Reading Fluency and Its Intervention

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This 3-part article represents an effort to confront 3 large lacunae in the research on reading fluency: definition, component structure, and theory-based intervention. The 1st section describes several historical approaches to fluency and the components of fluent reading that are implicit in these approaches. We then present our own developmental- and component-based definition of reading fluency. In the 2nd section we discuss how different types of current fluency interventions correspond to particular components in fluency’s structure and to particular phases of its development. The last section presents an overview of an experimental fluency program that attempts to address multiple components in the development of fluent reading. Finally, we argue that increased exploration of the issues surrounding fluency and comprehension will contribute to our understanding of both reading development and dyslexia subtypes.

The history of fluency research in the field of reading might best be characterized as intellectually spasmodic: There are periods of great effort and creativity, followed by fallow periods of relative disinterest. In 1983 fluency was described as the “most neglected” reading skill (Allington, 1983). In 1997 Lyon and Moats summarized the state of intervention research with a call to refocus attention on fluency:

Improvements in decoding and word-reading accuracy have been far easier to obtain than improvements in reading fluency and automaticity. This persistent finding indicates there is much we have to learn about the development of componential reading skills and how such skills mediate reading rate and reading comprehension. (p. 579)

The recent attention to fluency and fluency intervention is the result, we believe, of a convergence of three major factors. First, the systematic research on the role of phonological processes in reading failure and intervention has proven both
highly successful and insufficient in dealing with the heterogeneity of reading disabil-
ities and the complexity of reading breakdown—particularly in the area of flu-
ency. (For a recent comprehensive review, see Meyer & Felton, 1999; also see
Breznitz & Share, 1992; Rashotte & Torgesen, 1985; Torgesen et al., 1999;
Torgesen, Rashotte, & Wagner, 1997; Young & Bowers, 1995.) The wish to ad-
dress the needs of children who do not completely respond to phonological-based
treatment is a motivating impulse in turning to additional explanatory principles
like fluency (Torgesen, Rashotte, & Alexander, in press).

The second factor is an increased awareness of the multiple underlying sources
that can contribute to or impede fluency development. The concerted effort to un-
derstand the predictive ability of naming speed in reading failure is an example of
this focus (see reviews in Wolf & Bowers, 1999, 2000), as are the extensive studies
that explore a range of time-related deficits in children with reading disabilities in
various perceptual and motor areas (see reviews in Farmer & Klein, 1995;
Nicolson & Fawcett, 1994; Stein, in press; Waber, in press; Wolf, Bowers, &
Biddle, 2000; Wolff, 2000).

The third factor is related to naming-speed research and involves cumulative evi-
dence from subtype research in developmental dyslexia. A growing body of work
demonstrates that there are discrete groups of children with reading disabilities who
can be characterized by single deficits in either naming speed or phonological pro-
cesses or combined deficits in both areas (Badian, 1996; Compton, Chayna,
DeFries, Gayan, & Olson, in press; Levy, in press; Lovett, 1987; Lovett, Steinbach,
& Frijters, 2000; Manis, Doi, & Bhadha, 2000; Wolf, Bowers, & Biddle, 2000). This
conceptualization, known as the Double-Deficit Hypothesis, has several fluency-re-
lated implications (Wolf & Bowers, 1999, 2000). First, children with single nam-
ing-speed deficits are frequently difficult to diagnose in early primary years, but go
on to develop fluency and comprehension problems by the end of Grade 3. Second,
children with both phonological and naming-speed deficits are consistently found to
possess the most severe problems in reading and reading fluency. Third, and most
important, this work provides a theoretical rationale and foundation for intervention
that specifically addresses issues of speed of processing and fluency. Until very re-
cently, intervention was largely directed to treatment for phonologically based de-
coding problems. Children with either single processing-speed deficits or combined
deficits would be only partially served by such a focus, thus augmenting the ranks of
children who do not respond to treatment.

Represented by this special issue of *Scientific Studies of Reading*, the new,
evolving work on reading fluency and fluency-based intervention has much to
learn from the 2 decades of work that precede it in theoretically based, phonologi-
cally focused treatment. Specifically, there must be a greater concentration of ef-
fort (a) in defining what we mean by fluency, (b) in charting the development of its
component structure, (c) in understanding the breadth and nature of process-
ing-speed and fluency deficits in reading subtypes, and (d) in applying this knowl-

edge to the development of intervention programs. In the last years we have directed considerable attention to understanding the third area of concern, the processes underlying naming speed and other rate-related deficits in developmental dyslexia. We view this article as a working paper on the other three of these areas. The first section describes several historical approaches to fluency and the components of fluent reading implicit in these approaches. We then provide our own evolving definition. In the second section we discuss how different types of current fluency interventions correspond to particular components in fluency’s structure and particular phases of its development. Finally, the last section presents an overview of our own first efforts to construct a theory-based, comprehensive fluency program that attempts to address multiple components in fluent reading.

TOWARD A DEFINITION OF FLUENCY AND AN UNDERSTANDING OF ITS COMPONENT STRUCTURE

We view this article as a working paper because there are still no consensual definitions of what is meant by fluency and what its relation might be to the subset of time-related terms most frequently related to it (e.g., automaticity, speed of processing, reading rate/speed, and word recognition rate/proficiency). In this section, our goals are foundational for the rest of the article and for our future work. We review several historical and current definitions and approaches to fluency as the basis for our own definition and as the context for examining the underlying components of fluency. These and other efforts toward gaining greater clarity about fluency will push forward not only our understanding of the component structure of reading fluency, but also the development of better assessment tools and more comprehensive interventions.

BACKGROUND: APPROACHES AND DEFINITIONS

Early Research

Perhaps predictably, any historical review of perspectives on fluency begins with the work of William MacKeen Cattell and Sir Edmond Huey. Cattell (1886), a 19th-century experimental psychologist, found that letters and words are named faster than other symbolic categories, such as colors, and other more concrete, semantic categories, such as pictured objects. Cattell was the first researcher to highlight the automatic-like rates of recognition achieved in letter naming and word reading, with words read as fast as letters and reading speed increased when semantic and syntactic information are provided (as in sentences). This set of findings was completely replicated almost a century later by Doehring (1976).
Also a century ahead of his time, Huey (1908/1968) presciently described what most cognitive scientists refer to as *automaticity* in reading (LaBerge & Samuels, 1974; Logan, 1988). More specifically, according to Huey, the development of fluent reading involves the steady accumulation and synthesis of “more and more complex constituent acts as these are progressively welded together by practice” (p. 105). An integral aspect of this synthesis to Huey was the development of a rate of processing, which through “repetition progressively frees the mind from attention to details, makes facile the total act, shortens the time, and reduces the extent to which consciousness must concern itself with the process” (p. 65).

Information-Processing Models

Similar to Huey’s notions, more recent perspectives on fluency in the last quarter of the 20th century emphasize automatic, effortless rates of processing that allow the reallocation of attention. For example, LaBerge and Samuels (1974), whose work ushered in an era of renewed attention to fluency, proposed a *model of automaticity* with principles derived from information-processing theory (e.g., Norman, 1968; Posner, Lewis, & Conrad, 1972). According to their model, reading becomes increasingly fluent as the result of the development of automaticity of the subskills: “When one describes a skill at the macro level as being automatic, it follows that the subskills at the micro level and their interrelations must also be automatic” (p. 295). The first stage of these subskills in their model involves the visual code and the *unitization* of visual stimuli. These stimuli may include letters, spelling patterns, words, and highly frequent word groups (e.g., *high school*). With exposure and practice, the visual features in stimuli like letters become unitized and then perceived as a single unit. As these units accumulate and letter perception becomes increasingly automatic, attention to early visual coding processes decreases. This decrease allows attentional resources to be reallocated to other areas, such as the semantic (or meaning) code.

The earlier physiological work of Donald Hebb (1949) undergirds the concept of unitization used here. An example from the visual system is helpful. When an unknown visual stimuli is first seen by the retina, there is an activation in the visual cortex of multiple individual cells. These cells correspond to each aspect of what the retina sees and are responsible for very specific types of information (e.g., curved lines, diagonals, etc.). After multiple exposures to the same stimulus, the individual cells in the visual areas become a working unit, or cell assembly. These unified groups of neurons learn to work together in synchrony so that recognition of frequently viewed stimuli such as letters becomes so efficient, it is virtually automatic. Hebb argued that the ultimate result of these cell assemblies in the visual area is a reservoir of mental representations of practiced, frequently viewed visual stimuli.
LaBerge and Samuels (1974) argued that a similar principle is found at more complex visual levels (and also in other modalities, such as phonological representations). For example, the orthography of every language permits particular, frequently seen spelling patterns or letter combinations (e.g., *th* in English, *schr* in German). With sufficient exposures and practice, these orthographic patterns also become quickly recognized. A similar principle, they believed, may apply to many frequently read words, although LaBerge and Samuels raised questions about how these larger units are perceived and processed by different readers (see, e.g., Gough, 1972).

The primary contributions of the LaBerge and Samuels model for work in fluency (McCormick & Samuels, 1979) include several principles about how we can process written information at highly rapid rates: (a) the concept of unitization; (b) the key notion that, with the increased speed of lower level subskills, attention can be reallocated elsewhere; and (c) the more reading-specific concept that with automaticity, attention can be shifted from lower level decoding to higher level comprehension skills. A fundamental premise of our work is based on their conceptualization that macrolevel fluency is based on the automaticity of microlevel subskills and their connections.

Consciously building on the work of Cattell, Hebb, and LaBerge and Samuels, Doehring (1976) provided one of the most systematic studies of the development of fluency in reading subskills in children from kindergarten until the end of high school. In his seminal monograph “Acquisition of Rapid Reading Responses,” Doehring studied the acquisition of rates of processing in symbols (colors and objects), letters, letter combinations, words, random word sequences, and sentences. In so doing, he sought to map

the relative course of acquisition of skills for processing the *graphological* features of letters, the *orthographic* regularities of letter combinations, the *semantic* features of words, and the *semantic-syntactic* constraints of word sequences. These are the skills that must be mastered beyond the level of simple accuracy to the point where accurate processing becomes rapid enough to be classified as fluent reading. (p. 2)

The data in this study went well beyond a replication of Cattell’s first findings about the “time it takes” human beings to acquire automatic-like rates in various processes; to our minds, Doehring described the first data in a developmental, component-process approach to reading fluency.

Perfetti’s (1977, 1985) verbal efficiency theory represents another highly influential perspective in the history of fluency-related research. Like LaBerge and Samuels (1974) and Doehring (1976), Perfetti worked within an information-processing approach. Perfetti did not refer to the word *fluency*, and he did not equate verbal efficiency with fluency. Rather, Perfetti discussed fluency-related concepts in terms of an overall account of reading ability in which verbal efficiency theory
played a major role. Within this context, fluency is closest to what Perfetti and what Jackson and McClelland (1979) called “effective reading speed,” construed as the outcome of comprehension accuracy and reading speed (words per minute).

Perfetti’s (1985) account of verbal efficiency was a theoretical effort to explain how “individual differences in reading comprehension are produced by individual differences in the efficient operation of local processes. The local processes are those by which temporary representations of text are established” (p. 100; here he included orthographic, phonological, and semantic processes). Some of the critical components in Perfetti’s model that contributed to the efficiency of local processes were (a) general symbol activation and retrieval, (b) recognition processes, (c) lexical access and retrieval, and (d) working memory.

Learning and practice also were thought to play a pivotal role in the acquisition of efficiency in the local processes. This efficiency was considered necessary to construct high-quality mental representations, a central concept in the theory. The quality of representations was hypothesized to affect both the further development of efficiency (by enhancing the ease of lexical retrieval) and working memory: “To the extent that these codes are retrieved rapidly and are high in quality, the system is efficient” (Perfetti, 1985, p. 118). When the underlying systems were efficient, the individual was considered able to free cognitive resources to focus on higher level demands in reading, which was important for comprehension. The converse was also predicted here. For example, Perfetti suggested that an inefficient system resulting in a slow rate of word recognition could obstruct the individual’s ability to hold large units of text in working memory, which, in turn would affect comprehension and recall.

Important to work today, Perfetti (1985) stressed that the quality of representations and of each of the local processes, components, and their various forms of integration (depending on the type of reading task) were potentially rate-limiting factors in reading acquisition. Furthermore, as Doehring (1976) suggested earlier, different emphases would be placed on processing systems, depending on development. We emphasize LaBerge and Samuels’ (1974), Doehring’s (1976), and Perfetti’s (1985) focus on the development of efficiency in lower levels of processing because this aspect of fluency development is frequently neglected in present fluency interventions.

There were immediate and long-term effects of this model on reading and reading disabilities research, particularly concerning short-term memory and lexical retrieval. Shankweiler and Crain’s (1986) influential article on reading disability incorporated aspects of Perfetti’s theory by hypothesizing that the demands of orthographic decoding and limited working memory capacity contribute to comprehension difficulties of poor readers. Swanson (as cited in Johnston & Anderson, 1998) proposed that many poor readers have difficulty in reading because they fail to establish effective, efficient visual–verbal connections, which may lead to difficulty in accessing or laying down long-term memory traces.
Perfetti’s description of the role of an efficient lexical retrieval process in reading development has influenced much of our own work on word-retrieval and its relation to reading disability (Wolf, 1982, 1991; Wolf & Goodglass, 1986; Wolf & Obregon, 1992). Perfetti used knowledge about retrieval and all components in verbal efficiency theory as ways to explicate individual differences in reading comprehension. In doing so, Perfetti’s work provides the figure–ground perspective from which to view fluency today—as a means to reading comprehension.

Rauding Theory

Carver (1991, 1997), who also focused on the links between fluency and comprehension, introduced an emphasis on the different purposes of reading and their respective rates. According to Carver, most reading is done in the *rauding* mode, which involves the fastest rate at which an individual can successfully understand complete thoughts in each sentence.

Carver’s work includes a model that depicts four levels of factors that affect the achievement of optimal reading rate and accuracy. Some of these factors are age, teaching variables, “aptitude” factors (i.e., verbal knowledge, decoding processes, and cognitive speed), decoding speed, and naming speed (see Spring & Capps, 1974). Carver reintroduced the complex concept of cognitive speed to reading fluency theory, a line of research (Kail, 1991, 1992) in reading and in other areas of cognitive development (see also Breznitz, in press; Marcus, 1997).

Connectionist Models

The last body of research with implications for fluency in this review involves the evolution of connectionist models of reading. These models are profoundly different from earlier information-processing models, particularly in the role of retrieval and unitization. Connectionist models emphasize the continuous, distributed interaction of phonological, orthographic, syntactic, and semantic-processing codes during word recognition (Adams, 1990; Caramazza, 1997; Foorman, 1994; Seidenberg & McClelland, 1989). There are no retrieval mechanisms, as such; rather, all codes are computed for every word. In these powerful models, the amount and level of activation in each system and the speed of processing within and among these systems are products of internal factors (e.g., learning) and external factors (e.g., the consistency of correspondence between a given letter and a sound pattern). These models add to any discussion of fluency the importance of accounting not only for intra- and intersystem factors in the learner (the emphasis in earlier information-processing models), but also for such linguistic features as frequency, regularity, and the amount of processing-code connections among individ-
ual words. The latter factor, we believe, has special importance for learning and, by extension, for the design of fluency interventions.

Current Research and Definitions

Throughout the period between LaBerge and Samuels (1974) and Carver (1997), the general consensus was that fluent reading could be defined as “that level of reading competence at which textual material can be effortlessly, smoothly, and automatically understood” (Schreiber, 1980, p. 177). Current research is largely consistent with this view. Indeed Meyer and Felton (1999), in a recent review of the literature, defined fluency in a similar manner as “the ability to read connected text rapidly, smoothly, effortlessly, and automatically with little conscious attention to the mechanics of reading such as decoding” (p. 284). Along similar lines, Hudson, Mercer, and Lane (2000) defined fluency as “accurate reading at a minimal rate with appropriate prosodic features (expression) and deep understanding” (p. 16).

Although this approach to fluency effectively captures the end goal of fluency—that is, effortless reading with good comprehension—it does not yet permit ease in validation or in conceptualizing the components underlying fluency. For example, Torgesen et al. (in press) argued that most previous fluency definitions do not allow empirical validation; they preferred, therefore, the minimalist definition of “rate and accuracy in oral reading” used in curriculum-based assessment research (Shinn, Good, Knutson, Tilly, & Collins, 1992). The National Reading Panel’s (2000) definition of fluency as “the immediate result of word recognition proficiency” (pp. 3–5) allows the simple procedure of testing for a particular level of proficiency in word recognition, just as Torgesen et al.’s view can be assessed by performance on an oral reading measure that incorporates rate and accuracy (e.g., the Gray Oral Reading Test; Wiederholt & Bryant, 1992).

Although we concur in principle with Torgesen et al.’s (in press) general admonition to use definitions that can be validated, their emphasis on oral reading and the National Reading Panel’s emphasis on word recognition ignore the multiple other dimensions of fluency, particularly lower level subskills, that were emphasized in earlier accounts. Few current approaches attempt to define fluency in terms of either its component parts or its various levels of reading subskills—that is, letter, letter pattern, word, sentence, and passage.

More to the point, almost all of the definitions until this time posit fluency as the outcome of learned skills. Kame’enui, Simmons, Good, and Harn (in press) suggested a figure–ground shift for the field. In a broad-ranging article, they conceptualized fluency in a more developmentally encompassing manner both as the development of proficiency in underlying lower level and component skills of reading (e.g., phoneme awareness) and as the outcome of proficiency in higher level processes and component skills (e.g., accuracy in comprehension; see also
Logan, 1997). Such a perspective, we believe, has profoundly different implications for prevention, intervention, and assessment than the traditional view. For, within a developmental perspective, efforts to address fluency must begin at the beginning of the reading process—that is, during acquisition—not after reading is already acquired. The importance of working proactively to prevent the development of difficult fluency problems is a major theme in the recent studies by Torgesen et al. (in press) and by Kame’enui et al. (in press).

Berninger, Abbott, Billingsley, and Nagy (in press) took an equally multidimensional view with a systems approach to fluency. In their conceptualization, fluency is influenced by (a) the characteristics of stimulus input (e.g., rate and persistence of a visual signal or speech signal), (b) the efficiency and automaticity of internal processes (e.g., the development of phonological, orthographic, and morphological systems), and (c) the coordination of responses by the executive functions system. As we discuss later, Berninger is one of the few researchers to place special importance on the role of morphological knowledge about words in facilitating the development of orthographic rate and overall fluency.

We regard Kame’enui’s (in press) developmental and Berninger’s (in press) systems-analysis approaches as the context for our own working definition:

In its beginnings, reading fluency is the product of the initial development of accuracy and the subsequent development of automaticity in underlying sublexical processes, lexical processes, and their integration in single-word reading and connected text. These include perceptual, phonological, orthographic, and morphological processes at the letter, letter-pattern, and word levels, as well as semantic and syntactic processes at the word level and connected-text level. After it is fully developed, reading fluency refers to a level of accuracy and rate where decoding is relatively effortless; where oral reading is smooth and accurate with correct prosody; and where attention can be allocated to comprehension.

THE COMPONENT STRUCTURE OF FLUENCY

This developmental and component-based definition of fluency poses a difficult challenge for empirical validation; at the same time it provides a foundation for the specification of processes, skills, and factors that underlie or influence reading fluency and that can guide assessment and validation efforts. In this subsection we unpack the previously discussed definitions and approaches in terms of the components that are implied as necessary in the development of fluency.

Most researchers describe three major types of processes as prominent in fluency’s development: orthographic, phonological, and semantic. Berninger et al. (in press) and Adams (1990) added emphases on morphological and syntactic
knowledge systems. For example, Adams proposed that both orthographic and semantic information are necessary for learning morphological knowledge about the patterns and roots that make up many words (e.g., derivational and compound words; Latin- and Greek-derived roots). The direct learning of these morpheme patterns enhances vocabulary acquisition, fluency, and reading comprehension. First, such knowledge provides rich semantic associations that can be applied to acquiring new vocabulary words. Second, morphological knowledge makes orthographic chunks more visible, more familiar, and more quickly retrieved. Third, the combination of rapid recognition of orthographic units and faster retrieval of meaning facilitates comprehension. The working notion here (and in the intervention described later) is that one retrieves faster what one knows better, thus continuously emphasizing the connections that link orthographic, semantic, phonological, and morphological systems. This conclusion is reinforced by recent research showing that morphological awareness is significantly related to reading fluency in third and fourth grades (Berninger et al., in press).

Multiple Components

The implications of a developmental, component-based conceptualization of fluency are far from simple. At a minimum such an approach implies three related premises: first, that multiple processes contribute to fluency development; second, that multiple sources of dysfluency are possible; and third, that assessment and intervention should be based on knowledge about the development and breakdown of these components. With regard to the first premise, the fluency-related processes and components described in the research summarized here include lower level attention and visual perception, orthographic (letter-pattern) representation and identification, auditory perception, phonological representation and phoneme awareness, short-term and long-term memory, lexical access and retrieval, semantic representation, decoding and word identification, morphosyntactic and prosodic knowledge, and connected-text knowledge and comprehension. Berninger et al. (in press) went further and argued that a systems approach to fluency would include the executive function’s coordination of all these discussed internal-processing systems so that they perform smoothly and in synchrony. Wood, Flowers, and Grigorenko (in press) added to the set of executive functions an emphasis on the role of anticipatory facilitation for tasks that become fluent.

In other words, the unsettling conclusion is that reading fluency involves every process and subskill involved in reading. We do not shy away from this conclusion; rather, we wish to underscore it. Unlike reading accuracy, which can be executed without utilizing some important reading components like semantic processes, we argue that fluency is influenced by the development of rapid rates of processing in all the components of reading. Kame’enui et al. (in press) would emphasize that reading
fluency involves the development of accuracy and proficiency in every underlying component. Researchers within connectionist approaches (Adams, 1990; Foorman, 1994; Seidenberg & McClelland, 1989) would stress the explicit linkages or connections among the orthographic, semantic, and phonological processes. Berninger et al. (in press) and Adams (1990) would add the connections between morphosyntactic knowledge and these other processes.

Multiple Sources of Dysfluency

The second premise is no less complex and is a logical outgrowth of the first premise and of time-allocation principles. Impairment in any one or more of the underlying processes could increase the processing time both within that process and in reading outcome behaviors (Wolf, 1991; Wolf, Bowers, & Biddle, 2000). Further, it appears that inefficiency not only can arise from accuracy or timing problems within a processing system but also may be based on the coordination and integration of information across processes. An example of the latter is found in recent research by Breznitz (in press), who proposed that a temporal discrepancy (i.e., asynchrony) between the speed of processing of visual information and the speed of processing of auditory information prevents the efficient cross-modal integration necessary for visual–verbal processing in reading.

If the two premises of a developmental, component-based conceptualization of reading fluency are true, a long and complex set of processes and variables could be implicated when fluency is not attained. What is the evidence that impaired readers break down across this continuum of processes? A full discussion of all the evidence that might be brought to bear on this large question is well outside the scope of this article. Meyer and Felton (1999), however, provided a first summary of the existing research on explanations of dysfluency. They divided this research into three major areas:

1. A breakdown in the lower level processes. At this level, dysfluent reading is based on deficits in phonological processing and/or orthographic processing systems that affect the timing and coordination of these systems. More specifically, deficits may arise from phonological, visio-spatial, and/or working memory processes. Breznitz (in press) used extensive evoked potential and behavioral data to indicate that the largest contribution to slowed word-reading rate among dyslexic readers is the slowed speed of processing in perceptual stages (see also Farmer & Klein, 1995; Stein, in press; Tallal, Miller, & Fitch, 1993).

2. A failure to make higher order semantic and phonological connections between words, meaning, and ideas (Adams, 1990). In this level, dysfluent reading is based on deficits that occur after perceptual identification has been completed. One manifestation may involve the slowed retrieval of names, meaning, or both
(see work on confrontation naming and receptive vocabulary by German, 1992; Haynes, 1994; Segal & Wolf, 1993; for naming speed, see Wolf, Bowers, & Biddle, 2000).

3. A breakdown in syntactic processing (Schreiber, 1980), with deficits exhibited in a lack of prosody and rhythm in oral reading and a lack of sensitivity to prosodic cues. These deficits may become apparent only at the level of connected text for reading but may be able to be assessed much earlier in speech development (e.g., through measures of prosody and syntax).

Assessment and Intervention

Meyer and Felton’s (1999) organization of possible areas of deficit implies that breakdown in fluent reading could originate at the sublexical, lexical, sentence, and higher-conceptual integration levels. In future efforts we will examine evidence for possible sources of dysfluency at the component level as well. There are significant implications for diagnosis, as just sketched, that can utilize the application of many existing measures. The most important implication, however, of Meyer and Felton’s review—and of our working definition of fluency—concerns a new, more comprehensive approach to intervention. In the second section of this article we briefly examine how current fluency interventions correspond to the different phases of fluency development and to the range of component processes (e.g., orthographic) and levels (e.g., sublexical, lexical) incorporated in this view of reading fluency.

THE CORRESPONDENCE BETWEEN CURRENT FLUENCY INTERVENTION AND THE DEVELOPMENTAL, COMPONENT-BASED VIEW OF READING FLUENCY

As discussed in work by Stahl and his colleagues (Stahl, Heubach, & Cramond, 1997), the oldest and most commonly used method for facilitating fluency is the repeated reading technique. Here readers are simply asked to read a passage of connected text (at a level appropriate to the learner) several times until a particular reading rate (words per minute) is attained. At each juncture the reader is given further passages at that level until the optimal rate is reached. Dowhower (1994) showed that practicing a series of passages helps build a large repertoire of quickly identified words, a principle also emphasized in the development of fluency by Torgesen et al. (in press) and by Stahl et al. (1997). Repeated reading can be assisted and thus necessitate oral reading (see Young, Bowers, & MacKinnon, 1996; also see their use of prosodic assistance methods) or unassisted and involve silent reading. First described in the literature by Dahl (1974) and named by Samuels (1985), repeated reading methods were designed to increase reading rate for the
given material and other similar materials and to improve comprehension. (As discussed earlier, this is based on the principle that comprehension can be allocated more time when the rate of lower level decoding skills is increased.)

First, does repeated reading achieve its own specified goals? Second, how does it fall on a developmental continuum of fluency’s growth, and what processes does it address? In their careful review of the most well conducted repeated reading studies, Meyer and Felton (1999) underscored the complexity involved in assessing comprehensive gains from fluency instruction, and suggest factors that need to be considered such as student age, reading level, instructional method type (types of repeated reading or rapid decoding of single words), and cueing. Furthermore, the question of whether fluency and comprehension reciprocally influence one another is unanswered. (p. 294)

There is by now a considerable history of studies documenting the relation between fluency and comprehension (Fuchs, Fuchs, & Maxwell, 1988; Jenkins, Fuchs, Espin, van den Broek, & Deno, 2000; Levy, in press; Levy, Abello, & Lysynchuk, 1997; Torgesen et al., in press). As Meyer and Felton (1999) suggested, however, whether the reciprocal direction also exists between comprehension and fluency remains unresolved. Equally unresolved to our minds is whether repeated reading or any existing fluency instruction significantly changes accuracy, rate, and comprehension of trained materials with transfer to other materials.

AN EXAMINATION OF FLUENCY STUDIES

To address this latter question, as well as issues about developmental stages and components that different interventions emphasize, we have taken a second look at many of the studies included in Meyer and Felton’s (1999) review and added several new fluency intervention studies. Depicted in Table 1, our framework examines the following variables: (a) the intensity of the intervention and the nature of the gains (i.e., rate, accuracy, comprehension, transfer), (b) the developmental level of reading subskills addressed (e.g., letter, letter-pattern, word, or passage) and the grade of the individuals, and (c) the components of fluency focused on in the intervention. In the remainder of this section we summarize what we found about each of the variables.

Intensity of Interventions

The length of interventions in the existing literature is extremely limited (most range between 1 and 15 days). Most of the existing studies were intended to be
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<th>Study</th>
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<th>Nature of Intervention</th>
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<th>No. of Rereadings in Intervention</th>
<th>Reading Rate Gains</th>
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<th>Transfer to Untrained Passages</th>
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<td>O’Shea, Sindelar, and O’Shea (1985)</td>
<td>Average to above-average readers</td>
<td>3 sessions</td>
<td>Half cued for comprehension, half for rate and accuracy</td>
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<td>+ For rate group</td>
<td>Comprehension gains only from 1 to 3 rereading. Comprehension</td>
<td>NA</td>
</tr>
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<td>Rashotte and Torgesen (1985)</td>
<td>Nonfluent readers with reading disabilities</td>
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<td>The three conditions: 1. Repeated reading within session of unrelated stories. 2. Repeated reading of stories with shared words. 3. Four different stories a day.</td>
<td>Passage Word recognition Exposure to words</td>
<td>4</td>
<td>1. 35.3 wpm, 2. 33.0 wpm, 3. 5.2 wpm (all significant)</td>
<td>1. 2.52 error decrease, 2. 2.16 error decrease, 3. 0.82 error decrease (only 1 &amp; 2 significant)</td>
<td>Comprehension was high to begin with, therefore may be ceiling effect. 1. More transfer when degree of word commonality among stories is high. 2. Word commonality had less effect on accuracy or comprehension.</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Reading group</td>
<td>Participants</td>
<td>Sessions</td>
<td>Training/Methodology</td>
<td>Across grades</td>
<td>Gains in both groups</td>
<td>Generalization</td>
<td></td>
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<tr>
<td><strong>Levy, Nicholas, and Kohen (1993)</strong></td>
<td>Poor readers</td>
<td>24 poor</td>
<td>One or two</td>
<td>Read silently stories, cross out misspelled words</td>
<td>Both groups</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>readers</td>
<td>readers Grade 3–5</td>
<td>sessions</td>
<td></td>
<td>+ For both groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Good readers</td>
<td>24 good</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>readers</td>
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<tr>
<td><strong>Stoddard, Valcante, Sindelar, O’Shea, and Algozzine (1993)</strong></td>
<td>Reading disabled</td>
<td>30 grades</td>
<td>15</td>
<td>Half received training in intonation. Half received training in sentence segmentation.</td>
<td></td>
<td>NA</td>
<td>Improved from 1 to 3 readings, but not to 7; did not differ among groups</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4–5 (read at least 70 wpm)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lemoine, Levy, and Hutchinson (1993) Study 1</strong></td>
<td>Poor readers</td>
<td>32</td>
<td>4</td>
<td>Blocked presentation of words families or scrambled presentation of word families</td>
<td></td>
<td></td>
<td>No generalization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td></td>
<td></td>
<td>sessions</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Study</td>
<td>Population</td>
<td>N</td>
<td>Length of Intervention</td>
<td>Nature of Intervention</td>
<td>Level and Component Emphasized</td>
<td>No. of Rereadings in Intervention</td>
<td>Reading Rate Gains</td>
<td>Accuracy Gains</td>
<td>Comprehension Gains</td>
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<tr>
<td>Lemoine et al. (1993) Study 2</td>
<td>Good readers</td>
<td>40</td>
<td>5 sessions</td>
<td>Readers were trained on 50 regular words or 50 irregular words</td>
<td>Lexical Word recognition</td>
<td>25</td>
<td>Good readers: Named both equally quickly, decrease of 100 msec over the first 4 trials. Poor readers: The difference between regular and irregular decreased over trials</td>
<td>+ For both groups</td>
<td>+ For both groups</td>
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<tr>
<td></td>
<td>Poor readers</td>
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<td></td>
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<td></td>
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<td></td>
<td>Grade 3</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Young, Bowers, and MacKinnon (1996)</td>
<td>Poor readers</td>
<td>40</td>
<td>1 session</td>
<td>Modeling Text practice Both Neither</td>
<td>Passage</td>
<td>3</td>
<td>Practice of text: 36.9 wpm. Both: 29 wpm. Only modeling: 17.7 wpm. Neither: 25.5 wpm.</td>
<td>+ In all groups approx. 2.5</td>
<td>+ For both groups</td>
</tr>
<tr>
<td></td>
<td>Grade 5</td>
<td></td>
<td></td>
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<tr>
<td>Authors</td>
<td>Type</td>
<td>Participants</td>
<td>Sessions</td>
<td>Methods</td>
<td>Measures</td>
<td>Results</td>
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<tr>
<td>Levy, Abello, and Lysynchuk (1997)</td>
<td>Poor readers</td>
<td>20 (FN) 20 (SN) Grade 4</td>
<td>4</td>
<td>Repeated oral reading of isolated content words</td>
<td>5 of isolated words 4 of stories</td>
<td>Fast RAN: 25.3, Slow RAN: 33.5 (on stories), Fast RAN: 80 sec, Slow RAN: 60 sec (on single words)</td>
<td>+ For both groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breznitz (1997) Study 1</td>
<td>Average readers, age matched (age 6.9), Poor-dyslexic readers (age 9.1), mostly boys</td>
<td>52</td>
<td>2</td>
<td>Reading at two rate conditions: Self-paced or fast-paced + auditory masking</td>
<td>3 of parallel texts: Self Fast Self</td>
<td>Average achievers: 9.13 sec; Poor readers: 8.43 sec (both sig. increase of 20%)</td>
<td>Both groups made the least errors in the masked, fast-pace condition. Sig. difference only for poor reader.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breznitz (1997) Study 2</td>
<td>Dyslexic readers (age 9.3)</td>
<td>23: 18 boys 5 girls</td>
<td>1</td>
<td>Reading at two rates: self-paced, fast paced</td>
<td>3 parallel sets of materials</td>
<td>0.1 letters per second (sig.)</td>
<td>Decrease in 7.9 errors per passage (sig.)</td>
<td>Recall increased in 8% (sig.)</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Most of these studies are from experimental studies; intervention was done in a 1:1 setting, except Rashotte and Torgesen (1985).
brief, experimental explorations of what different versions of repeating reading methods could do to facilitate accuracy and rate gains in oral reading. Several of the studies measured comprehension, but in ways that varied widely from study to study. It is not our intention to criticize the goals of these studies, but to indicate the need for more intensive studies that allow a more meaningful evaluation of comprehension and transfer.

Developmental Level of Reading Subskills Addressed by Interventions

The second general need that can be inferred from Table 1 is that the majority of the experimental studies focus on passage-level reading with no attention to lexical-level, much less sublexical-level, instruction to increase rate. This means that fluency was being addressed late in its development at a time when only a few underlying processes could be addressed (e.g., prosody). The few fluency studies that did emphasize increased single-word rate showed mixed results for comprehension (e.g., Tan & Nicholson, 1997, found gains). Levy is one of the few researchers to conduct systematic, experimental rate studies on sublexical levels, although her major interest in these studies was in increasing accuracy and rate of word recognition, not comprehension (Levy, in press; Levy, Bourassa, & Horn, 1999). Interestingly, in a recent study Levy et al. (1999) found little difference between single-word and connected-text repeated reading practice on the rate of reading. Torgesen et al. (in press) concluded from studies like these that “the primary locus of the repeated reading effect is on individual word reading efficiency.” Torgesen et al. (in press) argued that this sight vocabulary is key to closing the large gap between the words read by average or good readers—estimated by Nagy and Anderson (1984) to be 1 million words a year—and those read by less skilled readers, estimated at 100,000 words.

Several questions emerge from such a conclusion: first, whether an emphasis solely on word-level efficiency is sufficient to change comprehension; second, whether increases in word-reading efficiency are enough to build a sufficiently large sight vocabulary. As seen in Table 1, there are real gains that are possible in oral reading accuracy and rate from various repeated reading methods at both the connected-text and word levels. It appears reasonable to us that such gains in word-reading rate—if accumulated over time within more intensive intervention programs—could result in an expanded working sight vocabulary for children. Whether there are concomitant gains in comprehension remains as unresolved for this summary as for Meyer and Felton’s (1999).

These kinds of questions and the enormity of the existing vocabulary discrepancy between good and impaired readers have led some researchers, including Torgesen et al. (in press), to conclude that intervention efforts are best invested in the prevention of such a gap. Many, including us, are in agreement concerning the
need for developmental prevention models that address the growth of accuracy and fluency before fluency problems ever have an opportunity to develop. As Torgesen et al. (in press) and Kame’enui et al. (in press) have begun to demonstrate, there are impressive ways we can prevent an enormous number of at-risk children from developing later reading and reading fluency problems.

Despite all our best prevention efforts, however, some children—for various well-discussed reasons (see Wolf & Bowers, 1999, 2000)—will continue to develop serious reading fluency and comprehension problems. The fluency needs of most of these children, we believe, will be insufficiently addressed by most of the experimental interventions described in Table 1. These studies address only the final levels of fluency development and few of the components underlying it.

Levels of Subskills and Component Processes of Reading Fluency Instruction

The most difficult question in this article concerns what components that fluency intervention should emphasize. The most difficult implication of our view of reading fluency is that each component and each level of subskills in reading should be addressed in fluency intervention. Following connectionist principles (see Adams, 1990; Foorman, 1994; Seidenberg & McClelland, 1989), we believe that explicit instruction is necessary to link phonological, orthographic, semantic, and morphological processes to sublexical and word-level subskills (see Berninger et al., in press). As seen in Table 1, only a very small number of intervention programs include any systematic attention to the explicit linking of phonological, orthographic, and semantic processes in the acquisition of reading (see discussion of Decoding Pilot Program and RAVE-O program in Meyer & Felton, 1999). Furthermore, we believe that systematic instruction should be directed to accuracy and then to rate at each developmental level of the acquisition of reading subskills—that is, at the level of the phoneme, grapheme, letter, letter pattern (orthographic chunk), word, phrase and sentence, and passage.

On the surface, this is a great deal to ask. In actuality it is asking that each level in the teaching of reading incorporate both an accuracy and a rate of processing component. For example, following Ehri’s (1998) framework, we believe that instruction for fluency development should begin with an emphasis on the accuracy of underlying representations (i.e., phonological, orthographic, semantic, and morphological) for each level up to the word level. In the second phase the focus should be on facilitating the rate of processing in these same lower level processes and subskills, until they become automatic and can be orally read within the context of connected text. In what we refer to as the fluency outcome stage (the equivalent of Ehri’s speed phase), instruction would emphasize attainment of an efficient reading speed with good comprehension of passage-level connected text (see Biemiller, 1977; Chall, 1983; Doehring, 1976, for average reading rates at different ages).
In the last section of this article we discuss an experimental fluency program based on the developmental, componential view of reading fluency articulated in this article. This program represents our first efforts to squarely confront the complexity and developmental changes in fluency development. We do not conceptualize this program as the only solution to the questions raised in this article. Rather, we see it as an evolving approach that will be empirically tested and refined as our collective understanding of fluency increases.

TOWARD A COMPREHENSIVE APPROACH TO FLUENCY INTERVENTION: THE RAVE-O PROGRAM PRINCIPLES

Following concepts outlined in the last section, the RAVE-O program (Retrieval, Automaticity, Vocabulary, Engagement, and Orthography; see complete description in Wolf, Miller, & Donnelly, 2000) was designed as a comprehensive, fluency-based intervention with three major goals: (a) accuracy and automaticity in the components and subskills underlying reading; (b) fluency in word identification, word attack, connected text, and comprehension; and (c) a transformed attitude in children with reading disabilities toward written language. As such, the program is one example of a developmental, component-based approach to fluency development. The program emerged out of theoretical-based knowledge about dyslexic children whose particular deficits go beyond phonological-based deficits. The RAVE-O program was specifically designed to address the needs for increased rate of processing and reading fluency among two well-represented subtypes of children with reading disabilities (Wolf & Bowers, 1999).

RAVE-O is aimed at increasing processing speed both in underlying components (i.e., visual and auditory recognition, orthographic pattern recognition, lexical retrieval, and semantic activation processes) and in three reading outcome behaviors (i.e., word identification, word attack, and comprehension). Drawing on research by Doehring (1976) and connectionist models of the reading process (Adams, 1990; Caramazza, 1997; Foorman, 1994), RAVE-O simultaneously addresses the need for automaticity in phonological, orthographic, and semantic systems and the importance of teaching explicit connections among these three systems.

PROGRAM IN PRACTICE

Goals 1 and 2

The program is to be taught only in combination with a program that teaches systematic, phonological analysis and blending. Children are taught a group of core
words each week that exemplify critical phonological, orthographic, and semantic principles. Each core word is chosen on the basis of (a) shared phonemes with the phonological-treatment program, (b) sequenced orthographic patterns, and (c) semantic richness (e.g., each core word has at least three different meanings). First, the multiple meanings of core words are introduced within their varied possible semantic contexts. Second, children are directly taught to connect the phoneme analysis skills (taught in the phonological program) with the trained orthographic patterns in RAVE-O. For example, children are taught individual phonemes in the phonological program (like a, t, and m) and orthographic chunks with the same phonemes in RAVE-O (e.g., at and am, along with their word families).

A central program emphasis is on rapid recognition and practice of the most frequent orthographic letter patterns in English. A special set of computerized games (see Speed Wizards; Wolf & Goodman, 1996) was designed both to allow for maximal practice and to increase the speed of orthographic pattern recognition (i.e., onset and rime) in a fun fashion. In addition, the format of the games was designed to enhance the speed and accuracy of the multiple underlying components like visual scanning, auditory discrimination at the phoneme and phoneme cluster levels, and letter and word identification (see more complete description in Wolf, Miller, & Donnelly, 2000).

Another key emphasis in the program involves the direct integration of vocabulary development and increased lexical retrieval skills. The dual emphasis on vocabulary and retrieval is based on earlier work in vocabulary development that suggested that one retrieves fastest what one knows best (see Beck, Perfetti, & McKeown, 1982; German, 1992; Kame’enui, Dixon, & Carnine, 1987; Wolf & Segal, 1999). Vocabulary growth is conceptualized as essential both to rapid retrieval (in oral and written language) and to improved comprehension, an ultimate goal in the program.

The combination of the vocabulary and retrieval areas also helps address several clinical and theoretical issues in research on children with reading disabilities. First, in the clinical domain, although many dyslexic children begin with adequate to superb vocabularies, their vocabulary falls behind the level of average readers who are reading increasingly sophisticated texts with words unavailable in oral discourse. This is a key part of the sight word vocabulary discrepancy discussed by Torgesen et al. (in press) and Nagy and Anderson (1984). Second, although a child with reading disabilities may well know a given word, our work has demonstrated that many dyslexic readers often cannot retrieve known words (Wolf & Goodglass, 1986; Wolf & Obregon, 1992). Third, whether it is an antecedent or a consequence of reading and fluency problems, or a combination of the two, some children with reading disabilities appear to have a less flexible set toward determining the often multiple meanings of words. They simply may not be able to allocate more time to processing more than one meaning to a known word, thus affecting later comprehension development.
RAVE-O’s daily structure combats flagging vocabulary development, word-retrieval problems, and inflexibility in word usage by teaching an imaginative set toward language from the start. Every core word in the program with its varied meanings and syntactic uses is practiced every day in different ways. For example, “Word-webs” are created for many of the words as a teaching tool to illustrate the principle “If you know one word, you know a hundred!”

To enhance the speed and accuracy of lexical retrieval, four metacognitive strategies for word retrieval—called Sam Spade Strategies—are taught. Each strategy incorporates some of the phonological, orthographic, and semantic principles of the program (see earlier RAVE program in Wolf & Segal, 1999). For example, children are taught during “Tip of the Tongue” occurrences to try to remember an onset, rime, or semantic associate of the missed word.

Sam Spade also appears as a character in the series of timed and untimed comprehension stories (e.g., Minute Mysteries). These stories accompany each week of RAVE-O and directly address fluency in comprehension in several ways. The controlled vocabulary in the stories incorporates the week’s particular orthographic patterns and emphasizes the multiple meanings and semantically related words of the week’s core words. In addition, the stories provide a good vehicle for repeated reading practice, which facilitates fluency in connected text. Thus, the Minute Mysteries facilitate fluency in phonological, orthographic, and semantic systems at the same time that they build comprehension skills.

The Third Goal: Engagement With Language

An important, implicit goal of the RAVE-O program concerns a whole new cognitive–affective set toward language use and is specifically geared toward children who have begun to feel disenfranchised from their own language. As Chukovsky (1963) once stated in another context, many of our children have begun to feel “like strangers in the realm of their own language” (p. 9). RAVE-O is built around the notion that a combination of systematic goals, incremental successes, and whimsical imaginative activities go hand in hand with building a new attitude to language, reading, and learning in general. From colorfully animated computer games to webs of words, children learn they can master this task of reading. The motivational component of RAVE-O is one of its real strengths for both teacher and learner, particularly in overcrowded urban schools.

PRELIMINARY ANALYSES

Preliminary data on the RAVE-O program are now available for 200 second- and third-grade children with severe reading impairments who participated in the large
The preliminary data indicate significant gains in word attack, word identification, oral reading rate and accuracy, and passage comprehension. Although these data will be presented in full report in a subsequent study, the preliminary analyses offer our first hint that a developmental–componential approach to fluency intervention can change the reading rate of severely impaired readers on standardized oral reading measures and, most important, increase their comprehension on standardized measures. The findings, therefore, provide one promising piece of evidence that severe processing speed deficits in individuals with reading disabilities may be amenable to treatment. That said, these data do not yet represent an empirical validation of the developmental–componential view to reading fluency that we offer in this article; rather, they offer a starting place for further efforts.

SUMMARY

There are many unresolved theoretical and applied questions in research on reading fluency and fluency-based deficits in individuals with reading disabilities. Prominent among the theoretical questions are issues of definition and clarification of time-related terms. There is no consensus concerning how we use such basic terms as rate, automaticity, speed of processing, temporal processing, dynamic processing, or precise timing, much less fluency. Yet, as illustrated here, our definitions have critical implications for how and who we diagnose and for how we construct and evaluate intervention. We argue strongly for a definition of fluency that is developmental- and component-based, where rate and speed are the characteristics of the components and subskills of reading, and where accuracy and automaticity are assessable outcome stages of reading and reading fluency. Within this admittedly complex view, there are large lacunae in our understanding of how and how much individual component processes (e.g., orthographic, semantic, morphosyntactic) contribute to fluency and how fluency and comprehension influence each other. There are also frank omissions even in this broad view of fluency concerning the contributions of basic processes like general cognitive speed (see Breznitz, in press; Carver, 1991; Kail, 1992). There remains much to understand.

At such a moment it is good to reflect on our own recent history as a field. Thirty years ago, powerful questions about the role of phonological processes in
reading led to a systematic body of research on phonological-core deficits, diagnostic measures, and phonological-based treatments. In a similar vein, we believe that the exploration of the basic structure and development of reading fluency will lead to a heightened understanding of fluency-based reading problems in children, their assessment, and their amelioration. The articles in this special issue are a part of that exploration.

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