sets of phenotypes related to the impaired writing and/or reading skills and related skills, which included common and unique phenotypes.

Dysgraphia was associated with impaired handwriting, orthographic coding (storing written words and processing letters in them), and finger sequencing (Denckla, 1973; Wolff, Gunnoe, & Cohen, 1983). All these contribute to function of the orthographic loop (written word stored in the mind’s eye connected via sequential finger movement for output through the hand with feedback through eye) (Berninger et al., 1992; Berninger, Rutberg, et al., 2006; Berninger, Cartwright, Yates, Swanson, & Abbott, 1994; Berninger et al., 1992; Berninger, Raskind, Richards, Abbott, and Stock (2008); Eckert et al. (2003); Richards, Berninger, and Fayol (2009)

### Table 1. Multidisciplinary Evidence for Hallmark Phenotypes in Dysgraphia, Dyslexia, and Oral and Written Language Learning Disability (OWL LD) (Berninger, 2007, 2008a) from Programmatic Research 1989–2008

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Hallmark Phenotypes</th>
<th>Representative Multidisciplinary Studies (Assessment, Brain Imaging, and Family Genetics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysgraphia</td>
<td>Automatic legible letter writing</td>
<td>Berninger et al. (1992); Berninger, Cartwright, Yates, Swanson, and Abbott (1994); Berninger, Whitaker, Feng, Swanson, and Abbott (1996); Richards et al. (in press)</td>
</tr>
<tr>
<td>Orthographic coding</td>
<td>Abbott and Berninger (1993); Berninger et al. (1992, 1994); Berninger, Raskind, Richards, Abbott, and Stock (2008); Eckert et al. (2003); Richards, Berninger, and Fayol (2009)</td>
<td></td>
</tr>
<tr>
<td>Finger succession</td>
<td>Berninger and Rutberg (1992); Berninger et al. (1992, 1994); Peter et al. (2009); Richards, Berninger, Stock, et al. (2009)</td>
<td></td>
</tr>
<tr>
<td>Dyslexia</td>
<td>Pseudoword reading</td>
<td>Berninger, Abbott, Thomson, and Raskind (2001); Berninger, Abbott, et al. (2006); Chapman, Raskind, Thomson, Berninger, and Wijsman (2003); Hsu, Wijsman, Berninger, Thomson, and Raskind (2002); Raskind, Hsu, Thomson, Berninger, and Wijsman (2000); Raskind et al. (2005); Richards et al. (2007); Stanberry et al. (2006)</td>
</tr>
<tr>
<td>Spelling</td>
<td>Berninger, Nielsen, Abbott, Wijsman, and Raskind (2008a, 2008b); Hsu et al. (2002); Richards, Berninger, and Fayol (2009); Raskind et al. (2000); Wijsman et al. (2000)</td>
<td></td>
</tr>
<tr>
<td>Phonological coding</td>
<td>Berninger et al. (2001); Berninger, Abbott, et al. (2006); Berninger, Raskind, et al. (2008); Richards et al. (2005, 2006b, 2007); Brkanac et al. (2008); Eckert et al. (2003); Wijsman et al. (2000)</td>
<td></td>
</tr>
<tr>
<td>Orthographic coding</td>
<td>Berninger et al. (1992, 1994); Berninger, Abbott et al. (2001); Berninger, Abbott, et al. (2006); Berninger, Raskind, et al. (2008); Eckert et al. (2003); Richards, Aylward, Berninger, et al. (2006); Richards, Berninger, Nagy, et al. (2005); Richards, Berninger, and Fayol (2009)</td>
<td></td>
</tr>
<tr>
<td>Rapid automatic naming</td>
<td>Amtmann, Abbott, and Berninger (2007); Berninger, Abbott et al. (2001); Berninger, Abbott, et al. (2006); Berninger, Raskind, et al. (2008); Eckert et al. (2003)</td>
<td></td>
</tr>
<tr>
<td>Inhibition</td>
<td>Altemeier et al. (2008); Altemeier, Jones, Abbott, and Berninger (2006); Berninger, Abbott, et al. (2006); Berninger, Raskind, et al. (2008); Richards, Aylward, Raskind, et al. (2006); Thomson et al. (2005)</td>
<td></td>
</tr>
<tr>
<td>Rapid automatic switching</td>
<td>Altemeier, Abbott, and Berninger (2008); Amtmann et al. (2007); Berninger et al. (2001); Berninger, Abbott, et al. (2006); Berninger, Raskind, et al. (2008); Hsu et al. (2002); Raskind et al. (2000)</td>
<td></td>
</tr>
<tr>
<td>OWL LD</td>
<td>Morphological coding</td>
<td>Berninger; Abbott, et al. (2006); Berninger, Raskind, et al. (2008); Nagy, Berninger, and Abbott (2006); Richards, Aylward, Berninger, et al. (2006); Richards, Aylward, Raskind, et al. (2006); Richards et al. (2005)</td>
</tr>
</tbody>
</table>

Note: Phenotypes = behavioral markers of impaired writing, reading, oral language, and related skills with biological bases; phenotypes may be modified in epigenetics—gene expression (Cassiday, 2009)—but not gene sequence in response to instructional intervention.
Dyslexia was associated with impaired orthographic and phonological coding (storing written words and spoken words and analyzing the letters and sounds in them, respectively), phonological loop (spoken words stored in the mind’s ear connected with mouth’s articulation and feedback through the ear) and orthographic loop, and executive functions (inhibition, rapid automatic switching, and self-monitoring during verbal fluency) (Berninger, Abbott, et al., 2006; Berninger, O’Donnell, & Holdnack, 2008; Berninger, Raskind, Richards, Abbott, & Stock, 2008). In these studies, rapid automatic naming (RAN) (Wolf & Bowers, 1999) was used to assess the phonological loop for time-sensitive, cross-code integration of phonological naming and orthographic or visual stimuli. Expressive orthographic coding and/or automatic legible letter writing was used to assess the orthographic loop for time-sensitive, cross-code integration of written words or letters in the mind’s eye and writing them by hand. Color naming of color-inconsistent written words on the Stroop task was used to assess inhibition (focus on the irrelevant, ignore the irrelevant). Rapid automatic switching (RAS) (Wolf, 1986) was used to assess flexibility in switching attention from a previously relevant stimulus category that becomes irrelevant to a new stimulus category, which was previously irrelevant but now becomes relevant. Repetitions on a verbal fluency task (orchestrate executive functions to search long-term semantic memory for exemplar words in a specified category) were used to assess self-monitoring of verbal working memory over time.

Although many think of dyslexia as a specific reading disability, it is really a specific reading and writing disability; initially children struggle with phonological decoding, but the persisting problem is spelling disability (Berninger, Nielsen, et al., 2008b). Although word reading and spelling are significantly related across adjacent grades, the magnitude of the relationship is substantially higher within spelling or within reading than across them, showing that they are related but not identical skills (Abbott, Berninger, & Fayol, 2010).

OWL LD was associated with impaired orthographic, phonological, and morphological coding (storing bases and affixes in spoken and/or written words); syntactic coding (storing and processing accumulating spoken and/or written words); the phonological and orthographic loops; and the same executive functions as for dyslexia (inhibition, rapid alternating switching, and self-monitoring during verbal fluency/word retrieval).

**Comorbidities.** Some individuals showed impairments in hallmark deficits for dysgraphia plus dyslexia or dyslexia plus OWL LD, but many showed the hallmark deficits for only one of these specific learning disabilities. Individuals might exhibit impairment in all hallmark phenotypes or a subset of them (Berninger, 2008a; Berninger, Abbott, et al., 2006; Berninger, Raskind, et al., 2008).

**Educationally handicapping conditions.** These three specific learning disabilities affecting written language acquisition are educationally handicapping conditions because although the affected individual may, in response to effective instruction, appear to overcome his or her reading or writing disabilities at a behavioral level (i.e., compensate), they may remain impaired in the phenotypes reflecting underlying genetic vulnerability such as spelling (e.g., Berninger, Abbott, et al., 2006; Berninger, Nielsen, et al., 2008b; Berninger, Raskind, et al., 2008). Instruction may modify the epigenetics of gene expression (Cassiday, 2009), but cannot change the gene sequences inherited at birth, which may render an individual vulnerable throughout schooling and the adult years, especially as the nature of written language requirements change and increase in complexity and volume (e.g., Berninger, 2006; Berninger, Nielsen, et al., 2008a, 2008b). Brain imaging studies show that treatment can normalize specific brain regions, but none to date has shown that evidence-based treatment can normalize the functional connectivity of all relevant brain systems for reading and writing across the life span in individuals with evidence-based diagnosis and multigenerational history of dysgraphia, dyslexia, or OWL LD.

Moreover, individuals with specific, biologically based learning disabilities may have to exert extra effort to achieve the same achievement outcomes as peers; as a result, they may experience considerable anxiety or frustration (Berninger, 2008c). They may have to exert extra effort because of extreme difficulty in sustaining verbal processing in working memory over time; research showed that they fall into two classes on RAN and RAS compared to nonaffected individuals—steady slow or slow and slower (Amtman, Abbott, & Berninger, 2007). Thus, the extra effort may be due to difficulty in sustaining working memory activity over time due to inefficiencies in phonological loop (RAN) or executive functions for flexible switching (RAS). This educationally handicapping condition (Berninger, 2008c) is not visible to others like many physical and communication disabilities are. That is why formal assessment is often necessary to diagnose the working memory problems associated with the three specific learning disabilities on which this article focuses.

The third model is a working memory architecture consisting of coding units for storing and processing three word forms (phonological for spoken words, orthographic for written words, and morphological for bases and affixes in spoken and written words) and syntax (accumulating words), two loops for time-sensitive, cross-code coordination (phonological and orthographic/visual or orthographic and finger sequences), and a panel of executive functions (inhibition—attend to what is relevant, ignore what is irrelevant; rapid switching attention between what is and is not relevant; and self-monitoring and updating during verbal fluency/word retrieval). For review of evidence, see Berninger, Abbott,
et al. (2006) and Berninger, Raskind, et al. (2008). This architecture may be the language learning mechanism, which when components are adequately developed and function in concert (i.e., are temporally coordinated), supports oral and written language development (Berninger, Abbott, et al., 2010). Consistent with Swanson’s long-standing, programmatic research on working memory (e.g., Swanson, in press), individuals with reading and writing disabilities have working memory impairments as illustrated by the brain differences between those with and without dyslexia, on an fMRI n-back working memory task (Richards, Berninger, Winn, Swanson, et al., 2009). However, individuals vary in which working memory component or set of components is impaired and mediates their response to instruction.

**Word forms.** Individuals vary in whether they are impaired in phonological, orthographic, and/or morphological word form coding (storage and processing of word forms in working memory). More children with dyslexia fell outside the normal range on orthographic word form tasks carefully designed so that they could not be answered solely on the basis of phonological correspondences (Berninger, Abbott, et al., 2006). Consistent with triple word form theory, learning to decode and spell words requires coordination among all three word forms: For both children with and without dyslexia and adults with dyslexia, the path for the second-order factor underlying all three word forms (phonological, orthographic, and morphological) was significant and of greater magnitude than the paths for single factors to all the reading and writing outcomes, including phonological decoding (Berninger, Raskind, et al., 2008). A growing body of evidence shows that individual differences in each of the word forms and their coordination (interrelationships) contribute to reading and writing outcomes of children with and without learning disabilities, who benefit from instruction aimed at each of the word forms and their interrelationships. See Berninger and Fayol (2008) for a review of this research for educators and Henry and Redding (1996) and Berninger and Wolf (2009a) for evidence-based instruction.

**Syntax coding of accumulating word forms (Berninger, 2008a).** For syntax, two findings are important. First, impaired syntax occurred much less often than impaired phonological coding in individuals with dyslexia (Berninger, Abbott, et al., 2006; Leonard, Eckert, Given, Berninger, & Eden, 2006), which is why they probably have impaired phonological decoding early in schooling, impaired spelling throughout schooling if not treated, but generally in the upper grades do not have impaired silent reading comprehension. Second, in a structural imaging study, a different neural signature was observed for (a) individuals with only mild phonological impairment, who may represent the majority of the fast responders to early intervention in school settings, and (b) individuals with a positive or negative neuroanatomical risk factor, who are more likely to have severe learning disabilities with impaired reading comprehension and written composition (see Leonard et al., 2006). Thus, assessment of specific learning disabilities should determine if an individual’s problems are specific to phonology or include both phonology and syntax.

**Loops.** Loops contribute in at least two ways to working memory functions. First, they support cross-code integration (e.g., orthography and phonology or orthography and finger movement). Second, they coordinate the sensory and motor processes, which are the only brain processes with direct contact with the external world (e.g., mouth and hand) and internal mental processes, which have only indirect contact with the external world through corresponding sensory and motor systems (e.g., phonology and orthography). On the Wechsler Scales, Digit Span may assess phonological loop function and Coding may assess orthographic loop function (Berninger, Abbott, Swanson et al., 2010). In a structural imaging study, all three neuroanatomical structures that differentiated children with and without dyslexia—left pars triangularis (associated with phonological coding) and right pars triangularis (associated with orthographic coding) in the frontal region and subcortical right anterior cerebellum (associated with precise timing)—were significantly correlated with RAN (Eckert et al., 2003). These structures may participate in the phonological loop of working memory, which enables time-sensitive cross-talk between orthographic/visual input and phonological/oral output while learning to read and write.

In a functional imaging study, children with and without dysgraphia differed in both orthographic coding in the mind’s eye (Richards, Berninger, & Fayol, 2009) and finger sequencing (Richards, Berninger, Stock, et al., 2009). Note that all orthographic coding tasks used in our studies were designed so that they cannot be performed correctly based only on phonological processing or correspondences. Five regions of significant activation during finger sequencing were consistently predicted by automatic legible letter writing (requires sequencing of strokes), spelling (requires sequencing of letters), and composing (requires sequencing of words, sentences, ideas in discourse schema) in the combined sample of good and poor handwriters (Berninger, Richards, & Abbott, 2009; Richards, Berninger, Stock, et al., 2009). These regions (bilateral inferior temporal, right precuneus, left superior parietal, right inferior frontal orbital) may participate in the neural network for the orthographic loop of working memory involved in time-sensitive, cross-code integration of written words or letters and motor output through sequential finger movements.

**Executive functions.** For children with dyslexia, executive functions (inhibition and RAS) fell outside the normal range more often than did the phonological loop or word form components of working memory (Berninger, Abbott, et al., 2006). That is why many individuals with specific learning disabilities affecting word decoding and spelling may require and benefit from being taught self-regulation.
strategies and receiving continual teacher guidance for maintaining focus, sustaining work, switching between activities during reading and writing, and self-monitoring working memory over time.

**Reconciling phonological core deficit and working memory architecture models.** This working memory architecture model is compatible with the well-documented phonological core deficit in dyslexia (Stanovich & Siegel, 1994; Wagner & Torgesen, 1987). On the one hand, the phonological word form coding unit may be impaired and interfere with development of decoding or spelling. An individual may be an accurate decoder who is slow on decoding tasks or both inaccurate and slow in decoding (Lovett, 1987). Accuracy and rate of decoding may have common and unique genetic mechanisms (Chapman, Raskind, Thomson, Berninger, & Wijsman, 2003; Raskind et al., 2005). On the other hand, the various working memory components may not be synchronized in time, resulting in fluency problems for tasks that require coordination of multiple processes. For example, inefficiencies in the storage or processing of the syntax coding unit or its temporal coordination with the word form region and phonological loop may result in impaired oral reading fluency for passages (see Berninger et al., 2010). For further discussion and evidence, see Berninger, Abbott, et al. (2006) and Berninger, Raskind, et al. (2008).

**Fluency and flexibility.** A recent review of cross-disciplinary research on fluency supported two conclusions (Berninger et al., 2010): First, in cognitive psychology, automaticity refers to a single process that is executed quick and effortlessly, for example, rapidly naming a letter (RAN) or written word (automatic word reading), but fluency, in contrast, refers to the coordination of multiple processes in synchrony, for example, oral reading of a passage accurately, quickly, and smoothly in coordinated fashion. Such fluent oral reading of passages reflects the musical melody of spoken language, functioning of the syntactic coding unit as discussed earlier, and verbal fluency in orchestrating executive functions to search through categories in semantic memory for exemplar words that can be retrieved and named. Second, fluency can be not only a causal mechanism but also an outcome that reflects how well the multiple processes involved in reading and writing are developed and coordinated in time. For example, relationships between reading comprehension and fluency can be bidirectional: reading comprehension → fluency as well as fluency → reading comprehension (Berninger et al., 2010). Moreover, research is showing that not only fluency but also flexibility is important in reading and writing (Cartwright, 2008). For example, rapid automatic switching, which is the time required to name orally visual symbols or stimuli that alternate in category of stimuli (e.g., letters and digits), is often used to assess individuals’ flexibility in switching mental set. In theory-driven, hierarchical multiple regression, RAS explained unique variance in more reading and writing outcomes than inhibition (Altemeier, Abbott, & Berninger, 2008), which may be related to automatic retrieval (Berninger, Nielsen, et al., 2008b; Berninger, O’Donnell, et al., 2008).

**Case Studies to Illustrate Value of Differential Diagnosis and Treatment**

Because more attention has been given to developmental dyslexia than developmental dysgraphia and OWL LD in research and practice, cases were selected to illustrate diagnosis and instructional issues specific to these specific learning disabilities, which also occur in school-age children and youth and young adults. In the section that follows we describe our thought processes in planning, conducting, and evaluating the instruction yoked to prior differential diagnosis and treatment planning, which also drew on evidence from prior instructional studies.

**Kinds of evidence.** We begin with reflection on what counts as evidence in evidence-based assessment and instruction. On the one hand, the evidence may be from scientific studies that analyze results for groups and have external validity for generalizing results to learners in general. On the other hand, evidence may be from single-subject studies and have external validity for generalizing results only to that individual and not to other learners. In the current study, we drew on prior instructional studies with large or moderate size samples, which provided knowledge of instructional activities that were beneficial for students with specific learning disabilities in general. However, we gathered new data on how two individuals responded to these instructional activities and generalized results only to each individual as appropriate to evaluate whether diagnosis for the individual was relevant to the effectiveness of the treatment for the individual. Thus, we drew on the contributions of the two scientific disciplines of psychology (Cronbach, 1957). The purpose was to model how knowledge from evidence-based, group instructional studies can be applied to gathering evidence about how individuals respond to instruction tailored, based on diagnostic assessment, to their individual instructional needs.

**Gender differences.** Not surprisingly, both cases were boys. Although recent research has not supported gender differences in reading disabilities, gender differences do occur in writing disabilities and often in individuals with comorbid writing and reading disabilities (Berninger, Nielsen, et al., 2008a). In a family study of dyslexia, boys and men were more impaired in handwriting and composing than were girls and women, and men were more impaired in spelling, handwriting, and composing than women. Males were consistently more impaired than females in orthographic skills, which may be the source of gender differences in writing rather than motor skills. In fMRI studies of finger sequencing,
the only gender difference in brain activation was in the left superior parietal region, which has been found to be associated with orthographic processing, and no gender differences in brain activation were observed on other writing tasks.

IQ. In formulating a differential diagnosis, index/factor scores were used rather than Full Scale IQ but not in a traditional IQ–achievement discrepancy formula for four reasons. First, Berninger, Abbott, Thomson, and Raskind (2001) reviewed prior NICHD-funded studies showing that verbal reasoning factor/index/composite score is a better predictor of reading achievement in referred and unreferral populations. Second, for individuals with language learning ability (OWL LD) that surfaces in the preschool years, however, perceptual organization/nonverbal reasoning may be a more appropriate measure given their language problems to evaluate if cognition falls at least within the normal range (Berninger, O’Donnell, et al., 2008). Like the wise old owl, some individuals with OWL LD are very bright in nonverbal cognition (Berninger, 2008c). Third, the publishers of the Wechsler Scales recommend, based on research, using the index/factor rather than Full Scale IQ in diagnostic assessment (Prifitera, Weiss, & Saklofske, 1998). Also, for discussion of caution in using Full Scale IQ scores and other assessment applications of cognitive measures on IQ tests, see Fiorello, Hale, and Snyder (2006); Hale, Fiorello, Kavanagh, Holdnack, and Aloe (2007); and Hale et al. (2008). Fourth, as shown in Table 2 each of the cases had so much scatter across the index/factor scores that the full scale score could not be meaningfully or appropriately interpreted. It was helpful though to have cognitive assessment results so that the instruction could be geared to individuals whose reasoning was well above the average student of the same age but who had significant working memory problems. Finally, we note that IQs are not really quotients or measures of all human intellectual abilities but rather evidence-based measures of scholastic aptitude, which when used appropriately can facilitate individuals’ education (e.g., identifying intellectual talents, developmental disabilities in which not only cognition but also other domains of development fall outside the normal range, and factor scores that are phenotype markers for specific learning disabilities such as working memory or processing speed).

Evidence-based group instructional program with differentiated instruction for individuals. In designing comprehensive instruction that would develop each component of the working memory architecture and facilitate its temporal coordination, we drew on evidence-based Tier I early intervention, Tier 2 intervention for high stakes standards, and Tier 3 differential diagnosis and instruction for writing (e.g., Berninger, 2008b) and reading (e.g., Berninger & Richards, 2009, Chapter 8) and integrated reading-writing instruction (Berninger & Wolf, 2009b). The lessons selected were designed, as in prior instructional research, to overcome the problems in working memory by teaching to all levels of language close in time (subword, word, and text), teaching for transfer from one level of language to the next (e.g., subword letter writing to word spelling, word spelling to text composing), teaching procedural knowledge until it is automatic (e.g., automatic letter writing or phoneme–grapheme correspondences in spelling), and providing hands-on, intellectually engaging and motivating activities and themes that support reflection about language and idea construction and expression in reading comprehension and written composition.

Each boy participated in a 4-week summer program (3 hours a day, 4 days a week, for 4 weeks) in which the teacher worked with both boys together. The table in the appendix summarizes the common instructional components included in each 3-hour session. The basic instructional core (appendix; units refer to Berninger & Wolf, 2009a) that both boys received consisted of (a) warm-up activities in Unit IV, word-form reflection activities for phonology and morphology in Unit I, and word play and sentence play activities we designed for the current study to develop awareness of all three word forms and syntax, and (b) 14 lessons in Unit II for composing (planning, translating, reviewing/revising), a lesson for an independent writing assignment Star Wars or Star Peace 3002, and a final session for compiling writing portfolios. Instruction was provided within the context of a Writers’ Workshop because this instructional context is developmentally appropriate for fifth and seventh graders and both boys had difficulty with completing written assignments successfully.

However, based on the initial assessment, designed to diagnose why each had previously failed to respond to instruction, differentiated instruction was also planned. The first boy had just completed seventh grade and was referred because he had persisting severe writing problems. The second boy had completed fifth grade and was referred because he had persisting reading problems, especially with reading comprehension. For reasons related to differential diagnosis assessment results, the first boy also completed handwriting lessons geared to automatic letter writing (Berninger, 1998a), note taking, and reflective writing in a journal (Unit IV). The second boy completed additional sound and morphological word part games because he had difficulty perceiving the second phoneme in blends and perceiving word parts that mark grammar information. Pseudoword reading was taught in a way that facilitated attention to sequential orthographic units in words during decoding (Berninger, Winn, et al., 2008).

The treatment was implemented by the second author, an experienced, certified teacher who was a graduate student in school psychology. She had participated as a teaching assistant in prior intervention studies supervised by the first author. Both authors collaboratively planned the instructional program for the boys and monitored their progress.
Case 1: Diagnosing and treating dysgraphia (A.B.). The following background information is relevant to understanding A.B.’s diagnosis and treatment needs. In seventh grade A.B. had a 504 accommodation plan, which involved use of a laptop, but he did not use the laptop for all his writing assignments. He failed some courses because he could not complete written assignments and he received low grades because of his illegible handwriting. His mother reported that A.B. read at least 8 hours independently at home each week. Although he scored in the very superior range (99th percentile) on cognitive assessment at school, he was not selected for the gifted program. Dysgraphia is not uncommon in intellectually gifted individuals, but is often not identified or treated; in addition, gifted children with writing disabilities often do not receive programming for their intellectual talents because of difficulty in completing written work (Yates, Berninger, & Abbott, 1994).

From birth to age 3, A.B. had received early intervention services for motor delay. His handwriting problems were first evident in kindergarten. A private occupational therapy

Table 2. Response to Instruction Relative to Peers Following Differential Diagnosis and Treatment

<table>
<thead>
<tr>
<th>Test (Construct Assessed)</th>
<th>Case (A.B.) With Dysgraphia Pretest</th>
<th>Case With Dysgraphia Posttest</th>
<th>Case (C.D.) With OWL LD Pretest</th>
<th>Case with OWL LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest</td>
<td>Case With Dysgraphia Pretest</td>
<td>Case With Dysgraphia Posttest</td>
<td>Case (C.D.) With OWL LD Pretest</td>
<td>Case with OWL LD</td>
</tr>
<tr>
<td>WISC-IV index scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Comprehension</td>
<td>130</td>
<td></td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>Perceptual Reasoning</td>
<td>131</td>
<td></td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>Working Memory</td>
<td>91</td>
<td></td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>Processing Speed</td>
<td>73</td>
<td></td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>UW Alphabet Writing 15</td>
<td>−1.03 z</td>
<td>+0.05 z</td>
<td>0.20 z</td>
<td>0.80 z</td>
</tr>
<tr>
<td>WIAT-II Spelling</td>
<td>90</td>
<td>107</td>
<td>73</td>
<td>70</td>
</tr>
<tr>
<td>WIAT-II Written Expression</td>
<td>93</td>
<td>103</td>
<td>93</td>
<td>na</td>
</tr>
<tr>
<td>WJ-III Writing Fluency</td>
<td>109</td>
<td>111</td>
<td>65</td>
<td>68</td>
</tr>
<tr>
<td>WIAT-II Word Reading</td>
<td>105</td>
<td>110c</td>
<td>68d → 74</td>
<td>78d</td>
</tr>
<tr>
<td>WIAT-II Pseudoword Reading</td>
<td>104</td>
<td>107c</td>
<td>97a</td>
<td>99</td>
</tr>
<tr>
<td>PAL Finger Succession</td>
<td>10th decile</td>
<td></td>
<td>10th decile</td>
<td></td>
</tr>
<tr>
<td>PAL rapid automatic naming</td>
<td>20th decile</td>
<td></td>
<td>10th decile</td>
<td></td>
</tr>
<tr>
<td>PAL rapid automatic switching</td>
<td>30th decile</td>
<td></td>
<td>10th decile</td>
<td></td>
</tr>
<tr>
<td>CELF 4 Formulated Sentences</td>
<td>11</td>
<td>13</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>UW Morphological Comes From</td>
<td>0.47</td>
<td>0.47</td>
<td>−0.42</td>
<td>0.19</td>
</tr>
</tbody>
</table>
| BRIEF critical range > 65 | Based only on
case with OWL LD |

Behavioral Regulation Index | Critical |
Inhibit | Critical |
Shift | Critical |
Emotional control | Critical |
Metacognitive Index | Critical |
Initiate | Critical |
Working memory | Critical |
Plan/organize | Critical |
Monitor | Critical |
Global Executive Composite | Critical |

evaluation at age 7 documented that A.B. was severely delayed in handwriting legibility and speed, especially when he had to write letters from memory and could not copy them, and in spelling dictated words. Although A.B. cried whenever a school assignment required handwriting and began avoiding writing assignments, he did not receive any services at school for his writing problems. The curriculum did not emphasize spelling. His mother helped him at home with letter formation. He was assessed for attention-deficit/hyperactivity disorder (ADHD), but results were inconclusive—A.B. seemed to show more signs of anxiety. When he was in fifth grade, he was hospitalized for depression and anxiety related to school problems. However, despite concerns expressed by his teacher, the pretreatment, comprehensive assessment of writing (handwriting, spelling, and composing), and differential diagnosis of A.B.’s writing problems were first conducted in the summer prior to entry to eighth grade.

Pretesting confirmed a differential diagnosis of dysgraphia. As shown in Table 2, A.B.’s automatic letter writing, spelling, and written composition skills were well below the mean and below his Oral Verbal Comprehension Index. Note that on writing fluency, which is a sentence writing task, he did not show evidence of disability; his strong syntax awareness skills may have served him well when given three words and asked to quickly create a sentence containing them. His writing problems were specific to certain levels of language. He did not have word-form coding problems (see Note a on Table 2), but he did have significant problems at the subword level (letter writing) and transword level (composing). In addition, he showed the impaired hallmark phenotypes in sequential finger movements, even based on sixth-grade norms, and executive function problems (see mother’s ratings for inattention, ability to focus attention in Table 2), which fell in the critical range for a problem. Although his reading skills were not as well developed as one might expect for his verbal reasoning, they were well above the population mean.

A.B. participated in all 16 3-hour tutoring sessions. He enjoyed the activities with the pseudowords and wanted to give the fake words definitions. Posttesting showed that after A.B. was given comprehensive writing instruction geared to transcription (handwriting and spelling) and composition, with differentiated instruction for overcoming his diagnosed dysgraphia (impaired handwriting), A.B. was a treatment responder at all levels of written language. He improved to above the population mean in subword handwriting (>1 SD), word spelling (>1 SD), and text composing (2/3 SD) relative to his age or grade peers. We did not conclude that he would no longer need explicit, comprehensive writing instruction with specialized instruction for handwriting. Rather, like all middle school students he would benefit from explicit, systematic writing instruction in planning, translating across levels of language (subword, word, and text), reviewing, and revising (e.g., Berninger, Winn, et al., 2008; Troia, 2009). Moreover, without ongoing specialized instruction, his biological vulnerability may surface again, especially as the nature and complexity of writing requirements for written assignments increase in the upper grades. Another student who had adequate handwriting legibility and automaticity but impaired spelling may have needed the same comprehensive writing instruction with specialized instruction for spelling.

Case 2: Diagnosing and treating OWL LD (C.D.). The following background information is relevant to understanding C.D.’s diagnosis and treatment needs. In preschool C.D.’s teachers discussed his problems with his parents: Although C.D. excelled in motor skills and had learned to play chess, his speech was not intelligible despite normal hearing. Parents noted that he still mispronounces some words. Thus, he showed signs of speech sound disorder (SSD). He was also diagnosed with word retrieval problems early in schooling, which are often found in children with OWL LD (Silliman & Scott, 2009). C.D. received very poor grades in reading and writing during fifth grade. He had difficulty with spelling and composition and reading, but not with handwriting. According to his parents, C.D. read books at home each week for about 30 to 60 minutes and read text on the monitor while playing computer games for about 30 to 60 minutes each week. He always needed help from his parents to complete homework.

Because of concerns about lack of progress in reading and writing despite an Individual Education Plan (IEP) and special education services at school since kindergarten and private tutoring, C.D.’s parents referred him for a neuropsychological evaluation to find out why he was not responding to intervention. C.D. had previously been diagnosed with ADHD and was taking Ritalin at the time of the initial assessment and subsequent intervention. Even with medication, parents reported he had difficulty staying on task unless an adult worked with him. The school was also puzzled and asked to meet with the evaluation team. In keeping with the recommendations of the National Reading Panel (NICHD, 2000), the school had been providing intensive phonics and phonological decoding instruction since second grade and could not understand why C.D. had made no progress in real word reading or reading comprehension. He was considerably delayed in those skills compared to phonological decoding, which was near the population mean, even though he had speech sound disorder.

The first author supervised the neuropsychological evaluation, which confirmed a differential diagnosis of OWL LD rather than dyslexia because C.D. had significant oral language problems over and beyond his phonological awareness and he had more severe problems in reading real words than reading pseudowords. It is not unusual for students with OWL LD to show a reliable pattern of phonological decoding > word reading, whereas students with dyslexia show the reverse pattern (Berninger, 2008a; Berninger,
O'Donnell, et al., 2008; Berninger, Raskind, et al., 2008). He also had text-level reading comprehension and composition writing problems, which are common in children with OWL LD (also referred to as selective language impairment, SLI, or language learning disability, LLD; Silliman & Scott, 2009). Also, significant problems in oral language beyond phonological awareness, namely, in morphological and syntactic awareness and expressive oral language, were identified. He had spelling and composing problems, but not handwriting problems. As a result of the evaluation, the school expanded his IEP beyond special education services for reading only to speech, oral language, and communication services as well.

During the parent feedback, the trainee and supervisor explained that C.D. had significant deficits in orthographic, morphological, and syntactic awareness, which needed remediation for C.D.’s real word reading and reading comprehension skills to improve. A copy of Patterns for Success in Reading and Writing (Henry & Redding, 1996) with lessons for developing morphological, orthographic, and phonological awareness in words of different word origin was lent to the team to use with C.D. during the last 6 weeks of the school year. When the real word reading measures were readministered after his teachers introduced the morphological program in the last 6 weeks of school, C.D. showed an upward trend from the neuropsychological evaluation earlier in fifth grade to the end of fifth grade (see Table 2). His scores on the three word forms (phonology, orthography, and morphology).

C.D. participated in 14.5 3-hour tutoring sessions. He needed a lot of help staying focused and organized during writing. He had trouble transferring word spelling to composing sentences. On the before and after activities he had to recite the whole alphabet to find specific letters. Note he could write letters, but had difficulty finding and accessing letters as well as words in memory (i.e., letter and word retrieval).

Posttesting showed that C.D. was a treatment responder in three of the five skills relevant to his diagnosis and treatment plan. He showed marked gains in morphological and syntactic awareness and reading comprehension. His lack of gains in reading and spelling real words may be related to his long-standing word retrieval problems, which the instructional activities, that were designed to develop awareness and coordination of word forms and their parts, did not address. Silliman and Scott (2009) discussed strategies for treating word retrieval problems.

Nevertheless, considering his lack of progress at school in reading comprehension over the years, the measured gains on reading comprehension from well below to above the population mean after just 14 3-hour lessons indicated that treatment nonresponders can be transformed into treatment responders when given instructional components related to their diagnosed instructional needs. C.D.’s improved morphological and syntactic awareness may also have contributed to his reading comprehension gains.

C.D.’s initial response to treatment will need to be nurtured with ongoing appropriate instruction for it to be sustained and ongoing progress monitoring to evaluate whether he continues to respond to instruction. RTI and differential diagnosis can be used in mutually facilitative ways. However, RTI alone is not sufficient—at times diagnostic assessment is warranted and helpful. Likewise, diagnostic assessment alone without treatment planning and evaluation of response to treatment is not sufficient.

### Applying Cognitive/Neuropsychological Assessment—Intervention Links

These case studies show that treatment nonresponders can be transformed into treatment responders when instruction is tailored to their instructional needs identified through differential diagnosis. Seven educational implications and applications of these findings are now considered.

First, evidence-based diagnoses of specific learning disabilities are as needed as are evidence-based instructional interventions. However, evidence-based diagnoses that specify instructional needs for individuals are not the same as eligibility decisions for qualifying for special education services (e.g., under the heterogeneous category of specific learning disabilities). The Individuals with Disabilities Education Improvement Act (IDEIA) federal special education law mandates FAPE for students with educationally handicapping conditions, which is their civil right. However, legal code for implementing the federal law regarding making eligibility decisions is left to each state. Eligibility decisions are not mandated to be based on evidence-based differential diagnosis with treatment relevance. True diagnoses are based on research evidence and address probable etiology, generation of evidence-based treatment plans with progress monitoring, and concern for issues of prognosis (e.g., Is it treatable or curable? What is a reasonable outcome?). See Berninger and Holdnack (2008) for further discussion of the distinction between evidence-based diagnoses and eligibility decisions, which is not widely understood by educational practitioners. Evidence-based diagnostic practices may also improve home-school relationships. For over a decade the first author listened to the many parents from families with multigenerational histories of dysgraphia, dyslexia, or OWL LD who explained that they want is diagnosis and related treatment rather than eligibility decisions about whether their child qualified for special education services (Berninger, 2008c). Concerned educational professionals...
professionals might begin working now for evidence-based, treatment-relevant differential diagnosis in the next reauthorization of IDEIA. Concerned parents might work with the federal government agencies toward obtaining funding to support more research on this issue.

Second, the initial efforts of the federal government to disseminate research findings to school practitioners (e.g., NICHD, 2000), which was an important first step, may need to be expanded. On the one hand, the rapidly accumulating new research on writing (e.g., Troia, 2009) should be reviewed by a national panel of researchers with focus on evidence-based specific writing disabilities alone or associated with other specific learning disabilities and validated instructional approaches linked to diagnoses for specific reading disabilities with or without related oral language disabilities. All the specific learning disabilities discussed in this study were associated with writing problems (handwriting in dysgraphia, spelling in dyslexia and OWL LD, and written composition in all three written language learning disabilities). If this research-generated knowledge about dysgraphia had been available to A.B.'s teachers, his instructional needs in writing may have been met in the early primary grades rather than at entry to eighth grade.

On the other hand, national review is also needed of the rapidly accumulating new research showing that (a) orthographic and morphological awareness are as important as phonological awareness in literacy learning (e.g., review by Berninger, Abbott, Nagy, & Carlisle, 2009), (b) coordination of all three word forms contributes to learning to decode (Berninger, Raskind, et al., 2008) and spell (Garcia, Abbott, & Berninger, 2010), and (c) children with OWL LD have syntactic awareness problems, which are as important to address as phonological awareness problems (reviewed by Silliman & Scott, 2009). If this research-generated knowledge about morphological and syntactic awareness had been available to A.B.'s teachers, his instructional needs in writing may have been met in the early primary grades rather than at entry to sixth grade.

Third, criteria for qualifying students with specific learning disabilities for FAPE in K to 12 vary greatly from state to state, from school system to school system, and from school to school in K to 12. The most recent reauthorization (IDEIA, 2004) may have exacerbated rather than remedied this problem. Assessing response to intervention, which master teachers always employ as discussed in the introduction, is not a substitute for evidence-based diagnosis of why an individual student does not respond to whatever the instructional intervention may be and what can be done to transform the nonresponding student into a responder. Neither is administering a standard battery of tests to everyone without understanding the construct validity or treatment validity of each subtest a substitute for evidence-based diagnosis. Evidence-based diagnoses should be consistent from state to state, which is another goal to strive for in the next reauthorization of IDEIA. Likewise, preserve professional training programs in education or related fields (e.g., in school psychology, speech, hearing, and language sciences, physical and occupational therapy) should teach treatment-relevant, differential diagnosis for specific learning disabilities. The public would not tolerate a medical system in which decisions about whether to provide medical treatment depended on the state or county in which one resided and medical treatments were not related to relevant research on diagnosis or diagnosis-treatment links related to one’s medical problem, with flexible adaptation of treatment depending on how an individual responds to it. Nor should they tolerate such practices in education.

Fourth, we are increasingly concerned that the laws and implementation practices in place are not sufficiently coordinated to ensure a smooth transition for those with specific learning disabilities from K to 12 (for FAPE and accommodations) to higher education (accommodations). This problem is not trivial at a time when the national education agenda calls for greater access to higher education for all. Those who do not come from privileged backgrounds often cannot pay for private evaluations or negotiate the confusing array of assessment and/or eligibility requirements. If a clear system of evidence-based diagnosis were in place in elementary and secondary schools, affected individuals would not only receive appropriate differentiated instruction and accommodations in general and special education K to 12, but also the transition to higher education would be facilitated in more appropriate ways to ensure that the civil rights of those with educational handicapping conditions or adult disabilities are guaranteed in a seamless fashion throughout their formal education across the life span. Although recent changes in the law for adults have changed the focus from impact of the educational handicapping condition on general educational achievement and functioning to impact on specific skills such as reading rate or transcription mode of writing (keyboard or pen), as determined by formal assessment, considerable confusion exists, which can interfere with quality of life and access to education for some individuals with specific learning disabilities. The system in place would benefit from review and revision by educational professionals from K to higher education, who have an important contribution to make to FAPE and/or accommodations for individuals with specific learning disabilities.

Fifth, we are increasingly concerned that many individuals, especially those who mask their problems because they are verbally fluent in oral language, have specific learning disabilities that are not being identified and treated during the elementary or secondary school years and in some cases not until the undergraduate or postgraduate years. Failure to identify and provide FAPE and appropriate accommodations for these biologically based educational handicapping conditions, for which considerable new knowledge has emerged about the genetic and brain basis, may cause
enormous emotional and social consequences for some affected individuals and is a violation of their civil rights. If these specific learning disabilities had been diagnosed earlier, treatment could have been initiated earlier in schooling and the severe reading and writing problems may have been prevented.

Sixth, evidence-based, treatment-relevant differential diagnosis and RTI are not mutually exclusive alternatives. Just because a student responds to evidence-based instruction earlier in schooling, it does not mean that the biological vulnerability has been eliminated and will not surface in new ways later in schooling (Berninger, 2006). For example, a student may normalize in a specific brain region but fail to develop normal functional connectivity among brain regions (see Richards & Berninger, 2008). The brain is a complex organ; normalization may occur at one level of neural substrate but not all levels (Berninger & Richards, 2009). The studies showing normalization of brain response to intervention in specific brain regions provide hope that early intervention may prevent the severity of expression of biologically based specific learning disabilities, but do not guarantee that brain differences can be eliminated forever solely by instruction earlier in development. Without ongoing progress monitoring and specialized instruction later in schooling, if needed as the curriculum changes, specific learning disabilities may resurface, expressing themselves in new ways (e.g., early reading problems resolve but significant writing problems emerge; Berninger, 2006). No evidence has been reported that teaching changes the genes one inherits at conception, which affect biological vulnerability. Environmental variables may influence the transcription and translation processes of messenger RNA and result in epigenetic effects (Cassiday, 2009), which to date have been investigated mostly in white rats (e.g., Molfese, manuscript submitted for publication; also research reviewed in Berninger & Richards, 2010). Nevertheless, appropriate teaching does matter and can alter gene expression if not underlying gene sequences.

Furthermore, not all individuals will show a constellation of phenotypic markers consistent with dysgraphia, dyslexia, OWL LD, or other known neurogenetic disorder or have a medical condition. For groundbreaking work on dynamic sources of individual differences not related to a specific disorder, see Gilger and Wilkins (2008). Also see Fiorello et al. (2006) and Hale et al. (2008) for the need for other kinds of assessment than discussed in this article, which benefit from a cognitive hypothesis testing approach.

Seventh, professionals in education (general education teachers, reading specialists, special educators) and education-related fields (psychology, speech and language, occupational/physical therapy, medicine) need to create a truly interdisciplinary approach to evidence-based early differential diagnosis and treatment for specific learning disabilities, which includes ongoing monitoring throughout formal schooling to evaluate whether individuals are (a) responding to whatever instruction is provided, (b) completing written and other assignments and assessments in a grade-appropriate way, and (c) receiving appropriate accommodations when necessary. As part of this interdisciplinary effort, a diagnostic manual might be written and disseminated that is based on a review of research related to evidence-based, treatment-relevant differential diagnosis, as well as medical conditions and issues specific to family, school, and culture of an individual student (Wodrich, 2008). This diagnostic system should take into account an individual’s profile in the five evidence-based developmental domains (cognitive, language, motor, social emotional, and attention/executive functions) so as not to confuse reading and writing disabilities in low incidence developmental disabilities and high incidence learning disabilities (Berninger, 2007). For example, children with autism, Down’s syndrome, cerebral palsy, or fetal alcoholism may have writing and/or reading problems, but the etiology, current instructional needs, and prognosis are unlikely to be the same as for an individual with a specific learning disability such as dysgraphia, dyslexia, or OWL LD whose development in all five developmental domains is otherwise in the normal range. This diagnostic manual should cover low incidence developmental disabilities and high incidence learning disabilities and span early childhood to the young adult years (preschool to graduate school). Such a manual should be educationally relevant to school settings (Wodrich, 2008).

Nothing in current federal or state law says that professionals in education and related fields cannot proactively develop an evidence-based diagnostic manual for best practices and implement it consistently across states and developmental levels of affected individuals. The legal profession made their contribution in guaranteeing the civil rights of individuals with educationally handicapping conditions such as specific learning disabilities. The law is there to protect their civil rights if educational professionals do not serve individuals’ educational needs. The law does not specify how professionals should educate (integrate assessment and instruction for individuals) to optimize the learning and educational achievement of all students. Now the time has come for educational and related professionals to make their contribution to FAPE for all by creating evidence-based, treatment-relevant differential diagnoses to acknowledge developmental and individual differences and implement the diagnoses consistently across states and schools so that all affected individuals are identified and taught appropriately across formal schooling. Both educational professionals and researchers should contribute to this effort. The time for change has come and it is up to professionals across disciplines who work with school-age children, youth, and young adults to bring about this change.
## Appendix

### Evidence-Based Lessons Used With Student with Dysgraphia and Student with Oral and Written Language Learning Disability (OWL LD)

<table>
<thead>
<tr>
<th>Session</th>
<th>Instructional Activity Components and Probes for Each Lesson (Units I, II, III, or IV from Berninger &amp; Wolf, 2009a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduce Writers' Workshop with Mark Twain Hope Theme (see Unit II)</td>
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<tr>
<td></td>
<td>Writers' Warm Up (Lesson 1, Write letters before and after designated letters to automatize letter access, retrieval,</td>
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<td></td>
<td>and production, Berninger, 1998a; record accuracy on growth graphs for review of daily probes and correct errors.)</td>
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<tr>
<td></td>
<td>Talking Letters Warm Up (Lesson 1—consonant side of Talking Letter Card (Berninger, 1998b): Teachers and students</td>
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<td>alternate turns in unison naming letter or letter group, saying word containing corresponding phoneme, saying phoneme in isolation to automatize alphabetic principle; record time for the group activity on graph displayed for all to view daily probes; see Unit IV)</td>
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<td></td>
<td>Pseudoword Reading (Lesson 1, Transfer Words, record accuracy and time on growth graphs for daily review of probes; see Unit I, activity 4)</td>
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<td></td>
<td>Word Play: Building Awareness of Linguistic Cues in Words</td>
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<td></td>
<td>Phonological Awareness: (Lesson 1, Use the first 10 Instant Words in Lesson 39, Fry, 1996; children hold up fingers for the number of syllables they hear in words—clap them out if they disagree; children put one colored token on their palm desktop (5 × 8 card) for each phoneme in each syllable, see Berninger &amp; Abbott, 2003, Lessons 5 or Unit III)</td>
</tr>
<tr>
<td></td>
<td>Morphological Awareness (Lesson 1, Unit I): Underline Base and Circle Prefixes and Suffixes; Transfer Activity for Probes for Word Parts That Signal Meaning and Grammar; Comes From; Word Sorts; Does It Fit?</td>
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<td></td>
<td>Orthographic Awareness: (Lesson 1, Teacher-Designed Anagrams from the first 10 Instant Words in Lesson 39, Fry, 1996; teacher scrambles the word order of letters and children reorder them to spell a real word).</td>
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<td></td>
<td>Sentence Play:</td>
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<td></td>
<td>Teacher-created sentence anagrams using sentences for dictation in Lesson 39 (Fry, 1996); teacher writes each word on a 3 × 5 card and shuffles the cards; children reorder the cards to form a correctly ordered real sentence.</td>
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<td></td>
<td>Word Work: Spelling</td>
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<td></td>
<td>Teach the Photographic Leprechaun Strategy and the Proofreaders' Trick (Unit II) to learn to spell the Instant Words in Lesson 39 (Fry, 1996); then spell them from dictation and record accuracy on growth graphs for review as probes.</td>
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<tr>
<td></td>
<td>Bathroom/Snack Break</td>
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<td></td>
<td>Composing</td>
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<tr>
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<td>Planning, Translating by Hand, Entering into Computer for Reviewing and Revising, Feedback and Goal Setting for Next Lesson (Lesson 1, Unit II).</td>
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<tr>
<td>2 to 16</td>
<td>Continue discussing Mark Twain Hope Theme (see Unit II)</td>
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<td></td>
<td>Writers' Warm Up (Lesson number corresponding to session number: Write letters before and after designated letters to automatize letter access, retrieval, and production, Berninger, 1998a; record accuracy on growth graphs for review of daily probes and correct errors.)</td>
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<td>Talking Letters Warm Up (Lesson number corresponding to session number—vowel or consonant side of Talking Letter Card: Teachers and Students alternate turns in unison naming letter or letter group, saying word containing corresponding phoneme, saying phoneme in isolation to automatize alphabetic principle; record time for the group activity on graph displayed for all to view daily probes; see Unit IV)</td>
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<td>Pseudoword Reading (Lesson number corresponding to session number: Transfer Words, record accuracy and time on growth graphs for daily review of probes; see Unit I, activity 4)</td>
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<td></td>
<td>Word Play: Building Awareness of Linguistic Cues in Words</td>
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<td>Phonological Awareness: (Lesson number corresponding to session number: Use the first 10 Instant Words in Lesson 40–53 in successive order in each lesson (Fry, 1996); children hold up fingers for the number of syllables they hear in words—clap them out if they disagree; children put one colored token on their palm desktop (5 × 8 card) for each phoneme in each syllable (see Berninger &amp; Abbott, 2003, lessons 5 or Unit III).</td>
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<tr>
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<td>Morphological Awareness (Lesson number corresponding to session number, Unit I): Underline Base and Circle Prefixes and Suffixes; Transfer Activity for Probes for Word Parts That Signal Meaning and Grammar; Comes From; Word Sorts; Does It Fit?</td>
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<td>Orthographic Awareness: (Lesson number corresponding to session number: Teacher-Designed Anagrams from the first 10 Instant Words in Lesson 40–53 in successive order in each lesson, Fry, 1996; teacher scrambles the word order of letters and children reorder them to spell a real word).</td>
</tr>
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(continued)
Appendix (continued)

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<thead>
<tr>
<th>Session</th>
<th>Instructional Activity Components and Probes for Each Lesson (Units I, II, III, or IV from Berninger &amp; Wolf, 2009a)</th>
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<tbody>
<tr>
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<td>Sentence Play:</td>
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<td>Teacher-created sentence anagrams using sentences for dictation in Lesson 40-53 in successive order in each lesson (Fry, 1996); teacher writes each word on a 3 × 5 card and shuffles the cards; children reorder the cards to form a correctly ordered real sentence.</td>
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<td>Word Work: Spelling</td>
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<td>Bathroom/ Snack Break</td>
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<td>Composing</td>
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<td>Planning, Translating by Hand, Entering into Computer for Reviewing and Revising, Feedback and Goal Setting for Next Lesson (Lesson number corresponding to session number in Unit II).</td>
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<tr>
<td>17</td>
<td>Posttesting</td>
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</tbody>
</table>

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Notes

1. The psychological process that research shows the test assesses.
2. Relevance of the assessed construct for generating instructional approach(es) and evaluating effectiveness of instructional approach(es).
3. Following a year-long cross-country exchange that included work in the schools, Barbara Efere, an Italian developmental psychologist who studies writing and other language disorders as well as normal language development, wrote to the first author to ask why in the United States we do not have writing specialists in the schools. This question is a very good one that begs a thoughtful answer and action.

References


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**Virginia W. Berninger** (PhD, Psychology, Johns Hopkins University) has been a Professor at the University of Washington, Seattle since 1986. She has applied an interdisciplinary developmental, cognitive, linguistic, and neuropsychological approach to research on normal and disabled written language development (and relationships to oral language and other variables). A licensed psychologist, she is currently focused on application of this research to clinical and educational practice.

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