Literacy Studies: Perspectives from Cognitive Neurosciences, Linguistics, Psychology and Education

Rachel Schiff
R. Malatesha Joshi *Editors*

Interventions in Learning Disabilities

A Handbook on Systematic Training Programs for Individuals with Learning Disabilities

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Literacy Studies

Volume 13

While language defines humanity, literacy defines civilization. Understandably, illiteracy or difficulties in acquiring literacy skills have become a major concern of our technological society. A conservative estimate of the prevalence of literacy problems would put the figure at more than a billion people in the world. Because of the seriousness of the problem, research in literacy acquisition and its breakdown is pursued with enormous vigor and persistence by experts from diverse backgrounds such as cognitive psychology, neuroscience, linguistics and education. This, of course, has resulted in a plethora of data, and consequently it has become difficult to integrate this abundance of information into a coherent body because of the artificial barriers that exist among different professional specialties. The purpose of this series is to bring together the available research studies into a coherent body of knowledge. Publications in this series are of interest to educators, clinicians and research scientists in the above-mentioned specialties. Some of the titles suitable for the Series are: fMRI, brain imaging techniques and reading skills, orthography and literacy; and research based techniques for improving decoding, vocabulary, spelling, and comprehension skills.

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About the Editors

Rachel Schiff, Ph.D., is Professor of Education at Bar-Ilan University, Israel. Her work focuses on three aspects of the learning disabilities world: LD professional training, research, and diagnosis and remedial teaching of individuals with LD. She has established and currently chairs the Learning Disabilities Master's Program. The program trains students to become informed skilled learning disabilities diagnostician and remedial teachers who understand the theory and practice of teaching and assessing learners with LD of all ages. Schiff's lab group research integrates studies that focused on the literacy, linguistic, and cognitive abilities of adults and children with learning disabilities, involving the interface of spoken and written representations among Hebrew speakers, especially the reading disabled. A dominant theme that draws her lab research has been intervention programs. Prof. Schiff also serves as Head of Haddad Center for Dyslexia and Reading Disorders at Bar-Ilan University which provides diagnostic assessment and remediation to help reading disabled students who otherwise would remain disadvantaged.

R. Malatesha Joshi, Ph.D., is Professor of Reading/Language Arts Education, ESL and Educational Psychology at Texas A&M University, where he teaches and conducts research in literacy development and literacy problems among monolinguals and bilinguals in different orthographies. Dr. Joshi is the Editor of *Reading and Writing: An Interdisciplinary Journal* and the monograph series titled *Literacy Studies: Perspectives from Cognitive Neurosciences, Linguistics, Psychology and Education*. He has published numerous books and scientific papers on reading, writing, and spelling among speakers of English and other languages. Joshi has received several awards, such as Erasmus Mundus Visiting Scholar, Germany, and Beijing Normal University, China. He has received several grants and also has served on the review panels for Institute of Educational Sciences as well as the National Institute for Child Health and Human Development.

Introduction

Rachel Schiff and R. Malatesha Joshi

The chapters in this book provide a window into the research on effective interventions to help students with learning disabilities (LD) learn to succeed academically. The interventions described in this book are deeply informed by multi-disciplinary research. It is a knowledge base that derives from research and thinking in a wide range of contributing disciplines: education, language, applied linguistics, psychology, psycholinguistics, cognitive science, and second language acquisition, to name but a few. Many of these subject areas were in their infancy in the middle decades of the twentieth century but are now rigorous in research and intellectual activity, and are able to provide insights of relevance to LD intervention practice. We sought submissions that blended the theory and practice of intervention in LD and were complex in their perspective.

The aim of this book is to explore some of these insights, in particular those which can inform scholars of LD on issues of current research concern. Many of the chapters address the major components of reading and writing development. Several chapters focus on the development of emergent reading skills including preschool literacy instruction such as phonological awareness. Other chapters review the research on the early stages of word reading and teaching approaching for primary-grade students in the beginning reading skills. The complexities of vocabulary development and reading fluency warrant a couple of chapters. Chapters on spelling and writing reflect the relationship of reading and spelling, while chapters on listening and reading comprehension highlight the multiple processes and sub-skills involved in understanding text. A group of chapters on math skills, cognitive control

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and working memory offer supplemental training that contributes to students' academic outcomes. Finally, chapters that focus on teacher professional development emphasize the role of the interventionist in improving the performance of students with LD across various tasks.

This book also is intended for practicing teachers of students with LD who wish to discover more about ideas in LD which influence their work and the sources of these ideas. It would also be of relevance to teachers entering the profession who wish to gain an overview of theory and practice. Alternatively, it can be used as a textbook by teacher trainers working with pre-service and in-service teachers.

The intervention studies described in this book indicate that instruction to students with LD across grade levels must be informed by several factors related to the population (such as type of LD, screening process, age of students, size of group), the intervention (such as the skill taught, skill complexity, duration of program) and how it is implemented (who delivers the intervention? How? In which setting?). However, even if we consider all these factors, it is quite clear that there isn't one optimal model that can be considered "the best one". Rather, when choosing an instructional practice for students with LD, the question we should ask is: For which individual students with which individual profiles or characteristics and needs are the right opportunities likely to be provided through one intervention model or another? The approach that an LD intervention in a particular context is good for some students with LD but not for others, that different students need to learn different contents in different ways, and that much previous intervention research hasn't captured these unique individual differences seems more promising. It is more a question of having a foundation of knowledge against which research studies teachers can evaluate their own ideas about conducting research and teaching students with LD.

Although the book tries not to take a prescriptive stance in the sense of promoting certain routines or techniques, we believe that it is possible to discern a number of persistent factors that many interventions in LD share based on empirical research. While this book encourages reflection and the building of critical perspective, the professional and research practice of the LD interventions described in this collection might yield several generalizations. We do see that effective teaching for students with LD is best delivered explicitly, and is often complemented with strategy instruction and metacognitive strategies and self-regulation skills. These components have been associated with positive benefits for students with LD. Another factor that plays a significant role in teaching LD students is students' engagement and motivation throughout instructional planning and implementation.

We invited authors whose work in the field builds upon strong research foundation and offers valuable models and guiding principles. The authors contributing to this volume add their passionate voices to the discussion of issues surrounding and shaping intervention studies in LD. In each of the chapters in this book authors summarize research and theory, and outline features of instruction and teaching principles identified in intervention studies.

The chapter "Critical Components of Phonemic Awareness Instruction and Intervention: Recommendations for Teacher Training and for Future Research"

discusses the importance of phonemic awareness to literacy development. In this chapter Al Otaiba, Allorm Werfel, and Clemens review various assessment methods that help teachers screen students to determine risk, guide interventions, and monitor progress. Specifically, the chapter discusses four intervention programs and instructional practices that have been proven beneficial for the development of phonemic awareness of at-risk children. The chapter ends with practical information for the evaluations of other currently available programs, providing further tools for researchers and practitioners in assessing training programs that aim to develop students' phonemic awareness skills in different instructional contexts.

The chapter "Word Reading Interventions for Students with Reading Difficulties and Disabilities", by Denton and Masden, introduce word reading-based intervention programs for LD students. First, the authors explain the difficulties LD students are faced with compared to their typically developing peers. Following an explanation of the three aspects of word reading-based intervention programs, i.e., the focus of effective intervention, the Instruction through which the intervention is delivered, and factors related to the implementation of interventions, the chapter discusses specific intervention programs and instructional practices that have been proven beneficial for the word reading development of older students and adolescents. The chapter discusses both what these programs include (systematic instruction in the alphabetic principle, sound-spelling correspondences, phonological decoding, automatic recognition of high-utility words, and meaningful text reading) how they should be taught (explicit instruction, aspects of direct instruction, practice and feedback, and pacing of instruction) and implemented (group size, dosage and scheduling, and interventionists). Following intervention practices designed to teach adolescents, the chapter ends with the remaining challenges that instructors and LD students are faced with.

While the chapter "Word Reading Interventions for Students with Reading Difficulties and Disabilities" focuses on the role of linguistic abilities such as phonological awareness and alphabet knowledge in word reading development for LD students, the chapter "A Cognitive and Linguistic Approach to Predicting and Remediating Word Reading Difficulties in Young Readers" demonstrates an intervention program that aims to examine which cognitive abilities predict reading at the beginning and end of Grade 1. Integrating foundational literacy, cognitive and emotional readiness skills into a range of cyclical activities, the intervention was built on two different themes "my house" and "my neighborhood" both based on popular children's book in Hebrew. In this chapter Shaul, Katzir, Primor and Lipka show that visual perception and phonological awareness had the strongest correlation with reading, explaining most of the variance. Further, additional cognitive abilities such as executive functions, short term memory, and naming were also significantly connected with reading. Understanding the role of specific cognitive skills in reading, can possibly improve prediction of risk status of individuals and be the basis for a tailored intervention.

The purpose of the chapter "The Efficiency of Metacognitive and Metalinguistic Awareness in Word Spelling Among Hebrew Speaking Children with SLI: An Intervention Study" by Schiff, Sasson, Nuri, and Ben-Artzi is to present an

intervention program that assesses the effect of combining metacognitive and metalinguistic instructional practices on the spelling acquisition of Hebrew speaking children with specific language impairment (SLI). Sixty-seven kindergarteners with SLI in a supported learning context participated in the program. Children were classified into three groups according to the instructional practice used: metalinguistic with metacognitive strategies, metalinguistic, and control. The assessment measures included were letter naming, sounding letters, word spelling, and word recognition assessed both on the pretest and posttests. Findings indicate that both the group that received metalinguistic and metacognitive training and the one receiving only linguistic training made statistically significant gains in all spelling measures. However, the metacognitive instructional practice had a stronger effect on the spelling skills of children with SLI compared to the two other groups. This chapter provides evidence that children with SLI benefit from the combination of metacognitive and metalinguistic instructional practices when acquiring early spelling skills.

The chapter "Intervention and Assessment of Spelling Skills in LD Classrooms" further unpacks spelling acquisition. In this chapter, Joshi refutes the common myth about English spelling as being irregular by explaining that English spelling can be taught rather than memorized. For example, knowing the history of the language, the syllable patterns and how letters' sound based on neighboring letters or the position of the letter or letter groups can help in spelling words with complex and inconsistent letter-sound correspondences. The chapter has an insightful section on second language spelling, emphasizing that these interventions need to be tailored to meet the specific needs of students and the linguistic background of the learners. Joshi's chapter ends by reminding us that spelling is a neglected area and teachers must be provided with good spelling strategies in their teacher training courses, so they are better prepared to meet the needs of struggling spellers.

In the chapter "Seizing the Sounds: Considering Phonological Awareness in the Context of Vocabulary Instruction", Strom and Neuman introduce an innovative intervention program of vocabulary instruction using a recorded conversation between a student and a teacher about the words Ranch and Cot. This intervention showcases how phonological awareness and semantic development intermingle during reading lessons. To the best of our knowledge, the concept of combining semantics and phonology is very original and has not been investigated before, let alone using qualitative measures. The underlying hypothesis of this concept is the Lexical Restructuring Theory (Metsala & Walley, 1998) that posits that as children acquire more words, their lexicons are under a developmental pressure to reorganize, and that the way that a word is stored is connected to its meaning, as well as to its distinct sounds. Through the analysis of the conversation between the student and the teacher and the tables of students' errors, the authors explain how words were classified according to their salient phonological properties, as well as how they were contextualized—and given meaning—during lessons. The chapter demonstrates how phonemic awareness skills impact meaning-making and vocabulary skills, and particularly the ways in which teachers turn misrepresentations (of sounds or of meanings) into opportunities to deepen students' semantic knowledge.

The chapter "Effective Strategies for Developing Reading Comprehension" seeks to review the various cognitive and metacognitive strategies that are needed for effective reading comprehension. Gajria and Jitendra's divide the review to single strategy studies and multiple strategy investigations. The review of single strategy interventions yields that explicit instruction in cognitive strategies, such as using text structure, finding the main idea, self-questioning, cognitive mapping, and summarization techniques, leads to significant improvement in students' comprehension of both narrative and expository texts, across different grade levels. In addition, combining a self-monitoring component with a single cognitive strategy, such as self-questioning or summarization, has a powerful effect on promoting comprehension. The findings from multiple cognitive strategy studies support and reconfirm the effectiveness of explicit and strategic practices to help students with LD become more proficient readers. The choice of strategy depends on the careful selection of instructional level texts and explicit use of the procedures to address the learning problems of students with LD and engage them in the reading process.

O'Reilly and Sabatini, in their chapter "Using Advances in Cognitive Science to Improve Students Study Skills and Reading Comprehension", consider recent developments from the cognitive literature that can shed light on solutions for improving students' study skills, as well as their general reading comprehension. The authors use the four prong model: (1) Preparing to Read; (2) Interpret Words; (3) Sentences, and Ideas in Text Strategies that go Beyond the Text; and (4) Strategies to Organize, Restructure, and Synthesize text content (McNamara et al., 2007) to summarize results from previous studies. Thus, they make a strong case for a new assessment model that requires the application of reading strategy and study skills as part of the assessment experience. This assessment model includes explicit vocabulary instruction in content area texts; supplementing student's background knowledge of relevant concepts; providing instruction in making inferences in relating ideas in a text; and improving students' metacognitive strategies by answering questions, paraphrasing, or writing summaries.

In the chapter "What Is Listening Comprehension and What Does It Take to Improve Listening Comprehension?", Kim and Pilcher survey theoretical models and intervention studies of listening comprehension development and improvement. Though a neglected skill, the review reveals that many language and cognitive skills contribute to listening comprehension, including working memory, attention, vocabulary, syntactic knowledge, inferencing, theory of mind, and comprehension monitoring. The chapter emphasizes that creating a language-rich environment is critical for children's language development and that this environment should include listening comprehension training embedded throughout the school day and long-term throughout multiple years. Additionally, the involvement of multiple language and cognitive skills in listening comprehension has important implications for assessment as these skills should be part of the assessment battery diagnosing children's difficulty with listening comprehension. Finally, the intervention studies described in this chapter may develop listening comprehension skills not only in children with learning disabilities but in typically developed population as well.

In the chapter "Best Practices in Writing Instruction for Students with Learning Disabilities", Rouse and Graham summarize some of the best writing practices for LD students. Relying on the differences between writers with and without LD, the chapter discusses the instructional practices that have been proven beneficial for the writing development of individuals with LD. Some of these practices include: motivation to write, planning, content generation, and strategy instruction. The chapter closes with a powerful final section that includes practical information for the teaching of writing. This is the strength of chapter because in addition to theory and discussion of previous intervention studies, it provides further suggestions for researchers and practitioners in different writing instruction contexts. The authors have compiled a solid collection of resources to offer to researchers and practitioners about the complex relationship between motivation and explicit strategy instruction for writers with LD.

The chapter "Language and Literacy Interventions for ELs with LD: Two Steps Forward, One Step Back" examines interventions that sought to improve language and literacy skills among English language learners (ELL) who might be suspected of LD. In this chapter, Linan-Thompson, Cavazos, NcFarland, and Martinez explain that when teaching vocabulary, reading or writing, explicit and strategic vocabulary development is crucial for ELL and those experiencing academic struggles. Strategy instruction increases students' competency with various aspects of reading and writing processes through the explicit teaching of reading and writing strategies, combined with the self-regulation strategies necessary to successfully engage in the process itself. Writers of this chapter emphasize that more research is needed in a number of areas including ELL with LD from different language groups, in secondary, and in the different content areas.

In the chapter "A Research-Validated Program for Improving At-Risk Students' Fraction Magnitude Understanding, Word-Problem Solving, and Explanations", Malone, Fuchs, and Fuchs describe *Fraction Face-Off*, a 12-week intervention program designed to improve at-risk students' fraction magnitude understanding. The distinctive features of the program include focusing on the measurement interpretation of fractions rather than the part-whole interpretation, which dominates instruction in U.S. classrooms. In addition, the program incorporates seven design principles for effective Tier II interventions: (a) instructional explicitness, (b) instructional design to minimize the learning challenge, (c) a strong conceptual basis for procedures taught, (d) drill and practice, (e) cumulative review, (f) progress monitoring, and (g) on-task behavior motivators. Findings show that each year, at-risk students who participated in the intervention program significantly outperformed at-risk students receiving the schools' standard fraction instructional program. This intervention program also effectively reduced the achievement gap between at-risk students who received the intervention versus those of not-at-risk classmates, and in some instances, the at-risk intervention group outperformed the not-at-risk group.

In the chapter "Working Memory and Strategy Instruction in Children with Learning Disabilities", Swanson advances our understanding of how to improve memory performance in children with LD in reading and math. Based on three sets

of intervention programs targeting different working memory skills, the chapter conveys a straightforward and insightful message: working memory (WM) can be improved in children with LD, leading to substantial progress on important classroom tasks such as reading comprehension and/or math performance. Findings from two lines of experiment demonstrate that while children with LD benefited significantly in WM performance as a function of scaffolding (probing) instruction as well as direct strategy instruction (e.g., rehearsal), the relationship between WM and LD is unrelated to declarative or procedural knowledge of strategies.

The chapter "Training of Cognitive Control in Developmental Disorders: Pitfalls and Promises" seeks to review the various cognitive training programs that are available for the development of effective executive functioning abilities in individuals with attention deficit hyperactivity disorder (ADHD). This review includes computerized and non-computerized training programs as well as programs that focus on transfer skills and feedback. In this chapter Shalev, Kataev, and Mevorach make a strong case for using the cognitive training to improve the executive function skills such as planning, selection of an appropriate strategy, the ability to sustain attention over a long period of time, the ability to maintain information in working memory as well as other skills of cognition and academic outcomes in children with ADHD. These programs hold great potential in reducing the gap between the academic achievements of children with ADHD and typically developing children and may even be applicable to other groups at-risk for academic, social and behavioral problems.

Finally, the chapter "New Directions in Preservice and Inservice Professional Development for Teaching Students with and Without Specific Learning Disabilities in Middle Childhood and Early Adolescence" by Berninger and Joshi focuses on teacher education and student learning across the curriculum during middle childhood and adolescence. The chapter views pre-service and in-service teachers as key figures in children's literacy development, and therefore the way to enhance children's literacy skills, as Berninger and Joshi suggest is to become sensitive to teachers professional development and learn from advances in research. The chapter focuses on the instructional practices that have been proven beneficial for the literacy development of learners with SLD, including a solid collection of dos and don'ts that are grounded in conceptual frameworks for all language systems (language by ear, mouth, eye and hand). The idea that teachers need to continue developing professionally, in their phonological and morphological awareness skills is demonstrated at the end of the chapter by providing evidence from empirical research.

Thus, within the past 20 years, there has been growing recognition of the need to develop and research instructional practices for students with LD. This recognition has brought to the forefront the advancement of at risk children. We encourage scholars to continue research interventions for LD students using innovative research designs and methods. Future research will provide a fuller picture for supporting students with LD. Despite the growing presence of students with LD in regular classes, many teachers continue to feel underprepared to work with them. This discomfort may be due to the fact that that LD scholarship has been rather slow to reflect the influx of students with LD in schools. Additionally, many teachers feel

that students with LD would be better served exclusively by special education professionals. However, students with LD do find their way into regular classrooms, and as a response to this challenge, we offer this volume. We want to encourage teachers to stay current with research on instruction for students with LD, so that teachers consistently add new instructional practices to their repertoire. As editors of this volume, we take great pleasure in recommending these chapters to our readers.

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Critical Components of Phonemic Awareness Instruction and Intervention: Recommendations for Teacher Training and for Future Research

Stephanie Al Otaiba, Jill Allor, Krystal L. Werfel, and Nathan Clemens

Abstract The purpose of this chapter is to describe critical components of phonemic awareness instruction and intervention for students in pre-k through second grade who have language delays, reading disabilities, or who are at-risk for future reading problems. First, we describe our theoretical framework. Second, we describe existing assessments for screening, progress monitoring, intervention design. Third, we describe four evidence-based intervention programs that range from Tier 1 to more intensive interventions and we provide links to websites that review additional interventions. Finally, we conclude with directions for future research related to phonemic awareness instruction and intervention for students with language impairments or reading disabilities.

Keywords Early literacy • Teacher training • Phonemic awareness

The purpose of this chapter is to describe critical components of phonemic awareness instruction and intervention for students in pre-k through second grade who have language delays, reading disabilities, or who are at-risk for future reading problems. First, we describe our theoretical framework regarding how phonemic awareness is a foundational skill for reading and writing. Second, we describe existing assessments that can help teachers screen students to determine risk and then to monitor progress and guide interventions within multi-tier systems of supports or

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Response to Intervention (RTI) models (e.g., Gersten et al., 2009). We assume that the reader has working knowledge of the distinction between criterion-referenced and standardized measures with national norms, as well as basic principles of reliability and validity of assessments and about RTI. In RTI models, Tier 1 represents class-wide literacy instruction, screening for risk status and progress monitoring. More intensive intervention is provided for students who do not respond to Tier 1 in additional Tiers or layers of instruction. Interventionists may include an array of personnel from supervised volunteers or para-professionals to classroom or special education teachers or related service personnel such as speech language pathologists. We also provide helpful links to a website that reviews assessments. Third, we describe four evidence-based intervention programs that range from Tier 1 to more intensive interventions and we provide links to websites that review additional interventions. Finally, we conclude with directions for future research related to phonemic awareness instruction and intervention for students with language impairments or reading disabilities.

1 Theoretical Framework for Understanding How Phonemic Awareness Is Foundational to Reading and Writing Skills

The theoretical framework that guides our chapter about teaching phonemic awareness derives from an expanded, or Not-So-Simple View of Reading (Joshi & Aaron, 2000), based upon the Simple View of Reading (Hoover & Gough, 1990). The Simple View posits that reading comprehension is the product of two broad sets of skills: (a) accurate and fluent word recognition, and (b) language comprehension. In addition, the Not-So-Simple View recognizes that background knowledge, working memory, behavior, and motivation impact both sets of skills (Joshi & Aaron, 2000; Saez, Folsom, Al Otaiba, & Schatschneider, 2012), which is consistent with more complex models of reading comprehension (e.g., Perfetti, Landi, & Oakhill, 2005). Another aspect of our theoretical frame is that both sets of skills develop across time in fairly predictable stages (Chall, 1996; Ehri, 2005). What is most relevant to this chapter on phonemic awareness instruction is the need for early teaching to ensure that children develop the ability to hear and manipulate sounds in words. Only when students can efficiently sound a word out, blend the sounds in a word, and then retrieve both the pronunciation and meaning of individual words from long-term memory, can they read fluently with deep understanding. Furthermore, effective teaching of phonemic awareness supports working memory, motivation, and integration of phonemic awareness with letter-sound and decoding instruction.

There is also an analogous Not-so-Simple View of Writing (Berninger, Garcia & Abbot, 2009), which hypothesizes that writing is the product of three basic processes: transcription skills (including spelling and handwriting), self-regulation, and text production (planning and ideation). In addition, inefficient working memory resources could limit these three sets of skills; in other words, if more cognitive resources are required for spelling, then fewer resources are available to produce text. The reason for using these Not-So-Simple Views of reading and writing and

the stages of development to frame our chapter is to help the reader understand the vital importance of early phonemic awareness assessment and intervention to prevent and remediate reading and writing difficulties.

What is phonemic awareness and how does it contribute to reading and spelling skills? Phonemic awareness is a set of skills that help children perceive that a word they hear, such as "mom" can be broken into beginning, middle, and ending sounds; and that the sounds /m/ /o/ /m/ can be blended or combined to form the word "mom". This awareness develops in stages typically beginning in preschool and continuing through the end of second grade (for longer words with more than one syllable). Over time, with instruction, children learn to pay attention, think about, and manipulate the sounds, or phonemes, in words. First, they begin to understand the broader construct of phonological awareness, which includes the understanding that there are two syllables, or chunks of sounds, in a word like "cowboy." So, when asked to say "cowboy" without the "cow," they would say "boy." Then, they begin to hear and be aware of the shared rime in words like "dog", "bog, and "frog." They can sort pictures into a pile that start with the sound /s/ like sun and another pile that starts with the sound /b/ like boy. By the end of kindergarten, most children have learned to correctly segment each sound in a word three and four phonemes (Good, Wallin, Simmons, Kame'enui, & Kaminski, 2002). Similarly, within this developmental window, most children have learned to blend individually presented sounds together to form words (Torgesen & Morgan, 1990). During this time, most children can also learn the most common sounds that letters make as they develop letter-sound correspondence. The distinction between these broader or more general forms of phonological awareness and the more distinct form of phonemic awareness is critical because measures of phonemic awareness appear to be more predictive of individual differences in beginning reading development growth (Hoien, Lundberg, Stanovich, & Bjaalid, 1995).

Some children, particularly those who enter school with limited book-reading experiences or who have limited language, or speech and language disorders may not develop the ability to segment and blend or learn letter-sound correspondence because they have not received explicit and systematic instruction. However, a small proportion of children may not learn to isolate sounds in a word, blend, or segment during this developmental window, even if they have received explicit instruction (Al Otaiba, Kosanovich & Torgesen, 2012). It is vital for educators to understand several ways that phonemic awareness is linked to the ability to read and spell words. First, phonemic awareness helps children understand how chunks of sounds in English are represented by letters. This letter-sound correspondence is known as the alphabetic principle and when children lack phonemic awareness, they are unable to blend sounds to form words. Second, as Ehri (2000) noted, reading and spelling are "two sides of the coin," so just as children use phonemic awareness to decode a word, their ability to hear each sound in a word supports efficient spelling of words. Students with strong phonemic awareness are able to segment spoken words into sounds to aid in spelling words. Third, when children can hear and attend to each sound in a word like "frog," they can anticipate it will include four letters because it has four sounds. Relatedly, as Ehri (2005) has demonstrated, developing readers use their awareness of the phonemes in words as a mnemonic to help them

remember the words' spellings, which will enable them to recognize many thousands of words "by sight." Fourth, it will help them consider words that can only be partially sounded out with the skills they currently have. Their early phonemic awareness supports their search within their lexicon for words that begin with similar sounds. So if reading a sentence, the dog b----- at the cat, a child with phonemic awareness could use the knowledge that the word "barked" starts with a /b/ to constrain and refine their mental search for words that also fit the meaning of the sentence (Al Otaiba et al., 2012). This strategy will eventually expand to including ending and medial sounds, but may begin with using first sounds to inform a guess about the identity of an unknown word in text. Ehri pointed out that these strategies support accurate word reading, because words must be read accurately a number of times before they can become part of a child's sight vocabulary. Finally, a large synthesis of over 52 experimental studies revealed that explicit phonemic awareness instruction demonstrated a strong and positive effect on the development of reading skills (Ehri et al., 2001) and a small but statistically significant effect for reading comprehension.

2 What Assessments Help Teachers Screen Students to Determine Risk, Guide Interventions, and Monitor Progress?

Because emerging phonemic awareness skills are strongly predictive of later growth of reading skills (Blachman, 2000; Good, Simmons & Kame'enui, 2001; NELP, 2008) it is important to note that such skills can be used to (1) screen and identify children at risk for reading failure before word reading instruction actually begins, (2) monitor progress or response to instruction and intervention, and (3) describe the level of phonological impairment relative to a normative peer group in children being diagnosed with reading disabilities. Recently, researchers have noted that screening assessment using single measures of phonemic awareness (e.g., phoneme segmentation fluency) may yield false positives, or children who are at risk who do not develop reading difficulties (Catts, Petscher, Schatschneider, Bridges, & Mendoza, 2009; Clemens, Shapiro, & Thoemmes, 2011; Johnson, Jenkins, Petscher, & Catts, 2009). One solution is to monitor growth trajectories of phonemic awareness skills several times during kindergarten and first grade to not only determine risk early, but to use data about students' response to guide interventions (by indicating which skills are weak), and to monitor progress which indicates how intensive intervention should be based on the severity of risk (Good, Simmons, Kame'enui, Kaminski, & Wallin, 2002; Good et al. 2001).

According to Ehri et al. (2001) teachers need to be aware of their students' skill levels as they plan phonemic awareness instruction because some children will need more intensive intervention than others. Broadly speaking, there are three types of tasks that researchers have developed to assess phonemic awareness (Catts, Wilcox, Wood-Jackson, Larrivee, & Scott, 1997): sound identification, phoneme blending, and phoneme segmentation. Sound identification tasks typically offer picture sup-

port and ask a child to indicate which picture (from a choice of two to four) starts or ends with the same sound as a targeted word. Phoneme blending tasks provide a series of phonemes in isolation and ask the child to blend them together to form a word (i.e. "What word do these sounds make, /d/ /o/ /g/?). Again, the use of pictures may reduce the working memory load of this task by allowing the child to select among two or three pictures the word that is represented by a series of phonemes (e.g., Torgesen & Bryant, 1993). Phoneme segmentation tasks generally require the most explicit level of phonemic awareness because children are asked to count, pronounce, delete, add, or reverse the individual phonemes in words. Common examples of this type of task require students to say the sounds in a word "dog" (child says /d/ /o/ /g/), or to delete a sound or chunk of sound from words (say cowboy, now say cowboy without saying cow, which is "boy"; say fixed, now say fixed without saying /k/, which is "fist"). Clearly, differences in task difficulty relate to the grain size of phonemic manipulation of speech sounds, to working memory, and to whether words are familiar to children. Task difficulty is an important consideration for children with less developed vocabulary, to children with fewer home literacy opportunities for book reading, to children with speech and language delays, and to children who do not have English as their first language.

Because more assessments are continually being developed, it is helpful to know that the website for the Center on Response to Intervention provides a very helpful up to date tool that reviews instruments, describes the skills tested at which grade levels, and indicates reliability and validity information (http://www.rti4success.org/resources/tools-charts/screening-tools-chart). Thus, what follows are some examples of widely-used curriculum based measures (CBM) that are useful for screening and monitoring the progress of students on phonemic awareness skill development, rather than a conclusive or exhaustive list. Most programs have between three and five forms for universal screening and additional probes for more frequent progress monitoring. It is noteworthy that in the last decade test publishers have conducted considerable work using item response theory to establish which items best discriminate at various skill levels, to ensure alternate form reliability, and in some cases, to develop efficient computer-adaptive testing formats (Measures of Academic Progress for Primary Grades; Northwest Evaluation Association, 2013; Adaptive Reading, FastBridge Learning, (2015); Istation's Indicators of Progress; Mathes, Torgesen, & Herron, 2014, and STAR Early Literacy, Renaissance Learning, 2015). Further work is ongoing to establish and to keep updated benchmarks or goals that are associated with risk and no risk (e.g., https://dibels.uoregon.edu/market/assessment/recommendedgoals). Some web-based assessment programs also provide teachers with immediate graphic displays of student data not only for phonemic awareness, but also for other critical early literacy and language skills and highlight students who need additional intervention. Others include links to instructional recommendations (e.g., Istation's Indicators of Progress).

There are several examples of CBM in the area of sound identification for K-1. First Sound Fluency from the Dynamic Indicators of Basic Early Literacy Skills Next system (DIBELS Next; https://dibels.org/dibelsnext) asks students to repeat the first sound from a series of words spoken by the examiner. This measure is scored in terms of the number of correct sounds produced in 1 min. On the Onset

Sounds task from the Formative Assessment System for Teachers (FAST), students are shown a set of pictures that are named by the examiner, and are asked to identify the one that begins with a specific sound. In contrast to First Sound Fluency, timing on Onset Sounds is open-ended and scores are not dependent on fluency with the task. For preschool children, the Alliteration task from the Individual Growth and Development Indicators (IGDIs) asks students to choose from two pictures to indicate the one that starts with a particular sound (http://www.myigdis.com/preschool-assessments/early-literacy-assessment/), and scores consist of the number of correct responses in 1 min.

In the area of phonemic blending, FAST Word Blending asks students to repeat a word that has been segmented into phonemes by the examiner. Administration is not fluency-based, and scores consist of the number of correctly blended words out of 16 trials. Several CBM versions of phonemic segmentation exist. The Phoneme Segmentation Fluency measures (PSF) from the AIMSweb (www.AIMSweb.com), DIBELS, and EasyCBM (www.easycbm.com) systems are nearly identical; each requires the student to segment a series of words spoken by the examiner, and scores consist of the number of phonemic segments produced within 1 min. It should be noted that students may receive points for any sound segments, which may include syllables or multiple blended phonemes, not necessarily individual phonemes. The FAST Word Segmenting task is similar to other segmentation tasks in that students are instructed to segment words spoken by the examiner, however it differs in that timing is open-ended, and only individual phonemes are awarded points.

Versions of PSF have been included in considerable research investigating their validity and screening accuracy in predicting early reading difficulties. Overall, PSF measures demonstrate acceptable reliability, however they tend to demonstrate lower predictive validity compared to other print-based early literacy indicators such as letter naming fluency (Catts et al., 2009; Clemens et al., 2011; Goffreda & DiPerna, 2010; Goffreda, Diperna, & Pedersen, 2009; Johnson et al., 2009; Kim, Petscher, Foorman & Zhou, 2010). Additionally, analyses of screening accuracy of PSF (i.e., the accuracy of identifying students who are/are not at risk for reading difficulties) have revealed problematic accuracy, by either over- or under-identifying students that may be at-risk (Catts et al. 2009; Clemens et al. 2011; Johnson et al. 2009). One possible reason for the fact that PSF measures have demonstrated weaker validity and classification accuracy may be related to the outcome variables used in most studies, which typically include measures of word and text reading. In completing PSF measures students do not respond to print at any point, therefore the association to print-based outcome measures might be expected to be somewhat weaker compared to predictors that require students to identify letters or decode words. In addition, the common approach to scoring PSF measures in which any separate or unique sound segment is scored (not just individual phonemes) may result in equal scores between two students with varying levels of sophistication in their segmentation skills. Other research has included PSF measures in analyses of growth over time. Studies have revealed that growth in PSF is not typically associated or predictive of subsequent reading outcomes (Clemens, Hilt-Panahon, Shapiro, & Yoon, 2012; Ritchey & Speece, 2006). However, PSF can certainly inform teach-

ers diagnostically about students' patterns of errors so it can be useful but educators should use it in conjunction with more valid diagnostic measures.

Additionally, studies have indicated that growth in PSF across kindergarten and first grade is typically non-linear, as rates of growth have been found to differ both within and across semesters (Clemens et al., 2012; Al Otaiba, Clemens, & Rivas, 2015). This issue is not unique to PSF measures, as nonlinearity has been observed across grade levels and academic skill areas including oral reading (e.g., Ardoin & Christ, 2008), math (Keller-Margulis, Mercer, & Shapiro, 2014), and written expression (Keller-Margulis, Mercer, Payan, & McGee, 2016), with rates of growth during the fall typically being greater than rates of growth during the spring. Several factors may be associated with seasonal effects, such as greater intensity of instruction during one portion of the school year versus another, or depressed skills following the summer break result in a "rebound" effect during the fall semester. Nevertheless, the implication is that when teachers monitor student growth on a regular basis, as in their responsiveness to instruction, or when changes over time are assessed, consideration must be given to the tendency for growth nonlinearity to be present. Thus, slope estimation methods must take this tendency into account. Commonly used web-based progress monitoring systems summarize student growth with a straight line (OLS regression line of best fit). Educators should expect growth to be nonlinear.

Phonemic awareness activities have been incorporated into software-based assessments. Examples include Measures of Academic Progress for Primary Grades (Northwest Evaluation Association, 2013), Adaptive Reading (FastBridge Learning, 2015), Istation's Indicators of Progress (https://www.istation.com/Assessment/ISIPEarlyReading; Mathes et al., 2014), and STAR Early Literacy (SEL; Renaissance Learning, 2014). Phonemic awareness content in these assessments typically includes tests in which students are asked to choose pictures that begin or end with the same sound as a target picture, or select a picture from a set of choices that matches a word segmented by the software. The preceding examples include assessment content developed using item response theory, and all adaptive technology to tailor the test items that are presented based on the students' accuracy on previous items. Several software-based assessments provide instructional recommendations based on the results. For example, the *mclass: CIRCLE* (www.amplify.com/assessment/mclass-circle; Landry, Assel, Gunnewig, & Swank, 2005) software is designed for pre-school students and includes a set of phonological awareness tasks such as alliteration, syllabication, and onset-rime segmentation. Examiners score students' responses electronically, and the software provides reporting and instructional recommendations. Standardized, norm-referenced tests of phonemic awareness can provide a more comprehensive assessment of students' skills in this area. The Comprehensive Test of Phonological Processing – Second Edition (Wagner, Torgesen, Rashotte, & Pearson, 2013) and the Phonological Awareness Test 2 (Robertson & Salter, 2007) provide multiple subtests to evaluate skills across phonemic awareness domains. Other assessments of reading or early literacy skills include phonological and phonemic awareness composites, usually comprised of a series of different tasks. Examples of these assessments include the Woodcock

Reading Mastery Test, 3rd edition (Woodcock, 2011), Test of Preschool Early Literacy (Lonigan, Wagner, Torgesen, & Rashotte, 2007), TPRI Early Reading Assessment (Texas Education Agency & University of Texas System, 2013), and the Kaufman Test of Educational Achievement, 3rd edition (Kaufman & Kaufman, 2014).

Several options exist for assessing phonological awareness skills in Spanish. CBM Spanish options include Phoneme Segmentation Fluency from the DIBELS Indicadores Dinamicos de Exito en la Lecture (IDEL), Syllable Segmentation Fluency from AIMSweb Medidas Incrementales de Destrezas Esenciales, and a series of measures (Onset Sounds, Word Rhyming, Word Blending, Word Segmenting) from the FAST Early Reading Spanish materials. The Test of Phonological Awareness in Spanish (Riccio, Imhoff, Hasbrouck, & Davis, 2004) provides a set of subtests that assess skills in initial and final sound identification, rhyming, and deletion.

Although early phonological awareness instruction on its own cannot guarantee later literacy success, the National Reading Panel (NRP; NICHD, 2000) highlighted the importance of phonological awareness instruction as one component of effective early literacy instruction. The results of this meta-analysis indicated that phonological awareness training generally is effective at improving phonological awareness skills for all types of children under all conditions when it was implemented by any professional (or even a computer). In the follow section we describe the general components of phonological intervention programs, describe the characteristics of students who likely would need intervention, and then highlight four programs that are evidence based.

3 Components of Phonological Awareness Intervention

First, although the inclusion or exclusion of letters in phonological awareness instruction is not an important determinant of phonemic awareness outcomes, including an explicit focus on the relation of manipulating phonemes to letter knowledge is more effective for improving reading and spelling outcomes (Cunningham, 1990). Indeed it is not surprising that including letter instruction explicitly bridges the gap from analyzing sounds to decoding and encoding text. Further clarification of *how* to include letter instruction in phonemic awareness intervention, however, is needed. Should all instruction include letters? Should no instruction include letters? The answer likely falls somewhere in between; that is, letter sound knowledge should be combined with phonological awareness instruction after a base of segmentation and blending skill is established (Ball & Blachman, 1991; Schuele & Boudreau, 2008). In a single-case research study conducted with struggling kindergarten students in the latter part of kindergarten, Allor, Gansle, and Denny (2006) demonstrated that a game focused on using a limited set of letters to sound out and spell words was effective in increasing phonemic awareness. Students pronounced the sounds of letters and blended them to form words and they

segmented words, matching each sound to letters to spell words. In this way, students developed phonemic awareness skills, while learning the alphabetic principle. Although not the focus of the study, Boyer and Ehri (2011) included letters in a phonemic segmentation intervention that was successful with preschoolers. Further research is needed regarding when and how to include print. Further, research supports the benefits of learning the alphabetic principle early (O'Connor, Bocian, et al., 2013; Simmons, Coyne, Kwok, McDonagh, Harn & Kame'enui, 2008). Combining phonemic awareness and letter-sound instruction has been effective for low-performing students who were in classrooms that emphasized meaning-based approaches (Ryder, Tunmer, & Greaney, 2008).

Second, phonological awareness instruction is most effective when instruction includes a focus on one or two rather than multiple types of manipulation of phonemes. Specifically, focusing on blending and segmenting phonemes results in higher reading and spelling outcomes (O'Connor, Jenkins, & Slocum, 1995; Yeh & Connell, 2008). Learning to blend phonemes helps children in learning to decode, and learning to segment phonemes helps them in learning to spell. Theoretically, this seems reasonable in that blending sounds is needed to sound out simple words and segmenting words into sounds is needed to spell simple words. Making these relationships explicit appears to be important for students at risk for disabilities (Allor et al., 2006).

Third, according to findings from the NICHD (2000), 20 h of total instructional time addressing phonological awareness appears to be sufficient for most students. It is important for teachers to assess carefully to ensure that instructional time is used appropriately. If students require more than 20 h to master phonological awareness, this points to the need for phonological awareness interventions to be provided in Tier 2.

Fourth, as mentioned in the introduction, words used during phonological awareness instruction should be meaningful to students. Using pictures can provide students who are struggling with a scaffold and using words that are familiar to students will help them to verify that their response is reasonable. Consistent with our theoretical framework, it is also important to link the alphabet, sounds, and meaning as much as possible to strengthen these processing links.

Finally, although phonological awareness instruction is most effective when implemented by researchers in highly structured conditions, instruction or intervention that is implemented by classroom teachers is also effective. It is important for teachers to receive adequate training so they are able to replicate research conditions. This training should include proper pronunciation of sounds in isolation and how to model blending and segmenting clearly and correctly (O'Connor, Fulmer, Harty, & Bell, 2005). Techniques commonly used by researchers include stretching continuous sounds when modeling how to blend, following a model-lead-test procedure during activities, and providing differentiated instruction. Teachers need to be skilled observers so they are able to recognize incorrect responses and provide assistance through scaffolding. It is vital for teachers to understand how to use data to screen children for risk, plan instruction and intervention, monitor progress, and

differentiate. Another trend in education is for phonemic awareness instruction to be computer-based or computer adaptive.

4 Characteristics of Students Who Will Likely Need Phonemic Awareness Interventions

For children with language or reading disabilities, effects of phonological awareness instruction are less robust than for children who make normal progress in reading (Al Otaiba & Fuchs, 2002; Lam & Mc Master, 2014; Puranik, Petscher, Al Otaiba, Catts, & Lonigan, 2008). For phonemic awareness outcomes, there is a positive effect of intervention for children with language or reading disabilities but it is not as robust as for children with normal reading skills. For reading outcomes, the positive effect of phonological awareness intervention for children with language disorders and reading disabilities is similar to that of children with normal reading skills. However, there is no effect of phonological awareness instruction for children with reading disabilities in spelling skills. It is likely that for these children with reading disabilities, phonological awareness instruction alone is not sufficient for improving spelling outcomes and instruction that includes morphosyntactic and semantic training as well as phonological awareness will be necessary for gains in this area (Apel, Masterson, & Hart, 2004).

5 Evidence-Based Intervention Programs

Next, we describe four evidence-based phonological awareness interventions: K-PALS, a Tier 1 phonological awareness intervention program; the Intensive Phonological Awareness Program; Sound Partners; and Early Interventions in Reading, all Tier 2 (or Tier 3) phonological awareness interventions that vary in terms of integration with other early literacy skills. All four of these intervention programs follow NRP recommendations and are consistent with current theory of reading acquisition and scientifically-based instruction.

5.1 K-PALS: A Tier 1 Phonological Awareness + Decoding Intervention

Kindergarten Peer-Assisted Learning Strategies (*K-PALS*; Fuchs et al., 2001a) is a structured class-wide peer tutoring reading program, ideal for Tier 1 instruction, designed for kindergarten classroom implementation for all students. *K-PALS* follows NRP recommendations (NICHD, 2000) with a theoretical basis in cooperative

learning (Slavin, 1980) and direct instruction (Engelmann & Carnine, 1982; Coyne, Kameenui, & Simmons, 2001). *K-PALS* consists of code-based lessons that focus on phonological awareness, letter-sound correspondence, and beginning decoding. Initially, teachers introduce the peer-tutoring program by modeling the activities class-wide. First, the teacher plays the role of the coach. Then individual students play the role of the coach with the entire class. Finally, students are paired and alternate the roles of coach and readers while the teacher monitors and provides feedback. Sample lessons are available at http://kc.vanderbilt.edu/pals/reading-kindergarten.html.

The What Works Clearinghouse rates the effectiveness of *K-PALS* on alphabetics as potentially positive, with the extent of evidence being medium to large. Multiple studies have demonstrated the positive effects of *K-PALS* on the reading and spelling outcomes of children who are at-risk for reading disabilities. Fuchs and colleagues (2001b) demonstrated that incorporating *K-PALS* into Tier 1 instruction resulted in better outcomes in reading and spelling for low-achieving as well as average-achieving students than a control group receiving typical instruction or a comparison group receiving non-peer-tutoring phonological awareness instruction without a focus on letter-sound correspondence. Importantly, improved outcomes as a result of *K-PALS* were seen in schools that served largely low-income and/or minority students, as well as schools that served largely middle-class Caucasian students. Further, Fuchs and colleagues (2002) demonstrated that, as a group, kindergarteners with disabilities in mainstream classrooms who participated in *K-PALS* outperformed those who participated in typical instruction. More than half of students with disabilities who participate in *K-PALS*, however, did not respond to the Tier 1 instruction. Additionally, Al Otaiba and Fuchs (2006) reported that 13 % of kindergarteners without disabilities were nonresponsive to *K-PALS*. Taken together, these studies suggest that *K-PALS* is an effective addition to Tier 1 instruction for most students without disabilities and some students with disabilities. Thus, it is necessary to consider the effectiveness of Tier 2 intervention programs for these nonresponders to Tier 1 instruction. It is likely that students who do not respond to K-PALS alone would require additional Tier 2 intervention.

5.2 Intensive Phonological Awareness Program: A Phonological Awareness Tier 2 Intervention

The *Intensive Phonological Awareness (IPA) Program* (Schuele & Dayton, 2014) is a supplemental small-group phonological awareness program, ideal for Tier 2 intervention, designed for struggling readers in elementary school (K – 2). The *IPA Program* follows NRP recommendations (NICHD, 2000) with a theoretical basis in phonological awareness development (Anthony & Lonigan, 2004). The *IPA Program* consists of highly structured, focused lessons targeting phonological awareness skills that can be implemented by speech-language pathologists or

reading specialists. The program focuses primarily on phonological awareness skills; additionally, each lesson includes a letter activity that is separate from the focus on phonological awareness. The table of contents, which details the progression of lesson plans, can be accessed at http://products.brookespublishing.com/The-Intensive-Phonological-Awareness-IPA-Program-P732.aspx.

Two studies have demonstrated that the *IPA Program* is effective for improving phonemic awareness and spelling for children at-risk for reading disabilities. Schuele and colleagues (2008) reported that the lowest-performing students who participated in the *IPA Program* outperformed the lowest-performing students in control classrooms on outcome measures of spelling. Additionally, Werfel and Schuele (2014) reported that a modified version of the *IPA Program* was effective for increasing phonemic awareness skills in preschool children with severe-to-profound hearing loss. In both of these studies, intervention was implemented by speech-language pathologists. Taken together, these studies provide evidence that a Tier 2 small group intervention that focuses primarily on phonological awareness is effective at improving both phonemic awareness and literacy skills.

5.3 *Sound Partners: A Code-Based Tier 2 Intervention*

Sound Partners (Vadasy et al., 2005) is a supplemental individualized tutoring program, ideal for Tier 2 intervention, designed for struggling readers in elementary school (K – 3). *Sound Partners* follows NRP recommendations (NICHD, 2000) with a theoretical basis in the Simple View of Reading (Hoover & Gough, 1990). *Sound Partners* consists of highly structured, scripted lessons that can be implemented by tutors, paraprofessionals, and assistants who have minimal training. The program is primarily code-oriented, with a focus on phoneme blending, as well as phonics-based skills (e.g., letter-sound correspondences, decoding and encoding words that are phonetically regular, and reading high-frequency words that are phonetically irregular); additionally, *Sound Partners* targets reading fluency and comprehension monitoring through storybook reading practice. Sample lessons from *Sound Partners* can be accessed at http://store.cambiumlearning.com.

The What Works Clearinghouse rates the effectiveness of *Sound Partners* on alphabetics as positive, with the extent of evidence being medium to large. Multiple studies have demonstrated the positive effects of *Sound Partners* on the reading and spelling outcomes of children who are at-risk for reading disabilities. For example, Vadasy, Sanders, and Peyton (2006) reported that at-risk kindergarteners who participated in *Sound Partners* tutoring performed higher on outcomes measures of decoding, developmental spelling, and reading fluency than a control group who did not receive tutoring. Additionally, the *Sound Partners* group had higher growth rates in phonemic awareness than the control group. Likewise, Jenkins, Peyton, Sanders, and Vadasy (2004) reported that at-risk first graders who participated in *Sound Partners* tutoring performed higher on outcomes measures of decoding and comprehension than a control group who did not receive tutoring. More recently, the

program has been demonstrated to be effective with students who have limited English proficiency (Vadasy & Sanders, 2011).

5.4 *Early Interventions in Reading: A Comprehensive Tier 2 Intervention*

Early Interventions in Reading (*EIR*: Mathes & Torgesen, 2005) is a comprehensive small-group intervention program, ideal for Tier 2 or Tier 3 intervention, designed for struggling readers in elementary school (K – 4). *EIR* follows NRP recommendations (NICHD, 2000), with instruction in phonemic awareness, phonics, fluency, vocabulary, and comprehension, and follows a theory of instruction or direct instruction model theoretical framework (Engelmann & Carnine, 1982; Coyne et al., 2001). *EIR* consists of highly detailed lessons that can be implemented by classroom teachers or reading specialists. Lessons consist of seven to ten short interrelated activities that can be implemented at one time or divided over multiple days as necessary. *EIR* provides teachers with extensive training over 9 months. *EIR* systematically focuses on the introduction of increasingly complex skills as students progress in the program. Additionally, *EIR* explicitly teaches children to apply previously-learned skills to the more complex skills and then to connected text. Sample lessons from *EIR* can be accessed at http://www.sraonline.com.

Multiple studies have demonstrated the positive effects of *EIR* on the reading and spelling outcomes of children who are at-risk for reading disabilities. For example, Mathes and colleagues (2005) reported that at-risk first graders who participated in *EIR* throughout their first grade year outperformed a control group who received typical instruction alone on outcome measures of phonological awareness, word reading, and reading fluency. Importantly, only 1 % of students who received *EIR* intervention remained below the 30th percentile on basic reading skills at the end of first grade, compared to 16 % of students receiving only typical instruction. Additionally, *EIR* intervention combined with focused vocabulary and oral language practice is effective for increasing phonemic awareness, letter knowledge, oral language, word reading, spelling, and reading comprehension for at-risk first graders who are English-language learners (Vaughn et al., 2006). In addition, the intervention was successfully used in a recent study of RTI as a Tier 3 intervention (Al Otaiba et al., 2014). Most recently, *EIR* has been implemented successfully as a Tier 3 intervention with students with below-average IQ scores, including those with intellectual disability, in grades 1 through 4 (Allor, Mathes, Roberts, Cheatham, & Al Otaiba, 2014). Students participating in *EIR* intervention outperformed students in the control group (who received typical instruction) on all outcome measures except one measure of untimed sight word reading. Outcome measures included phonemic awareness, real word and nonword decoding, letter knowledge, reading fluency, and reading comprehension. Taken together, these studies provide evidence that *EIR*, a comprehensive early literacy program that includes a strong

phonological awareness intervention component, is effective for improving phonemic awareness, reading, and spelling outcomes across a variety of students at-risk for reading disabilities.

6 Resources for Evaluations of Other Currently Available Programs

Finally, it is beyond the scope of this chapter to provide details of all evidence-based phonological awareness intervention programs. Therefore, we direct you to two online resources that publish evaluations of many available phonological awareness intervention programs. The Florida Center for Reading Research (http://www.fcrr.org) and Oregon Reading First at the University of Oregon (http://oregonreadingfirst.uoregon.edu/inst_curr_review_si.html) have available published reviews of many programs.

6.1 Directions for Future Research Related to Phonemic Awareness Intervention and Assessment for Students with Learning Disabilities

Our purpose in writing this chapter was to provide readers with a description of the critical components of phonemic awareness instruction and intervention for students in pre-k through second grade who have language delays, reading disabilities, or who are at-risk for future reading problems. First, we described a theoretical framework showing that phonemic awareness is a foundational skill for reading and writing. Second, we described existing assessments that can help teachers screen students to determine risk and then to monitor progress and guide interventions within multi-tier systems of supports or Response to Intervention (RTI) models (e.g., Gersten et al., 2009). Third, we described four evidence-based intervention programs that range from Tier 1 to more intensive interventions and we provide links to websites that review additional interventions. In this final section we describe some directions for future research related to phonemic awareness instruction and intervention for students with language impairments or reading disabilities.

Given the existence of the small number of children who do not respond to phonemic awareness instruction and intervention, there is a need for more longitudinal research that follows students across time. On the one hand, it is important to learn whether early response is like an inoculation against future reading problems. Researchers and practitioners need to understand that growth trajectories of early literacy skills, including phonemic awareness, may not be linear and to specify benchmarks accordingly. Clearly more measurement work is needed to help identify

the most efficient skills to identify risk. On the other hand, it is important to learn how intervention effects may accumulate across time and whether students' response improves with greater intensity or differentiated interventions. It is also critical for children receiving speech and language services that their phonological intervention be consistent or aligned across general education and speech-language settings (e.g., Boyer & Ehri, 2011). Further, it is vital to learn more about how phonemic skill development is impacted by working memory, motivation, self regulation and attention. For example, working memory load could be reduced by linking print and phonemes (Boyer & Ehri, 2011), or by stretching the sounds in words without stopping (O'Connor 2007; Gersten et al., 1988; Kuder, 1997), to lessen the impact of short-term memory and sequencing problems faced by some children with reading disabilities.

There is also a need for more research to explore the growth of phonemic skills in students' native language and in English to learn how best to support transfer of skills from one to another.

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Word Reading Interventions for Students with Reading Difficulties and Disabilities

Carolyn A. Denton and Keri M. Madsen

Abstract Many students with learning disabilities struggle to develop adequate word recognition and decoding skills. This chapter reviews findings from 21 summary documents related to word reading instruction and the effects of word reading interventions for students with reading difficulties and disabilities, with a focus on word reading interventions. These include meta-analyses, systematic syntheses of research, narrative reviews of literature, and government-sponsored guides for practitioners. Based on findings from these documents, the chapter provides an overview of current research related to the critical components of evidence-based word reading interventions. The chapter addresses both the prevention of word reading difficulties in young children and interventions for older students with word reading difficulties and disabilities.

Keywords Word reading • Reading intervention • Reading disabilities

1 Word Reading Interventions for Students with Reading Difficulties and Disabilities

Many students, particularly students with learning disabilities (LDs), fail to develop word reading proficiency. The majority of students with LDs have impaired word reading (Fletcher, Lyon, Fuchs, & Barnes, 2007), and the most common type of reading disability is dyslexia (Vellutino & Fletcher, 2005; Vellutino, Fletcher, Snowling, & Scanlon, 2004). In English and other languages with complex orthographies, the most pervasive characteristic of students with dyslexia is the inability to accurately read isolated words (Lyon, Shaywitz, & Shaywitz, 2003; Schatschneider &

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Torgesen, 2004; Vellutino & Fletcher, 2005). In languages with more transparent orthographies, dyslexia is often characterized by dysfluent word identification (Sprenger-Charolles, Siegel, Jiménez, & Ziegler, 2011).

In this chapter, we describe evidence-based word identification intervention for students with or at-risk for LDs in reading and for students who have word reading difficulties without identified disabilities. The instructional approaches described in this chapter have been found to be effective for students in both of these groups (Fletcher et al., 2007). We refer to this group of students collectively as students with word reading difficulties (WRD). We define evidence-based practices as instructional processes and routines that have either been investigated directly or that are components common to multiple interventions that have demonstrated effectiveness. Although some of the meta-analyses and syntheses we will cite reviewed studies in other alphabetic languages, most of the research we summarize has been conducted in English. Thus, this chapter is focused primarily on WRD in English. Although there is evidence that interventions like those we describe are effective in other alphabetic languages (e.g., Vaughn et al., 2006), additional research is needed to verify this conclusion.

As a foundation for the discussion of WRD, we first describe a theory of typical development of fluent, accurate word reading. Then, we synthesize findings of meta-analyses, systematic research reviews, government reports, and narrative research summaries in order to describe evidence-based practices for the prevention of WRD in the early grades and for the remediation of WRD in older students. We conclude with a discussion of significant challenges yet to be addressed.

2 Typical Development and Word Reading Difficulties

While many researchers have contributed to our current understanding of the development of word reading, the work of Linnea Ehri has offered substantial contributions. Ehri's theory explains the development of skilled word reading as a series of discernable phases (Ehri, 1995).

Children in the pre-alphabetic phase do not yet have working knowledge of the alphabetic system. Environmental print is often recognized based on memory of salient visual features or cues. During the partial alphabetic phase, emergent readers have partial knowledge of the alphabetic system, allowing them to begin to form connections between spellings and pronunciations. Alphabetic knowledge is used to assist in identifying printed words, but words cannot be fully decoded with this partial knowledge. Frequently, emergent readers in this phase connect the initial and final letters in words with their corresponding sounds, providing partial connections in memory that are used for word reading. However, these partial connections allow room for confusion among words that share similar spellings (Ehri & Wilce, 1987).

The full alphabetic phase is characterized by the ability to use the alphabetic system to decode printed words. Readers know common sound-spellings and are able to make complete connections between graphemes and pronunciations in many words, thereby securing complete spellings in memory (Ehri, 2005). With minimal repeated exposure, unfamiliar words that are both regularly- and irregularly-spelled become sight words. Thus, decoding skill facilitates memory for sight words, allowing the reader's lexicon to grow quickly. As words become bonded in memory, they are recognized instantaneously and read accurately.

With full alphabetic knowledge and repeated exposure to spellings, automatic and accurate decoding skill is strengthened. Letter patterns that are encountered across words become consolidated units in memory. As memory for larger orthographic patterns forms, the reader enters the consolidated alphabetic phase, characterized by rapid recognition of these larger units of print (e.g., morphemes, syllables, rimes) in addition to whole words that have been stored in memory as sight words (Ehri, 1998, 2005). These units become consolidated in memory and are accessed efficiently during reading (Ehri, 1998).

2.1 Word Reading Difficulties and Disabilities

Students with WRD may progress unevenly through the phases described by Ehri (2005). Due to limitations in the capacity to recognize and manipulate phonemes, they may experience difficulties acquiring even basic letter-sound correspondences. Some memorize instructed sound-spellings but do not fully grasp the alphabetic principle (i.e., letters represent sounds that can be combined and rearranged to form words). Due primarily to phonological processing limitations (Goswami, 2002; Sprenger-Charolles et al., 2011; Vellutino & Fletcher, 2005), students may continue to operate in the partial alphabetic phase, thereby failing to develop fully-specified phonological and orthographic representations of words and to generalize their knowledge of phonology and orthographic patterns to read unfamiliar words (Ehri & McCormick, 1998). Some students have command of most basic sound-symbol correspondences but have difficulties generalizing their knowledge of words and word parts and inferring the identities of newly encountered words, necessary if the reader is to amass a large sight word vocabulary that can be accessed with automaticity. Early difficulties with word reading acquisition tend to develop into more generalized reading difficulties over time (Stanovich, 1986) since students who lack the ability to read words accurately and fluently in early elementary school tend to read less than typically-developing students (Mol & Bus, 2011). This practice deficit impacts the development of word identification, spelling, vocabulary, and comprehension (Cunningham & Stanovich, 1991; Mol & Bus, 2011). Thus, older readers who continue to experience WRD often have complex reading difficulties involving multiple reading components as well as emotional repercussions of repeated reading failure, making remediation challenging.

3 Intervention

In this section, we summarize findings reported in a set of meta-analyses, structured syntheses of research evidence, government reports, and narrative summaries of literature related to the prevention and remediation of WRD. Table 1 lists the sources

Table 1 Articles and documents reviewed

Citation	Document type	Years reviewed	Nature of interventions	Studies reviewed	Grade levels
Connor et al. (2014)	Narrative review (G)	2002–2008	NS	111	NS
Denton (2012)	Narrative review	1998–2010	Classroom instruction, supplemental interventions	NS	K-3
DEST (2005)	Synthesis (G)	1960–2005	Literacy interventions	NS	S
Edmonds et al. (2009)	Synthesis and meta-analyses	1994–2004	Word study, fluency, vocabulary, comprehension	29	6–12
Elbaum et al. (2000)	Meta-analysis	1975–1998	1:1 tutoring	31	1–6
Galuschka et al. (2014)	Meta-analysis	1985–2013	Instructional and non-instructional treatments	22	S
Gersten et al. (2009)	Practice guide (G)	NS	Multi-tiered reading interventions	11	K-2
Goodwin and Ahn (2010)	Meta-analysis	1980–2010	Morphological instruction	17	K-12
Kamil et al. (2008)	Practice guide (G)	NS	Literacy interventions	14	4–12
NRP (2000) *Phonological Awareness*	Meta-analysis (G)	1970–2000	PA instruction	52	PK-6
NRP (2000) *Phonics*	Meta-analysis (G)	1970–2000	Phonics instruction	38	K-6
Rose (2006)	Practice guide (G)	NS	Classroom reading instruction, reading interventions	NS	S
Scammacca et al. (2007)	Meta-analysis (G)	1980–2006	Word study, fluency, vocabulary, reading comprehension, MC	31	4–12

(continued)

Table 1 (continued)

Citation	Document type	Years reviewed	Nature of interventions	Studies reviewed	Grade levels
Slavin et al. (2008)	Synthesis	1970–2007	Evaluation of curricula; teacher-delivered + CAI; CAI; classroom process approach	33	6–12
Slavin et al. (2011)	Synthesis	1970–2009	1:1 tutoring; small-group tutoring; classroom process approach; CAI	96	K-5
Snow and Juel (2005)	Narrative review	NS	NS	NS	NS
Swanson (1999)	Meta-analysis	1963–1997	Academic interventions for students with LD	92	Adults and children
Torgesen (2004)	Narrative review	NS	Prevention and remediation	NS	Elementary school
Vaughn et al. (2010)	Narrative review	NS	Intensive interventions	NS	S
Wanzek and Vaughn (2007)	Synthesis	1995–2005	≥100 sessions	18	K-3
Wanzek et al. (2013)	Meta-analysis	1995–2011	≥75 sessions; most MC	10	4–12

G government sponsored, *LD* learning disabilities, *NS* not specified, *PA* phonological awareness, *MC* multi-component, *CAI* computer-assisted instruction, *K* kindergarten, *S* school-aged, *DEST* Department of Education, Science and Training, *NRP* National Reading Panel

examined, the types of interventions they described, and grade levels addressed. This list of sources is not exhaustive, but represents several major papers and smaller narrative summaries published from 2000 through 2014 that summarize aspects of effective reading intervention for students from kindergarten through grade 12. We acknowledge limitations to our strategy of examining this set of documents. In particular, some documents surveyed some of the same original studies, producing redundancy in the findings; however, each approached the topic of reading intervention somewhat differently. In the following sections we report on the findings of these syntheses related to the instructional content, delivery, and implementation of interventions for students with WRD.

3.1 What Is the Focus of Effective Intervention?

A central theme related to effective interventions for students with WRD is that they involve reading instruction. This conclusion is not trivial, as thousands of dollars are spent on non-instructional treatments purported to treat dyslexia. Years of research

have failed to support non-instructional interventions for improving reading outcomes for persons with dyslexia (see special issue introduced by Pennington, 2011). A meta-analysis by Galuschka, Ise, Krick, and Schulte-Körne (2014) included studies of treatments that focus on underlying processes hypothesized to be related to reading (e.g., visual perception), motor exercise treatments, colored overlays, homeopathic treatments, and medical intervention. Galuschka et al. (2014) found no significant effect sizes associated with any of these approaches. At this time, best evidence indicates that, to improve reading for students with dyslexia, we must teach them to read. This may be a long and arduous process, but it appears there are no quick fixes that do not involve instruction.

What should be included in this instruction? The most pervasive finding across all sources was the importance of providing direct, systematic phonics instruction both as part of classroom reading instruction in the early grades and as a primary focus of remedial interventions for older students with WRD. Especially for students in grades K-3, there is an abundance of evidence that programs that provide systematic instruction in the alphabetic principle, sound-spelling correspondences, and phonological decoding are more effective than those that do not (Connor, Alberto, Compton, & O'Connor, 2014; Department of Education & Training [DEST], 2005; Galuschka et al., 2014; National Reading Panel [NRP], 2000; Rose, 2006; Slavin, Lake, Davis, & Madden, 2011; Snow & Juel, 2005; Torgesen, 2004; Wanzek & Vaughn, 2007).

Systematic programs introduce a comprehensive list of phonic elements in a carefully planned, sequential order. Systematic instruction is well-organized and progresses logically from easier to more challenging objectives. Skills are built gradually as new learning is integrated with prior learning (Gersten et al., 2009). This is not to say that all students require instruction in every sound-spelling pattern; rather, instruction should be individualized based on assessments. Systematic instruction can be provided effectively using a variety of curricular approaches, including highly specified, scripted interventions, and those in which teachers plan lessons according to program criteria, as long as a full set of phonic elements are taught in a defined order.

The NRP (2000) compared the effects of programs that included systematic phonics instruction to those that did not, reporting moderate to large effects associated with systematic phonics instruction for students at-risk for reading difficulties in kindergarten ($d = 0.58$) and first grade ($d = 0.74$) and smaller effects for students with reading disabilities in grades 2–6 ($d = 0.32$). Stuebing, Barth, Cirino, Francis, and Fletcher (2008) illustrated that effect sizes as small as 0.32 (or smaller) are educationally important in terms of the potential for reducing the incidence of at-risk readers in intervention programs or negative outcomes such as high school dropout rates. Although the conclusions of the NRP regarding the provision of systematic phonics instruction have been questioned (Camilli, Wolfe, & Smith, 2006; Hammill & Swanson, 2006), the NRP meta-analysis was valid for addressing the question that was explicitly addressed—the direct comparison of programs with and without systematic phonics instruction (Stuebing et al., 2008).

Others have similarly concluded that systematic phonics instruction is effective for students with or at-risk for WRD. Slavin et al. (2011) reported a mean effect size of 0.39 for teacher-delivered one-to-one tutoring, but for a subset of interventions that placed a strong emphasis on phonics, the effect size was 0.56. Galuschka et al. (2014) reported that, in their meta-analysis of studies of interventions provided to students with reading difficulties and disabilities, phonics instruction was the only approach that had statistically significant effects.

For students in the primary grades who are at-risk for WRD, there is also strong evidence supporting instruction in phonological awareness (PA; NRP, 2000; Snow & Juel, 2005; Torgesen, 2004). An important but often overlooked finding of the NRP is that, although PA instruction involves the oral manipulation of word parts and phonemes, printed letters should be linked with the manipulated phonemes as early as possible. For example, children can manipulate plastic letters as they practice segmenting words into component parts and blending parts to form words. Adding letters to PA instruction is associated with stronger effects on PA and word reading than teaching PA exclusively as an oral activity (NRP, 2000). For older students with WRD, intervening in phonemic awareness alone may not generalize to improved word reading, although multi-component intervention that includes PA instruction has promise (Edmonds et al., 2009).

Effective word reading intervention also includes instruction in the automatic recognition of high-utility words, including irregular words (Rose, 2006). In addition, several effective interventions include encoding as well as decoding (Rose, 2006; Wanzek & Vaughn, 2007). Young students are taught to use phonological analysis to spell words that include sound-spelling patterns they have learned. Typically, students learn and incorporate increasingly complex orthographic patterns and constraints into their spellings as they progress through their instructional programs.

Goodwin and Ahn (2010) reported that morphological instruction is effective in supporting outcomes in PA, vocabulary, comprehension, and spelling when incorporated into reading interventions. Surprisingly, effects were not statistically significant for decoding outcomes, and there was a significant negative effect on reading fluency. We speculate that teaching students to conduct morphological analyses in order to recognize words may cause them to process text more slowly than they would have otherwise; however, students may have improved understanding of the words.

Systematic word-reading instruction should be integrated with meaningful text reading and writing experiences that include instruction in vocabulary and comprehension (DEST, 2005; Rose, 2006; Snow & Juel, 2005). Wanzek and Vaughn (2007) reported higher effect sizes associated with interventions that included both phonics instruction and text reading than interventions that taught only word-level processes. Snow and Juel cite the research synthesis by the National Research Council (Snow, Burns, & Griffin, 1998) in stressing that code-based and meaning-based instruction should be *integrated* rather than "balanced." Balancing code-based and meaning-based instruction could result in students receiving equal amounts of instructional time in each, but a highly fragmented instructional program. In an

integrated program, students are taught that the same word reading skills and strategies they are learning in word-level instruction should be consistently applied whenever they read in order to make meaning from text.

Not all students require identical instructional content. There is strong empirical support for targeting intervention according to students' strength and needs, both at the early elementary level (Connor et al., 2014) and for older students (Kamil et al., 2008). Connor et al. described positive effects in multiple studies from individualizing the proportion of code-based and meaning-based instruction elementary school students receive. Kamil et al. stressed the importance of administering diagnostic assessments to struggling readers in grades 4–12, whose reading difficulties could involve one or more components of reading as well as factors related to motivation.

3.2 How Is Instruction Delivered in Effective Interventions?

Evidence supports the practice of directly teaching students with WRD the skills, strategies, and key content they need to learn. Students benefit most when certain instructional characteristics are incorporated into interventions.

Explicit Instruction Considerable research demonstrates that interventions that teach key content directly and explicitly are associated with better outcomes for students with WRD than less explicit instruction (Connor et al., 2014; DEST, 2005; Gersten et al., 2009; Rose, 2006; Torgesen, 2004; Vaughn, Denton, & Fletcher, 2010). Explicit instruction involves providing clear modeling, demonstration or explanation, followed by guided and independent practice with timely and effective feedback. When instruction is explicit, students do not have to infer critical content, and students who are easily confused are more likely to be successful.

Aspects of Direct Instruction Swanson (1999) conducted a comprehensive meta-analysis of the impact of various instructional characteristics on interventions for students with LDs, reporting that interventions with the largest effects on word reading outcomes included direct instruction. Swanson found that certain instructional practices characteristic of direct instruction were related to positive word recognition outcomes. These include matching task difficulty to student abilities, carefully sequencing activities, breaking down a task into its component parts and using prompts to guide students in each part, and synthesizing component parts and fading prompts or cues, as well as providing advance organizers. Advance organizers are implemented prior to instruction to focus students' attention on information such as instructional objectives, the tasks they will perform, or materials they will use.

Practice and Feedback Students with learning difficulties require more extensive opportunities to practice newly learned skills than do typically-developing students.

It is critical that teachers provide extended guided practice with feedback (Gersten et al., 2009; Torgesen, 2004; Vaughn et al., 2010). When struggling readers are not provided with timely feedback during guided and monitored independent practice they are likely to "practice their mistakes", automatizing incorrect responses and habitualizing ineffective strategies. Feedback should include corrective feedback, positive reinforcement, and instructional scaffolding. Hattie and Timperley (2007) summarized 12 meta-analyses on the effects of feedback, finding that providing feedback was associated with an average effect size of 0.79 and concluding that effective feedback includes providing cues or reinforcement, providing information about correct responses, and building on changes from previous attempts.

Feedback should be provided to students with WRD not only when they are practicing isolated skills, but also when they are reading connected text (Snow & Juel, 2005). Students should read orally with a teacher who models the application of word reading skills and strategies and provides purposeful instructional scaffolding and feedback. When students encounter difficulty with a decodable word, teachers model appropriate use of effective skills and strategies for word reading and/or prompt students to apply the skills and strategies they are taught. It is equally critical that teachers prompt students with WRD to self-monitor their reading and self-correct their errors. Older struggling readers, who are likely to have habitualized ineffective strategies such as guessing unknown words, may also benefit from supported oral text reading practice for a few minutes daily, when they can be instructed and prompted to apply skills and strategies to increase reading accuracy.

Pacing of Instruction There is evidence that students in preventative interventions benefit when teachers individualize the pacing of instruction. When teachers use standardized reading programs they tend to simply teach one lesson after another, providing the same instruction to all students. Coyne et al. (2013) directly examined the effects of having kindergarten teachers use systematic guidelines based on data from ongoing curriculum-embedded assessments to make adjustments in the implementation of a highly standardized reading intervention. Treatment and comparison students received the same intervention, but treatment teachers followed guidelines based on data indicating students' mastery of instructed content to regroup students and modify their rates of progress through the program. At the end of kindergarten, treatment students significantly outperformed comparison students in letter knowledge, word reading, and fluency; at one-year follow-up, treatment students were significantly higher in decoding, word reading, spelling, fluency, and comprehension.

3.3 Factors Related to the Implementation of Interventions

Interventions for students with WRD must be sufficiently intensive to accelerate their rates of progress. Students with more severe and pervasive WRD require interventions with greater intensity than those with milder impairments (Galuschka

et al., 2014; Gersten et al., 2009; Kamil et al., 2008; Vaughn et al., 2010). These students can be identified based on pre-intervention assessments, as students with very low baseline scores typically make the lowest gains (Vaughn et al., 2010). Older students, especially those who perform appreciably below grade level, require very intensive interventions (Kamil et al., 2008; Vaughn et al., 2010; Wanzek et al., 2013).

Intensity can be increased by decreasing group size, increasing the dosage of intervention (i.e., number of hours provided), and providing explicit instruction that offers students many opportunities to respond and receive feedback (Vaughn et al., 2010). Intervention may also be considered more intensive if provided by highly qualified teachers who have received extensive professional development in instruction for students with serious WRD. We discuss evidence related to these dimensions of intervention implementation.

Group Size Interventions may be implemented in whole-class, small group, or individual (i.e., one-to-one) formats. Intuitively, individually-delivered interventions seem preferable for students with WRD, and that has been the finding of some syntheses (Slavin et al., 2011; Wanzek & Vaughn, 2007); however, the evidence is mixed, with some finding no advantages for individual over small-group implementation in preventative interventions. The NRP (2000) reported that effect sizes for phonics interventions did not differ significantly if they were provided individually, in small groups, or in large groups. There is evidence that supplemental interventions provided in very small groups (e.g., groups of three) can be effective (Denton, 2012; Gersten et al., 2009). Gersten et al. recommended that supplemental interventions be provided to young children at-risk for RDs in groups of three to four. Both Gersten et al. (2009) and Kamil et al. (2008) emphasize that children and adolescents with serious and intractable reading difficulties require high-intensity instruction provided in very small groups or individually.

Dosage and Scheduling There are also questions related to the optimal dosage of interventions for students with reading difficulties. We might assume that more is better; however, there may be a point of diminishing returns. For example, the NRP (2000) PA subgroup reported that providing 5–18 h of PA instruction was associated with larger effects than either longer or shorter treatments. Denton (2012) described three studies that directly manipulated dosage in early reading interventions and reported conflicting conclusions. Several syntheses and meta-analyses have found that intervention duration was not significantly associated with outcomes (Elbaum, Vaughn, Hughes, & Moody, 2000; Galuschka et al., 2014; Swanson, 1999; Wanzek et al., 2013); however, Goodwin and Ahn (2010) reported significant effects for morphology interventions lasting for at least 10 h, but not for briefer interventions. Students in the secondary grades, especially those who perform well below grade level, are likely to require interventions for an extended period of time—over an entire school year or even over multiple years (Kamil et al., 2008; Vaughn et al., 2010).

Research provides little guidance related to optimal dosage and scheduling of reading interventions, most likely because these factors are heavily dependent on the degree of students' impairment and how amenable students' difficulties are to instruction, as well as properties of the intervention itself. The best approach may be to closely monitor students' progress in interventions and make adjustments to the intensity, delivery, and/or instructional focus of intervention accordingly. Providing extended treatment with an ineffective intervention is unlikely to have positive results.

Interventionists Studies in which intervention is implemented by the researchers often demonstrate stronger effects than those implemented by regular school personnel (Galuschka et al., 2014), but Connor et al. (2014) reported evidence that interventions delivered by school personnel in authentic school contexts can be highly effective. Slavin et al. (2011) concluded that teacher-provided intervention is superior to intervention provided by instructional assistants or volunteers, although instructional assistants can deliver effective interventions. Elbaum et al. (2000) reported that the most effective interventions they reviewed were delivered by college students or well-trained volunteers. Other sources also concluded that interventions can be delivered effectively by non-certified personnel (Denton, 2012; Rose, 2006; Scammacca et al., 2007). Denton noted that instructional assistants can provide effective interventions when they are carefully selected and receive ample training along with ongoing coaching support provided by a highly-qualified teacher. Instructional assistants are most likely to be successful when they implement highly specified, well-structured interventions in very small groups. Both Gersten et al. (2009) and Kamil et al. (2008) noted that students with the most severe reading impairments should receive instruction from highly-qualified teachers who have a thorough understanding of the intervention itself and of children or adolescents with reading difficulties.

Kamil et al. (2008) emphasized that middle and high school content-area teachers should not be asked to implement intensive interventions for struggling readers, although they should receive professional development enabling them to implement approaches to enhance learning for students with reading difficulties. Slavin, Cheung, Groff, and Lake (2008) reported small, but educationally meaningful, effect sizes associated with providing teachers of adolescents with professional development to implement strategy instruction or cooperative learning, or as part of comprehensive school reform.

Slavin et al. (2008, 2011) reported generally weak effects associated with computer-assisted instruction (CAI). A systematic synthesis on CAI for students with LDs (Hall, Hughes, & Filbert, 2000) reported positive effects when CAI was used to provide extended opportunities to practice skills taught in teacher-delivered formats. Similarly, Slavin et al. (2008) reported positive effects for adolescents with reading difficulties for interventions that combined teacher-delivered instruction with CAI.

4 Interventions for Older Students with Word Reading Difficulties

Many students continue to have word reading difficulties beyond the early grades. A study of 846 middle school struggling readers found that nearly half of the students who were identified as poor readers based on annual state tests of reading comprehension were significantly impaired in word identification (Cirino et al., 2013). Some older students with WRD have identified disabilities, but many do not, making it critical to identify students in need of word study intervention through assessment (Kamil et al., 2008).

Remediating WRD in older students can be challenging. Interventions provided to younger students typically yield stronger effects on reading outcomes than interventions provided to older students (Wanzek et al., 2013). Scammacca et al. (2007) found that studies of reading interventions for middle school students yielded larger effect sizes than those implemented with high school students. Despite the challenges, it should never be considered "too late" to intervene. A rigorous review of literature supported the conclusion that there is strong evidence supporting the provision of intensive, individualized reading interventions for adolescents (Kamil et al., 2008). This recommendation was based on studies that included students with LDs and took place in a variety of contexts, including urban and rural schools and reading clinics.

4.1 Word Reading Interventions for Adolescents

Compared to research with younger children, relatively few experimental or quasi-experimental word reading intervention studies have been conducted with students in the secondary grades. Scammacca et al. (2007) conducted a meta-analysis of intervention research conducted with struggling readers in grades 4–12, locating only four word study intervention studies that met inclusionary criteria. These were associated with a mean effect size of 0.60 across all outcome measures. The literature currently provides varying levels of support for four approaches to word study instruction for adolescents: graphosyllabic analysis, morphemic analysis, long-term explicit and systematic phonics instruction, and multicomponent intervention that includes word study.

Graphosyllabic Analysis Secondary-grade students benefit when taught to read multisyllable words using graphosyllabic analysis or structural analysis, "chunking" words into syllables (or pronounceable word parts) and reassembling the syllables to read words. Edmonds et al. (2009) synthesized three intervention studies examining graphosyllabic analysis conducted with students in grades 4–11 with and without identified LDs, reporting a mean effect of 0.36 on word reading. Among the studies, effect sizes varied. Moderate to large effects were reported for high school

students instructed in graphosyllabic analysis relative to untreated comparison groups, while small effects were reported for students in grades 4–7 relative to an alternate form of word reading instruction.

Extended Synthetic Phonics Programs The NRP (2000) reported an effect size of 0.32 for systematic phonics instruction provided to students with reading disabilities in grades 2–6. However, there is less evidence supporting the provision of extensive synthetic phonics programs to older students with WRD than to younger students, primarily due to the low number of rigorous studies directly evaluating such programs. In one such study, Torgesen et al. (2006) experimentally evaluated the effects of three published word reading intervention programs for students in grade 5, relative to typical school instruction. The first (Program A) provided explicit instruction in PA and phonics along with opportunities to read and write for meaningful purposes. Program B provided direct, structured, multi-sensory synthetic phonics instruction similar to that provided in many dyslexia interventions. Program C delivered highly explicit instruction in synthetic phonics using a scripted Direct Instruction curriculum. Programs B and C were modified for this study so that they focused exclusively on word-level instruction. Torgesen et al. evaluated the impacts of the interventions for the full sample, and then separately for students who began the study with word attack scores below the 30th percentile. For the group with impaired word attack skills, the three word-level interventions, combined, were associated with small significant impacts on untimed word identification (ES = 0.11) and word attack (ES = 0.31). Although the study was not powered to evaluate the individual interventions for the subgroup of students with impaired decoding, Program A was associated with significant moderate effects on timed and untimed word attack, and Program C was associated with significant positive effects on timed word identification. Program B had no significant effects. None of the interventions that focused only on word-level instruction was associated with effects on comprehension for students with impaired decoding. It appears insufficient to remediate word-level difficulties in older struggling readers in order to impact reading comprehension; instruction must be provided in both domains.

Multi-Component Interventions Multi-component interventions that include word study instruction along with fluency, vocabulary and/or comprehension instruction have demonstrated small positive effects for adolescents when implemented for 75 sessions or more, with slightly larger effects when implemented for at least 100 sessions (Wanzek et al., 2013). It may also be effective to combine word study instruction with instruction in cognitive and metacognitive reading strategies. In a study with high school students with serious WRDs, Lovett, Lacerenza, De Palma, and Frijters (2012) reported significant effects on decoding and comprehension associated with an intervention that combined systematic, explicit phonics instruction with instruction in strategies for word identification and comprehension; however, students remained impaired following the intervention.

5 Remaining Challenges

This chapter described evidence-based practices for the prevention and remediation of WRD. These practices have been associated with positive effects in experimental and quasi-experimental studies, and they are likely to enhance outcomes for many students with WRD. In many prevention studies and in some remediation studies, interventions result in high proportions of students achieving average levels of word reading performance (Torgesen, 2004). For example, Mathes et al. (2005) reported that only 7 of 163 first graders at-risk for WRD who received enhanced classroom reading instruction plus small-group intervention performed below the 30th percentile on a composite score of word reading and decoding after intervention. Indeed, the implementation of explicit, intensive instruction has been associated with observable changes in brain functioning indicating a trend toward normalization of the regions involved in word reading (Simos et al., 2002, 2007). Despite this positive evidence, two formidable challenges remain.

The first concerns the fact that, although intervention studies frequently report significant positive effects relative to comparison conditions, many students in these studies do not respond adequately and remain impaired following intervention (Torgesen, 2004). Even when mean group outcomes are in the average range, individual variation in post-intervention scores can be considerable. For example, Denton, Fletcher, Anthony, and Francis (2006) provided systematic phonics intervention to students in grades two and three who had previously demonstrated inadequate response to first grade intervention. Intervention was provided for 1–2 h per day over 16 weeks in groups of two. Mean gains were significant, and some students made considerable progress, while others made no progress at all, even with this high degree of intensity. Much work remains to be done to investigate alternative approaches for students with intractable WRD. Compton, Miller, Elleman, and Steacy (2014) propose a set of theoretically-motivated "next generation" (p. 62) word reading interventions to reduce the incidence of inadequate response to intervention.

The second challenge involves ensuring that primary-grade teachers consistently deliver classroom reading instruction that includes systematic, explicit phonics instruction integrated with meaningful opportunities to read and write connected text with feedback. Less systematic and explicit approaches to early literacy instruction are widely implemented, although there is evidence that they are less effective for students with reading difficulties (Denton, Fletcher, Taylor, Barth, & Vaughn, 2014). Schools must also find ways to ensure that all students who have persistent WRD, even those in middle and high school, receive supplemental interventions of sufficient quality and intensity to accelerate their progress so they can access grade-level materials.

The problem of bringing evidence-based practices to widespread classroom implementation is certainly not new. The field must focus creative energy on re-addressing this issue if research is to have an appreciable impact on student outcomes. Teachers are likely to need not only professional development, but also

instructional materials that are practical and easy to implement and result in observable progress in their students. If teachers learn to implement such materials with confidence and fidelity, the incidence of WRD may be reduced.

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A Cognitive and Linguistic Approach to Predicting and Remediating Word Reading Difficulties in Young Readers

Shelley Shaul, Tami Katzir, Liron Primor, and Orly Lipka

Abstract Most research on the development of reading has focused on linguistic abilities, such as naming and phonological awareness, and their role in reading, recent studies have found several specific cognitive dimensions to be associated with the development of early decoding and word recognition skills such as visual attention span, working memory and executive functions. The current study examined the connection between cognitive abilities and reading at the beginning of first grade and at the end of first grade after an intervention program. As well as the cognitive and linguistic profile of children who benefited most from the intervention.

Strong correlations between several cognitive skills, such as memory, executive skills, speed of processing, and other aspects of general ability and word reading at the beginning and end of grade were found among Hebrew speaking. In addition children with low phonological processing and slow naming benefited and low memory skills the least from the intervention program.

This study has advanced us towards a complex model of word reading difficulties in young children. Furthermore, the results demonstrate universal cognitive processes that are necessary in order to acquire adequate reading development as well as language specific cognitive processes.

Keywords Reading • Decoding • Intervention program • Cognitive abilities • Linguistic abilities

The most common factor identifying young poor readers is word reading difficulties. This finding is consistent across orthographies (Share, 2008). While most of the research on word reading difficulties has focused on phonological awareness and rapid naming, recent research suggests that other cognitive factors such as visual attention span, short term memory, and working memory also play a significant role in word reading level (Brunswick, Martin, & Rippon, 2012). In this

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chapter we review the foundations of word level difficulties in children and examine which factors are associated with response to intervention in word reading development in the Hebrew orthography.

1 Development of Word Reading

Reading is one of the most complex cognitive processes that a person is required to learn; it involves input from the visual system that must be converted into sounds, which are then connected to form a word with meaning. Learning how to read is a challenge for many children and some of them have difficulties in mastering this complex process. Several developmental models have tried to explain the process of learning how to read. Ehri (2014) has claimed that reading development progresses through several stages, from a pre-alphabetic stage, typically in preschool, when children begin to identify letters, followed by a partial alphabetic stage in which they know the letters and some of their sounds. After learning all the sounds they reach the full alphabetic stage in which they can decode all words. The next stage is the consolidated alphabetic stage, at which children are fluent readers and good spellers of words and the words are well presented in the child's memory. An interesting question is what factors are involved in this learning process, and are there multiple factors or does reading mainly depend on language skills?

Adams (1990) suggested that word reading involves multiple systems and an interrelated complex task. More recently, Perfetti and Hart (2002) suggested a lexical quality model of word reading in which the quality of the word representation is influenced by phonological, orthographic, and semantic information. The higher the threshold for each process and the quality of the representation the more accurate and fluent the reading is. These models provide a framework for the multifaceted nature of word reading. They suggest that breakdown in reading development can differ among children in different stages of development and from different backgrounds (Dehaene, Cohen, Morais, & Kolinsky, 2015). In addition, there may also be cultural effects on children's reading development.

These connectionist word reading models were developed based on the English orthography (Share, 2008), however there may be language specific features that influence how children learn how to read in different orthographies and their rate of reading development (Ziegler, Bertrand, Tóth, Csépe, & Reis, 2010). In a study which examined the connection between phonological awareness and reading in five different languages (Finnish, Hungarian, Dutch, Portuguese, and French) among second grade children, phonological awareness was found to be a main factor in reading performance in all languages, but its impact was differential according to the language's transparency. Phonological awareness had a major role in the less transparent languages (deep orthography), and its role decreased among the more transparent orthographies.

Hebrew represents a special orthography, as children learn to read in a fully transparent version of the script and transition around fourth grade to reading in a less transparent version (Katzir, Schiff, & Kim, 2012). The trajectory of responding to reading intervention in a shallow orthography, specifically in Hebrew, has not been studied before.

While most research on the development of reading has focused on linguistic abilities, such as naming and phonological awareness, and their role in reading, several specific cognitive dimensions have also been found to be associated with the development of early decoding and word recognition skills. Skills such as working memory (Bull, Espy, & Wiebe, 2008), visual spatial attention (Franceschini, Gori, Ruffino, Pedrolli, & Facoetti, 2012), and executive functions (Shaul & Schwartz, 2014) have been established as a significant foundation that helps children learn to read.

Therefore, the current study aimed to uncover the basic cognitive abilities which help children learning to read in Hebrew reach the alphabetic stage of reading, have a good lexical representation of words, and become fluent readers.

2 Predictors of Reading Development

Typical models of reading development have focused on the linguistic and orthographic features of written text, specifically, phonological awareness, semantics, and orthographic knowledge. In recent years several studies have pointed to the role of other cognitive factors in word reading. We will first review the linguistic factor related to reading acquisition, followed by the cognitive (non-linguistic) factors. Finally, we will discuss the response to different interventions to enhance reading.

3 Linguistic Factors

Phonological awareness has been comprehensively studied and is regarded as a well-established factor in learning to read (e.g. Melby-Lervåg, Lyster & Hulme, 2012; Share, 1995; Vellutino, Scanlon, Sipay, Small, & Pratt, 1996). Phonological awareness was found to be a strong predictor of reading achievement (e.g., Share, Jorm, Maclean, & Matthews, 1984) and to discriminate between children who did not benefit from an intervention program, as well as, between average and poor readers (Vellutino et al., 1996). For example, following reading intervention given to first graders, Vellutino et al. found that children who did not improve their reading, performed below children who benefited from intervention and below average readers on measures of phonological awareness, but not on other tests evaluating visual, semantic, and syntactic skills.

Some research suggests that other language skills, such as vocabulary, syntax, and morphology, are also important for reading development (Partanen & Siegel,

2014). However, there are inconsistent findings regarding the exact language skills and tasks (Stuebing et al., 2014). For example, Fletcher et al. (2011) compared adequate and inadequate responders to Response to Intervention (RTI) reading intervention in the first grade. Their analysis identified phonological awareness as the most significant contributor to group differentiation. In addition, measures of rapid letter naming, syntactic comprehension\working memory (understanding concepts and direction with instruction varying in complexity), and vocabulary also contributed uniquely to some comparisons of adequate and inadequate responders.

Another well-established factor is rapid automatized naming (RAN), which has also been shown to have good power in predicting beginning reading word-level skills, in addition to the variance explained by phonemic awareness skills (Scarborough, 1998; Schatschneider, Carlson, Francis, Foorman, & Fletcher, 2002; Vellutino et al., 1996; Wagner, Torgesen, & Rashotte, 1994; Wolf, Bally, & Morris, 1986). For example, McCallum et al. (2006) studied the role of different cognitive and linguistic variables in reading among children aged 5–13. RAN was found to be the strongest correlate of word recognition, decoding, and reading fluency. Even more specifically, Georgiou and colleagues (2008) reported that the correlation of RAN with fluency measures was stronger than it's correlation with reading accuracy measures.

There is some evidence that aspects of orthographic knowledge are also predictors of reading (e.g., Georgiou, Parrila, & Papadopoulos, 2008; McCallum et al., 2006; Roberts & Mather, 1997). For example, in a comparison of the contribution of phonological and orthographic processing to reading ability in first and second grade, Georgiou, Parrila, et al. identified that both processes contributed uniquely to reading ability. However, the importance of these two predictors was different with respect to their effect on word decoding.

In addition to these linguistic abilities, studies have shown that early literacy knowledge and exposure to a home literacy environment at an early age are a foundation for the development of reading and writing skills (Sénéchal & Young, 2008). For example, knowledge of letter names has been found to significantly predict reading from kindergarten to tenth grade (e.g., Badian, 1995; Levin, Shatil-Carmon, & Asif-Rave, 2006; Share et al., 1984). This may be because knowing letter names helps children learn letter sound correspondences (Share, 2004).

4 Cognitive (Non-linguistic) Factors

As reading involves many linguistic factors, it is well established that many of the factors mentioned above predict reading ability. Other studies have found additional cognitive factors that predict reading as well. Evidence from behavioral and neuroimaging studies has also highlighted different aspects of memory, and especially working memory deficits among children and adults with developmental dyslexia (Beneventi, Tøønnessen, Ersland, & Hugdahl, 2010; Berninger, Raskind, Richards, Abbott, & Stock, 2008; Smith-Spark & Fisk, 2007). Nevo and Breznitz (2011)

found that, at the age of 6, a phonological working memory composite contributed most to reading ability, and concluded that a minimal ability of phonological memory is necessary in order to achieve average reading levels. Verbal working memory may be related to phonological awareness, since phonological awareness tasks often require the ability to simultaneously hold in memory and manipulate several phonemes (Partanen & Siegel, 2014). In another study, Nevo and Breznitz (2013) discovered that poor decoders showed lower scores on working memory measures compared to average decoders.

Nevertheless, in a review of the literature, Georgiou, Das, and Hayward (2008) state that despite the acknowledged contribution of working memory to reading, there are inconsistencies across research results. The reason is different operationalization of working memory, such as use of tasks in different modalities (auditory, visual, and spatial) or types of tasks that put more emphasis on the storage component or on the processing component.

Other cognitive abilities have also been linked to reading, but have received less research attention. For example, Franceschini et al., (2012) reported that a weakness in visual-spatial attention in pre-reading kindergartners is an important risk factor for becoming a poor reader. In particular, future poor readers showed twice the number of errors in the serial visual search task compared to normal readers at the pre-reading stage, showing that selective visual spatial attention was impaired before reading acquisition (Franceschini et al., 2012). This research may be related to other studies suggesting that various visual abilities are associated with reading (Bell, McCallum, & Cox, 2003; McCallum et al., 2006; Valdois, Bosse, & Tainturier, 2004)

Executive functions have also been linked to reading development (Cartwright, 2012). Reiter, Tucha, and Lange (2005) demonstrated, in their study, that children with dyslexia exhibit impairments in a variety of executive functions. Furthermore, children with dyslexia displayed impairments in both verbal and figural fluency specific functions. In addition, de Lima, Azoni, and Ciasca (2013) studied dyslexic and non-dyslexic children aged 7–11 and found that children with dyslexia had more difficulties with performing visuospatial and auditory attention tasks, as well as tasks involving executive functions such as flexibility, inhibitory control, strategy use, working memory, and verbal fluency.

It can be concluded that word reading is a complex ability which builds on a wide base of cognitive abilities. The question this raises is which of these abilities are needed in order to help children improve their reading abilities.

5 The RTI and Cognitive Hypothesis Testing Models

Children entering school are at different levels of readiness for learning. This variance requires the schools to identify which children will be able to learn with no extra help and who will need extra assistance in order to acquire reading (Ramey & Ramey, 2004).

Understanding the role of specific cognitive skills in reading, may possibly improve prediction of the risk status of individuals and form the basis of a tailored intervention (Stuebing et al., 2014). Response to Intervention (RTI) is a method for preventing, as well as helping identify, children who may be at risk for academic difficulties. It is based on a layered evidence-based intervention, which begins in general education and increases in its intensity and differentiation depending on the child's instructional response (Fletcher & Vaughn, 2009; Fuchs, Compton, Fuchs, Bryant, & Davis, 2008). RTI models are highly used in reading intervention, and their effects have been extensively studied (Fuchs & Vaughn, 2012).

Another theoretical framework that calls for creating a cognitive profile prior to intervention is the Cognitive Hypothesis Testing (CHT) model for learning difficulties (LD) identification and intervention, constructed by Hale and Fiorello (2004). CHT is based on four premises: (a) A number of complex cognitive and neuropsychological processes have been empirically linked to academic achievement; (b) children often have unique profiles of cognitive strengths and weaknesses; (c) Learning profiles must be evaluated both through direct assessment of cognitive processes and by examination of ecological and treatment validity; and (d) the children's academic deficits must be remediated and/or compensated for based on underlying cognitive strengths and weaknesses (Fiorello, Hale, & Snyder, 2006; Hale et al., 2004). The notion that an intervention should be based on an individual's strength and weaknesses is the scarlet thread of our study.

6 The Cognitive Profile of Children Who Benefit from Intervention

Results of intervention program studies reveal that not all students benefit equally from intervention. Lack of desirable improvement following evidence based and intensive intervention is considered in determining whether a child has a learning disability (Molfese, Fletcher, & Denton, 2013). For this reason, and in order to effectively place children in intervention programs, it is very important to study the attributes of children who responded adequately and inadequately to intervention.

Fletcher et al. (2011) reviewed previous studies of the characteristics of students who did not improve their reading following intervention. These studies identified difficulties with phonological awareness, rapid naming, vocabulary, and oral language skills, as the most consistent cognitive attributes of inadequate responders. In addition, Denton et al. (2012) reported that measures of phonological awareness and language processing characterized children who did not benefit from 2 years of intervention.

Fletcher et al. (2011) evaluated the cognitive attributes of first grade students who responded adequately and inadequately to a Tier 2 reading intervention. The study included two groups of inadequate responders, one based on both decoding and fluency criteria and the other only on fluency criteria. In addition, there were

two other groups, one of adequate responders and one of typically achieving students. The following cognitive variables were assessed: phonological awareness, rapid letter naming, oral language skills, processing speed, vocabulary, and nonverbal problem solving. Comparisons of all four groups identified phonological awareness as the most significant contributor to group differentiation. Measures of rapid letter naming, syntactic comprehension/working memory, and vocabulary also contributed uniquely to some comparisons of adequate and inadequate responders. Therefore, it seems that predictors of word reading, such as phonological awareness, RAN, and verbal working memory are found to be more severely impaired among students who did not benefit from intervention across different studies.

Greulich, Al Otaiba, Schatschneider, Wanzek, Ortiz, & Wagner (2014) studied attributes of inadequate responders in first grade to a year-long three-tier intervention. They found that teacher ratings of behavior and academics explained additional variance above initial skills such as letter and word reading, fluency and phonologic awareness. In addition, qualitative observation suggested that students who did not benefit from intervention demonstrated physical and verbal task avoidance and displayed emotions of hopelessness and shame.

In contrast, in a recent meta-analysis, Stuebing et al. (2014) examined the magnitude of the relationship between individual cognitive differences and response to intervention within different analytic models. Results showed that adding cognitive individual differences did not improve the prediction of responses to intervention. Therefore, the authors concluded that there is no need to assess cognitive predictors beyond a pretest assessment of reading. This is not true of preschool and kindergarten since they have not started reading instruction yet. In these cases a combination of different cognitive variables may be valuable, although assessing early reading measures may perhaps be sufficient.

In conclusion, different studies found predictors of word reading, such as phonological awareness, RAN, and verbal working memory, to be more severely impaired among students who did not benefit from intervention. In addition, preliminary evidence suggests that behavioral measures are also possible predictors of response to intervention.

7 Effective Intervention

Reading Intervention has typically focused on language and reading related foundation skills. In a recent review, Snowling and Hulme (2014) noted that most of the reading intervention programs have focused mainly on reading accuracy and fluency and did not take into account additional factors that influence reading. They claim that reading interventions need to be broader in order to be effective. Recent research has suggests that reading is a multifaceted construct (Katzir, Lesaux, & Kim, 2009). Therefore, reading intervention programs should not focus only on the linguistic factors that have been found to form the foundation for reading improvement, such as phonological awareness, vocabulary, and oral language skills, but also

create a firm cognitive base needed in order to learn how to read and improve reading, such as working memory and executive functions. It may be that the combination of these linguistic and non-linguistic factors may be more of a help to children and improve not only reading skills but also more general learning skills.

8 The Current Study

Based on the literature on the heterogeneous factors underlying word reading difficulties in young readers, we developed a pilot program that addresses each child's linguistic, literacy-related, and cognitive profile at the beginning of the first grade. The current study will examine the connection between cognitive abilities and reading at the beginning of first grade and at the end of first grade after an intervention program. We also examined the cognitive and linguistic profile of children who benefited most from the intervention within the RTI and CHT framework (e.g., Lipka, Leasux, & Siegel, 2006). The current study was guided by the following three research questions:

1. What are the connections between cognitive and linguistic abilities and reading at the beginning and end of first grade?
2. Which cognitive skills at the beginning of first grade predict reading abilities at the beginning and end of first grade?
3. What are the cognitive and linguistic characteristics of children who improve their reading abilities and respond better to intervention, compared to children who show less improvement from the beginning to the end of first grade?

9 Method

9.1 Participants

Participants in this study were 43 first grade students, 25 (59.57 %) boys and 18 (40.43 %) girls, age range 6–8 years (M = 6.77, SD = 0.4), from the same school. The average age for boys was 6.81 and 6.7 for girls. The study included all of the students enrolled in two classes at the school. All participants had a medium-low SES and a normal IQ.

9.2 Measures

A battery of cognitive and literacy-related measures was administered at the beginning of first grade, pre-intervention, and at the end of first grade, upon completion of the intervention program.

9.2.1 Cognitive Measures

1. Short-term memory (STM): Digit Span test (Kaufman & Kaufman, 2004). Participants were orally presented with a series of numbers. After listening to the experimenter participants were asked to repeat out loud the numbers heard in the exact same order. The test began with a series of 2 or 3 digits (depending on the participant's age). Participants who managed two of the three steps in each series of digits continued to the next series with more digits. The final score was the number of digits that the participant remembered correctly
2. Naming objects (Shatil, 1995): Participants had to name, as fast as possible, 21 pictures of objects (such as house, dog, tree). Each test had five different stimuli repeated several times. The total time of naming was measured, as well as the number of errors in each test.
3. Naming letters (Shany, Lachman, Shalem, Bahat, & Zieger, 2006): Participants had to name, as fast as possible, 50 letters (such as the Hebrew letters *samech*, *alef*, *dalet*, *gimel*, *lamed*). Each test had five different stimuli repeated ten times. The total time of naming was measured, as well as the number of errors on each test.
4. Head-Toes-Knees-Shoulders (HTKS) (Ponitz, McClelland, Matthews, & Morrison, 2009): This test aims to examine the participant's self-regulation, in addition to comprehension and memory of instructions, attention, inhibition, and cognitive flexibility. The test includes 20 items and each item can receive a score of 0 (incorrect response), 1 (self-correction), or 2 (correct response). In the first part participants are requested to place their hands on a certain part of their body according to the instructions. In the second part participants are requested to put their hands on other parts of the body (the opposite) of the instructions. If participants are asked to put their hands on their shoulders, they are supposed to put them on their feet, and if they are asked to put their hands on their head, they are supposed to put them on their knees.
5. Working memory (CSOT- Children's Size-Ordering Task) (McInerney, Hrabok, & Kerns, 2005): Participants are given a list of objects and must repeat the names of the objects according to their actual size, such as ring, glass, door. The number of objects in each series increases from 2 to 6. The final score is the number of words that could the participant can remember in the correct order.
6. Visual perception (Beery test) (Berry & Beery, 2006): In this test participants have 3 min to complete as many shapes as possible. In each trial participants have a target shape and they are supposed to find the identical shape out of additional three to five shapes. The number of correct responses is calculated.
7. Phonological awareness. Syllable Deletion (Shany & Ben-Dror, 1998) and Phoneme Deletion (Schwartz, 2006). This test included three types of tasks (syllable, first phoneme, and last phoneme deletion), in which participants were required to delete a given syllable or phoneme from a spoken word in Hebrew. For example, "Say *mispar* ('number'). Now, say *mispar* without *mis*". Each test list included ten words. In the phoneme deletion task the deletion resulted in the formation of nonwords. In the syllable deletion test the deletion resulted in the

formation of a word. The maximum possible score for each test was 10, internal consistency (alpha) for syllable deletion was 0.85, first phoneme deletion was 0.94, and last phoneme deletion was 0.93.

9.2.2 Word Reading and Fluency Measures

Test of Word Reading Efficiency (TOWRE; Schiff et al., 2006; adapted from Torgesen et al., 1999): Participants were instructed to read aloud as many words as possible in order to examine reading speed under timed conditions (45 s). The list contained 104 words ordered by increasing difficulty of the number of syllables, phonological structure, length, frequency, and morphological complexity. Scores ranged from 0 to 104, reflecting the number of accurate words the participant read in 45 s, with higher scores indicating higher reading speed.

9.3 The "OR" Intervention Program

In this study we administered a pilot intervention program (Lipka, Katzir, & Shaul, in prep), which addresses the multiple sources of word reading difficulties in children. The main goal of the "OR" innovative intervention program for first grade was to promote foundational literacy, cognition, and emotional readiness for learning skills, by integrating these three domains into a range of cyclical activities for the first time.

The intervention was built on two different themes, "my house" and "my neighborhood", both based on a popular children's book in Hebrew. These child-oriented topics served as a general framework for in-depth cognitive and literacy activities. In addition, the topics were in line with the first grade curriculum. Each unit consisted of nine scripted lesson plans, and a total of 18 intervention sessions were given. The program was implemented twice a week in each classroom for a period of 45 min in the second half of the year within the school day for the duration of 3 months.

Participants were first screened in order to build a cognitive and linguistic profile for each child. Then they were grouped into small homogeneous groups of five each, based on their cognitive, literacy, and emotional readiness profiles described below. The whole class worked on the same shared book, yet each group received intervention correspondent to their needs in decoding, vocabulary, memory, and at a level that matched their ability. All the children in the class received the intervention at the same time in the same time slot. All the children participated in all sessions.

The program was delivered by the homeroom teacher, who led each lesson, and by three trained Master's degree students specializing in literacy. Both teachers and students received specific training on the program materials.

Each lesson plan was divided into three main sections:

(a) Opening activity: The homeroom teacher introduced the topic and led the classroom opening activity.
(b) Small group activities: The class was split into four small groups based on students' literacy and cognitive profiles. The teacher and three Master's degree students conducted the small group activity.
(c) Concluding activity: The homeroom teacher led the concluding activity and summarized the goals of the lesson and the activities.

In-depth work in the small groups was conducted on linguistic skills such as fluency and vocabulary, as well as on cognitive skills such as memory and metacognitive skills. For example, within the small groups setting, the leaders presented different strategies for memorizing roles and students practiced different memorization strategies. In addition to metacognitive skills of knowing how to memorize required material, the students developed self- awareness about strategies that are effective for them.

9.4 Procedure

The pre and post tests were administered individually over two sessions by trained Master's degree students in a quiet room at the school. Each session lasted approximately 20–30 min. After the first testing the children underwent a 20 session intervention conducted over 10 weeks, with two 1-hour session per week. Each session of the intervention was composed of two parts. The first part was led by the classroom teacher and lasted 15 min, the second part was held in small groups of five children each and lasted 35 min. The pilot program was run in two classrooms.

10 Results

The aim of the first question was to explore the association between cognitive abilities, linguistic abilities, and reading at the beginning and end of first grade.

To answer this question, correlations were examined between the different cognitive skills measured at the beginning of the year and reading ability at the beginning and end of the year. The correlations are presented in Table 1.

A significant correlation was found between reading ability at the beginning of the year and several cognitive skills (phonological awareness, speed of processing, and visual scanning time and perception). At the end of the year, a significant correlation was found between additional cognitive abilities and reading ability (naming, short term memory, and executive functions), while the correlation with speed of processing was no longer significant.

To answer the second question and to examine which cognitive abilities predict reading at the beginning and end of first grade, a linear regression was performed

Table 1 Correlation between reading ability at the beginning of first grade, the end of first grade, and the cognitive skills measured at the beginning of first grade

	Phonological awareness	Naming	Short term memory	Working memory	Speed of processing	Visual scanning time	Visual perception	EF
Word reading beginning of first grade	0.47**	−0.31	0.27	0.26	0.34*	−0.34*	0.62**	0.23
Word reading end of first grade	0.54**	−0.43**	0.46**	0.25	0.24	−0.33*	0.45**	0.40*

*p≤0.01, **p≤0.05

Table 2 Stepwise regression results for predicting word reading at the beginning of first grade

Predictors		R	R^2	ΔR^2	ΔF
Step 1	Visual perception	0.471	0.222	0.222	9.40**
Step 2	Phonological awareness	0.643	0.413	0.187	10.50**
Step 3	Speed of processing	0.647	0.419	0.006	0.30
Step 4	Visual scanning time	0.648	0.420	0.001	0.06

**p≤0.01

Table 3 Stepwise regression results for predicting word reading at the end of first grade

Predictors		R	R^2	ΔR^2	ΔF
Step 1	Executive functions	0.394	0.155	0.155	6.255*
Step 2	Phonological awareness	0.566	0.321	0.166	8.043**
Step 3	Visual perception	0.659	0.435	0.114	6.431*
Step 4	Short term memory	0.667	0.445	0.010	0.569

*p≤0.05, **p≤0.01

and the variables were entered according to their correlation. Results are presented in Tables 2 and 3.

Table 2 demonstrates that Step 1 in the model (visual perception) explained 22 % of the variance ($p<0.01$), in the second step phonological awareness added an additional 19 % ($p<0.01$), and in total the model explained 41 % of the variance in reading.

In the next step we performed a linear regression and entered the variables according to their correlation, to predict reading ability at the end of first grade. Results are presented in Table 3.

Table 3 demonstrates that when predicting word reading at the end of first grade by measures collected at the beginning of the year, executive functions explained 15.5 % of the variance ($p<0.05$), phonological awareness explained an additional 16.6 % of the variance ($p<0.01$), and in the third step visual perception accounted for an additional 11.4 % of the variance ($p<0.05$). Short term memory did not

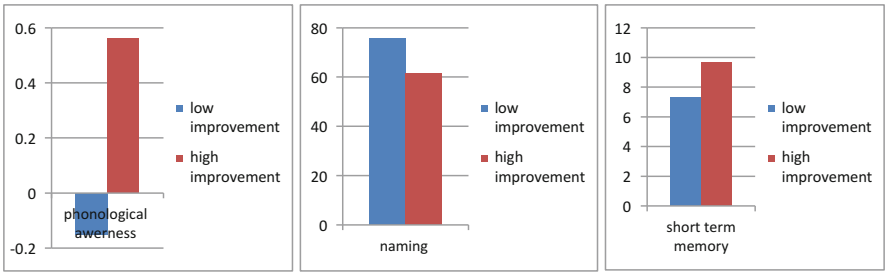

Fig. 1 Differences between the low and high improvement groups in phonological awareness, naming, and short term memory at the beginning of first grade

account for any of the variance and in total this model explained 44.5 % of the variance in reading at the end of first grade.

The next question examined was which cognitive and linguistic measures best predict response to intervention. Specifically, what cognitive abilities characterize children who benefited from the intervention and had a larger gain in words, compared to children who showed less progress after the intervention. In order to examine this question, a gap score was calculated by comparing the number of words read at the beginning of the year compared to the number of words read by the end of the year. The children were divided into two groups by the median of the gap score. The low group (n = 19), improved by 16 words on average while the high group improved by 29 words on average (n = 24).

When examining the cognitive profiles of all the children at the beginning of the year it was found that, in general, the group that showed less improvement in reading at the end of the year, was lower in all the cognitive skills and slower in naming and speed of processing tasks. A comparison between the groups with a *t*-test revealed a significant difference between the groups in phonological awareness, $T_{(36)} = -2.00$ $p < 0.05$, naming time, $T_{(37)} = -2.62$ $p < 0.01$, and short term memory span, $T_{(37)} = -2.75$ $p < 0.01$.

Figure 1 presents the performance of both groups in cognitive skills at the beginning of first grade, which were found significant.

In addition, a regression was conducted to predict improvement in reading. Only improvement in phonological awareness, as measured at the end of first grade versus the end of first grade, predicted improvement in reading and explained 11 % of the difference in the gap score ($R = 0.34$, $R^2 = 0.115$, $F = 4.80$, $p < 0.05$).

11 Discussion

The current chapter reviewed the heterogeneity of difficulties associated with word reading difficulties in young Hebrew speaking children in first grade. Many developmental studies on alphabetical orthographies have identified several early basic

linguistic skills related to reading acquisition. These skills can be measured in kindergarten or early on in first grade and include phonological abilities, rapid automatized naming (RAN), letter knowledge, grammatical skills, and vocabulary (Badian, 1995; Muter, Hulme, Snowling, & Stevenson, 2004). Our findings among Hebrew speaking children replicate and expand several studies that have identified additional cognitive skills related to word reading, such as memory, executive skills, speed of processing, and other aspects of general ability (Brunswick et al., 2012; Kim & Pallante, 2012; Lervag, Braten, & Hulme, 2009; Muter et al., 2004). In the discussion we address the importance of including multiple measures to identify poor word readers. We further suggest that the profile of poor readers is both potentially innate as well as driven by the orthography the children read in. Finally, we suggest that young children should be proficient in certain foundational skills before they embark on the reading acquisition journey.

11.1 Visual Perception and Word Reading Difficulties

When exploring which cognitive skills at the beginning of first grade predict reading, visual perception had the highest correlation and explained most of the variance in reading. The next significant contribution was made by phonological awareness. While rarely reported in the literature as a main predictor of reading development, this finding is not surprising. Reading is a cognitive process that begins with visual processing. According to the model developed by Vellutino, Fletcher, Snowling, and Scanlon (2004), visual processes enable the acquisition of knowledge and of skills that are critical determinants of the ability to learn to read. The model defines visual coding processes as sensory and higher-level visualization processes that facilitate storage of representations, which characterize the visual attributes of environmental stimuli, including the graphic symbols used to represent written words. Together with linguistic coding processes, visual processes build the associations between the spoken and written counterparts of printed words, enabling the acquisition of a sight word vocabulary.

Our results among young Hebrew speaking children may be more pronounced than in other orthographies, due to the block-like architecture of Hebrew letters, which have a predominance of highly similar horizontal and vertical strokes. Because of the visual features of this square-like, fairly uniform letter architecture, several authors have suggested that Hebrew letters resemble one another more than do Latin letters (e.g., Sampson, 1985). In addition, the placement of vowel information (diacritics) adds additional complex visual information. The vowel information is placed along two to three horizontal axes simultaneously (above, alongside, and beneath the letters). These visual characteristics described above may affect reading processes. In particular, the spatial representation of vowel information is believed to be an important component of orthographic representation for children and has been associated with reading acquisition in Hebrew (Feitelson, 1988; Share & Levin, 1999). Therefore, children with low visual perception will find it hard to

learn how to read in Hebrew. Nevertheless phonological awareness is needed in order to learn how to read, as in other languages (e.g., Lervåg, Lyster, Halaas, & Hulme, 2012; Share, 1995; Vellutino et al., 1996).

11.2 Executive Functions, Short Term Memory, Rapid Naming, and Word Reading Difficulties

When exploring which other cognitive abilities predicted reading at the end of the first grade we found that cognitive abilities such as executive functions, short term memory, and naming were significantly associated with reading, in addition to visual perception and phonological awareness. It seems that as children progress with their reading abilities, additional cognitive skills are needed in order to read accurately and fluently. It is important to note that in Israel children do not learn how to read in kindergarten. In kindergarten they are exposed to the letters but do not learn how to decode them. Children merely acquire pre-literacy skills and emergent mathematic knowledge. The Hebrew orthography is a shallow orthography and children learn how to decode and read accurately by the end of first grade (Share & Levin, 1999). There is a considerable difference in reading abilities among children who learn how to read in different languages (Katzir et al., 2012; Katzir, Shaul, Breznitz, & Wolf, 2004). Therefore, at the end of first grade, children who have learned how to read in Hebrew begin to improve their reading fluency and to develop their comprehension. These higher level processes demand additional cognitive skills such as executive functions and memory skills, as well as retrieval abilities (naming), in order to improve their reading abilities (Cutting, Materek, Cole, Levine, & Mahone, 2009).

It appears that these are the abilities that differentiate between children who improved their reading skills and benefited more from intervention compared to children who advanced more slowly in their word reading skills. It seems that cognitive abilities may be the necessary base in order to progress in one's reading ability.

11.3 Phonological Awareness as the Driving Force of RTI

When comparing the children who benefited less from the intervention and those who showed significant gains (an average of 29 extra words read correctly within 45 s), the poor responders were slower at letter naming, had a lower short term memory and lower phonological awareness, and advanced by only 16 words on average. These findings further support previous work by Fletcher et al. (2011) and Denton et al. (2012) on the role of both linguistic and cognitive factors not just in word reading but also in word reading development. It seems that in Hebrew similar basic abilities are needed in order to improve reading abilities.

Interestingly, while an array of skills characterized poor word reading development, in our regression analysis the only ability that predicted improvement in reading was improvement in phonological awareness. This finding is also similar to that of Fletcher et al. (2011), who found that phonological awareness was the most significant contributor to group differentiation for response to interventions. These findings suggest a developmental model of word reading interventions. There are foundational cognitive skills such as visual perception, EF, and memory. It seems that in the first stages of learning how to read children need a certain level of proficiency in phonological awareness; together with visual perception these abilities allow them to learn the basic phonological decoding process and to read accurately. Once these abilities are learnt and the linguistic foundation is stable the child can focus on the development of higher level skills in reading, such as fluency and comprehension. These abilities can be developed on the basis of these proficient phonological skills together with additional cognitive skills.

This study has advanced us towards a complex model of word reading difficulties in young children. It seems that children with difficulties not only in linguistic abilities such as phonological awareness but also in basic cognitive skills such as visual perception, executive function, and memory may have difficulties in acquiring reading in different stages of learning. This point should be further examined among a larger sample of children in different languages and at different ages in order to expand our knowledge about this development of reading.

In addition, the results demonstrate universal cognitive processes that are necessary in order to acquire adequate reading development as well as language specific cognitive processes.

The current study has illuminated the fact that, along with phonological awareness, cognitive abilities and especially visual perception at the first stages of learning the letters and diacritics (in Hebrew), and executive functions and memory at the end of the year, are central for learning how to read. In addition, these abilities are important for children to help them benefit from different intervention programs.

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The Efficiency of Metacognitive and Metalinguistic Awareness in Word Spelling Among Hebrew Speaking Children with SLI: An Intervention Study

Rachel Schiff, Ayelet Sasson, Yoci Nuri, and Elisheva Ben-Artzi

Abstract The purpose of the present study was to assess the effect of metacognitive and metalinguistic instructional practices on the spelling acquisition of Hebrew speaking children with specific language impairment (SLI). Sixty-seven kindergarteners with SLI in a supported learning context participated in the study. Children were classified into three groups: metalinguistic with metacognitive strategies (MLMC); metalinguistic (ML); and control. Letter naming, sounding letters, word spelling, and word recognition were assessed both on the pretest and posttests. Findings indicate that both the MLMC and the ML group made statistically significant gains in all measures. However, the metacognitive instructional practice had a stronger effect on the spelling and reading skills of children with SLI compared to the ML group and the controls. This study provides evidence that children with SLI benefit from the combination of metacognitive and metalinguistic instructional practices when acquiring early spelling skills.

Keywords Metacognition • Metalinguistic awareness • Specific language impairment • Spelling

1 Introduction

Specific language impairment (SLI) is a persistent developmental disorder, which is diagnosed when delays appear in oral language skills (Bishop, 1997; Leonard, 1998). Children with SLI demonstrate learning deficits and poor performance on

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various language tasks. These deficits may arise from combinations of deficits in specific aspects of language such as phonology, morphology, syntax, semantics, and pragmatics (Catts, Hogan, & Adolf, 2005; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Naucle, 2004). The SLI literature provides evidence that in many cases these children are later diagnosed with dyslexia (Catts et al., 2005), and have difficulty catching up with their typically developing peers.

In addition to language-based difficulties, recent literature provides evidence that children with SLI also exhibit deficits in nonverbal cognition. This body of research proposes that both the linguistic and cognitive deficits of children with SLI result from a nonlinguistic cognitive and an Executive Function (EF) deficiency (e.g., Im-Bolter, Johnson, & Pascual-Leone, 2006). Data from studies with children with SLI suggest that these children might suffer from non-linguistic difficulties. For example, Vugs, Hendriks, Cuperus, and Verhoeven (2014) have recently indicated that children with SLI aged 4–5 years scored worse than age-matched typically developing controls on EF tasks (i.e., inhibition, shifting, emotional control, and planning/organization) and on both verbal and visuospatial working memory (Marini, Gentili, Molteni, & Fabbro, 2014). Additional studies have also found difficulties in response management and strategic planning (e.g., Finneran, Francis, & Leonard, 2009; Henry, Messer, & Nash, 2011) as well as impairments in verbal working memory among children with SLI (e.g., Montgomery, 2000). The reduced capacity to store the incoming phonological information might contribute to their linguistic impairments (Archibald & Gathercole, 2007; Bishop, 2006).

So far, interventions designed for children with SLI usually addressed the linguistic awareness of the learners (Pinto, Iliceto, & Melogno, 2012), focusing three main metalinguistic awareness aspects: phonological awareness (Gillon, 2002; Otaiba, Puranik, Zilkowski, & Curran, 2009), print awareness or grapheme-phoneme correspondence, separately or together. Phonological awareness plays a pivotal role in spelling and reading acquisition (Ashby, 2010; Diependaele, Ziegler, & Grainger, 2010). This linguistic domain, which represents knowledge about the sound system of a language, has been found to have the most significant impact on spelling (Caravolas, Vólin, & Hulme, 2005; Plaza & Cohen, 2007). Research indicates that children with SLI have poor phonological processing abilities (Joffe, 1998), often due to their limited cognitive capacity for processing sequential segments of sounds, words and syllables (Gathercole, Briscoe, Thorn, & Tiffany, 2008; Montgomery & Windsor, 2007). It has been further demonstrated that clearly-planned phonological awareness instruction, that practices the ability to reflect and manipulate the sound structure of spoken words, contributes to reading and writing development both for typically developing populations (Ouellette & Sénéchal, 2013) as well as children with SLI (Segers & Verhoeven, 2004; Tyler, Gillon, Macrae, & Johnson, 2011).

Print awareness is defined as the ability to reflect on the forms, functions and conventions of print, as well as understanding the difference between print and pictures, letters and numbers, and conventions of print, which in alphabetic languages include the knowledge that words are separated by spaces, and that writing is arranged linearly (Justice, Bowles, & Skibbe, 2006). Print awareness covers a wide variety of print recognition skills, and studies have demonstrated that this type of

awareness plays a pivotal role in spelling acquisition (Ehri & Wilce, 1985; Share, Jorm, Maclean, & Matthews, 1984). Yet, despite the fundamental role of print awareness in the process of early spelling acquisition, more research is needed on what role grapheme awareness plays in the early spelling of children with SLI (Cordewener, Bosman, & Verhoeven, 2012).

Phoneme-grapheme correspondence, i.e., forming complete connections between letters in spellings and phonemes in pronunciations (Ehri, 2005) is a necessary component of metalinguistic awareness that promotes the mastery of graphic-sound relations. Being able to write phonemes correctly does not necessarily mean being able to use them in a word. Therefore, learning to spell both develops phoneme awareness and shapes the child's conception of phonemes (Ouellette & Sénéchal, 2013).

The characteristics of Modern Hebrew orthography allow a unique opportunity to examine both the effects of phonological transparency and opacity on early spelling abilities. Hebrew is a Semitic language, and as such it is written from right to left. Hebrew letter architecture is more uniformly block-like, with more horizontal and vertical strokes and fewer curves and diagonals. Hebrew is a transparent language in which the grapheme to phoneme correspondence is highly consistent and symmetrical. Because in Hebrew the phoneme is a reliable unit to focus on (Ziegler & Goswami, 2005), mapping letters and sounds is an ability that is mastered earlier as compared to children who acquire deep orthographies (Seymour, Aro, & Erskine, 2003).

While the universally used orthographic version of Hebrew, the *non-vocalized* orthography, represents all consonants by all letters, vowels are only partially and ambiguously represented by *matres lectionis* AHWY אהוי, which serve a double function as designators of consonants and vowels. AHWY matres lectiones 'mothers of reading' are the most complex and inconsistent spelling category in Hebrew. They designate vowels and consonants which are often interchangeable, they mutate towards each other, they have non-equal distribution in various spelling sites, and all of this complexity is conditioned by morpho-phonological considerations. The graphemes AHWY(אהוי may occur anywhere in the word as consonants. As vowels they fall into two sets: One includes Aא and H ה (both designating a and e), which usually occur only at the end of the word: For example, yafe 'nice' spelled YFH .יפה A second set includes W ו (designating o and u) and Y י (i), which may occur anywhere in the word. For example, kaniti (I) bought' is spelled KNYTY .קניתי Thus novice spellers not only have to perceive the double function of AHWY as consonants and as matres lectionis, but also to learn which vowels they represent and where they may appear (Ravid & Kubi, 2003).

There are three morphological roles that AHWY can fulfill as vowel graphemes: (1) Root letters. While root letters are generally consonantal, in some cases they represent vowel values. For example, one of the few cases when A appears in word-internal position is as a root letter, e.g., A in karati '(I) read', spelled QRATY קראתי, root Q-R-A. (2) Function letters. Vowels often participate in expressing function (i.e., non-root) morphological roles, especially in word-final position. For example, Y in kosi 'my glass', spelled KWSY כוסי expresses genitive case, 1st person singular. (3) Internal vowel letters. W and Y alone also have an additional, in a sense less meaning-bearing role in representing word-internal o, u, i as part of the pattern of

the word (e.g., o in gadol 'big', spelled GDWL גדול). Because of its secondary, less salient and less consistent and transparent status in Hebrew spelling, vowel representation tends to be a major source of spelling errors for Hebrew speaking kindergarteners who tend to represent only consonants in their spelling (Levin, Patel, Margalit, & Barad, 2002). The major question addressed by the current study is: To what extent is metacognitive awareness combined with metalinguistic awareness effective in promoting the spelling abilities of Hebrew speakers?

1.1 Metacognitive Awareness

A reflection-based ability which helps learners master the comprehension and production of oral and written language is metacognitive awareness. It is defined as the ability to think carefully and consciously about how to approach tasks, is a central component of the learning process (Flavell, 1979; Kecskes & Papp, 2000). Metacognition includes both knowledge about cognition which refers to knowledge of why and when to use a given strategy and monitoring of cognition (Lai, 2011; Schraw, Crippen, & Hartley, 2006), which relates to planning, monitoring or regulating, and evaluating (Cross & Paris, 1988). Researchers have suggested several instructional approaches to developing learners' metacognitive awareness. Many studies stress the importance of providing explicit instruction in both cognitive knowledge and cognitive regulation (Schraw et al., 2006). Studies also recommend that teachers assist students in developing their abilities to monitor and regulate their cognition (Kuhn, 2000) by leading them through the following stages: (a) What is the problem/task, (b) constructing connections between previous and new knowledge, (c) using appropriate strategies to solve the problem/task, and (d) reflecting on the processes and the solution (Lai, 2011; Montague, 2008).

Applying a combination of metacognitive and metalinguistic awareness to spelling training can serve as an effective platform for developing children's spelling abilities (Kim, 2010, 2011). The practice of spelling has both motivational and cognitive benefits (Brouwer, 2012). Beyond the sense of ownership, through spelling, children practice breaking words down into smaller sound segments and connecting these sounds to letters (Ehri & Wilce, 1987). Through spelling, children become aware of the nature of writing, and construct hypotheses regarding the logic of the segments that are represented in print (Alves-Martins & Silva, 2006). As children become more proficient in representing sounds in print, resources are available for the higher level aspects of writing, such as ideation (Graham & Harris, 2000) and reading (Treiman, 1993; Uhry & Shepherd, 1993).

Despite the assumed importance of metacognitive awareness, the combination of metacognitive and metalinguistic awareness for the development of spelling skills in children with SLI has attracted little attention. In light of the linguistic and cognitive deficits children with SLI experience and the benefits of metacognitive strategies for typically developing children, the present study examined the effect of the combination of metacognitive and metalinguistic instructional approaches on the

spelling abilities of Hebrew-speaking kindergarten children with SLI, and compared its effectiveness with the metalinguistic instructional method and a control group.

2 Method

2.1 Participants

The participants were 67 Israeli monolingual Hebrew-learning kindergarten children (53 boys, 14 girls; mean age = 5.8, range = 5.1–6.9 years). All methods and procedures were approved by the Institutional Review Board of Bar-Ilan University and the Israeli Ministry of Education. All parents signed written informed consent prior to the beginning of the study. The participants were recruited through contact with local kindergartens for children with SLI. Children in these kindergartens were diagnosed with SLI by a speech therapist and a psychologist appointed by the Ministry of Education. Based on these evaluations, a Placement Committee composed of the psychologist, the speech therapist who diagnosed the child, a kindergarten teacher, and the regional supervisor of the Ministry of Education, assigned them to an SLI pre-school program. Initially, 78 children were included in the research. Three children were excluded due to ADHD and eight dropped out since they didn't attend the sessions regularly. Only children with normal nonverbal intelligence were selected for this study. Nonverbal intelligence was assessed by the Block Design subtest of the Wechsler Preschool and Primary Scales of Intelligence (WPPSI; Wechsler, 1989). Groups did not differ in this test (MCML: $M = 9.9$, $SD = 1.6$; ML: $M = 9.3$, $SD = 1.7$; Control: $M = 9.8$, $SD = 1.9$, $p = 0.39$). It is important to note that the WPPSI scores reported are scaled scores. Verbal intelligence was assessed by the vocabulary subtest of the WPPSI (Wechsler, 1989). Groups did not differ in this test (MCML: $M = 5.3$, $SD = 2.8$; ML: $M = 5.1$, $SD = 2.4$; Control: $M = 5.1$, $SD = 2.4$, $p = 0.94$). None of the children had any hearing impairment or attention deficit disorder (ADD or ADHD) or any other disability, as reported by the teacher and the psychologist. Children were recruited from three urban kindergartens in the greater Tel-Aviv area, and came from a high SES background. None of the children knew how to read – a fact that was verified by the kindergarten teacher and the researchers.

The participants were randomly assigned to one of three groups. The final composition of the groups was as follows: (1) Metalinguistic with metacognitive strategies (MLMC) – ($n = 25$) comprised of 18 boys and 7 girls (mean age = 6, range = 5.11–6.9 years) who learned spelling by metalinguistic instruction. (2) Metalinguistic (ML) – ($n = 25$) comprised of 21 boys and 4 girls (mean age = 5.6, range = 5.11–6.5 years) who learned spelling by linguistic instruction. (3) Control group – ($n = 17$) comprised of 14 boys and 3 girls (mean age = 5.9, range = 5.11–6.8 years) who participated in a vocabulary-based discussion and drawing activity.

2.2 Intervention

For all three groups, the 8-week intervention program was comprised of two 25-min group instruction sessions per week. In each session, the children learned three words consecutively, thereby totaling 48 words (3 words × 16 sessions). Each word was only taught once, but the phonological structure of the words was taught multiple times. Word complexity varied over the course of the practice (see Appendix 1). All three groups had papers, pencils, crayons, and erasers on the table. Members of all groups were also provided with a plastic ruler that contained the alphabet and a picture of an item starting with each letter. In order to verify that the children understood the meaning of the word, prior to the instruction, the researcher showed a picture of the object the children were asked to spell and later read (e.g., *gader*/'fence'), and the children were asked: "What is shown on the card?" None of the groups saw a written copy of any of the words spelled out prior to the spelling instruction.

Both Experimental Groups (ML and MCML) Instruction in both experimental groups focused on four metalinguistic tasks reflecting phonological segmentation, letter knowledge, and grapheme-phoneme correspondence. At the beginning of each lesson, the researcher introduced the letters of the day using previously made letter cards, and named them with the children, referring to the sound of each letter (e.g., "The letter *reish* makes the sound *r*").

Phoneme Segmentation The researcher introduced the word orally and the children were taught to orally break it into sub-syllabic units. For example, the children were taught to break the word *gader* into three phonemic units: *ga*, *de*, and *r*.

Applying Letter Knowledge/Oral Grapheme-Phoneme Correspondence The researcher and the children orally matched the sounds in the word to the letters that represent these sounds, for example, for the word *gader*: ga – the letter *gimel*, de – the letter *dalet*, and r – the letter *reish*.

Word Spelling The children were asked to spell the word twice in their notebooks.

The MCML Group Only Instruction in this group included metacognitive strategies such as goal definition, planning, process monitoring during performance, and product evaluation after performance in addition to phonological segmentation, letter knowledge, and grapheme-phoneme correspondence. During each session and for every word, the researcher modeled the process of word spelling by using signs to signal the stages of spelling practice and by asking guiding questions using the following four strategies:

Goal Definition The researcher first hung the "Target" sign (a sign with an illustration of a target) on the marker board in order to prepare the children for the writing task. While hanging the sign, the researcher said: "Look, here's our target sign" and announced the objective of the task: word spelling. When presenting the next word,

the researcher asked the children whether they remembered the meaning of the sign. From spelling the third word and on, the researcher asked: "Children, what sign should we put up now?"

Planning Before spelling the word, the researcher hung the "Planning" sign (a sign with an illustration of stairs) on the marker board and said: "Look, here's our planning sign" adding that before writing a word we need to listen to the word, break it down into sounds, and match a letter to each sound. When presenting the next word, the researcher asked the children whether they remembered the meaning of the sign. From spelling the third word and on, the researcher asked: "Children, what sign should we put up now?"

Process Monitoring Before spelling the word, the researcher hung the process monitoring sign (an illustration of stairs with checkboxes). With the researcher's guidance, the children verbalized the stages (phoneme segmentation, applying letter knowledge/oral grapheme-phoneme correspondence, and word spelling) that needed to be completed while applying them to each assigned word. After each stage was completed, the researcher and the children verified that it was carried out properly (e.g., "Did we listen to the word?" "Did we break the word down correctly?" "Did we match a letter to each sound correctly?"). The researcher then provided each group member with the word written on a 5×5 card and wrote the word on the marker board. With subsequent words, the researcher elicited the meaning of the sign to be used from the children.

Product Evaluation To encourage children to monitor their productions, the researcher hung the "Evaluation" sign (an illustration of a magnifying glass) on the marker board. The children read the word out loud to verify that each sound was represented by a letter. Again, the researcher gradually elicited the sign to be used from the learners.

Control Group Using the same picture cards, work with this group revolved around discussing the words' meanings in context and drawing illustrations of them, with no explicit instruction in the words' letters, letter sounds, or spelling. For example, the researcher asked the participants: "What does *gader* ('fence') mean? This question was accompanied by additional questions to stimulate children's brainstorming regarding the use and function of the word (e.g., Where do we have fences? Why do we need fences? Who has a fence in their house?). At the end of the discussion, the children were asked to draw and color a fence on a piece of paper.

2.3 Fidelity of Implementation

In order to ensure fidelity of implementation, three weekly session observations per instructor were conducted by the principal researcher to monitor teaching behavior, totaling 72 observed sessions. The teachers were found to be able to effectively

implement strategies that were specified in the intervention program and the training workshops into the classes. Observations were not only used to verify the degree of fidelity, but also to identify areas where implementation is somewhat problematic and where additional training and support may be needed. Therefore, information obtained from observations was used as a basis for the weekly meeting in which the instructors participated, where they shared experience and received support and consultation from the principal researcher.

2.4 Tasks and Scoring

The following tasks were used both before and after the intervention:

(a) **Letter naming task** – The task included 27 letter cards (22 regular and 5 final consonants) and 5 pictures of objects which were arranged in a pile. The children were instructed to name the letter or picture they were shown. Responses to the first three letters received corrective feedback. The children received one point for each correct answer. The total number of points for this task was 27. Cronbach's alpha on the pretest and posttest was $\alpha = 0.93$ and $\alpha = 0.91$, respectively.

(b) **Sounding letters task** – Using the same letter cards, the children were instructed to say which sound each letter produces. Each child was given an example of a letter taken from his name. Responses to the first three letters received corrective feedback. The child was awarded 1 point for each correct response. Vowels in the Hebrew language can represent both a consonant and a vowel, and the child therefore received 1 point for uttering either the phonemic sound of the vowel or the consonant. The total number of points for this task was 27. Cronbach's alpha reliabilities on the two phases were $\alpha = 0.96$ and $\alpha = 0.96$, respectively. The measurement range for this instrument is 0–27 points.

(c) **Simple word spelling task** – The children were instructed to write eight different words uttered by the researcher, for example: *bat* (girl). Two of the eight words were constructed of consonants only, while the other six included vowel letters. The first six words had a CVC phonological patterns (in the first two words the vowel is not represented orthographically, only phonologically), and the last two words had a CVCV structure. Cronbach's alpha reliabilities on the two phases were $\alpha = 0.91$ and $\alpha = 0.93$, respectively.

Scoring of the word (produced by the children) task was carried out in three dimensions: consonants, vowels and order of the letters in the word (Levin & Aram, 2012). Each dimension was analyzed separately, and the children were given separate scores for the type of production based on the following scale. The selection of this three-dimensional coding system is based on the characteristics of Hebrew morphology in which the semantic core of a word is consonantal, with or without

vowels. An additional morphological feature of Hebrew is letter sequence, due to the fact that most content words consist of a 3-consonant "root". Words are produced when a root is embedded into a pattern consisting of vocalic infixes, primarily CV prefixes and/or suffixes. The order of consonants in the root is critical to the meaning, as changes in letter sequence may create a new word.

1. **Consonant representation** – The child received four points for each correct consonant. A homophonous letter (for example /*c*/ instead of /*k*/) awarded the child with three points. Writing a final consonant that has a similar sound to the required letter pronounced in the same place of articulation (for example: /*p*/ and /*b*/) awarded the child with one point. No points were given when no letter that represented the consonant was written. The measurement range for this instrument is 0–64 points.
2. **Vowel representation** – The child was given two points for writing a correct vowel. One point was given for writing an incorrect vowel or a consonant instead of a vowel. No points were given when no letter that represented the sound was produced. The measurement range for this instrument is 0–14 points.

Trained and Untrained Word Spelling Task In addition to the simple word spelling task which was administered before and after the intervention, the participants took the trained and untrained word spelling task which included both intervention words and non-intervention words that had the same phonological structure and level of difficulty as the intervention words. The children were instructed to write out 16 words, half of which were taught during the intervention, and half were new words with phonological structure similar to the intervention words. Two words were orthographically represented by consonants only, and 6 included the three vowel letters taught: *yod* (short /i/ sound), *vav* (short /o/ sound) and silent *hay* (/h/ sound). The words that the children were instructed to write were given in different phonological structures: CVC, CVCV, CVCVC, CVCCV, CVCCVC. Cronbach's alpha reliabilities on the two phases were $\alpha = .90$ and $\alpha = .91$, respectively. Scoring for the trained and untrained word spelling task was done separately for the intervention and non-intervention words. Scoring was done in the same way as previously described (consonants, vowels and letter sequence). The measurement ranges of the consonants, vowels and letter sequence for this instrument is 0–84, 0–14, 0–16 points respectively.

It is important to mention here that although one would typically administer tests both before and after the intervention, in this specific case, participants took the trained and untrained word spelling test only after the intervention. The decision is based on the presumption that there was no point burdening the participants with another spelling task – had the participants taken the test prior to the intervention, they would have failed because of their poor spelling ability (See Appendix 2).

3 Results

To evaluate intervention effects on metalinguistic and metacognitive knowledge, one-way ANOVA and two- and three-way mixed-design ANOVAs were conducted for each measure. General significance level was set at $\alpha = 0.05$. Pairwise comparisons were conducted using Bonferroni's adjustment to overall significance level. Significance level for differences was 0.001.

Table 1 presents percentages of correct responses for letter names and letter sounds by study Group and time. One-way ANOVAS revealed no pretest differences between groups for both tests ($p = 1.0$, $p = 0.42$) for letter names and letter sounds.

3.1 Letter Naming Task

A two-way mixed-design ANOVA for the overall correct responses by Group (MLMC, MC, control) and Time (pre, post) did not reveal a significant group effect F (2, 64) = 2.45, $p = 0.09$, $\eta^2 = 0.07$. However, the Group × Time interaction was significant, F (2, 64) = 3.47, $p = 0.03$, $\eta^2 = 0.09$. Bonferroni tests indicated that whereas the control group did not improve significantly from pre to post measurements ($p = 0.93$), both the MLMC group and the ML group improved significantly following the intervention (p's < 0.001).

3.2 Sounding Letter Task

A two-way mixed-design ANOVA for the overall correct responses by Group (MLMC, MC, control) and Time (pre, post) revealed a significant group effect, F (2, 64) = 13.66, $p < 0.001$, $\eta^2 = 0.29$. The Group × Time interaction was also significant, F (2, 64) = 20.47, $p < 0.001$, $\eta^2 = 0.39$. Bonferroni tests indicated that whereas the control group did not improve significantly from pre to post measurements ($p = 1.00$), both the MLMC group and the ML group improved significantly following the intervention (p's < 0.001).

Table 1 Descriptive statistics of correct responses for letter names and sound by study group and time of measurement

	MLMC		ML		Control	
	Pre	Post	Pre	Post	Pre	Post
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Letter names	61.33 (23.23)	86.96 (7.86)	54.22 (32.12)	81.77 (16.45)	54.90 (25.33)	65.14 (28.02)
Letter sound	7.55 (9.59)	60.59 (28.54)	18.37 (30.09)	37.48 (30.00)	1.52 (3.71)	6.75 (5.27)

Table 2 Descriptive statistics of percentages of correct responses of consonants and vowels in simple word spelling task by study group and time of measurement

	MLMC		ML		Control	
	Pre	Post	Pre	Post	Pre	Post
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Consonants	19.75 (18.10)	90.25 (9.56)	14.75 (21.03)	70.00 (12.88)	15.44 (18.89)	14.33 (25.07)
Vowels	4.00 (7.73)	100.00 (0.00)	1.17 (4.73)	65.14 (29.18)	0.00 (0.00)	8.40 (23.72)

Table 3 Descriptive statistics of percentages of correct responses of consonants and vowels for trained word spelling task by group

	MLMC	ML	Control
	M (SD)	M (SD)	M (SD)
Consonants	91.23 (8.09)	72.19 (11.30)	8.12 (20.32)
Vowels	97.71 (5.34)	62.85 (28.86)	5.88 (16.79)

General significance level was set at $\alpha = 0.05$. Pairwise comparisons were conducted using Bonferroni's adjustment to overall significance level of 0.05.

3.3 Simple Word Spelling Task

Correct Responses Tables 2, 3, and 4 presents descriptive statistics of percentages of correct responses of consonants and vowels in the one syllable word spelling task for pre- and post-intervention tests by study group. A three-way mixed ANOVA conducted on percentages of correct responses with letter type (consonant, vowel) and time (pre-, post-intervention) as within-subjects variables and group (MCML, MC, control) as a between-subject variable revealed significant effects of letter type, $F(1, 64) = 20.96$, $p < 0.001$, $\eta_p^2 = 0.25$, time, $F(1, 64) = 647.07$, $p < 0.001$, $\eta_p^2 = 0.91$, and group, $F(2, 64) = 74.87$, $p < 0.001$, $\eta_p^2 = 0.70$. However, the Letter type × Time × Group interaction was not significant, $F(2, 64) = 3.00$, $p = 0.057$.

Consonants Table 5 presents descriptive statistics of percentages of consonants errors for the one syllable word spelling task for pre- and post-intervention tests by study group.

A three-way mixed ANOVA conducted on percentages of errors with error type (homophonous, incorrect letter, no letter) and time (pre-, post-intervention) as within-subjects variables and group (MCML, MC, control) as a between-subject variable revealed significant effects of group, $F(2, 64) = 30.07$, $p < 0.001$, $\eta_p^2 = 0.53$, time, $F(1, 64) = 320.08$, $p < 0.001$, $\eta_p^2 = 0.83$, and error type, $F(2, 64) = 384.54$, $p < 0.001$, $\eta_p^2 = 0.92$. More importantly, significant Error type × Time × Group inter-

Table 4 Descriptive statistics of percentages of correct responses of consonants and vowels for the untrained word spelling task by group

	MLMC	ML	Control
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Consonants	92.95 (7.02)	72.95 (12.50)	9.24 (21.05)
Vowels	99.42 (2.85)	62.85 (25.08)	5.88 (16.79)

Table 5 Descriptive statistics of percentages of consonants correct responses and errors in simple word spelling task by study group and time of measurement

	MLMC		ML		Control	
	Pre	Post	Pre	Post	Pre	Post
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Correct responses	19.75 (18.10)	90.25 (9.56)	14.75 (21.03)	70.00 (12.88)	15.44 (18.89)	14.33 (25.07)
Homophonous Con	2.00 (3.47)	5.25 (5.31)	3.00 (7.88)	6.00 (7.09)	0.00 (0.00)	0.00 (0.00)
Incorrect letter	1.75 (3.83)	0.50 (1.73)	0.50 (1.73)	1.00 (3.46)	0.00 (0.00)	0.00 (0.00)
No letter	76.50 (22.62)	4.00 (6.72)	81.75 (23.93)	23.00 (12.59)	84.55 (18.89)	85.66 (25.07)

action, F (4, 126) = 24.72, $p < 0.001$, $\eta^2 = 0.44$. Multiple comparisons with Bonferroni's correction for significance level indicated that the MLMC group made more homophonous and less no letter errors at post- as compared to pre-intervention, and showed no change in incorrect letter errors. The ML group made less no letter errors at post- as compared to pre-intervention, and showed no change in homophonous and incorrect letter errors. Finally, the control group showed no change in neither homophonous, incorrect and no letter errors. To test whether the MLMC and ML groups differ in the level of reduction in no letter errors between pre- and post-intervention, an additional two-way mixed ANOVA was conducted on percentages of no-letter errors by time (pre-, post-intervention) and group (MCML, MC). The analysis revealed a significant Time × Group interaction, F (1, 48) = 5.42, $p = 0.02$, $\eta^2 = 0.10$, indicating that the MLMC group showed a larger reduction in no letter errors between pre- and post-intervention than did the ML group.

Vowels Table 6 presents descriptive statistics of percentages of errors of vowels for the one syllable word spelling task for pre- and post-intervention tests by study group.

A three-way mixed ANOVA conducted on percentages of errors with error type (incorrect letter, no letter) and time (pre-, post-intervention) as within-subjects variables and group (MCML, MC, control) as a between-subject variable revealed significant effects of group, $F(2, 64) = 95.06$, $p < 0.001$, $\eta_p^2 = 0.75$, time, $F(1, 64) = 409.68$, $p < 0.001$, $\eta_p^2 = 0.87$, and error type, $F(1, 64) = 1290.41$, $p < 0.001$, $\eta_p^2 = 0.95$. More importantly, significant Error type × Time × Group interaction, $F(2, 64) = 79.11$, $p < 0.001$, $\eta^2 = 0.71$. Multiple comparisons with Bonferroni's correc-

Table 6 Descriptive statistics of percentages of vowels correct responses and errors in simple word spelling task by study group and time of measurement

	MLMC		ML		Control	
	Pre	Post	Pre	Post	Pre	Post
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Correct responses	4.00 (7.73)	100.00 (0.00)	1.17 (4.73)	65.14 (29.18)	0.00 (0.00)	8.40 (23.72)
Incorrect letter	1.17 (6.28)	0.00 (0.00)	1.17 (6.28)	4.00 (8.76)	0.84 (3.46)	0.00 (0.00)
No letter	94.28 (9.22)	0.00 (0.00)	96.57 (8.53)	30.85 (29.64)	99.15 (3.46)	91.59 (23.72)

tion for significance level indicated that the MLMC group showed no change in incorrect letter errors and made less no letter errors at post- as compared to pre-test. The ML group made more incorrect letter error and less no letter errors at post as compared to pre-test. Finally, the control group showed no change in neither incorrect and no letter errors. To test whether the MLMC and ML groups differ in the level of reduction in no letter errors between pre- and post- tests, an additional two-way mixed ANOVA was conducted on percentages of no-letter errors by time (pre, post) and intervention (MCML, MC). The analysis revealed a significant Time × Group interaction, F (1, 48) = 22.22, $p = 0.02$, $\eta^2 = 0.32$, indicating that the MLMC group showed a larger reduction in no letter errors than did the ML group.

3.4 Trained (Intervention) Word Spelling Task

Correct Responses Table 3 presents descriptive statistics of percentages of correct responses of consonants and vowels in the spelling intervention words by study group. A two-way mixed ANOVA conducted on percentages of correct responses with letter type (consonant, vowel) as within-subjects variable and group (MCML, MC, control) as a between-subject variable revealed a significant effect of group, $F(2, 64) = 182.90$, $p < 0.001$, $\eta_p^2 = 0.85$. The letter type effect was not significant, $F < 1$. More importantly, the letter type × Group interaction was significant, F (2, 64) = 5.59, $p = 0.006$, $\eta_p^2 = 0.15$. Bonferroni tests revealed that whereas the control group showed no difference in correct responses for vowels and consonants ($p = 0.58$), the MLMC group had more correct responses for vowels than for consonants ($p = 0.048$) and the ML group had less correct responses for vowels than for consonants ($p = 0.007$).

Consonants Table 7 presents descriptive statistics of percentages of consonants errors for the intervention words spelling task by study group.

A two-way mixed ANOVA conducted on percentages of errors with error type (homophonous, incorrect letter, no letter) as within-subjects variables and group (MCML, MC, control) as between-subject variable revealed significant effects of group, $F(2, 64) = 208.28$, $p < 0.001$, $\eta_p^2 = 0.87$, and error type, $F(2, 63) = 269.36$,

Table 7 Descriptive statistics of percentages of consonants correct responses and errors in trained word spelling task by group

	MLMC	ML	Control
	M (SD)	M (SD)	M (SD)
Correct reponses	91.23 (8.09)	72.19 (11.30)	8.12 (20.32)
Homophonous Con	1.90 (3.63)	2.47 (3.66)	0.28 (1.15)
Incorrect letter	0.95 (2.38)	0.76 (1.78)	0.28(1.15)
No letter	5.90 (5.87)	24.57 (10.61)	91.31 (21.83)

Table 8 Descriptive statistics of percentages of vowels correct responses and errors in trained word spelling task by group

	MLMC	ML	Control
	M (SD)	M (SD)	M (SD)
Correct responses	97.71 (5.34)	62.85 (28.86)	5.88 (16.79)
Incorrect letter	1.14 (3.95)	4.00 (8.76)	0.00 (0.00)
No letter	1.14 (3.95)	33.14 (29.94)	94.11 (16.79)

$p < 0.001$, $\eta_p^2 = 0.89$. More importantly, significant Error type × Group interaction, $F(4, 126) = 57.77$, $p < 0.001$, $\eta^2 = 0.65$. Multiple comparisons with Bonferroni's correction for significance level indicated that the intervention groups did not differ in either homophonous or incorrect letter errors. However, the MLMC group made less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group.

Vowels Table 8 presents descriptive statistics of percentages of vowels errors for the intervention words spelling task by study group. A two-way mixed ANOVA conducted on percentages of errors with error type (incorrect letter, no letter) as within-subjects variables and group (MCML, MC, control) as between-subject variable revealed significant effects of group, $F(2, 64) = 108.47$, $p < 0.001$, $\eta_p^2 = 0.77$, and error type, $F(1, 64) = 161.57$, $p < 0.001$, $\eta_p^2 = 0.72$. More importantly, a significant Error type × Group interaction emerged, $F(2, 64) = 90.73$, $p < 0.001$, $\eta^2 = 0.74$. Multiple comparisons with Bonferroni's correction for significance level indicated that the intervention groups did not differ in incorrect letter errors. However, the MLMC group made less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group.

3.5 Untrained (Non-Intervention) Word Spelling Task

Correct Responses Table 4 presents descriptive statistics of percentages of correct responses of consonants and vowels in the spelling new words by study group. A two-way mixed ANOVA conducted on percentages of correct responses with letter type (consonant, vowel) as within-subjects variable and group (MCML, MC, con-

trol) as a between-subject variable revealed a significant effect of group, $F(2, 64) = 198.61$, $p < 0.001$, $\eta_p^2 = 0.86$. The letter type effect was not significant, $F(1, 64) = 1.89$, $p = 0.17$. More importantly, the letter type × Group interaction was significant, $F(2, 64) = 9.38$, $p > 0.001$, $\eta_p^2 = 0.23$. Bonferroni tests revealed that whereas the control group showed no difference in correct responses for vowels and consonants ($p = 0.31$), the MLMC group had more correct responses for vowels than for consonants ($p = 0.02$) and the ML group had less correct responses for vowels than for consonants ($p > 0.001$).

Consonants Table 9 presents descriptive statistics of percentages of consonants errors for the new words spelling task by study group.

A two-way mixed ANOVA conducted on percentages of errors with error type (homophonous, incorrect letter, no letter) as within-subjects variables and group (MCML, MC, control) as between-subject variable revealed significant effects of group, $F(2, 64) = 196.61$, $p < 0.001$, $\eta_p^2 = 0.86$, error type, $F(2, 63) = 252.53$, $p < 0.001$, $\eta_p^2 = 0.89$. More importantly, a significant Error type × Group interaction emerged, $F(4, 126) = 59.06$, $p < 0.001$, $\eta^2 = 0.65$. Multiple comparisons with Bonferroni's correction for significance level indicated that the intervention groups did not differ in homophonous errors. However, the ML group made more incorrect letter errors than the control group. As for no letter errors, the MLMC group made less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group.

Vowels Table 10 presents descriptive statistics of percentages of vowels errors for the intervention words spelling task by study group.

A two-way mixed ANOVA conducted on percentages of errors with error type (incorrect letter, no letter) as within-subjects variables and group (MCML, MC, control) as between-subject variable revealed significant effects of group, $F(2, 64) = 143.07$, $p < 0.001$, $\eta_p^2 = 0.82$, and error type, $F(1, 64) = 187.72$, $p < 0.001$, $\eta_p^2 = 0.75$. More importantly, a significant Error type × Group interaction emerged, $F(2, 64) = 112.91$, $p < 0.001$, $\eta^2 = 0.78$. Multiple comparisons with Bonferroni's correction for significance level indicated that the intervention groups did not differ in incorrect letter errors. However, the MLMC group made less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group.

Table 9 Descriptive statistics of percentages of consonants correct responses and errors in untrained word spelling task by group

	MLMC	ML	Control
	M (SD)	M (SD)	M (SD)
Correct responses	92.95 (7.02)	72.95 (12.50)	9.24 (21.05)
Homophonous Con	0.00 (0.00)	0.57 (1.57)	0.56 (1.58)
Incorrect letter	0.95 (2.38)	2.85 (3.88)	0.00 (0.00)
No letter	6.09 (6.37)	23.61 (11.03)	90.19 (22.49)

Table 10 Descriptive statistics of percentages of vowels correct responses and errors in untrained word spelling task by group

	MLMC	ML	Control
	M (SD)	M (SD)	M (SD)
Correct responses	99.42 (2.85)	62.85 (25.08)	5.88 (16.79)
Incorrect letter	0.57 (2.85)	5.14 (10.81)	0.84 (3.46)
No letter	0.00 (0.00)	32.00 (23.79)	93.27 (18.97)

4 Discussion

The present study investigated the relationship between early literacy acquisition and an intervention program that utilized a combination of metacognitive and metalinguistic awareness among kindergarten children with SLI. The program was implemented through spelling, a commonly practiced skill for kindergarten children and an antecedent of later literacy skills (Graham & Harris, 2000; Kim, 2010, 2011). The present study reveals that the combination of metalinguistic awareness and metacognitive strategies provides the foundation for spelling development, which is reflected in the spelling of simple, trained and untrained words. In other words, the MLMC outperformed the ML group which demonstrated high levels of performance compared to the control group on all spelling tasks. This indicates that the metacognitive strategies helped children with SLI in the MLMC group to internalize spelling principles and processing better than the ML group. This pattern was found throughout the different spelling tasks in the consonant and vowel responses and scoring.

In agreement with previous research, this study also indicated strong relations between spelling and metalinguistic awareness (Leppänen, Niemi, Aunola, & Nurmi, 2006; Lervåg & Hulme, 2010). As the data show, the ML group also improved in letter naming, letter sounds, and spelling from pre to post tests, yet not as much as MCML group. This finding supports the idea that working on spelling while emphasizing alphabet knowledge and letter-sound matching, contributes to spelling abilities and results in transfer to novel contexts (Ehri, 1986; Ritchey & Speece, 2006).

The error analysis reveals that the pattern of mistakes varies between the MLMC and the ML groups. In the simple word spelling task, while the MLMC group made more homophonous and less no letter errors at post- as compared to pre-intervention test, the ML and control group showed no change in homophonous and incorrect letter errors. A similar pattern was found in the trained word spelling task with the MLMC group making less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group. Finally, when asked to spell untrained words, the MLMC group made less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group. This pattern of findings proposes that for children with SLI forming and representing the connections between phonemes in pronunciations and letters in spelling emerges as a result of a combination of metacognitive strategies and metalinguistic awareness.

Perhaps surprisingly, the findings regarding children's performance on vowel spelling indicate a wider gap between the groups, with the MLMC group demonstrating higher accuracy on vowel spelling in all spelling tasks. In the simple word spelling task, while both the MLMC and ML group made less no letter errors at posttest, the MLMC group showed a larger reduction in no letter errors than did the ML group. When tested on both trained and untrained words the MLMC and ML groups did not differ in incorrect letter errors. However, the MLMC group made less no letter errors as compared to the ML group, which in turn made less no letter errors as compared to the control group. The error analysis of all three spelling tests (simple, trained, and untrained) also provides support to the claim that metacognitive strategies may serve as a complementary mechanism that enhances vowel spelling for children with SLI. Given its secondary, less salient and less consistent and transparent status in Hebrew spelling, vowel representation tends to be a major source of spelling errors for Hebrew speaking kindergarteners who tend to represent only consonants in their spelling (Shatil & Share, 2003). Therefore, the major improvement in vowel spelling for children with SLI is a significant finding that may suggest that complex spelling properties require metacognitive strategies in addition to metalinguistic awareness.

Given that both the linguistic and cognitive deficits of children with SLI result from a nonlinguistic cognitive and an Executive Function (EF) deficiency (e.g., Im-Bolter et al., 2006), metacognitive strategies may offer another form of support in addition to metalinguistic instruction. Compared to successful learners who think about their own thinking and reflect on their learning, children with SLI do not independently develop metacognitive abilities and are not aware of the internal process that assists them in overcoming linguistic challenges. This study suggests that children with SLI can become aware of their own thinking through metacognitive instruction, and can learn to spell despite the challenges. Focusing on metacognitive strategies while practicing spelling helps children to grasp the behind-the-scenes thinking required for good performance on spelling and reading assignments.

The results of this study indicate that metacognitive strategies enable children with SLI spell more words correctly. Moreover, they were transferring new orthographic knowledge when spelling and reading untrained words. Future studies might also follow children's literacy development over longer periods of time to examine how the combination of metacognitive and metalinguistic awareness continues to interact with spelling as children grow older. Another benefit of the significant relation between metalinguistic awareness and metacognitive strategies may be for word reading. Children with SLI who practice metacognitive strategies as well as the metalinguistic awareness skills may be able to use the simple skill of linking grapheme to phoneme to read words they were not exposed to during the intervention. This practice makes children more aware of the connection between the visual representation of language and the written form of the word, making them focus on the pronunciation of seen words and ultimately leads them to read new words. Future studies might consider extending the effect of metalinguistic and metacognitive awareness to reading performance in kindergarteners with SLI.

From a pedagogical point of view, we believe it is worthwhile to further explore the possibility of incorporating metacognitive instructional practices into kindergartens for children with SLI using different platforms other than spelling, since children with SLI also experience difficulties with nonlinguistic tasks (Bishop, 2002). Use of verbal self-reminding strategies learned in metacognitive training may compensate for difficulties associated with more complex cognitive abilities for children with SLI. This study shows that metacognitive and metalinguistic interventions are effective in improving spelling particularly for children who struggle to acquire literacy. Expanding this knowledge base to children with SLI will be important.

Appendices

Appendix 1

Intervention Words

Session	Phonological structure	Phonetic transcription/orthographic representation/ translation
1	3 letters CVCVC	gader/GDR/‘*fence*’, barad/BRD/‘*hail*’, beged/ BGD/‘*garment*’
2	3 letters CVCVC	gamad/GMD/‘dwarf’, gamal/GML/‘camel’, naxash/ NXSH/‘snake’
3	4 letters CVCCVC	sandal/SNDL/‘sandal’, sargel/SRGL/‘ruler’, mazleg/ MZLG/‘fork’
4	4 letters CVCCVC	masmer/MSMR/‘nail’ parpar/PRPR/‘butterfly’, masger/ MSGR/‘welder’
5	3 letters CVCVC + 4 letters CVCCVC	zemer/ZMR/‘song’, xacer/XCR/‘yard’, carcar/ CRCR/‘cricket’
6	3 letters CVCVC + 4 letters CVCCVC	naxal/NXL/‘stream’, namer/NMR/‘tiger’, Kalmar/ KLMR/‘pencilbox’
7	3 letters with the vowel H at the end CVCV	Shana/SNH/‘year’, cama/CMH/‘braid’, kala/KLH/‘bride’
8	3 letters with the vowel H at the end CVCV	xala/XLH/‘challa’, gada/GDH/‘bank’, xasa/XSH/‘lettuce’
9	4 letter with the vowel letter H at the end CVCCV	malka/MLKH/‘queen’, xalma/XLMH/‘dreamed’ (female), kalba/KLBH/‘dog’ (female)
10	4 letter with the vowel letter H at the end CVCCV	kanta/KNTH/‘bought’ (female), gamba/GMBH/‘pepper’, shatka/STKH/‘was silent’
11	3 letters with the vowel letter Y in the middle CVC	shir/SYR/‘song’, gil/GYL/‘joy’, sir/SYR/‘pot’
12	3 or 4 letters with the vowel letter Y in the middle CVC	nir/NYR/‘meadow’, pil/PYL/‘elephant’, xacil/ XCYL/‘eggplant’

(continued)

Session	Phonological structure	Phonetic transcription/orthographic representation/ translation
13	3 letters with the vowel letter W in the middle CVC	kor/KWR/‘coldness’, xod/XWD/‘tip’, mashot/ MSWT/‘paddle’
14	3 or 4 letters with the vowel letter W in the middle CVC	rok/RWK/‘saliva’, raxok/RXWK/‘far’, mot/MWT/‘pole’
15	A different vowel letter per word	mana/MNH/‘portion’, gir/GYR/‘chalk’, yod/ YWD/‘iodine’
16	2 different vowel letters per word	gina/GNH/‘garden’, shoteh/SWTH/‘drinks’ (female), sodi/SWDY/‘secretive’

Appendix 2

Test Words

Simple Word Spelling Task

bat/BT/‘*girl*’
ner/NR/‘*candle*’
gir/GYR/‘*chalk*’
pil/PYL/‘*elephant*’
sod/SWD/‘*secret*’
kol/KWL/‘*voice*’
shana/SNH/‘*year*’
mita/MTH/‘*bed*’

New Word Spelling Task

Intervention words

gader/GDR/‘fence’
sandal/SNDL/‘*sandal*’
shir/SYR/‘*song*’
xacil/XCYL/‘*eggplant*’
xod/XWD/‘*tip*’
mashot/MSWT/‘*paddle*’
sapa/SPH/‘*coach*’
gina/GNH/‘*garden*’

Non-intervention words

sapar/SPR/‘*hairdresser*’
shaldag/SLDG/‘*kingfisher*’
lama/LMH/‘*lama*’
shamra/SMRH/‘*kept*’ (female)

bish/BYS/‘*bad*’
xol/XWL/‘*sand*’
macil/MCYL/‘*lifeguard*’
rina/RYNH/‘*dance*’

Appendix 3

Intervention Description

MCML group	ML group	Control group
Making a statement  **about the purpose of the meeting**: “Today we’ll learn how to spell words”		What is a fence?
Planning the steps that need to be completed for spelling a word “What is required from us to do for write a  word”?		Where do we have fences?
Breaking the word into sub-syllabic units and directing the child’s attention to listen to the sounds of the word.  Ga-de-r “We need to break the word into sounds and listen to each sound”	Breaking the word into sub-syllabic units Ga-de-r	Why do we need fences?
matching the sounds to the letters (Phoneme-grapheme correspondence)  - /ג/ga - /ד/ de - /ר/ r “When we write a word, every sound is getting a letter. Let’s find out letters are in the word fence (gader)” Matching the sounds to the letters (Phoneme-grapheme correspondence) - /ג/ga - /ד/ de - /ר/ r	matching the sounds to the letters (Phoneme-grapheme correspondence) - /ג/ga - /ד/ de - /ר/ r	What kind of fences are there?

(continued)

MCML group	ML group	Control group
Write the word using letters cards /ד/ /ד/ /ג/	Write the word using letters cards /ד/ /ד/ /ג/	Who has a fence at home?
Providing feedback to the child which encourages evaluation of the written word "Did we write correctly? Let's find out!"		Each child received a paper and colors and draw the word fence
Reading the word	Reading the word	
Writing the word in a notebook	Writing the word in a notebook	

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Intervention and Assessment of Spelling Skills in LD Classrooms

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Abstract Spelling is a prerequisite for good writing and spelling can also aid in improving vocabulary and reading comprehension. Good spellers are almost always good readers. However, a majority of children with Learning Disability (LD) have problems with spelling and yet, research on spelling instruction is lacking compared to research on reading instruction; perhaps due to several misconceptions about the development, assessment, and instruction of spelling English words. After providing an overview of the myths and realities about English spelling, this chapter discusses what teachers in LD classrooms should know about the current research on the instruction and assessment of spelling. The role of dialect in spelling and the influence of orthography of first language on spelling English words as well as the teacher preparation in spelling is also outlined. It is concluded that spelling is a window on a person's knowledge about words and spelling English words requires an understanding of phonological, morphological, and orthographic factors of written language.

Keywords Dialect • ESL • Learning disabilities • Spelling assessment • Spelling instruction

1 Introduction

Noah Webster who published the basic books to teach reading in the 1780s titled them as American Spelling Book highlighting the importance of spelling in learning to read and write. Further, Webster stated in 1783 that, "spelling is the foundation of reading and the greatest ornament of writing" (cited in Venezky, 1980) implying that reading and spelling should be taught simultaneously. Interestingly, even after more than 200 years, this statement has been found to be true based on current empirical research. In a recent comprehensive meta-analysis of 53 studies including students

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from Kindergarten through 12th grade, Graham and Santangelo (2014), showed that teaching spelling improved spelling, reading, phonological awareness, and writing. Further, these gains were maintained irrespective of the grade levels or the literacy levels of students. As children learn to spell, their knowledge about words improves and there is a close relation between reading and spelling skill (the correlation between the two ranges from 0.66 to 0.90 according to Ehri (1989)) and further, when spelling skills are mastered, reading becomes easier (Ehri, 1997; Joshi & Aaron 1990, 2003; Moats, 2005/2006). Students with poor spelling tend to write less and use the same words whose spelling they know for fear of making spelling mistakes of unknown words. Additionally, children with spelling difficulties also tend to write less as it may take more time thinking about how to spell a word and thus lose the train of thought and ideas. Eventually, they start writing less and the vicious cycle continues resulting in poor academic performance.

Even though good spelling is critical for literacy, spelling has not received as much attention as reading, both in terms of research relating to assessment and instructional recommendations. Many more research studies have addressed how children learn to read than how they learn to spell even though spelling instruction provides the foundational knowledge of phonological, morphological, and orthographic awareness that are necessary for both spelling and reading. In this chapter, I shall outline some myths and realities about English spelling and what does the research findings support for assessment and instructional purposes that can be applied in LD classrooms.

Perhaps, one of the most common myths about English spelling is that it is an irregular language with complex and inconsistent letter-sound correspondences, like spelling *cat* and *kangaroo*, being spelled with different letters for the same sound. However, Hanna, Hanna, Hodges, and Rudorf (1966) estimated that the spellings of nearly 50 % of English words are predictable based on letter-sound correspondences and that a further 37 % are almost predictable except for one sound (e.g., *knit* and *boat*). Hanna et al. further stressed that, if other information such as word origin and word meaning are considered, only 4 % of English words could be truly considered as irregular and may have to be learned as visual units. Indeed, the linguists Chomsky and Halle (1968) claimed that English spelling, far from being irregular and illogical, is a "near optimal system for lexical representation" (p. 49). Other scholars, too, have argued that English includes many statistical patterns that make it less chaotic than often thought (Kessler & Treiman, 2003; Treiman, 2006).

Due to the generally held myth that English spelling is irregular, the commonly accepted instructional procedure to master spelling skills is to memorize the words by repeating the words letter by letter several times and copying the words repeatedly. However, it should be noted that it would be nearly impossible to visually memorize even a fraction of the approximately 700,000 words in English language. Further, if rote visual memorization is the mechanism for spelling English words, then children should make about the same number of errors on regular and irregular words as well as the same amount of errors on consonants and vowels. However, studies have shown that children make more errors while spelling irregular words like *sew* than on regular word like *cat* (Treiman, 1993) and also make more errors

on vowels than on consonants because five vowels in English make about 20 sounds (Caravolas, Kessler, Hulme, & Snowling, 2005; Kessler & Treiman, 2001).

Some authors even have claimed that English spelling is 'chaotic and a roadblock to reading' (Dewey, 1971) and some notable names have made fun of English spelling. For example, one of our former presidents, Andrew Jackson, in 1833, noted, 'It is a damn poor mind indeed which can't think of at least two ways to spell any word' and Bernard Shaw quipped, 'English can't be spelt'. Shaw further remarked that the word 'ghoti' can be pronounced as 'fish', by using the /f/ sound from the word rough, /ɪ/ from the o sound of the word women, and /sh/ sound from the syllable, tion, like in the words recognition and condition. However, if the principles of English orthography/spelling were followed, ghoti cannot be pronounced as fish. First, gh is not pronounced as /f/ in the initial position but can make that sound in the final position; o is pronounced as /ɪ/, perhaps only in the word women. In old English, the word was spelled as wimmen, but the typesetters inserted an 'o' to make it visually pleasing and the word just does not look like a series of wiggly lines. 'tion' is final stable syllable pattern and 'ti' makes /sh/, sound only when used as a syllable but not as individual sounds. The reason I have explained why 'ghoti' cannot be pronounced as fish is to illustrate that if we take into consideration three principles, letter neighborhoods, history of English language, and syllable patterns, majority of the English words can be spelled correctly and spelling instruction should highlight these principles.

2 Spelling Instruction

It is interesting to note that one of the earliest studies in evaluating instructional effectiveness was conducted on spelling intervention was by Rice as early as 1897. Rice, a physician, developed his own spelling tests and administered them to hundreds of children in schools in the Midwest. He was appalled by the spelling performance of children and urged schools to take special steps to improve spelling instruction. Rice found that just 15-min of daily spelling instruction can be very effective compared to an hour or more per week of drill.

Blachman and her colleagues (Ball & Blachman, 1991; Blachman, Ball, Black, & Tangel, 1994; Blachman, Tangel, Ball, Black, & McGraw, 1999) conducted a series of studies on teaching phonological awareness to improve reading and spelling skills, especially in low performing, inner city elementary schoolchildren. The results showed that phonological awareness training did improve spelling skills and students also had retained the correct spelling pattern after 6 months. In the meta-analysis of 52 studies conducted by the National Reading Panel (NRP) (NICHD, 2000), it was found that teaching phonemic awareness (PA) (identifying individual sounds in a spoken word) moderately improved spelling ability with an effect size of +0.59. Further, PA instruction was especially beneficial in improving spelling for at-risk readers with an effect size of +0.76 and typically achieving readers, with an effect size of +0.88 (Ehri, 2004). Further, phonemic awareness training was

particularly helpful when introduced along with letters and letter sounds. Additionally, the NRP review of studies on phonics instruction provided a strong support for systematic phonics instruction, especially for synthetic phonics instruction (teaching sounds of individual letters or letter groups to make a sound and then combine them to form a word) in Kindergarten and Grade 1 (Ehri, 2004).

Studies included in the NRP meta-analysis covered from 1970 to 2000 published in peer-reviewed journals. Wanzek et al. (2006) performed a meta- analysis of all the studies relating to spelling interventions conducted from 1995 to 2003 for learning disabled students. Even after perusing various sources and journals, they found only 19 studies that were related to spelling intervention and majority of them were based on single case design. Nevertheless, they found that those studies that included explicit instruction with multiple practice opportunities, and immediate feedback of corrected words resulted in significant gains in spelling. Further, using assistive technology in written compositions had a positive effect on spelling. In the meta-analysis of spelling intervention that included 53 studies dealing with over 6,000 students from Kindergarten to Grade 12, Graham and Santangelo (2014) found that explicit spelling instruction improved spelling and the gains in spelling were also maintained for an extended period of time. The gains in spelling were found not only in spelling measures but also in writing. Additionally, teaching spelling explicitly also improved performance on phonological awareness and reading skills. Recently, Chen and Savage (2014) provided 9-week intervention in the basic grapheme-phoneme correspondence to 38 children in Grades 1 and 2 and this intervention significantly improved spelling.

While referring to why Bernard Shaw's example of 'ghoti' cannot be pronounced as fish, I had mentioned that if we take into consideration three principles, letter neighborhoods, history of English language, and syllable patterns, majority of the English words can be spelled correctly and spelling instruction should highlight these principles.

2.1 How the Knowledge of Letter Neighborhoods Can Improve Spelling

Having the knowledge of how letters sound based on neighboring letters or the position of the letter or letter groups can help in spelling words. For example, English words cannot end with the letter 'v'; that is the reason words like love, have, and give have an e at the end, even though these words may sound irregular. Similarly, the letter q is always followed by u in English words (unless they are proper names like Iraq and Qatar) and the exception words can be taught later. For the diphthong sound of /oy/, if the sound comes at the beginning or the middle of the syllable or the word, then it is spelled with oi, like in oil and boil; however the same sound is spelled with oy, when it appears at the end of the syllable like in boy, toy, royal and voyage. Single syllable words ending in /ch/ sound with a short vowel sound should

be spelled with 'tch' like in match and batch, while words ending /ch/ sound and preceded by a vowel digraph or a consonant should be spelled with ch as in 'torch' and 'beach'. Similar principle is applied to spell 'dge' and 'ge' ending words as in judge, surge, and 'scrooge' (more information on the letter neighborhood can be found in Carreker, 2011; Joshi, Treiman, Carreker, & Moats, 2008).

2.2 Knowing the History of English Language Can Help in Spelling Words

English language has been a friendly language because it accepts words easily from other languages, like 'rabbi' and 'chutzpah', from Hebrew; 'algebra' and 'assassin' from Arabic, 'sputnik' and 'troika' from Russian, and 'jumbo' and 'Kwanzaa' from Africa. However, approximately 60 % of English words are of Latin origin, 10 % of which came to English from France. About 25 % of English words are of Anglo-Saxon origin and another 10 % are of Greek origin. Perhaps, many of the readers might have observed the contestants in the National Spelling Bee, first ask the word to be used in a sentence to help them spell the word correctly. If the word is /blu/, knowing the sentence, whether it is 'the sky is blue' or 'the whistle blew', helps in spelling the correct word. The next question, contestants generally ask is the word origin. Thus, in old English, /ch/ is spelled with the digraph ch, whereas words of French origin with /sh/ sound are spelled with ch, like chef, and champagne; and Greek word with /k/ sound are spelled with ch also as in chemistry and orchid. So, even though at first glance, the spelling may look irregular with ch making different sounds, knowing the history of English language helps in spelling English words correctly in majority of the instances. Incidentally, the contestants also ask for the parts of speech of the word. So, /ist/ ending words are spelled with ist, like in physicist or druggist, if they are nouns but with an est, like slowest, fastest, if they are adjectives. A helpful guide for the morphemic patterns and Latin-based instruction can be found in Henry (2010).

2.3 Knowledge of Syllable Patterns Helps in Spelling Words

The two most common syllable patterns in English are open and closed syllable patterns. Closed syllables end in one or more consonants, like 'cat' and 'hand', and the vowel is short, while open syllables end with one vowel and the vowel is long as in 'he' and 'hi'. Having this knowledge can help to spell two syllable words. In a two syllable word, when the first syllable is a closed syllable with a short vowel sound, then the medial consonant letter should be doubled, like in middle, parrot, and goggle, while in a two syllable word, if the first syllable is an open syllable, then the medial consonant is not doubled, like in 'lilac' and 'tiger'. Of course, it would

also be helpful to teach that some letters in the English language seldom double, like v and x, hence the spelling of 'river' with one medial v, even though the first syllable has a short vowel sound.

As can be seen from above, with just knowing three important principles – letter neighborhoods, history of English spelling, and syllable patterns, hundreds of words in English can be spelled easily better than rote memorization.

3 Assessment of Spelling Errors

Spelling instruction depends very much on the needs of children with LD. Fluent writing depends on good spelling skills and an individual who has to spend a great deal of time and effort in producing correct spelling will either lose interest in writing or will write short, simple sentences. Hence spelling error analyses would provide a good insight into the nature of reading and writing problems of school children. With the increased emphasis given to writing at the early elementary grades, classroom teachers should be knowledgeable in new methods of assessing and teaching spelling. Spelling may be a good indicator of one's knowledge of alphabetic principle as expressed by Shankweiler, Lundquist, Dreyer, and Dickinson, (1996), "spelling provides a valuable indicator of the level of orthographic skill on which all literacy activities ultimately depend. Word recognition and all subsequent higher level processes that take place in reading are constrained by the ability to fluently transcode print into language" (p. 287). At the present time, spelling performance in classrooms is evaluated by scoring the word as right or wrong. However, this may not be a very meaningful way of evaluating spelling errors and further, this type of scoring words as right or wrong may not help in designing instructional procedures for the teacher. For instance, if a first grade student spells the word 'cat' as 'KT' and another grade 1 student spells the same word as 'DB', both students receive 'zero' points and are scored as incorrect. This type of scoring also does not help in remediation as both the students do not need the same kind of intervention. However, a careful examination of the spelling errors indicates that the first student has some understanding of letter-sound principles but does not have the knowledge of letter neighborhoods (In English, words with /k/ sound followed by the letter 'a' is written with c). On the other hand, the second student does not even have the knowledge of letter sound correspondence and so needs a different type of instruction. There are several different ways to evaluate the spelling errors. Moats (1995) and Treiman and her colleagues (Bourassa & Treiman, 2014; Read & Treiman, 2013) have proposed scoring errors based on the manner and place of articulation and Masterson and Apel (2010) have developed scoring criteria based on phonological, morphological, and orthographic patterns. Spelling errors of children with LD must be evaluated using both quantitative and qualitative analyses to tailor appropriate remediation.

Conway, Joshi, and Carreker (submitted) administered Test of Written Spelling (TWS-4; Larsen, Hammill, & Moats, 1999) to 89 students in Grade 3 and their

spelling errors were categorized as phonological, phonetic, orthographic, etymological, and morphological errors. It was found that poor spellers made a higher proportion of phonological and phonetic errors and good spellers made a lower proportion of phonological and phonetic errors but a higher proportion of errors that could be grouped as etymological and morphological. As this study shows, first of all, all spelling errors cannot be considered as the same and thus all poor spellers do not need the same type of intervention; one has to look at the degree of poor spelling on a continuum. Very poor spellers need intensive instruction in phonological and phonics first while some poor spellers may have mastered the basic spelling skills but need instruction in higher order skills such as morphological and etymological principles of the English language.

4 Dialectical Influences on Spelling

Spoken language influences spelling. For instance, Treiman, Goswami, Tincoff, and Leevers, (1997) analyzed the spelling errors of 6–7 year children from U.S. and UK and found that U.S. children spelled *car* with an r like *cr* or as *kr* while British children spelled it as *ca* or as *ka*, and *hurt* was spelled as *hrt* by U.S. children and as *hut* by British children. Interestingly, the dialect influence on spelling was observed among adults as well. University students in the UK spelled *leper* as *lepa* while such errors (nonrhotic r as in the pronunciation of park as /pahk/ or r intrusions as in the pronunciation of idea as /ideer/) were not observed among university students in the U.S. (Treiman & Barry, 2000). Similar findings about the influence of dialect on spelling between Australian and British students have also been reported by Kemp (2006), and between White and African American vernacular English by Terry and Connor (2010), Treiman (2004), and Washington and Craig (2002).

Keeping the finding in mind that African American dialect can influence reading and spelling, we conducted a study by teaching systematic spelling instruction to sixth grader African-American students who were poor readers from an 'academically unacceptable' school (Pittman, Joshi, & Carreker, 2014). After 9-weeks of systematic spelling instruction that included phonological, morphological, and orthographic principles of the English language, treatment groups performed significantly better than the control group who were receiving the regular classroom instruction. After the 9-weeks of intervention, the same program of spelling instruction was provided to the control group and the original treatment group received the regular classroom instruction. At the end of the 18 weeks of instruction, both the groups had made significant gains in spelling and the first treatment group had retained the spelling generalizations also. This study shows that spelling can be improved with systematic instruction even among poor readers and can maintain the spelling generalizations.

5 Spelling Performance of Students Who Are Learning English as a Second Language

With the increasing number of students who are learning English as a second language, it is important to teach them the phonological, morphological, etymological, and orthographic principles of English language systematically and explicitly. Further, the classroom should also be aware of the orthographic nature of student's first language as learning English spelling may be influenced by the orthography of first language. Joshi, Hoien, Xiwu-Feng, Chengappa, and Boulware-Gooden (2006) analyzed the spelling errors of English words by students whose first language was Norwegian, Kannada – a language in India with the basic written unit as a syllable, and Chinese. It was interesting that when students whose first language was Norwegian and Kannada, did not know the correct spelling of the word, would write with some phonetic notations while students whose first language was Chinese would write another real word. For instance, for the target word, 'night', the errors of Norwegian and Indian children were, *nte*, *nit*, *nigt*, and *niat*; while the errors of Chinese children for the same word, were *nice*, *like*, *nine*, and *light*. Students in this sample, however, were exposed to English at different grade levels and the chronological age was not controlled. In a second study, Dixon, Zhao, and Joshi (2012) controlled for the age and grade levels and selected the students from the same grade with the same amount of exposure to English through formal instruction and analyzed their spelling errors. Similar findings were observed again; students whose first languages were either Malay or Tamil, two orthographies where phonetic notations can be noticed – wrote many words phonetically whereas students whose first language was Chinese wrote another real word when they did not know how to spell the target word. For Instance, Malay and Tamil speaking children misspelled *green* as *grn* or *grene*, while the misspelling of Chinese speaking children was a real word like '*grass*'. The results were explained in terms of the nature of the orthography of the first language. Chinese is a morphosyllabic language where the smallest unit is a syllable providing the clue to the meaning, whereas Malay and Tamil orthographies contain the phonetic element in their written unit. Thus, when examining the spelling errors of students who are learning English as an additional language, it is important for the teachers to understand the orthography of their first language.

With the increasing number of students with different language backgrounds than English in American schools, it is important to know about the orthographic differences of different languages. For instance, a series of studies conducted by Frith and her colleagues, and Caravolas and her colleagues has shown that it may be easier to master spelling skills in transparent orthographies such as Italian and Czech than an opaque orthography like English (please see Joshi & Aaron, 2006, for spelling in various orthographies). It has been well documented that English speaking children make more errors on vowels than on consonants because five vowel letters in English make approximately 20 sounds (Treiman, 1993). If this reasoning is applied to Spanish orthography, which has a one-to-one correspondence for both vowels and consonants, it could be hypothesized that Spanish

speaking children should make the same amount of errors on consonants and vowels due to its transparency. However, several studies (Manrique & Signorini, 1994, 1998; Zamora et al., 2015) have shown that Spanish speaking children make more errors on consonants than vowels because of the stress (spelling of *orca* and *horca*). Boulware-Gooden, Joshi, and Grigorenko (2015) compared the spelling performance of matched English speaking and Russian speaking children in Grades 4 and 6 on spelling in their respective languages and compared their performance on various phonological, morphological, and orthographic tasks. They found that morphology and orthography contributed more to Russian spelling, while morphology and phonology explained more variance in English spelling and led them to conclude that both the nature of the orthography as well as instructional practices can influence spelling words.

6 Teacher Preparation for Teaching Spelling

In a national survey of elementary school teachers, Graham et al. (2008), randomly selected 168 primary level teachers in the United States and asked them to complete a survey relating to their instructional practices in spelling and the accommodations made for poor spellers. Almost every teacher reported that they teach spelling and a vast majority of them also stated that they use various spelling programs. The survey results also showed that 42% of the teachers hardly made any adaptations to address the issue of spelling difficulties among poor spellers and indicated that more than a quarter of their students have spelling problems. This may have a serious impact on the academic future of elementary school children.

Despite the national report that spelling is a neglected area and the teachers report that they make very few changes or adaptations to meet the needs of struggling spellers (Graham et al., 2008), we have observed that teachers may not have been provided with good spelling strategies in their teacher training courses. Many teachers are dismayed that a good number of their pupils have difficulty mastering spelling and teachers give reasons such as English spelling is complex and illogical and poor visual memory on the part of the students. This is demonstrated in a study by Carreker, Joshi, and Boulware-Gooden (2010) where they tested preservice and inservice teachers on their ability to identify a student's underlying difficulty with spelling and choose the best instructional activity for remediation. The assessment included samples of common and consistent errors (e.g., *hv* for *have*; *rip* for *rib*; *hin* for *him*) and the errors were grouped by underlying difficulties (e.g., student does not detect all the sounds; student does not discriminate phoneme pairs such as /b/ and /p/ or /m/ and /n/). The assessment also included a list of possible instructional activities (e.g., have student segment three-and four-phoneme words, moving a counter for each sound; and have student use a mirror to help pronounce and spell words correctly). All the activities would improve spelling, but one activity would be the most appropriate to address the underlying difficulty suggested by a given group of spelling errors. The teachers were to match the groups of spelling errors

with the most appropriate instructional activities (e.g., "*gt* for *get*, *se* for *seed*, and *hv* for *have*" matched "have student segment three- and four-phoneme words, moving a counter for each sound"). The activity of having the student close his or her eyes and make a visual image of the word and writing the words five to ten times were included as distractors, and, unfortunately, the choices of closing the eyes to make visual images and writing the words five to ten times were selected more often, regardless of the types of spelling errors.

A series of studies by Joshi and colleagues (Joshi et al., 2009a; Washburn, Binks-Cantrell, & Joshi, 2014; Washburn, Joshi, & Binks-Cantrell, 2011) has shown that many pre-service and in-service teachers lack the basic knowledge of phonological and morphological awareness needed to perform well on spelling. What is more appalling is that many university instructors also lack the knowledge as shown by Binks-Cantrell, Washburn, Joshi, and Hougan (2012) in their 'Peter effect' paper and the text books used in the university reading courses do not provide scientific ways of teaching spelling Joshi et al. (2009b).

7 Conclusions

In this chapter, I have tried to highlight the importance of spelling to help reading and writing. Unfortunately, spelling research and instruction have not received as much attention as, for instance, reading. Good spelling is critical for literacy, and it makes writing much easier – allowing the writer to focus on the ideas to be conveyed and not the correct order of letters needed to spell. Just like decoding is a necessary but not a sufficient condition for reading comprehension, spelling is also a necessary but not a sufficient condition for writing. I have also outlined the role of dialect and first language influence on spelling English words along with some principles to know while assessing spelling and teaching spelling. It is recommended that Colleges of Education must provide systematic, explicit, and sequential spelling instruction in undergraduate classes for pre-service teachers and textbooks used in the classes must also provide detailed information about systematic spelling instruction.

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Seizing the Sounds: Considering Phonological Awareness in the Context of Vocabulary Instruction

Carolyn H. Strom and Susan B. Neuman

Abstract In this chapter, we call attention to vocabulary's role in the development of students' phonological awareness skills. First, we will consider how oral language and phonological development are related to each other, as a part of Lexical Restructuring Theory. Then, we present classroom-based research, which examines beginning readers' phono-semantic errors, highlighting the significance of both the phonological and semantic properties of words. Further, we consider how educators can use this knowledge to improve instruction for students.

Keywords Vocabulary instruction • Phonological awareness • Semantic development • Lexical Restructuring Theory • Phono-semantic errors

Struggling readers often have phonemic awareness deficits, which can impede the development of early reading skills. We've known this for several decades. As a result, an industry of interventions now exists that is aimed at improving phonological awareness, as well as letter knowledge, related phonics and metalinguistic skills. However, less attention is paid to how the meanings of words play a role in developing more fine-grained phonological representations. In order to advance our knowledge of how to help readers, we need to increase our understanding of *how vocabulary is connected to phonological development*.

In this chapter, we call attention to vocabulary's role in the development of students' phonological awareness skills. First, we will consider how oral language and phonological development are related to each other, as a part of Lexical Restructuring Theory (Metsala & Walley, 1998). After discussing this connection, we call attention to the need to develop a deeper understanding about the ways in which phonological and semantic development run alongside each other during word learning lessons.

Our position is that highly effective vocabulary instruction must attend to more than just meaning; it must emphasize the phonological properties of words, as well.

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Moreover, in return, lessons focusing on sounds in words must not exclude attention to the meanings of these spoken words. Students must understand the ways in which the smallest variation in sound can completely transform a word's meaning; in this way, sounds and meanings are linked.

Then, we present classroom-based research which examines beginning readers' phono-semantic errors (Strom, 2013), highlighting the significance of both the phonological and semantic properties of words. Throughout this chapter, we champion phonological awareness as an inextricable—and underexplored—dimension of vocabulary development. We also call attention to the ways in which focusing on the semantic aspects of words is absolutely central to all reading and language instruction. Further, we consider how educators can use this knowledge to improve instruction.

1 Lexical Restructuring Theory

Lexical Restructuring Theory, put forth by Metsala and Walley (1998), is based on the idea that as children begin to learn oral language, they process it as a whole—as a kind of seamless, undifferentiated stream of speech. Over time, their phonological awareness becomes increasingly attuned to the acoustics, words, and syllables in language. Finally, as brain development continues, children's perception of phonological nuances becomes more precise, facilitating their sensitivity to individual words. With this specialized level of awareness comes the ability to distinguish and represent distinct sounds in words, a skill that is essential for matching speech to print, a requisite skill for beginning to read.

However, the lexical restructuring process does not happen in isolation. Rather, it is related to other aspects of language development. Researchers have suggested that growth in oral language is related to vocabulary (Metsala, 1999; Walley, Metsala, & Garlock, 2003). That is, the process of being able to distinguish and represent smaller units of language is a function of a child's vocabulary size and growth rate (Metsala & Walley, 1998; Walley, 1993). Indeed, phonological awareness expands as more words are learned; increasing knowledge of words fosters finer phonemic distinctions (Luce & Pisoni, 1998). In many ways, vocabulary development and phonological skill development are dependent on one another; as one expands, the other refines and deepens. They're interrelated. As students are beginning to (or struggling with) learning words and their meanings, they are vulnerable to making errors that, we argue, can serve as valuable opportunities to contrast and elaborate on both new sounds and meanings. Meanings and sounds are the cornerstones of all language instruction; having a strong foundation in both is fundamental to being able to read well.

1.1 Words Under Pressure

The underlying hypothesis in Lexical Restructuring Theory (Metsala & Walley, 1998) is that, as children acquire more words (and become more facile with language overall), their lexicons are under a developmental pressure to reorganize. This structural shift hones their ability to distinguish and represent words into progressively smaller segments—such as the syllable, onset, rime, and phoneme. In other words, vocabulary growth pushes phonological boundaries, influencing the ways in which sounds are stored and represented in memory. Phonemic awareness skills are thought to emerge from this push, as well as from associated changes in phonological neighborhoods.

Typically, the words that are under the most pressure to restructure are ones that are familiar to children (already in their vocabulary) and/or which share phonological neighborhoods with already known words (Coady & Aslin, 2003). In other words, both vocabulary and phonology are implicated in this restructuring. The way that a word is stored is connected to its meaning, as well as to its distinct sounds. In contrast, words that are less familiar and/or phonologically dissimilar place fewer restructuring demands. So, for example, if a child knows just a few words (such as, for example, "bed" and "sister"), holistic representations would be sufficient to differentiate one word from the other; "bed" and "sister" share no phonemes. In effect, one would need very little phonemic information about these words in order to distinguish them. Further, the words "bed" and "sister" could be distinguished just by their number of syllables (one versus two, respectively).

However, as children's vocabulary expands, it becomes less efficient to mentally store words like these as wholes. As a student learns more words, it will become increasingly difficult to distinguish words from other, similar sounding words. For example, let's take "bed" from the example above. As discussed, when compared to the word "sister," it is relatively easy to distinguish globally and syllabically. However, as other words from the same phonological neighborhood are learned (such as, in this case, words that share a phonological neighborhood with "bed," like "bet," "bid," "bud" and "red"), it will become harder to distinguish "bed." At this point, in order to advance written and spoken language skills, "bed" would need to become stored in an *increasingly segmented way*, to make room for an *ever-expanding vocabulary*.

Going one step further, at the same time that these segmental representations are being altered, children are also learning about semantic concepts and words that are associated with "bed." In other words, they're developing a schema for "bed"—one that might include "nighttime," "sleep," or "pajamas." At the same time, they may also understand "bed" as closely related to the word "crib," since it, too, is a place for sleeping. Additionally, they might associate the word "bed" with a phrase such as, "time to go to bed." Put another way, the word "bed" ignites a storehouse of meaningful associations that are being learned and linked. One of the key ideas in this chapter is that *semantic knowledge and phonological knowledge shift alongside*

each other, why is why Lexical Restructuring Theory (Metsala & Walley, 1998), makes sense as framework.

Given these ideas, it follows that if we want to improve children's phonemic awareness skills, we must keep in mind that vocabulary plays a critical role. In order to improve instruction for struggling readers, a greater effort is required to understand early reading instruction in the context of Lexical Restructuring Theory. Framing phonological awareness and vocabulary development as intimately related helps make what we know about effective literacy instruction more robust, and capable of being more responsive to the needs of a wider range of learners.

2 Into the Classroom

To that end, in this chapter, we examine first graders' word errors through the lens of Lexical Restructuring Theory, showcasing how phonological awareness and semantic development intermingled during reading lessons. We analyze a conversation between a student and teacher about the word, "ranch," and use this analysis to discuss both phonological and semantic development. We share tables of students' errors and explain how words were classified according to their salient phonological properties, as well as to how they were contextualized—and given meaning—during lessons. Then, we discuss a conversation between a student and a teacher about the word, "cot," further demonstrating how phonemic awareness skills impact meaning-making and vocabulary skills. In particular, we note the ways in which teachers turned misrepresentations (of sounds or of meanings) into opportunities to deepen students' semantic knowledge.

2.1 Phono-semantic Errors

The data presented here is taken from a larger ethnographic study, which focused on the nature of students' errors during early reading instruction. One of the overall findings of that study was that students frequently made phono-semantic errors (Strom, 2013), which provided important information about phonological and vocabulary development. By "phono-semantic" errors, we mean students' oral errors during classroom conversations, which served to clarify the ways in which students were developing insights about differences in sounds, as well as differences in words and their associated meanings, more generally. In analyzing phono-semantic errors, we focus on how unfamiliar vocabulary and/or unfamiliar phonemes impacted the trajectory of word learning, as well as on how discussion of a word's meaning grounded linguistic and conceptual development. In the transcript that follows, the phono-semantic error is around the target word, "ranch," which was featured in a book the teacher was about to read with a group of students.

Teacher: Ok, who knows what a "ranch" is?
Student: A tool.
Teacher: Hmmm. What kind of tool?
Student: Um, like my dad, he uses a "ranch" to fix my bike. It is long and I think metal? It has two like, kinda like teeth, like little pieces, at the top?
Teacher: Oh! I think you're thinking of a "wrench." Yes, it sounds like the word "ranch," except let's listen to the middle. "R…ă…nch" and "wr…ĕ…nch." Can everyone repeat that?
Class: R…ă…nch and wr…ĕ…nch.

In this lesson, after the teacher queries the class about the target word, "ranch," a student's response alerts us that she probably heard it as "wrench" (which she then confirms as she explains that one function of a "ranch" is to fix a bike). So, going back to the teacher's original question, do we know whether or not this child knows what a "ranch" is? No, we don't. We don't know because the student made a *phono-semantic error*, which gives this particular instructional interaction a new twist. Phono-semantic errors obfuscate what we can know about a students' phonological and conceptual knowledge.

We define a phono-semantic error as: an oral response that shares a *phonological neighborhood* with the target word, and is also a *real word*. In the case of "ranch," the phono-semantic error comes in the form of the word "wrench," which is a word that shares all of its consonant speech sounds with "ranch" (/r/, /n/, /ch/) but is obviously not the same word. This kind of error plays a role in how the meanings of two different words are unraveled and classified. Further, phono-semantic errors become particularly significant when educators use them to contextualize—and elaborate on—a word's meaning.

Additionally, if treated as a unit of analysis, a phono-semantic error can tell us a lot about students' linguistic development, and about what kinds of instruction they need. While "wrench," may not be the sought after word in this exchange (which was "farm," a synonym for "ranch"), it has still taught us something about this particular student's way of thinking about the meaning a word, as well as about her phonological skills. Further, this error offers an opportunity for a teacher to respond in a way that helps students navigate new and contrasting meanings.

Going a little deeper, there are two main possibilities for why the student in this transcript confused "ranch" and "wrench." First, it is possible that this student heard the word "ranch" correctly during the lesson but perhaps had never heard of it before, so was unfamiliar with what a "ranch" signifies. In that case, it makes sense that she would not have a mental representation available for "ranch"—no matter how many times the word was repeated or enunciated. It would be a word that was meaningless to a student even if heard "properly." Thus, in trying to make sense of the word, she used her existing word knowledge as a default system, pulling up the closest phonological approximation she could find that she recognized: "wrench."

In other words, it is possible that she heard the word "ranch" correctly, but didn't know what it meant. So, she equated it with "wrench" (a word *unrelated semantically* but with very *similar phonological* properties to "ranch"). If this were the case,

then the student's implicit thinking was probably that words that *sound* like each other (like "ranch" and "wrench") must have the similar *meanings*. In this case, the student concludes that, like "wrench," a "ranch" is also a tool. This illustrates one way in which a phono-semantic error can give us some insight about what lexical restructuring looks like in classrooms—where a students' phonological skill levels (and assumptions about similar sounding words) are bumping up against their lexical knowledge.

However, a second possibility is that this student's phonological skills were not developed enough to allow her to hear the differences between the two medial vowels, short *ă* (as in "ranch") and short *ĕ* (as in "wrench"). So, perhaps, when the teacher said "ranch," the student actually heard it as "wrench" (and proceeded to define it in a context). In this case, it is safe to assume that the student was still working on differentiating short vowel sounds, as well as fine-tuning their related phonemic awareness skills. In this scenario, a weaker ability to discriminate between short *ă* and short *ĕ* became a complicating factor in the attempt to grasp the intended meaning of a word.

As the conversation moved along, the teacher did not simply ignore the student's "wrong" answer, or prompt her with the "right" answer. Rather, the teacher validated what the student had "heard" (in terms of similar sounds), called attention to the contrasting sounds and asked the class to repeat the sounds. After that, the conversation continued:

Teacher: Okay, good, so yes, a "wre…ĕ…nch" is a tool, yeah. But, a "r…ă…nch" is a place. It is just like a farm. See? (*opening the book and pointing to a picture*) Look at this page. See all of this? The farm, all of the horses. Yeah, this is a ranch. Remember we read a book about a farm a little while ago? A farm is just like a ranch. They're very, very similar things.

Here, the teacher used a phono-semantic error ("wrench") as an indication of what the student was *hearing* and *made conclusions about how they were making sense*, *overall*. Rather than evaluate the student's response as simply wrong (which some teachers may have done since a "ranch" is simply *not* a "tool"), the teacher took this answer, made some phonological sense of it herself, and then clarified the perceived confusion by calling attention to word meaning. The teacher ultimately grounded the conversation in the service of semantic development of the target word, "ranch."

As the teacher went on to clarify "ranch," she did so by providing an image, offering a synonym ("farm"), and associating it with other words ("horses"). Specifically, the teacher called students' attention to a picture of a "ranch," providing a visual explanation of the word. Further, the teacher reminded the class that they had read about a "farm," before and then explained that it is similar, in meaning, to a "ranch,"—contextualizing it in terms of a place they already know about. Additionally, the teacher also linked "ranch" to horses, explaining that they are often associated with each other, further building students' understanding of the word.

We argue that this type of exchange also illuminates lexical restructuring in action. In this case, a teacher managed to use a sound-based error to expand students' vocabulary knowledge and enrich their schema for "ranch." Seen through the lens of Lexical Restructuring Theory, this teacher instigated something like a metalinguistic, "restructuring push," characterized by calling attention to specific phonemes and to the ways in which they impact meaning.

2.2 Error Tables

Thus, in this conversation, phonemic properties and semantic properties of words implicated each other, and were deemed worthy of expansion. As noted earlier, phono-semantic errors were entered into Error Tables, which were designed to call attention to what happened (on both a phonemic and semantic level) to the target word. Further, Error Tables (See Fig. 1) facilitated error classification into one of the three phonological neighborhoods. Traditionally, phonological neighbors are classified in terms of: (1) consonant neighbors (CN); (2) rime neighbors (RN); (3) onset-vowel neighbors (OVN). An example of these categories for a target word such as "bed" would be "heard" words like *bid* or *bad* (CN), *red* or *fed* (RN), *bet* or *beg* (OVN).

Error tables were also used to keep track of how teachers clarified the meanings of—and between—words. They contained a column where researchers could record any vocabulary strategy used (such as providing visuals, synonyms, associations, or an associated movement, etc.…) to help students develop ascertain the meaning of "ranch."

For the larger study, Error Tables were used to further analyze and classify words within the larger data corpus. Details on that process are beyond the scope of this chapter but we include the Error Tables here in order to better illustrate the concept of a phono-semantic error, and to frame it as a valuable piece of research data. Further, by using the Error Table format to document students' phono-semantic errors, we want to illustrate how these can be *useful tools for educators*. If students' phono-semantic errors are systematically coded and analyzed for specific properties, teachers' can (more efficiently) determine which specific phonological proper-

Target Word	Phono-semantic Error	(CN)					(R)	(OVN)	How Meaning was Clarified
		A	E	I	O	U			
Ranch	Wrench	*X*	*X*	-	-	-	-	-	• *Visual method* (picture of ranch) • *Synonym* (farm) • *Conceptual association* (horses)

Fig. 1 Error table for "Ranch"-"Wrench"

ties need practice and review. Further, by collecting data on how teachers respond to these kinds of errors, we will be able to deepen our understanding of how vocabulary-teaching strategies work, and how semantic knowledge is elaborated upon and fostered by teachers.

The second phono-semantic error we are going to discuss is "cut," and is based on the target word, "cot" (referring to a small bed). This target word emerged as the teacher was previewing vocabulary from an upcoming story:

Teacher: "Does anyone know what a "cot" is? It is going to be in this story. Think about if you've ever heard of a "cot" before."
Student: Like you have a "cot" on your finger?
Teacher: What do you mean?
Student: Like a cot, and you need a band aid.
Teacher: Oh, I think you're thinking of "cut." They sound alike but let's look at them, they're different (*proceeds to write the words "cut" and "cot" next to each other, underlining the "u," and "o," respectively*). Let's say them together, okay?
Class: "C….ŏ….t," "c….ŭ….t."
Teacher: Okay, so a "c….ŏ….t," is a small bed (*draws picture*). We don't really hear the word "cot" so often, though.

Much like in the "ranch"-"wrench" exchange, this "cot-cut" exchange revolves around a medial vowel feature (see Fig. 2 for Error Table for "Cot"-"Cut"). Like "wrench" to "ranch," "cut" to "cot" fits the definition of a phono-semantic error: a "cut" refers to something real and shares a phonological neighborhood (in this case, consonant sounds) with the word "cot." In terms of phonological development, this conversation tells us that discriminating between short *ŏ* and short *ŭ* is a learning need for this student (and likely for some other students, as well). Semantically, we also learn from this error that this student is able to contextualize his understanding of "cut," which is a degree of linguistic understanding that is important to acknowledge.

As in "Ranch"-"Wrench," the teacher takes a semantic error (that a "cot" is something you might have on your finger) and gives it some phonological rationale, calling attention to the distinctiveness of the respective medial vowels. *But*, *the*

Target Word	Phono-semantic Error	(CN)					(R)	(OVN)	How Meaning was Clarified
		A	E	I	O	U			
cot	cut	-	-	-	*X*	*X*	-	-	• *Visual* (picture of cot) • *Synonym* (small bed)
shop	chop	-	-	-	-	-	*CH* *SH*	-	• *Synonym* (store) • *Movement* (motion of chopping vegetables for "chop")
strep	stress	-	-	-	-	-	-	*_P* *_SS*	• *Movement* (point to throat for "strep")

Fig. 2 Error table. "Cot"-"Cut." "Shop"-"Chop." "Strep"-"Stress"

teacher also expands and elaborates on the meaning of "cot," contextualizing it as very similar to a "small bed" (generating a synonym) and drawing a picture (providing an image). In contrast to "Ranch"-"Wrench," the teacher does not have the students solely "listen" for the middle sound. Rather, she writes the target word and its phono-semantic error as a pair, right next to each other, and underlines the medial vowels, "o" and "u," pointing out their distinct orthographic properties. Rather than directing the class to "listen to the middle" (as the teacher did with "ranch-wrench"), she directed the class to "look at" how the words were written—encouraging engagement in a different kind of compare and contrast exercise.

In order to illustrate how other phono-semantic errors would be recorded, we have included additional examples in Fig. 2. One of the phono-semantic error entries recorded is "chop." Unlike "cut" or "wrench," "chop" shares a rime with its phono-semantic error (-op). In this case, the sounds that are difficult to distinguish are the consonant digraphs, "SH" and "CH." To clarify the differences between the meanings of these words, the teacher provided the synonym "store" for "shop" and also modeled a motion of "chopping vegetables," providing a kinesthetic link to "chop." The third phono-semantic error in Fig. 2 occurred between "strep" (as in "strep throat") and stress. "Strep" and "stress" are OVN pairs, sharing the lead letters (s,t,r,e) but having different final sounds (_P, _SS, respectively).

Those familiar with miscue analysis (Goodman, 1973) will likely see commonalities between that process, and our process of classifying and coding phono-semantic errors. However, unlike what we traditionally think of when we think of "miscues," phono-semantic errors are based on spoken language during instruction rather than on the cueing systems being used while a student reads a text. Further, a phono-semantic error analysis is used to crystallize a student's specific phonological and semantic areas of strength and need—rather than to assess the kinds of more general reading skills strategies they need to work on. Phono-semantic analyses are based on how phonological and semantic properties intermingle, and how they instantiate ideas in Lexical Restructuring Theory.

3 Implications

Throughout this chapter, we have paid close attention to phono-semantic errors and to the ways in which they illuminate central aspects of Lexical Restructuring Theory. We have also called attention to some of the unique and productive ways that teachers capitalized on students' errors, treating them as opportunities to help them build semantic knowledge of a target word. Now, we turn to the implications that all of this has for instruction.

First, we make the point that phono-semantic errors are particularly important to consider in the context of struggling readers, who often have difficulty developing or advancing their phonological awareness skills, and who need strong vocabulary instruction, as well. Further, since we know that phonological awareness can be a

predictor of later reading achievement, it makes sense to loop more "sound awareness" or "sound consciousness" into all kinds of language instruction. In this way, we suggest a nuance to the idea of fostering "word consciousness," a popular idea in vocabulary instruction. We aim to promote the idea that semantic and phonological development are more inter-related than they are usually given credit for. Finally, we provide guidelines to help educators use phono-semantic errors as resources during instruction.

3.1 Struggling Readers

It is widely accepted that phonological awareness is a critical factor involved in a child's reading development. Typically, it is a fundamental piece of any reading program designed specifically for students with language-based learning disabilities. Indeed, since struggling readers and students with learning disabilities often have difficulty acquiring phonological skills, those who teach them are often trained to guide students in phonological and phonemic awareness activities. Of course, these often include levels of word and sound manipulation tasks (such as rhyming, clapping syllables, isolating onset and rime, isolating sounds, phoneme blending, segmentation and elision). This helps students with their auditory discrimination skills, facilitating their being able to then match individual sounds to symbols.

However, typically, these kinds of phonological awareness tasks do not pay much attention to the meanings of words, their semantic nuances, or associations. This is largely because vocabulary instruction is traditionally treated as relatively disconnected from phonological awareness instruction. By a similar token, phonological awareness instruction is often framed as being exclusively about sound identification and manipulation—rather than about the meanings of the words that they are attached to.

However, in line with Lexical Restructuring Theory, we posit that vocabulary and phonological awareness are related, and that improving one is connected to the other. As discussed in our data, students' *weaker phonological representations impacted the ways in which they came to understand the meanings* of words; this provides a clear connection between the phonologic and semantic dimensions of learning. In other words, instruction for struggling readers in phonological awareness should not exclude a focus on word meanings. Not only does a focus on the semantic level of words enrich and contextualize phonological awareness instruction, but it also helps students build conceptual knowledge and vocabulary—which are both essential to more global reading skills. Working to design more robust phonological awareness instruction for students with learning disabilities will involve taking vocabulary into greater account.

3.2 Word Conscious, Sound Conscious

In conjunction, creating more effective vocabulary instruction for struggling readers needs to take into account *how individual phonemes* are heard and produced, calling further attention to how sounds have the power to impact meaning. Related to this, *fostering word consciousness* is often cited as a best practice in vocabulary instruction (Beck, McKeown, & Kucan, 2002; Scott & Nagy, 2004). Students who are "word conscious" have a noted awareness and appreciation of words as they are written or spoken, read or heard (Graves & Watts-Taffe, 2002). Our work is in line with this idea but puts emphasis on words as they are spoken and heard.

In other words, more attention needs to be paid to the ways in which being *sound conscious* facilitates oral language development. While it is important to get students interested in thinking about words around them and engaging in language building practices, such as dialogic reading (Lonigan & Whitehurst, 1998), it is just as important to get students interested in thinking about *sounds* around them. Shared reading practices become more robust when explicit attention is paid to the nuances of sounds in words. Being *sound conscious* involves being curious about how sounds can drastically alter meaning.

3.3 A Phono-semantically Integrated Approach to Vocabulary Instruction

So, what would an actual lesson look like that integrated vocabulary knowledge and phonological awareness (what we're calling phono-semantically integrated vocabulary instruction)? Let's pretend that a new vocabulary word to be learned was the word "lime," referring to the sour, citrus fruit. First, an educator would show students picture(s) of a lime, or perhaps bring in a real one. They would help students classify "limes" into different semantic categories such as "small fruits" (with other words such as "lemons" or "kiwis") or in a category labeled "things that grow on trees." An educator would then direct the conversation to the ways in which "limes" share (or differ in their) semantic properties with the words in these categories and would contextualize "limes" in a text or in a familiar situation. In other words, an effective lesson would help identify these kinds of word properties so that *semantic base* would be established.

Our argument is that an effective vocabulary lesson does not end there. Phono-semantically integrated vocabulary also attends to the *phonological dimensions* of "lime." Our position is that more sophisticated vocabulary instruction focuses on this dimension of "lime," as well. By calling students' attention to the way words sound, it is possible that the word's conceptualization, overall, is strengthened. In the case of "lime," (in addition to focusing on its semantic properties mentioned earlier), an effective vocabulary lesson then turns attention to words that share pho-

Sequence for Phono-Semantically

Integrated Word Learning Instruction

1. Explain: Tell students what word will be learned.
2. Provide clear semantic context. Some suggestions:
   - Show picture
   - Act out meaning
   - List attributes
   - Help students make connections to their related, prior knowledge.
3. Provide phonological context using "buddy words":
   - Pick three words that share a phonological neighborhood with the target word (i.e. "line," "slime," and "dime" are neighbors of "lime" since they share all but one phoneme with it). These are "buddy words."
   - Choose 2-3 sound identification and manipulation activities with these words.
4. In future lessons related to target word, prompt students to recall some of its semantic, as well as phonologic, properties. Repeated exposure to target word should always address its semantic and phonologic dimension.

Fig. 3 Lesson sequence

nological neighborhoods (or, phonemes), with "lime"—such as "line," "slime," and "dime." In these lessons, words like these are labeled "buddy words," to facilitate students' understanding the premise that they are very similar to each other, which can make them more difficult to distinguish. Teachers use the "buddy words" to engage students in sound identification and/or manipulation activities.

For example, the teacher might have students generate words that rhyme with "lime" (dime, slime, time) or would have students engage in wordplay that requires them to substitute one of the phonemes for another (such as changing "lime" to "line" or to "like"). Our argument, buttressed by Lexical Restructuring Theory, is

that more intense focus on the unique sounds in new words helps students differentiate it from others that they know. This increases the likelihood that these sounds will become more refined and available to attach to a word's meaning, *strengthening the speech-meaning connection*. Further guidelines for phono-semantically integrated instruction are as follows are in Fig. 3.

4 In Conclusion

One of the key ideas in this chapter is that vocabulary and phonological awareness are related. To this end, we call explicit attention to the existence of phono-semantic errors, and to the ways in which they blur phonological and semantic lines. We also emphasize that order to be most effective for struggling readers, robust vocabulary instruction needs to be grounded in the meanings of words but it also means giving special attention to the particular sounds in words. We developed this idea in the context of Lexical Restructuring Theory, which also frames vocabulary and phonological development as connected. All students (but particularly those with learning disabilities and those who are working on refining their phonological skills) cannot afford to lose out on valuable opportunities to deepen and extend their semantic knowledge. By focusing on what students are both *hearing and thinking about* during word learning, we offer a more enhanced way of studying and responding to students' oral language errors during reading instruction.

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Effective Strategies for Developing Reading Comprehension

Meenakshi Gajria and Asha K. Jitendra

Abstract This chapter focuses on instructional strategies for improving reading comprehension of students with learning disabilities (LD). It discusses the nature of reading comprehension and highlights comprehension difficulties experienced by students with LD. This discussion is followed by a selective overview of the research on cognitive and metacognitive strategies, with a focus on components of effective instruction gleaned from the research on reading comprehension.

Keywords Reading comprehension • Reading strategies • Cognitive strategy instruction • Metacognition • Learning disabilities

1 Effective Strategies for Developing Reading Comprehension

Reading comprehension has been defined as "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language" (Shanahan et al., 2010, p. 5). Considered as the "essence of reading" (Durkin, 1993), reading comprehension is a complex task that involves processing at multiple levels. To comprehend text, readers must interact with the words, sentences, paragraphs, and larger discourse units (e.g., whole text). They must do more than simply interpret what is explicitly stated in the text. In order to learn in the content areas and achieve academic success, it is critical that students be purposeful in their reading. Purposeful reading entails planning, selecting, and using appropriate strategies to effectively engage with the text, connecting prior knowledge to new information, and simultaneously monitoring understanding.

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Many students with LD consistently experience problems in comprehending text. Although the group of students with difficulties in reading comprehension is diverse, some general characteristics of this group include problems in identifying main ideas and supporting details, asking questions, paraphrasing text, predicting information, drawing inferences, and recalling textual ideas (Gajria, Jitendra, Sood, & Sacks, 2007; Gersten, Fuchs, Williams, & Baker, 2001). Creating a summary or gist of the main ideas of a text is also difficult for many students as they struggle to differentiate important ideas from unimportant details and have trouble ignoring extraneous information (Gajria & Salvia, 1992). Moreover, they experience difficulty in understanding expository text patterns and using text structure knowledge to guide encoding and retrieval of academic concepts (Williams & Pao, 2013).

These challenges are not necessarily rooted in discrepant language experiences or decoding skills that are not automatic, but may be influenced by insufficient prior knowledge. Students may lack the requisite schema or background knowledge to draw inferences essential to comprehending a text (Kendeou & van den Broek, 2007), or in some cases may fail to activate it despite having the relevant schema (Elbro & Buch-Iversen, 2013). Working memory capacity is also critical for reading comprehension as it holds new information and allows the reader to connect it with prior knowledge to construct a representation of the text and to revise previous understanding of the text based on new readings (Swanson, Howard, & Sáez, 2007). Additionally, students with LD tend to be passive in their approach to reading. They either lack reading comprehension strategies or do not spontaneously deploy them to access information in textual material (Torgesen, 1982). Typically, these students do not go back and reread confusing sections of text or monitor and evaluate their ongoing understanding of text. Students' inability to flexibly apply cognitive and metacognitive strategies used by proficient readers on a reading task places limits on their reading comprehension and ability to learn from both narrative and expository texts.

This chapter focuses on the topic of reading comprehension and effective strategies for assisting students with LD become proficient readers. Specifically, it examines the research base on cognitive and metacognitive strategies, with a focus on components of effective instruction. This chapter is not an exhaustive review of effective practices for promoting reading comprehension in students with LD. Although findings from other studies of reading comprehension approaches (e.g., content enhancement) may add to this research base, the findings from studies in this chapter do highlight ways to help students with LD develop reading comprehension skills.

1.1 Cognitive and Metacognitive Strategies

Cognitive strategies are cognitive processes that the learner intentionally performs to influence learning and cognition (Mayer, 2001). These mental routines or procedures serve to organize and store incoming information in memory and facilitate

performance on specific cognitive tasks, such as solving a problem in mathematics or making sense of what is being read. Rosenshine (1995) defines a cognitive strategy as "a heuristic or guide that serves to support or facilitate the learner as she or he develops the internal procedures that enable them to perform the higher level operations [such as reading comprehension]" (p. 266). Studies have established the efficacy of instruction in reading strategies, such as self-questioning, activating prior knowledge, predicting, or summarizing, for promoting reading comprehension and content area learning in students with learning disabilities (see Gajria et al., 2007; Gersten et al., 2001). Specifically, these strategies help "readers enhance their understanding, overcome difficulties in comprehending text, and compensate for weak or imperfect knowledge related to the text" (Shanahan et al., 2010, p. 10).

Cognitive strategy instruction also involves a focus on metacognitive skills, an awareness of one's own cognitive processes and how to regulate them (Swanson & Hoskyn, 1998). Metacognitive skills, including self-monitoring, help students evaluate the difficulty level of a learning task and select, use, and monitor their ongoing performance. Essential for competent reading, comprehension monitoring directs the readers' cognitive resources as they strive to make sense of incoming information (Wagoner, 1983) and helps them evaluate the effectiveness of the reading strategy, and make changes when they detect a breakdown in comprehension. Unfortunately, students with LD often have trouble thinking about whether they understand what they are reading and do not know how and when to use reading strategies. Therefore, instruction in metacognitive strategies is an important consideration for students with LD to support the independent use of reading comprehension strategies.

1.2 Cognitive Strategy Instruction

An evidence-based approach to comprehension instruction is centered on teaching students the cognitive strategies used by proficient readers (Jitendra, Burgess, & Gajria, 2011). Within the framework of reading, the focus of cognitive strategy instruction is to improve how students approach and engage with a text so that they can become more active, focused, deliberate, independent, and self-regulated in processing information from texts. Early research focused on instruction in a single cognitive strategy to promote reading comprehension. Later, researchers embedded a metacognitive component such as self- monitoring with a specific cognitive strategy and also developed multicomponent reading packages (e.g., reciprocal teaching) that integrated the use of several cognitive strategies. The goal of cognitive strategy instruction, regardless of instruction in single or multiple strategies, is on 'how to learn' rather than 'what to learn.' The underlying premise is that students, including students with LD, can be taught cognitive strategies proven effective for increasing reading comprehension.

1.3 Single Strategy Studies

Several single strategy interventions to promote reading comprehension in students with LD have been studied, including the use of text structure, main idea instruction, self-questioning, cognitive mapping, and summarizing.

Text Structure Proficient readers are knowledgeable about how a text is organized and can use the underlying structure of the text to understand, learn, organize, and remember what they read. Knowledge and use of text structure is critical for comprehending and remembering content, as it can guide students in extracting and constructing meaning while reading (Shanahan et al., 2010). Instruction that focuses on text structure should help students differentiate between the two genres of text structure, narrative and expository. Narrative texts, such as historical fiction, fables, and autobiographies, are typically stories that are structured by a temporal sequence of events. In contrast, expository texts, such as content area textbooks, news articles, and speeches, communicate information on a topic and reflect organization of abstract thought based on logical relations.

Narrative texts are generally easier to understand than expository texts as the content is more familiar to students and they have a single organizational structure commonly referred to as story grammar or story schema. Typically, story grammar elements include the setting, characters, events, goal, problem, solution or resolution, and a theme (Baumann & Bergeron, 1993; Morrow, 1996). In comparison with their nondisabled peers, students with LD do not have a good grasp of story grammar elements and often have trouble recalling elements of a story, particularly the theme, which is abstract and rarely stated explicitly in the story (Dimino, Gersten, Carnine, & Blake, 1990). Interventions focused on teaching story grammar promote students' reading comprehension and recall as they help students understand *where*, *who*, *what*, *when and why* in a story (Trabasso & Bouchard, 2002).

In a landmark study conducted by Idol and Croll (1987), five elementary students with LD were taught to use a story map, a visual organizer with story elements as headings, while reading. A basic assumption was that a link between the story's organizational structure and students' knowledge structure would promote comprehension. The positive results suggest that "mapping of story components is an effective way to build structural schemata" (p. 225). Building on Idol and Croll's work, Gardill and Jitendra (1999) used a multiple baseline design across participants to teach story elements to six middle school students with LD. Instructional procedures included teacher modelling, guided practice with feedback, and independent practice. Results indicated that story map instruction improved comprehension, students maintained the strategy, and generalized the strategy to novel passages.

A body of research provides evidence that story maps can be used successfully to teach reading comprehension to elementary (e.g., Boulineau, Fore, Hagan-Burke, & Burke, 2004; Stagliano & Boon, 2009) and secondary school students (Onachukwu, Boon, Fore, & Bender, 2007). Dimino et al. (1990) developed an instructional program to help secondary students learn the concept of a theme and

identify the theme in complex stories. They directly taught an interactive comprehension strategy based on story grammar that provided opportunities for secondary students, including students with LD, to "clarify and discuss important elements of the story as they read" (p. 29). Results indicated significant posttest differences in favor of the story grammar instruction group related to performance on story grammar, factual, and theme questions. As results were not disaggregated for students with LD, the success of this intervention for students with LD cannot be confirmed. However, using a similar approach, Gurney, Gersten, Dimino, and Carnine (1990) provided evidence that comprehension of important elements in literature anthologies, including the theme, can be improved as a function of story grammar instruction for high school students with LD.

Several studies have also shown that when story grammar interventions integrated metacognitive strategies (e.g., recognizing when and how to apply the story grammar strategy, asking questions about story elements), students' reading comprehension improved (Carnine & Kinder, 1985; Faggella-Luby, Schumaker, & Deschler, 2007; Griffey, Zigmond, & Leinhart, 1988; Therrien, Wickstrom, & Jones, 2006). Carnine and Kinder taught elementary students with LD to construct generic story grammar questions to address the characters, events, and resolution of the story. Results indicated that directly teaching students how to ask questions about story elements improved their comprehension. Griffey et al. documented that while story grammar intervention alone or used along with a self-monitoring strategy showed modest pretest to posttest gains for elementary students with LD, it did not result in better comprehension than teaching students to ask questions about the text. Perhaps, the four instructional sessions in this study may not have been sufficient for students with LD, who often need more time to realize gains in reading comprehension.

More recently, researchers have documented the effectiveness of combined use of story grammar instruction and question generation (Therrien, Wickstrom, Jones, 2006) with self-questioning before reading (Faggella-Luby et al., 2007) for increasing reading comprehension performance of students with LD. Therrien et al. successfully taught students with LD (grades 4 through 8) to answer factual and inferential questions using cue cards with generic story structure questions. Faggella-Luby et al. established the efficacy of an Embedded Story Structure (ESS) Routine, an intervention that incorporated student self-questioning, story structure analysis, and summarizing, with high school students with LD. The success of the intervention in improving student story structure knowledge and comprehension may be attributed not only to the careful design of the intervention, but also the intensive instruction (17 h) that students received.

Together, the above studies provide strong evidence that, across grade levels, directly teaching students with LD story grammar can highlight important relations, which, in turn, facilitates understanding of the story. Also, adding a metacognitive component to story grammar instruction positively influences comprehension.

Research has also addressed the effect of instruction in expository text structure to promote conceptual understanding of informational texts for students with LD. Unlike narrative texts that follow one structural pattern, expository or

informational texts have a variety of underlying structures, compare-contrast, sequence, cause-effect, and description. Expository texts entail a variety of text structures, which deal with abstract, unfamiliar information and are often challenging for students with LD who experience difficulties in understanding and learning information from these texts. Research has shown, however, that students' comprehension and recall of informational text are both positively linked to instruction in specific expository structures.

A study by Smith and Friend (1986) investigated the effect of text structure instruction on the comprehension and recall of high school students with LD. Students were taught to recognize and use five different text structures (time-order, problem/solution, comparison, description, and cause-effect) to guide their comprehension of expository prose. Results indicated that the intervention group statistically outperformed the control group on both structure recognition items and recall of main ideas. In another study, Bakken, Mastropieri, and Scruggs (1997) taught eighth-grade students with LD to identify three kinds of text structures (i.e., main idea, list, and order) in science passages and apply structure specific strategies to study passages. Compared to students in paragraph restatement and traditional instruction groups, students in the text structure based strategy group scored higher on recall measures and showed better transfer to untrained social studies passages. More recently, instruction in main idea and compare – contrast text structure significantly increased comprehension of science text passages for postsecondary students with LD (Gaddy, Bakken, & Fulk, 2008). In general, teaching genre specific text strategies favorably impacts students' comprehension and recall of text information.

Finding the Main Idea The ability to identify the main idea or most important idea unit in text is central to reading comprehension. According to Williams (1988), finding the main idea is "the basis for being able to draw appropriate inferences from the text, to study effectively, and to read critically" (p. 2). It is important to note that the nature of the main idea differs between narrative and expository text types (see Baumann, 1986; Moore, Cunningham, & Rudisill, 1983; Pearson & Johnson, 1978). In narrative texts, the reader has to discern the theme of a story from the description of events and their temporal sequence, whereas in expository text the reader must develop a generalization or a thesis based on the logical relationship of ideas about a topic. As expository prose has several different genres, including description, compare-contrast, sequence, cause-effect, and problem-solution, the main idea may be defined by a specific genre (Williams, 1988, 2004).

Students with LD frequently struggle with identifying the main idea in reading passages, and the challenge is more pronounced with content area texts. To compound this situation, the main idea is not always explicitly stated in the text, and in such cases, readers must generate a statement to represent the main ideas. Several researchers have investigated instructional strategies to help students with LD identify or construct the main idea of texts. These investigations have typically included the direct instruction paradigm in isolation or in combination with metacognitive skills such as self-questioning or self-monitoring procedures. In an early

investigation, Jenkins, Heliotis, Stein, and Haynes (1987) taught elementary school students with LD to restate the most important idea for each paragraph in a narrative. Students were taught to ask themselves two questions, "who" the paragraph was about and "what's happening," and to briefly restate the gist of the story in their own words. Results supported the usefulness of writing restatements of important ideas to improve reading comprehension.

Other studies that focused on a paraphrasing or restatement strategy combined with self-questioning procedures also produced similar results. Schumaker, Denton, and Deshler (1994) developed a paraphrasing strategy for use with expository texts. Students learned to use the acronym RAP to follow three steps to determine the main idea in paragraphs, **R**ead a paragraph, **A**sk what are the main idea and details of the paragraph, and **P**ut the information into your own words. Ellis and Graves (1990) documented positive results for instruction in the paraphrasing strategy on reading comprehension skills of upper elementary and middle school (grades 5–7) students with LD.

Wong and Jones (1982) used a self-questioning approach to teach students with LD in grades 8 and 9 to interact with the text in order to create "a paraphrased version of the main idea" (p. 231). The training resulted in increased awareness of important textual units and performance on passage comprehension tests. In the Bakken et al. (1997) study, eighth-grade students who were taught to apply a paragraph restatement strategy to science passages involving three types of text structures (main idea, list, order) improved their performance compared to students in a traditional instruction group on immediate and delayed recall measures, as well as transferred the strategy to social studies.

Another strand of research on main idea instruction combined principles of direct instruction with self-monitoring procedures with considerable success. Graves (1986) compared two approaches to main idea instruction – direct instruction and direct instruction plus self- monitoring. Students with LD in grades 5 through 8 were taught a rule to find the main idea in expository passages. Students in the combined condition, direct instruction and self–monitoring, were taught to question themselves on the main idea and to check their understanding on a self-monitoring card. Results of the study indicated that both groups showed improvement in comprehension performance as compared to a control condition. In addition, the self-monitoring component was found to have added value regarding increased comprehension of main ideas. In a related study, Graves and Levin (1989) found that self-monitoring was more effective than a mnemonic condition for recognizing main ideas in texts. Jitendra, Cole, Hoppes, and Wilson (1998) also documented the benefits of direct instruction and self-monitoring for main idea identification in passages for three grade 6 students with LD.

Essentially, research supports principles of direct instruction combined with self-questioning or self-monitoring as tools for main idea instruction and increasing comprehension skills. Students with LD in grades 5 through 9 saw improved outcomes on comprehension measures on both narrative and expository texts as a result of main idea instruction. Furthermore, main idea instruction resulted in maintenance and transfer in some studies.

Cognitive Mapping Students with LD typically experience difficulties in identifying main ideas and important details in a text, and understanding their interrelationships, a skill essential for making meaning. Cognitive maps make "use of lines, arrows, and spatial arrangements to describe text content, structure, and key conceptual relationships" (Darch & Eaves, 1986, p. 310), thereby making implicitly stated relationships explicit and difficult to understand information more memorable. While several researchers have successfully used teacher constructed cognitive maps and documented gains on reading comprehension for students with LD (Bos & Anders, 1990; Darch & Eaves, 1986), research on teaching students to independently generate cognitive maps is limited.

Boyle (1996) examined the effects of instruction in a cognitive mapping strategy on the literal and inferential comprehension skills of middle school students with LD and those with mild cognitive disabilities. Students were taught to independently construct cognitive maps for expository passages using a mnemonic that prompted them to identify and link the main ideas with the supporting details. Results indicated that students trained in generating and using cognitive maps during reading showed improvements in both literal and inferential comprehension skills but failed to transfer the strategy to a standardized reading comprehension assessment. In a related study, Boyle (2000) taught high school students with LD and mild cognitive disabilities to construct a Venn diagram, a specific type of cognitive map most applicable to compare-contrast main ideas in text. Results indicated that students improved on measures of literal comprehension and relational comprehension more than they improved on inferential comprehension. It appears that a lack of details and explicit relationships in the Venn diagrams could have contributed to weak performance in inferential comprehension.

Questioning This reading strategy promotes comprehension by teaching students how to activate prior knowledge, focus attention on important information, summarize key points, and monitor their ongoing understanding of the text by asking themselves a series of questions before, during, or after reading a passage. When students ask questions about the material they are reading, they interact more closely with the text and are more engaged in the reading. While teacher generated questions and textbook questions are certainly critical in developing students' understanding of the material across a wide range of learners, students can also be taught self-questioning as a cognitive strategy to promote deeper processing of the information (Englert, 2009; Rosenshine, Meister, & Chapman, 1996).

Wong and Jones (1982) examined the effects of a questioning strategy that taught students to generate questions about the main ideas and answer these questions as they interacted with the text. Results indicated that compared to a traditional instruction group, eighth- and ninth-grade students with LD trained in self-questioning significantly improved their ability to generate text based questions and comprehension performance. In a different approach to questioning, Simmonds (1992) examined the effects of the question-answer relationship (QAR) strategy on text comprehension of students with LD in grades 1 through 9. Students who were taught

the QAR strategy learned to differentiate between three kinds of comprehension questions, 'Right There' (literal question), 'Think and Search' (text implicit – text-based inference question) and 'On My Own' (script implicit – prior-knowledge-based inference question). After intervention, QAR strategy students outperformed their peers on a social studies comprehension test. Taking a different approach to questioning, Mastropieri et al. (1996) examined the effect of elaborative interrogation on comprehension of science content. Middle school students with LD were taught to reason through the material in science passages, ask the question 'why does that make sense' about each science fact, and generate a suitable explanation. When compared to a control group that was directed to remember the information, students trained in reasoning skills produced more correct explanations for the facts but did not recall more information. The authors suggested that the weak effects could be attributed to the short training period and more instruction may be essential to realize intended effects.

Berkley, Marshak, Mastropieri, and Scruggs (2011) examined the effects of a self-questioning strategy for three 7th-grade inclusive classrooms that included students with disabilities, five with LD. Students were explicitly taught to use headings and subheadings to create comprehension questions and to answer these questions for a grade level social studies text. Results indicated that students in the self-questioning strategy group scored higher than the traditional practice group in comprehension as assessed by both multiple choice and essay tests of the social studies content. While research on self-questioning as a cognitive strategy for promoting reading comprehension appears promising for students with LD, most researchers have focused on teaching students at the middle or high school grade levels. Lately, researchers were successful in extending the research to upper elementary school students (Rouse, Alber-Morgan, Cullen, & Sawyer, 2014). Two 5th graders with LD were taught to generate questions for expository reading passages using a prompt fading procedure. Initially, students answered text embedded questions, which were systematically faded and replaced by a prompt for students to generate their own questions. Results showed positive effects of self-questioning on comprehension. Clearly, research evidence supports explicitly teaching students to monitor their understanding of the material by asking and answering questions while they are reading.

Summarization The National Reading Panel (2000) identified summarization as an instructional approach with a solid scientific basis for improving reading comprehension. It helps students to concentrate on what is important, understand relationships between ideas, focus on text structure, extract main ideas and supporting details from texts, and condense the information that needs to be remembered. Summarizing is a complex skill, different from paraphrasing or restating information; it requires students to develop a concise account or gist of the most important points in the text. To construct a summary, students must draw upon their prior knowledge to perform a series of cognitive operations on the information that is read; evaluate to determine whether the information is important enough to include

in a summary; condense to combine important idea units; and transform to present the gist in 'their own words.' As such, summarization is an essential strategy for comprehension and studying, and is often a crucial component of strategy packages (e.g., reciprocal teaching, Brown & Palincsar, 1982; collaborative strategic reading, Klingner, Vaughn, Arguelles, Hughes, & Leftwich, 2004).

Typically, poor readers and students with LD experience problems in summarizing as they are unable to determine the relative importance of different idea units in text and make decisions about what to include on a sentence-by-sentence basis. Additionally, they struggle to put the information in their own words. Research has examined the value of summarizing as a comprehension strategy, with a focus on making students aware of the highest level of information or main ideas in a text as well as details that support the main ideas, because both are critical to remember for learning across the content areas.

Gajria and Salvia (1992) combined a direct instruction approach with mastery learning to teach students with LD in grades 6 through 9 to develop a summary of the main ideas of an expository passage by applying the five rules proposed by Brown and Day (1983) – reduce lists, select topic sentences, construct topic sentences, delete redundancies, and delete unimportant information. After students mastered each rule in isolation, they were taught how to combine the rules. They began with guided practice and gradually assumed increased autonomy in applying the rules in order to summarize passages. Instruction results were positive; students in the treatment group outperformed students in the comparison condition on factual and summarization questions, maintained the skill, and showed transfer of performance on a standardized reading assessment. Similarly, Nelson, Smith, and Dodd (1992) examined the effects of explicit instruction in the five rules of summarization in conjunction with a summary writing guide for five students with LD in grades 4 through 8. Study findings supported the use of explicit instruction on both quality of student generated summaries and performance on comprehension questions.

Using a different approach, Malone and Mastropieri (1992) examined the differential effects of combining self-monitoring with summarization. Middle school students with LD in the summarization training group were taught to construct a summary sentence for each paragraph in narrative passages by asking questions about the subject of each paragraph and the related action. In addition to summarizing information, students in the combined group were taught to use a self-monitoring card to check application of the strategy. Students in both intervention groups, summarization and summarization with self-monitoring, outperformed students in the self study group on reading comprehension measures. Students also trained in the self-monitoring component successfully transferred the strategy from narrative to social studies passages. Similarly, working with middle school students with LD, Jitendra, Hoppes, and Xin (2000) assessed the effectiveness of combining self-monitoring with a summarization strategy. Students were taught to identify or generate main idea sentences that summarized the passage and to use a self-monitoring card to cue the strategy. Results indicated a positive effect on comprehension

performance, and these effects maintained over 6 weeks. Transfer effects were less robust, and were documented on selection items but not on production responses. The authors attributed this to the higher readability level and more implicit idea units in the transfer passages as compared to the training passages.

The findings of summarization training studies point to the importance of explicit instruction in summarization, preferably with a self-monitoring component. Summarization instruction enhanced students' ability to effectively summarize both narrative and expository text and resulted in improved comprehension and recall, with robust maintenance and transfer effects.

In summary, explicit instruction in cognitive strategies, such as using text structure, finding the main idea, self-questioning, cognitive mapping, and summarization techniques, leads to significant improvement in students' comprehension of both narrative and expository texts, across different grade levels. In addition, combining a self-monitoring component with a single cognitive strategy, such as self-questioning or summarization, has a powerful effect on promoting comprehension. The next section discusses multiple strategy studies, with a focus on the integrated use of several strategies to enhance comprehension.

Multiple Strategy Studies Research has focused on developing reading strategies before, during, and after reading to support understanding of text. The focus on higher-level reading and thinking skills in the different phases of reading has led to the importance of instruction in multiple strategies. Although learning multiple strategies might seem complicated initially, such instruction "familiarizes students with using the strategies together from the very beginning, providing a more authentic, strategic reading experience" (Shanahan et al., 2010, p. 13). Multiple-strategy instruction assists students as they coordinate the use of a repertoire of strategies as they read the text, ask questions, draw connections, find main ideas, clarify meaning, reread, and paraphrase or summarize key information (see Jitendra et al., 2011). Based on research with students with LD, reciprocal teaching (RT) and its variants, as well as verbal rehearsal strategies such as the SQ3R (Survey, Question, Read, Recite, Review) and its adaptations, are key examples of multiple-strategy formats that combine various strategies.

Reciprocal Teaching Reciprocal teaching (RT), which is based on Vygotsky's (1978) notions about social construction of knowledge and the importance of interactive dialogue for learning, was developed by Palincsar and Brown (1984) for children with adequate decoding proficiency. The key features of RT include: (a) four comprehension-fostering and comprehension-monitoring strategies (i.e., prediction, clarification, question generation, and summarization) to comprehend narrative and informational texts, (b) interactive teacher-student dialogue in applying the four strategies and (c) scaffolded instruction in which initial teacher modeling (expert scaffolding) is replaced by students gradually assuming responsibility in leading a discussion of the text and understanding why, when, and where the four strategies are applied to understand new text. A seminal study by Palincsar and Brown provided evidence of the effectiveness of RT in improving the reading

comprehension of junior high-school students with comprehension problems, as well as retaining the effects 8 weeks following the end of the 20-day intervention. Results also demonstrated generalization to a classroom setting, with students meeting or surpassing the average performance of their peers without comprehension problems.

Although there is a body of research suggesting the benefits of RT for elementary through postsecondary students with reading comprehension problems in different settings and geographic areas (e.g., Alfassi, 1998; Bruce & Chan, 1991; Hart & Speece, 1998; Le Fevre, Moore, & Wilkinson, 2003; Lovett et al., 1996; Lysynchuk, Pressley, & Vye, 1990; Palinscar, Brown, & Martin, 1987; Takala, 2006), we identified only two published studies of reciprocal teaching for students with LD. The early investigation of RT by Labercane and Battle (1987) was conducted with ten middle school students with LD. Researchers supplemented the question generation strategy in the RT framework with Raphael's (1982) QAR (Question-Answer-Response) procedure, an effective strategy for both answering and generating questions. During the first 4 weeks, RT was implemented with the ten participants in the study in a whole group arrangement. For the remaining 10 weeks, the class was divided into two small groups to better foster interaction among group members. Results indicated no significant differences between students in the RT condition and those who did not receive such instruction on the Gates-MacGinite standardized reading subtest. The ineffectiveness of RT may be explained by the less than ideal peer interactions in the groups since all students in the study experienced significant reading problems (functioning at least three grades below grade level), as well as the use of a standardized reading comprehension test that placed considerable demands on students with LD (e.g., require different strategies than the ones in RT) and was less sensitive to the intervention effects.

Lederer (2000) worked with upper elementary students (grades 4 through 6), including students with LD, in mixed-ability groups and taught them to apply the strategies in RT to comprehend social studies texts. Results indicated that students who received the strategy instruction outperformed their counterparts in the control condition on answering short questions, generating questions, and composing summaries. Unfortunately, Lederer did not disaggregate the data for students with LD. As such, the extent to which students with LD were responsive to RT intervention conducted in heterogeneous classrooms is not known.

In addition to the studies that used conventional RT, researchers have developed variations of RT for use with students with LD. An adaptation of RT that has received much attention is collaborative strategic reading (CSR), which has "combined modified reciprocal teaching components … and cooperative learning strategies" (Klingner, Boardman, Eppolito, & Schonewise, 2012, p. 55). The modified RT components include four strategies – preview, click and clunk, get the gist, and wrap up. Students are taught to apply these strategies in different phases of reading – before reading (preview the text by connecting the topic with what is already known and predict what will be learned about the topic), during reading (monitor comprehension and use fix-up strategies to decipher unknown words or phrases [referred to

as the *click and clunk strategy*] and identify the most important ideas in the text to get the gist), and after reading (*wrap up* – generate questions and review key ideas learned).

Several quasi-experimental and experimental studies have been conducted to improve grade-level expository text comprehension of students with LD, struggling readers, and English language learners. In a study of fourth-grade students with LD (Klingner et al., 2004), researchers trained teachers in the treatment condition to implement CSR instruction using social studies texts. Compared to students in the control condition who received standard school based instruction, students in the CSR classrooms showed superior performance on reading comprehension measures. In a study of sixth- and eighth-grade students with LD, Kim et al. (2006) implemented a computer adapted CSR intervention. Results showed that students in the CSR condition performed higher on reading comprehension measures than students in the control group. The study by Bryant et al. (2000) incorporated CSR as one of several reading comprehension interventions and investigated its effects for sixth-grade students, including students with LD and English language learners. Although the researchers reported gains on word identification, there was no improvement in reading comprehension scores.

Developed by Englert and Marriage (1991), another adaptation of RT involves explicitly teaching text structure (e.g., description, compare-contrast) to students with LD within the framework of RT. In their work with upper elementary students with LD, researchers used the RT model to combine text structure mapping with instruction in an integrated set of comprehension strategies cued by the acronym, "POSSE" (i.e., Predict, Organize, Search, Summarize, and Evaluate). Similar to CSR, students apply these strategies in different phases of reading. Before reading strategies include predicting (i.e., activating background knowledge), and organizing ideas using the text structure. During reading, students learn to apply the remaining strategies to search for and summarize main ideas based on text structure and evaluate comprehension. Researchers developed strategy sheets and cue cards to scaffold student learning. The use of strategy sheets makes "visible to students both the strategies and the text structures for performing the reading process" (p. 126) and cue cards serve "to prompt the self-talk and inner language related to a particular reading strategy, such as predicting, organizing, searching, summarizing, and evaluating" (p. 127). Results showed that the students in the intervention condition outperformed students who received traditional instruction in the same text on several measures of comprehension, total free recall of ideas, recall of main ideas, overall organization of recalls, and strategy knowledge.

SQ3R Developed by Robinson (1941), SQ3R prepares students to read strategically to promote reading comprehension and recall. The use of verbal rehearsal strategies (i.e., **S**urvey headings and subheadings to gain an overview of the reading passage; **Q**uestion, change headings and subheadings to questions to set a purpose for reading; **R**ead the passage/text to answer questions; **R**ecite the important information and write brief notes about key ideas; **R**eview the main points and try to recall them, checking to see if correct), a key component of SQ3R, helps students

organize, elaborate, and rehearse information from expository text. Initially, the teacher describes and models each strategy, followed by students rehearsing orally and practicing implementing each strategy using selected texts; finally, the teacher provides feedback to students.

In one of the earliest studies on the effectiveness of SQ3R, Adams, Carnine, and Gersten (1982) explicitly taught typically achieving fifth graders to: (1) preview the 800 word passage in social studies text by reading headings and subheadings, (2) recite the subheadings, (3) ask questions based on subheadings, (4) read to find important details under the subheading, (5) reread the subheading and recite important details, and (6) after steps 2–5 are repeated for each subheading, reread the subheading and recite important details. Compared to students who were instructed to independently study the same materials and a group that received no instruction, students in the instructed group did significantly better on factual short answer comprehension tests and maintained their performance 10 days after training.

Evidence from a study by Alexander (1985), in which three 11-year old students with LD with grade level decoding skills but poor comprehension were taught to apply the study strategies package developed by Adams et al. (1982), suggests that variability in the population and materials may play a role in whether effects from the early study replicate. Although the instructional materials differed to include 200–word third-grade level expository passages modified to contain suitable subheadings, results showed an increase in students' oral retelling of the passage, with the effect maintained over time.

Across a series of three studies, McCormick and Cooper (1991) taught secondary students with LD diagnosed with reading deficits to apply SQ3R to history texts. Students were prompted to survey the text for clues, ask text-related questions, read the text to find answers, paraphrase (recite) the answers found in the text, and review the information in the text. Results indicated that SQ3R did not influence literal comprehension outcome as assessed by oral retells. However, consistent with previous research (Adams et al., 1982; Alexander, 1985), the percentages of retelling were strongly related to the length of the text read, with higher percentages of recall found for shorter than longer passages.

A successful adaptation of the SQ3R is the Multipass strategy (Schumaker, Deshler, Alley, Warner, & Denton, 1982). This multicomponent intervention requires three passes of the material (i.e., survey, size-up, and sort-out). Students are taught to familiarize themselves with the main ideas and organization of the chapter by focusing on subheadings, illustrations, and reading the chapter summary in the "survey" pass. They learn to focus on end of the chapter questions to determine what is important, and then skim the text to find answers without completely reading the text (size up). Last, students test themselves on questions and other important material (sort-out). Schumaker et al. reported improved reading comprehension of instructional and grade level expository texts for secondary students with LD when instruction in Multipass strategy embedded principles of direct instruction, including teacher modeling, verbal rehearsal of strategy, and guided practice in controlled and grade level materials. In sum, the findings from multiple cognitive

strategy studies support and reconfirm the effectiveness of explicit and strategic practices to help students with LD become more proficient readers.

2 Conclusion

Regardless of the nature of reading comprehension difficulties, the cognitive and metacognitive strategies described here and the instructional components we have highlighted illustrate practices that can improve reading comprehension skills of students with LD. The effectiveness of single strategy (e.g., using text structure, finding the main idea, cognitive mapping, questioning, summarizing) or multiple strategy instruction (e.g., reciprocal teaching, SQ3R) depends on the careful selection of instructional level texts and explicit use of the procedures to address the learning problems of students with LD. Ensuring that students with LD transition from being passive readers to engaging in reading processes demonstrated by strategic readers requires providing teacher-directed supports and instruction regardless of students' proficiency in using the strategies.

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Using Advances in Cognitive Science to Improve Students Study Skills and Reading Comprehension

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Abstract National and international assessments of reading, science and math indicate that students and adults in the United States lag behind citizens of other developed nations. While there are multifaceted reasons for this lag, recent advances in cognitive science and technology have uncovered promising ways to intervene and help struggling students. This chapter will review recent developments from the cognitive literature that can potentially shed light on solutions for improving students study skills, as well as their general reading comprehension. We draw upon the available literature from reading strategy research and recent advances in assessment. Collectively, while this research indicates that the construct of reading has shifted; modern reading interventions are positioned to help prepare students for twenty-first century literacy activities.

Keywords Study skills • Reading strategies • Assessment

1 Background and Context

Both national and international surveys of reading, math, and science indicate that students in the United States are falling behind students in other developed nations. For instance, only 26 % of 12th grade students are proficient in math and 38 % of 12th graders are proficient in reading on the National Assessment of Educational Progress (U.S. Department of Education, Education Sciences, National Center for Education Statistics, & National Assessment of Educational Progress (NAEP) (NAEP), 2013). Probably even more alarming is the fact that the scores on the reading and math NAEP tests have remained unchanged since 2009. Data from international assessments is also alarming. The results from the Programme for International Student Assessment (PISA) indicate that only 8 % of 15 year olds across all

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countries score at the higher levels in reading (5 or 6) (OECD, 2014). In sum, there is evidence to suggest that both young and old learners in the U.S. and other nations have room for improvement on a wide range of skills.

Raising the Bar for Proficiency While student performance on existing measures is concerning, current and future efforts may magnify skill gaps. For instance, recent large scale efforts have suggested expanding what it means to be proficient. These include the Common Core State Standards for K-12 education in the U.S. (National Governors Association Center for Best Practices & Council of Chief State School Officers (NGA & CCSSO), 2010), new social studies (NCSS, 2013) and science (NRC, 2012) standards, the Partnership for twenty-first century skills (Partnership for 21st Century Skills, 2008) in the business sector, and other assessment reforms (Bennett & Gitomer, 2009; Gordon Commission, 2013; IAEEA, 2013; Schraw & Robinson, 2011). Collectively, these and other sources advocate that what it means to be proficient is evolving with simultaneous advances in technology and how people communicate and interact (Leu, Kinzer, Coiro, Castek, & Henry, 2013).[1]

For example, researchers and educators are arguing for an expanded construct of reading and associated skills (Afflerbach, Cho, Kim, Carassas, & Doyle, 2013; Alexander, 2012; Coiro, 2009; Deane, Sabatini, & O'Reilly, 2012; Goldman, Lawless, Pellegrino, Braasch, & Gomez, 2011; Leu et al., 2013). A fresh view of the construct argues that reading in the twenty-first century is selective and purpose driven (van den Broek, Lorch, Linderholm, & Gustafson, 2001). Students are expected to integrate, synthesize (Goldman, 2012), and evaluate (Metzger, 2007) multiple sources of information (Britt & Rouet, 2012) to satisfy their specific purposes and goals for reading. Increasingly, students are encouraged to collaborate and communicate with one another (NGA & CCSSO, 2010) as they solve problems and make decisions (Sabatini, O'Reilly, & Deane, 2013), often in digital environments (Coiro, 2011). Collectively, these new standards, expectations and arguments for updating the construct of reading will undoubtedly impact future test scores-educators could potentially be faced with new skill gaps.

Overview of the Paper Despite these challenges, recent advances in instruction, technology, and assessment have the potential to help address the skill gaps. The purpose of this paper is provide a review of the literatures in cognitive science and education and how they can be used to help improve student learning, study strategies, and organizational skills including students with or at risk of learning disabilities. Although there are many skills and strategic approaches, this paper specifically focuses on advances in learning from text sources, that is, reading for understanding or general literacy. We begin with a discussion on what makes reading and learning challenging, then proceed to provide an overview of empirically supported strategies and recent advances in assessment design relevant to study skills. It is our hope

[1] Both the PISA and PIAAC assessments are very progressive in their approach to measuring competencies that are relevant to twenty-first century learning. Interested readers are encouraged to see the framework documents (OECD, 2009a, 2009b).

that a multifaceted approach that combines strategy instruction coupled with more useful assessments will provide a better foundation for improving students' study habits and learning performance.

2 Reading Comprehension: The Construction of Meaning from Incomplete Texts

Reading comprehension is a complex process that involves the integration of a wide range of skills (McNamara & Magliano, 2009). Given this complexity, it is not surprising that many students have difficulty understanding what they read. While there are a wide range of reading theories and areas of dispute (Cain & Parrila, 2014), most theories of reading comprehension propose the idea that reader constructs a mental model of the text while reading (Gernsbacher, 1997; Graesser, Singer, & Trabasso, 1994; Kintsch, 1998; Myers & O'Brien, 1998; van den Broek, Young, Tzeng, & Linderholm, 1999; Zwaan & Radvansky, 1998). A mental model is a representation of the text that contains the key ideas, the relation among those ideas, and the basic organization of the texts. The model may contain some verbatim words or phrases, but it is usually a truncated version of the texts in the students own words. Building a mental model requires the student engage in a number of processes including finding the main ideas and distinguishing them from irrelevant details (Franzke, Kintsch, Caccamise, Johnson, & Dooley, 2005), extracting the organization and macro-structure of the text (Meyer & Ray, 2011; Meyer & Wijekumar, 2007), and integrating the text with their prior knowledge (Kintsch, 1998).

The challenges of building a quality mental model from text are also exacerbated by the nature of the texts. Texts can be perceived as lengthy, disconnected, and incoherent by less knowledgeable readers (Beck, McKeown, & Gromoll, 1989; McNamara & Kintsch, 1996). This is because authors often leave out "unnecessary" elaborations and connections between ideas that they "assume" their readers already know. Thus, students need to infer connections among ideas and also draw upon their background knowledge to infer the gaps in text (Ozuru, Dempsey, & McNamara, 2009). In other words, reading and learning are active processes that require effort, attention, motivation, and self-regulation (Goldman, 2004; Hacker, Dunlosky, & Graesser, 2009; McNamara, 2007; Schaffner, Schiefele, & Ulferts, 2013). These cognitive demands may be especially challenging for students with learning disabilities, as has been found in the existing literature (Catts, Tomblin, Compton, & Bridges, 2012; Cirino et al., 2013; Reed & Santi, 2015; Thiede, Anderson, & Therriault, 2003). Below, we describe some strategy instruction approaches and interventions that are designed to improve reading and learning through active processing.

3 Reading Strategy Training

Reading and learning are complex processes that can go off track in a number of ways. To the extent techniques and interventions can be developed to help understanding, students should be better prepared for college and career readiness and twenty-first century learning. We refer to the term strategy here as a technique or collection of techniques that are designed to improve understanding and learning, thus, the foundation to what are sometimes referred to as study skills. Strategies are typically effortful and conscious activities.[2] Students may plan to use strategies before they read, while they are reading, or after they read (McNamara, Ozuru, Best, & O'Reilly, 2007). Strategies may be selected when a student notices a problem in their understanding (metacognition), when current processing or an initial strategy is ineffective (self-regulation), or when students want to strengthen their understanding of a text for later recall. Strategies may help improve comprehension and learning by reducing memory load, simplifying complex ideas, enriching the context, making implicit ideas explicit, providing an organizing frame, connecting distal information, making connections to existing knowledge, and providing multiple traces or modes of information (see McNamara, 2007).

4 The Four Prong Strategy Framework

The Center of the Framework: Metacognition and Self-Regulation There are a wide range of individual reading strategies. However, keeping track of the various strategies can be difficult and confusing, as different strategies are often designed to address different problems. To manage some of this complexity, McNamara and colleagues developed a four pronged framework that organizes related sets of reading and learning strategies (McNamara et al., 2007a). At the center of the model are the set of metacognitive and self-regulatory strategies. These strategies serve as the executive management system for the four prongs. In essence, students need to monitor their understanding (metacognition) and take action to select appropriate strategies to address any comprehension gaps or misconceptions (Hacker et al., 2009; Zimmerman & Schunk, 2001). These metacognitive and self-regulatory skills "oversee" the process of comprehension, how well it is going, and help determine suitable courses of action to enhance learning goals.

There are a number of ways to help promote metacognitive and self-regulatory processing. These techniques include strategies such as rereading (Rawson, Dunlosky & Thiede, 2000); note taking (Faber, Morris, & Lieberman, 2000), generating key words (Thiede, Dunlosky, Griffin, & Wiley, 2005); and summarizing text (Thiede & Anderson, 2003). While these are not metacognitive activities in and of themselves, they do require students to be aware of their understanding at different

[2] Over time, strategies could become or appear to be automatic in highly skilled readers.

levels. For example, note taking helps students identify problematic areas, while generating key words and summarizing helps students focus on the important parts of a text.

Another simple but effective way to stimulate and promote metacognitive and self-regulatory type processing is self-testing. Often referred to as the "testing effect" (McDaniel, Anderson, Derbish, & Morrisette, 2007), self-testing can be an effective way to determine whether a student knows and has learned the content sufficiently. In short, students who are tested on content, understand and learn more (McDaniel et al., 2007), and make more appropriate metacognitive judgments (Finn & Metcalfe, 2007)[3] than students who do not test themselves. Self-testing may reveal problems or gaps in understanding, and guide further study and deeper processing, because students become more aware of "what it takes" to learn the material at a deep level. In any event, metacognitive and self-regulatory processes can occur at any phase of learning and tend to guide the use of other strategies such as the ones discussed below.

Prong 1: Preparing to Read The remaining four prongs in the framework serve as a set of actions and strategies that can be leveraged at different points in the comprehension and learning process. Before reading, students can select from a host of strategies that help them *Prepare to Read*. The prepare-to-read prong is designed to serve a number of functions including goal setting (Bråten, Gil, & Strømsø, 2011; McCrudden, Magliano, & Schraw, 2011); the activation of relevant knowledge, schemata, and frames (Kintsch, 1998; Ozuru et al., 2009); and question generation to guide reading (Graesser & Lehman, 2006; Graesser, Ozuru, & Sullins, 2009).

A popular strategy commonly used in education settings that exemplifies the *preparing to read* strand is previewing (Spires, Gallini, & Riggsbee, 1992). During the previewing strategy, students are expected to preview key sections of the text before they read. The key sections include the title, chapter headings, bold and italics words, and chapter review questions. The purpose of this strategy is to both activate relevant knowledge on the topic and provide the student with an idea of what the text will be about. While the preview strategy is designed to set expectations, it also serves as a way to ask questions that guide further reading. If unknown words, sections or topics are encountered during the preview, students can generate questions that can structure later reading. In this way, previewing can serve metacognitive and self-regulatory functions.

A slightly different take on the previewing strategy is called *KWL*, *or Know*, *Want* (*to Know*), *Learn* (Cantrell, Fusaro, & Dougherty, 2000; Ogle, 1986). In the KWL strategy, students are instructed to carry out three sets of related activities before, during, and after they read. Like the previewing strategy, students are first instructed to skim the key sections of text before they read, generate pre-reading or guiding questions, and activate their relevant background knowledge (i.e., Know &

[3] Students typically overestimate their confidence when judging their learning. However, after testing, they typically underestimate their confidence, which is arguably a better strategy than over confidence, because it forces the student to be more vigilant and take additional action.

Want to Know phases). After previewing, students are expected to read the text and try to find out answers to their guiding questions. After reading, students write down what they have learned in relation to what they already knew. This part of the process also involves producing answers to pre-reading questions (i.e., learning). The KWL strategy is designed to activate and integrate background knowledge and ensure students are monitoring and regulating their reading. In essence, the prepare-to-read prong sets the stage for later reading strategies that are enacted *while* reading.

Prong 2: Interpret Words, Sentences, and Ideas in Text The second set of strategies called *Interpret Words*, *Sentences*, *and Ideas in Text* occurs before or *while* students read text. This prong is designed to help students construct a coherent model of the text. As students read, they need to know the meaning of the words and how the words and concepts are related to each other. At the word level, some estimates indicate that students need to know at least 90–98 % of the words in text in order to form a general understanding (Hsueh-Chao & Nation, 2000). In terms of relevant strategies for prong 2, students can use dictionaries (Chiu & Liu, 2013) or outside resources to look up the meaning of the words, or they could use the surrounding context to infer the meaning of unknown words (Baumann, Edwards, Boland, Olejnik, & Edward,, 2003; Penno, Wilkinson, & Moore, 2002).

Going beyond the word level, students also need to comprehend sentences. One of the simplest strategies to help understanding is to reread the text (Millis & King, 2001; Rawson, Dunlosky, & Thiede, 2000). Rereading can sometimes reduce working memory demands, strengthen one's mental representation of content, or help clarify areas that were previously skimmed over too quickly. However, sometimes rereading is not enough and students need to try other strategies that may help them represent the text in a different way. When students encounter a problem, they may try to paraphrase the sentence (Youjia, Woods-Groves, Ford, & Nobles, 2014). Paraphrasing transforms the meaning of the sentences into the students own words. Paraphrasing may make the information more memorable by activating nodes that are more familiar to the student's vocabulary and discourse structures. While the ability to paraphrase might not be causally related to comprehension, there is a positive relationship between the number of inaccurate paraphrases and poor understanding (McNamara, 2004).

Beyond words and individual sentences, students also need to make connections across proximal and distal sentences. Creating these types of connections is sometimes called bridging inferences (McNamara, 2004). Information that is separated across sentences is often left unstated in many texts. Readers have to infer them in order to reduce gaps in coherence. While this process might seem easy and automatic for skilled readers, it is difficult for less skilled readers (Cain, Oakhill, Barnes, & Bryant, 2001; Magliano & Millis, 2003). Fortunately, inference training has been successful in helping student comprehension (Yuill & Oakhill, 1988).

In addition to teaching inferences, students may also benefit from knowing the various organizational patterns, or text structures, that are common in expository and narrative text (Meyer, 1987). Texts often contain predicable structures such as

description, problem/solution, cause effect, compare contrast, and so forth. Familiarization with a variety of text structures can help students recognize when a particular text structure is being used. With the appropriate structure in hand, students may be in a better position to make connections across sentences. Indeed, strategy instruction that focuses on text structure have been successful in improving reading comprehension (Meyer & Ray, 2011).

Prong 3: Strategies That Go Beyond the Text The third prong of the strategies framework is called 'strategies that go beyond the text'. While the first two prongs are designed to prepare students to read and to help students form a basic understanding of the text, the third prong is designed to build upon or extend what was read, such that it is learned and remembered. This extension can occur in the form of integrating information with background knowledge (Kintsch, 1998; McNamara, de Vega, & O'Reilly, 2007b), generating questions (King, 1994), consulting other sources for further reading, using visualization and imagery strategies (Oakhill & Patel, 1991), or elaborating and explaining the meaning of the text to oneself (McNamara, 2004).

The questioning strategy has taken on many forms, but may involve teaching students differences between superficial verses deep questions (see, Graesser et al., 2009; Graesser & Person, 1994), or using question prompts that help structure question generation. In its most generic form, students are asked to answer "why" questions to help them elaborate the text content, as in the elaborative interrogation strategy (O'Reilly, Symons, & MacLatchy-Gaudet, 1998; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988). A more structured form of the questioning strategy was developed by King (1989, 1994, 1995). It provides a set of question prompts to the reader that can be used to generate questions to a wide range of text types and topics. Some examples of these question prompts include: "How is … related to … ?"; "What are strengths and weakness of..?"; What would happen if…?"; "What are the implications of…?"; "Why is … important?"; How does … apply to everyday life?"; and "What is another way to look at…?". The aim of these prompts is to encourage students to actively process the text by thinking critically, elaborating the text with background knowledge, and to enrich their mental model of the text, making it more stable and information more easily retrieved.

Enrichment is a key factor in other strategies in the third prong, such as imagery and visualization strategies (Oakhill & Patel, 1991). Asking students to form an image of the text may help create a second, visual representation that can be used to elaborate a lexical or linguistic representation (see dual code theory, Paivio, 1986). This is in line with classic research that shows visual images are sometimes better remembered than raw text (Shepard, 1967). Having more pathways to the content elaborates the representation and makes it more memorable. In a more involved elaboration strategy, students are asked to physically act out the story or events in the text, or manipulate physical models of the text (Glenberg, Jaworski, Rischal, & Levin, 2007). The process of acting out the story is said to strengthen the representation thorough embodiment: understanding often involves action and engaging in the physical action discussed in text helps enable deeper processing.

Probably the most exemplary strategy in the third prong are variants of the self-explanation strategy (Chi, de Leeuw, Chiu, & LaVancher, 1994; McNamara, 2004). A simple instantiation of the self-explanation strategy is enacted when students are asked to explain what the text means to themselves and how it relates to what they already know. More elaborated versions of the strategy utilize a combination of other strategies in the four prongs including metacognition (comprehension monitoring), prediction, paraphrasing, drawing bridging inferences, and elaboration (McNamara, 2004). This more elaborated version of self-explanation called Self-Explanation Reading Strategy training of SERT has been effective in helping improving the quality of students' self-explanations and comprehension for less knowledge readers (McNamara, 2004). In sum, strategies in the third prong are designed to encourage students to elaborate and enrich the text representation by questioning, explaining, and integrating their background knowledge with the text content.

Prong 4: Strategies to Organize, Restructure, and Synthesize The fourth and final prong in the strategy framework is called 'strategies to organize, restructure, and synthesize the text content'. Strategies in the fourth prong are designed to strengthen the students' mental model by focusing on the global and interconnected elements of the text. The primary strategies in this strand are the use of text structure (Williams, 2007), graphic organizers (Griffin, Malone, & Kammenui, 1995; Robinson & Kiewra, 1995), knowledge/concept maps (Vitale & Romance, 2007), and summary writing (Head, Readence, & Buss, 1989; Radmacher & Latosi-Sawin, 1995).

Graphic organizers are visual representations of the text that depict the text structure (e.g., compare-contrast, problem solution). They can be represented in tables, charts, or figures. Knowledge maps are similar to graphic organizers, but may represent a larger body of knowledge and highlight the relations between the various concepts. Summaries on the other hand are concise written representations of the text. In any event, both graphic organizer and summary writing strategies are designed to reduce memory load and highlight the organization of the text. In both cases, important concepts are selected, irrelevant concepts or details are omitted, and the structure and relations among the key ideas are represented. While graphic organizers and summaries can be completed while students are reading, they might best be used after students have read the text. As concise representations, graphic organizers and summaries can be a useful resource when studying or preparing for exams and courses (Bean, Singer, & Frazee, 1986; Radmacher & Latosi-Sawin, 1995).

Reading Strategies: Summary and Limitations The above review covered a range of reading strategies that have been shown empirically to be successful in improving students' comprehension and learning from text sources. The central aim of this work has been to encourage readers to actively process the text and to use what resources are available to identify comprehension difficulties and to fix them. While there is a wealth of literature on the effectiveness of using strategies to improve reading and learning, many of the studies have been conducted in small contexts

and the benefits are often measured in the short term. Reading skill is complex and it develops over time. Obtaining long lasting and stable effects of reading interventions is challenging (Denton, Wexler, Vaughn, & Bryan, 2008; Kim, Samson, Fitzgerald, & Hartry, 2010). Although there are a number of reasons for not obtaining effects, such as the nature of the assessment used to measure the intervention (O'Reilly, Weeks, Sabatini, Halderman, & Steinberg, 2014), educators should be cautious when expecting large gains in such a short period of time. Despite this word of caution, teaching reading strategies in the classroom is likely to have some benefit for students. Next, we turn to describing some recent efforts aimed at designing assessments that support students' acquisition of strategies and study skills that enhance learning from text sources.

5 Using Assessment to Promote Learning and Study Skills

In this section, we explore some recent developments in assessment design that may impact learning in the future. Traditionally, one thinks of assessment as divided into achievement or summative testing (assessment *of* learning) versus classroom or formative assessment (assessment *for* learning). Summative assessments are designed to maximize the information about students' ability on a unidimensional scale, while maintaining strong psychometric properties, and cost and time efficiency (Sabatini, Petscher, O'Reilly, & Truckenmiller, 2015). Formative assessments, by contrast, are designed to help students and teachers reflect on their understanding of content, with the goal of providing insights to guide future learning and instruction (Black & Wiliam, 1998).

To this mix, Bennett and colleagues (Bennett & Gitomer, 2009) have promoted the idea of assessment *as* learning – designing assessments that model effective learning and instructional practices, attempting to make the assessment experience valuable in and of itself. We have already noted that self-testing is a proven stimulus to learning and recall of the content tested (McDaniel et al., 2007), and that questioning (King, 1989, 1994, 1995) – a central feature of all assessments – is also an empirically supported strategy for enhancing learning. It only makes sense to consider the design of assessments as an opportunity to promote, model, and reinforce the value of deploying reading strategies and study skills in students.

Given this rationale, a new generation of assessments has been emerging that draws upon the learning science literature to inform assessment design (Bennett & Gitomer, 2009); uses more authentic tasks; moves beyond traditional forms of multiple choice items (Rupp, Ferne, & Choi, 2006); involves a social communicative and collaborate element (NGA & CCSSO, 2010); includes a wider range of technology enabled environments (Leu et al., 2013); and seeks to provide information that is useful for instruction (Gordon Commission, 2013).

For the remainder of the paper, we will explore two large scale research projects that have as a primary goal increasing the utility of assessment of, as, and for

learning to promote strategies and study skill behavior in students (but see also Coiro, 2011; Goldman et al., 2012; Hannon & Daneman, 2001; Hannon & Frias, 2012; Katz & Macklin, 2007; Lawless, Goldman, Gomez, Manning, & Braasch, 2012) for other exemplary innovations in assessments). The first project is called *Cognitively*, *Based Assessments of*, *for*, *and as Learning* or CBAL for short (Bennett & Gitomer, 2009; ETS, 2014a). CBAL is a research initiative funded by ETS since 2007 that is designed to create innovative summative and formative assessments for K-12 students in reading, writing, English language arts, math, and science. The second project is a federally funded initiative by the Institute of Education Sciences called Reading for Understanding or RfU for short (ETS, 2014b; IES, 2010). The RfU initiative was designed to improve students' reading comprehension through intervention and assessment. The ETS team was charged with the task of building innovative reading comprehension assessments for students in prek-12th grade.

At the heart of these new assessment designs is providing the student a goal or purpose for reading, thus, encouraging the use of reading strategies and study skills that a student typically deploys when learning content. Before reading any texts, students are provided with a plausible purpose for reading a collection of source materials. Usually, this purpose describes some overarching goal the student has to achieve by the end of the assessment. This may require students to solve a problem, make a decision, evaluate alternative solutions, or to produce a flyer. The reading purpose provides students with a standard of coherence (van den Broek, Risden, & Husebye-Hartman, 1995) for judging what information is relevant (Rouet & Britt, 2011) to the reader goals. As a secondary aim, the purpose also provides a context that is potentially more realistic and engaging than what is typical in a standard "testing genre"[4] (Hornof, 2008).

In addition to providing a purpose and context for reading, students are also given a wide range of source materials to work with. Sources can range from traditional print like texts, to electronic sources such as simulated web sites, blogs, e-mails, and chat forums. The sources are sometimes reliable and trustworthy, and other times they may contain errors, biases, or fallacies in reasoning. The test takers engage in a wide range of tasks that require them to integrate and synthesize multiple texts and evaluate the sources for quality, completeness, and to correct the errors. Such multiple text (Bråten et al., 2011; Britt & Rouet, 2012) and evaluation tasks (Metzger, 2007; Wiley et al., 2009) in digital environments (Coiro, 2009; Leu et al., 2013) are common in research and the new standards (NCSS, 2013; NGA & CCSSO, 2010; NRC, 2012) and other assessment reforms (Partnership for 21st Century Skills, 2008).

Although the above constructs and task demands are in line with creating a higher standard for what it means to be a proficient reader and learner in the twenty-first century, by themselves, they do not help learning and development. One of the

[4] Some people have argued the prevalence of testing has resulted in a unique testing genre that implicitly defines what students should expect and how they should approach the testing, tasks, items and texts. Implicit in this argument is that testing represents an artificial genre that does not reflect how people interact and solve problems in the real world.

key aims of these assessment is to balance the goals of measuring higher level skills, while simultaneously supporting learning. This is achieved in a number of ways. First, test takers are quizzed on relevant background knowledge (prong 1- preparing to read) before they read any texts (O'Reilly & Sabatini, 2013). This is designed to encourage student metacognition (the center of the four prong framework-metacognition and self-regulation), modeling the practice of reviewing what one knows and how that might be relevant to what one is about to study or learn (Ogle, 1986; Spires et al., 1992). It also provides an estimate of how much the student knows about the topic before reading (Shapiro, 2004) and also to see if they learned information after reading (prong 3- strategies that go beyond the text). This information can be used to contextualize the reading score (e.g., did the student have enough knowledge to answer the items? Did they know too much?). Alternatively the measure of background knowledge can be used instructionally: if test takers have a low level of background knowledge on the topic, students can seek (or instructors can provide) additional resources to create a meaningful context for subsequent reading.

A second technique used in the design of the assessments is to sequence tasks and items to model learning and study strategies. For instance, texts may be sequenced such that students are first given easier texts that introduce the topic and provide a context at a high level (prong 1). This design feature models how to *build up* ones background knowledge in support of learning new topical content. Subsequent texts are then presented that dig deeper into more complex issues, concepts and relations (prongs 2, 3, and 4). With the knowledge base gained earlier in the assessment, students are better prepared to answer, and learn from more demanding texts and questions later.

Third, efforts are taken to provide clear expectations of what is required of the students, so that they can apply these requirements outside of the assessment context (prong 3). For instance, before students write a summary (prong 4), students are given a set of guidelines they should follow that is associated with the scoring rubric (e.g., include only main ideas, no outside information, no plagiarism). In other cases, they are given specific criteria to be used to evaluate website sites such as is the source trustworthy?, is it out of date?, is it biased?, etc. Again, these are practices that could be applied by a student when learning content outside of the assessment.

Fourth, in modern education and workforce settings, students and colleagues often collaborate in groups – to build shared understanding, negotiate goals, or seek help and support (prong 3). In a group setting, people can receive help or provide help to others as they solve problems. In the assessment, examinees are introduced to simulated peer students and teachers to help facilitate various assessment goals. Simulated teacher and other authority figures provide guidance and hints on how to perform tasks. Simulated students can serve similar functions, but they may also require the test taker's help. In some cases, simulated students provide interpretations of the text that may contain errors or misconceptions, and the test taker has to identify the errors and correct them. Errors can be strategically introduced in the

Table 1 Sections contained in a study group scenario for science

Section 1: Practice – what do you already know?
Section 2: Read and summarize important texts
Section 3: Consider evidence and connect science to policy
Section 4: Understand and apply scientific terms
Section 5: Say it in your own words
Section 6: Review scientific data
Section 7: Check your understanding

assessment to help reveal difficulties in test taker's understanding or their component skills. Collectively, simulated teachers and peers can serve as a useful assessment tool to elicit desired responses from students, support test taker performance, as well as providing a more authentic and potentially less anxiety provoking testing experience for students.

Fifth, many of the specific reading strategies reviewed earlier in the paper are also included in the assessment design. These reading strategies include the use of prediction, paraphrase, summarization, graphic organizers, and the questioning strategy (prongs 1, 2, 3, and 4). By integrating a range of reading strategies into the design, the assessment is promoting the teaching and use in the classroom, as well as encouraging students to use reading strategies as they learn and study. In this way, strategies can both serve as a way to measure reading ability, and potentially as a way to improve it by modeling good practice.

An example of the explicit signaling of assessment as learning is illustrated in a collection of assessments in what we call the "study group" family (O'Reilly et al., 2014). Study group assessments have been built for topics in U.S. history, biology, and English literature. While the details of each assessment are unique to the domain (i.e., disciplinary reading, Goldman, 2012) they do share a common design and structure. Table 1 presents the as the set of structured tasks and sequence for the biology study group form. Before beginning the test students are told: You are preparing for an upcoming science test. In order to prepare for the test efficiently, you and some classmates decide to form a study group. You are responsible for helping each other identify key concepts, review and learn from readings, and organize information. Though space precludes a detailed description of the rationale for the sequence and content of each section, we hope the reader is able to infer how one approach to strategy use and study skills is modeled in the structure of this assessment. By encouraging students to think of completing a simulation of studying for an exam (or in other cases to prepare to write an essay), we are striving to design tests that may themselves be worthy of teaching to.

6 Implications for Students with Learning Disabilities

The policy and practice for students with learning disabilities has been trending towards prevention and pro-active support of students at-risk versus a wait-to-fail identification approach (Reed & Santi, 2015). As part of this trend, schools have been encouraged to use response to intervention models (Fletcher & Vaughn, 2009; O'Reilly, Sabatini, Bruce, Pillarisetti, & McCormick, 2012). The trend has also been towards inclusion of students with disabilities in general education programs versus pull-out classrooms, with greater emphasis on the application of effective research-based instructional interventions for all students (Reed & Santi, 2015).

While interventions targeting struggling and learning disabled adolescents have met with mixed results (Flynn, Zheng, & Lee, 2012; Solis et al., 2012), we see promise in a more sophisticated integration and alignment of assessments *and* strategy-instruction approaches. That is, with innovative assessments that both model and measure strategic reading and study skills, teachers will be more motivated and empowered to implement effective strategy instruction in their classrooms, and more able to examine whether that instruction was effective via its impact on student assessments scores. Similarly, students will see a more transparent relationship between their strategic and study skill practices and the assessment tasks that measure their learning.

Assessments emerging from projects such as CBAL and RfU are designed explicitly with the goal of fostering strategy use and effective instructional practices that have been recommended for students at-risk or with reading-based learning disabilities. For example, Reed and Santi (2015) note that common recommendations for addressing the needs of LD students include: explicit vocabulary instruction in content area texts; supplementing student's background knowledge of relevant concepts; providing instruction in making inferences in relating ideas in a text; and improving students' metacognitive strategies by answering questions, paraphrasing, or writing summaries. These are all explicit features included in the next generation of assessments we have been describing (O'Reilly & Sabatini, 2013; Sabatini et al., 2013; Sabatini, O'Reilly, Halderman, & Bruce, 2014).

Finally, we observe that much of the study skills and strategy research reviewed in this chapter has been conducted with students from late elementary through middle and secondary school, when the complexity of texts and the demands of learning disciplinary content from text is continuously increasing (ACT, 2006). We note also that twenty-first century reading takes place increasingly and predominantly in digital environments. This context represents both challenges and opportunities for students with learning disabilities. On the one hand, digital environments increase the complexity and variety of text sources, and therefore demands new skills of search, navigation, source evaluation, and multiple text integration (Leu et al., 2013; Britt & Rouet, 2012). On the other hand, the digital reader has both more literacy support tools (e.g., spell checkers, dictionaries) and ready access to background knowledge to support reading and learning (e.g., hyperlinks to word definitions and to encyclopedic background knowledge). Again, the new assessments described in this chapter

also model and measure digital literacy reading and learning skills, further supporting their application for all students. We do agree with others (e.g., Kosanovich, Reed, & Miller, 2010), however, that it will require significant teacher professional development, especially at the middle and secondary level, where reading instruction is no longer taught explicitly, and may require supplemental instructional support (e.g., study skill classes) outside of the general education classroom to provide sufficient time and intensity for learners with disabilities to practice strategies and develop the habits of mind to use them effectively in applied contexts.

7 Summary and Conclusion

In this paper, we have reviewed some of the empirically supported techniques to enhance student strategic reading or study skills, focusing primarily on reading text sources for understanding and learning. We argued that recent advances in cognitive science have uncovered promising ways to intervene and help struggling students. We presented results organized by the four prong model (McNamara et al., 2007a). We then presented new research on assessment design that seeks to promote 'assessment of, as, and for learning' – assessments that model and require the application of reading strategy and study skills as part of the assessment experience, thus, encouraging wider spread use and teaching of study skills. Collectively, while this research indicates that the construct of reading has shifted, there is also great promise that approaches to reading for understanding instruction (and assessments) are positioned to help prepare students for twenty-first century literacy and learning demands.

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What Is Listening Comprehension and What Does It Take to Improve Listening Comprehension?

Young-Suk Grace Kim and Heather Pilcher

Abstract One's ability to listen and comprehend spoken language of multiple utterances and oral texts (i.e., listening comprehension) is one of the necessary component skills in reading and writing development. In this chapter, we review theoretical frameworks and empirical evidence of listening comprehension development and improvement. A review of correlational and intervention studies indicates that many language and cognitive skills contribute to listening comprehension, including working memory, attention, vocabulary, grammatical knowledge, inferencing, theory of mind, and comprehension monitoring. Although limited in number, studies indicate that these skills are malleable. We conclude that listening comprehension instruction should be an integral part of reading and writing instruction, incorporating these multiple language and cognitive skills. Instruction on these components can be incorporated into existing instruction such as bookreading or reading comprehension instruction.

Keywords Listening comprehension • Vocabulary • Language • Cognitive • Intervention • Reading comprehension • Writing

1 Introduction

The role of oral language in literacy development is unquestionable in terms of theory and empirical evidence. Oral language, however, is a broad construct encompassing lexical, sentence, and discourse-level skills. A lexical-level oral language skill, vocabulary, has received much attention in terms of theoretical models of reading (e.g., Perfetti, 2007), and empirical studies (see Chap. 5). In contrast, our

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understanding of listening comprehension has been limited. Recent emerging evidence, however, indicates that listening comprehension is a higher-order skill that requires multiple language (including vocabulary) and cognitive skills (Florit, Roch, & Levorato, 2013; Kim, 2015, 2016; Kim & Phillips, 2014; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012; Tompkins, Guo, & Justice, 2013). In this chapter, listening comprehension is defined as one's ability to comprehend spoken language[1] at the discourse level – including conversations, stories (i.e., narratives), and informational oral texts – that involves the processes of extracting and constructing meaning. In this chapter, we review the role of listening comprehension in literacy acquisition, theories of text comprehension, and empirical studies. We close the chapter with a summary of instructional approaches to improve listening comprehension based on a review of empirical studies.

2 Why Listening Comprehension for Reading and Writing Development?

One of the widely supported models of reading comprehension, the simple view of reading, specifies that linguistic comprehension is an essential skill in addition to decoding (or word reading proficiency) (Gough & Hoover, 1990). Much evidence has provided support for the simple view of reading in several languages (Catts, Adlof, & Ellis Weismer, 2006; Johnston & Kirby, 2006; Joshi & Aaron, 2000; Joshi, Tao, Aaron, & Quiroz, 2012; Kendeou, van den Broek, White, & Lynch, 2009; Kim, 2015; Protopapas, Mousaki, Sideridis, Kotsolakou, & Simos, 2013), and showed that oral language skills such as vocabulary and listening comprehension are critical for reading comprehension, and their importance increases as children develop reading skills (Foorman, Koon, Petscher, Mitchell, & Truckenmiller, in press; Kim & Wagner, 2015; Kim, Wagner, & Lopez, 2012). Despite its recognized importance, however, what it takes to develop listening comprehension has been nebulous, which is in stark contrast to our understanding about skills that contribute to word reading (see Adams, 1990; Bowey, 2005; National Early Literacy Panel, 2008). Note that according to Gough and Tunmer (1986), linguistic comprehension is "the process by which given lexical (i.e., word) information, sentences and discourses are interpreted" (p. 7), and thus includes lexical, sentence, and discourse skills (i.e., listening comprehension).

Oral language skills including listening comprehension are also important for writing development. Oral language skills are essential because writing requires generation of ideas, which then need to be translated into oral language at the lexical, sentence, and discourse levels (Berninger, Abbott, Abbott, Graham, & Richards, 2002). According to the simple view of writing, transcription and ideation are two necessary skills for writing (Juel, Griffith, & Gough, 1986). The ideation

[1] We acknowledge that comprehension of sign language is listening comprehension, but use spoken language following conventional use of the term.

component includes generation and translation of ideas, and thus implicates oral language skills. Similarly, oral language is implicated in the "text generation" component of the not-so-simple view of writing (Berninger & Amtmann, 2003). Empirical studies have indeed shown the importance of oral language, operationalized as sentence comprehension (Berninger & Abbott, 2010), vocabulary, syntactic knowledge (Kim et al., 2011, 2014; Olinghouse, 2008), and listening comprehension (Kim, Al Otaiba, Wanzek, & Gatlin, 2015). Oral language is particularly important to the quality aspect of writing (idea and organization), but not to productivity (amount of writing; Kim et al., 2014, 2015; Olinghouse, 2008). These indicate that children's oral language skills, including listening comprehension, facilitate the expression of ideas in an appropriate and rich way in their writing.

In summary, theoretical models of reading comprehension and writing as well as empirical evidence indicate the importance of oral language skills, including listening comprehension, in reading and writing development. One naturally rising question, then, is what it takes to develop listening comprehension.

3 Theoretical Models of Listening Comprehension

In order to understand what it takes to develop and improve listening comprehension, we need to know what component skills are necessary for listening comprehension. Theoretical models of text comprehension are relevant here as text comprehension includes comprehension of oral and written texts (i.e., listening and reading; Kintsch, 1988). There are several models of text comprehension. Although there are differences, at the center of these models is the "situation model" (Graesser, Singer, & Trabasso, 1994; Van Dijk & Kintsch, 1983). That is, successful text comprehension ultimately requires construction of the "situation model" (Graesser et al., 1994; Grasser, Millis, & Zwaan, 1997; Van Dijk & Kintsch, 1983) or the "mental model" (Johnson-Laird, 1983). The situation model is the mental representation of what a text is about (Kintsch, 1988) or "the microworld that the text is about" (Grasser et al., 1997, p. 167), and there are multiple dimensions of situation models including space, time, causation, intentionality (or goals), and characters and objects (Graesser et al., 1994; Zwaan & Radvansky, 1998). Below is a description of a few prominent models of text comprehension: the construction-integration model, the constructionist model, and the landscape model.

The construction-integration model was proposed and refined by Kintsch and his colleagues (Van Dijk & Kintsch, 1983; Kintsch, 1988, 1994; Kintch & Rawson, 2005). As the name indicates, this model hypothesizes that text comprehension involves two phases, construction and integration of propositions. The comprehender constructs initial elementary propositions based on words and sentences in the text. These initial propositions, then, have to be integrated with propositions from preceding parts of the text, and ultimately across the text and with background knowledge. Based on these two phases of processing, the following three hierarchical

levels of mental representations[2] have been hypothesized with supporting empirical evidence (Grasser et al., 1997; Kintsch, 1988): surface code, textbase, and situation model. The surface code is the representation of words and phrases in the text. The surface code representation is the foundation and input for constructing initial, text-based propositions, called textbase representations. As these propositions are initial, first pass propositions based on linguistic input, some are potentially incorrect. To establish the situation model, these initial, elementary propositions have to be cross-checked across the text, and against the comprehender's background knowledge, and missing information has to be inferred to establish global coherence.

The constructionist model (Graesser et al., 1994) is largely similar to the construction-integration model. An important difference, however, is that according to this model, inference generation occurs primarily due to the comprehender's search (or effort) after meaning, a goal-directed, effortful activity, whereas in the construction-integration model, inference generation is automatic. The search-after-meaning principle is based on the following three assumptions: (1) the comprehender's representation of meaning is based on her/his goals, (2) meaning representation is coherent at local and global levels; and (3) the comprehender wants to know causal connections in the texts (e.g., actions and events). Therefore, text comprehension is a consequence of the comprehender's engagement in text to achieve construction of coherent meaning – i.e., search after meaning. The constructionist model specifies a variety of different inferences including referential ones (e.g., what 'it' refers to in the text), causal antecedent, thematic (main idea), character emotional reaction, causal consequence, state, and so on (Graesser et al., 1994). Among these, referential inferences are primarily needed for local coherence whereas thematic and character emotional reaction are needed for global coherence. Not all inferences are generated or needed during on-line processing.

The landscape model (or interactive view) by van den Broek and his colleagues is an attempt to integrate memory-based and constructionist frameworks (van den Broek, Rapp, & Kendeou, 2005). This model is similar to the construction-integration model, but explicitly specifies how the construction and integration processes interact and influence each other, and how they lead to the situation model. The memory-based processes are "autonomous and passive" whereas the constructionist processes are strategic and effortful. According to the landscape model, both memory-based and constructionist processes are needed to operate simultaneously during text comprehension. An important concept in the interaction of memory-based and constructionist processes is standards of coherence (van den Broek, Lorch, Linderholm, & Gustafson, 2001). Standards of coherence refer to the comprehender's "knowledge and beliefs about what constitutes good comprehension as well as the reader's (comprehender's) specific goals for … the particular text" (van den Broek, Virtue, Everson, Tzeng, & Sung, 2002, p. 137; text in parentheses is not in original, but inserted by authors). Standards of coherence vary across comprehenders and text types and situations. Depending on the comprehender's levels of

[2] Note that Perfetti and colleagues also had a similar hierarchical representation of comprehension processes in their reading comprehension models (e.g., Perfetti & Stafura, 2014).

standards for different types of coherence (e.g., referential, causal), activated information might be sufficient or insufficient to meet the comprehenders' standards of coherence. When sufficient, there is no further engagement in effortful construction processes. However, when the activated information is not sufficient, effortful constructionist processes are activated/triggered.

Note that text comprehension models have been primarily studied in the context of 'reading' comprehension. Studies indicate that oral language comprehension and reading comprehension tap into the same processes, particularly for proficient readers (Townsend, Carrithers, & Bever, 1987), and that component skills that contribute to reading comprehension for children (e.g., grades 2 and above; Cain, Oakhill, & Bryant, 2004; Cromley & Azevedo, 2007) are similar to those that contribute to listening comprehension (Florit, Roch, Altoè, & Levorato, 2009; Kim & Phillips, 2014; Kim, 2015, 2016; Lepola et al., 2012). However, for developing readers, word reading ability is likely to constrain reading comprehension (Perfetti, 2007), and therefore, in the review of literature below, we draw on studies which focused on oral language comprehension, not reading comprehension.

4 Component Skills of Listening Comprehension: Empirical Evidence from Correlational Studies

The theoretical models above inform us about which language and cognitive skills[3] would be involved in listening comprehension. A few prominent areas that received much attention across these theoretical models are cognitive skills such as memory (working memory and long-term memory), inference-making, and comprehension monitoring; and knowledge such as background or world knowledge (Graesser et al., 1994; Kintsch, 1988; McNamara & Kintsch, 1996; van den Broek et al., 2005). Not explicitly emphasized in these models, but instead implicitly assumed, is linguistic knowledge (vocabulary, syntactic/grammatical knowledge) needed for parsing. Although these have been primarily examined in the context of reading comprehension, recent studies indicate that these language and cognitive skills are also related to children's listening comprehension. Evidence includes working memory (Florit et al., 2009, 2013; Kim, 2016; Was & Woltz, 2007), vocabulary (Florit et al., 2009; Florit, Roch, & Levorato, 2014; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Kim, 2016; Tompkins et al., 2013), grammatical knowledge (Carrow-Woolfolk, 1999; Kim, 2015, 2016; Tunmer, 1989), inference (Florit et al., 2014; Kendeou et al., 2008; Kim, 2016; Lepola et al., 2012; Tompkins et al., 2013), theory of mind (Kim, 2015, 2016; Kim & Phillips, 2014) and comprehension monitoring (Kim, 2015; Kim & Phillips, 2014). It is of note that these theoretical models assume that the same processes are hypothesized to be involved in text comprehension across languages. Indeed, the empirical studies noted above were

[3] Note that we use the term, skill, to refer to both processes/capacity and knowledge.

conducted with children from various language backgrounds such as Italian, Dutch, English, and Korean, and they demonstrated similar magnitudes of relations in bivariate correlations (Kim, 2015).

Although informative, the majority of previous studies have provided piecemeal information about what is involved in listening comprehension as each study included a limited set of variables aligned with different foci in each study, and they did not systematically examine the structure or mechanism of these relations. That is, the focus of the majority of these studies was whether a few focal skills was independently related to listening comprehension after accounting for the other variables in the statistical model. However, the fact that one skill is not independently related to the outcome does not mean that the skill does not make a contribution. Instead, it means that its contribution is likely shared with other skills included in the statistical model, and thus its influence on the outcome is likely indirect or mediated. A downside of this approach (examining unique contributions using multiple regression) is that indirect contributions of potentially very important skills are easily masked. For instance, working memory has been hypothesized to be important to listening comprehension (Daneman & Merikle, 1996; Graesser et al., 1994; Kintsch, 1988; van den Broek et al., 2005) and empirical evidence supports this hypothesis (Florit et al., 2009, 2013; Was & Woltz, 2007). Then, is its influence on listening comprehension direct or is its influence partly or completely mediated by other skills that have been shown to be important to listening comprehension such as vocabulary and inference (e.g., Florit et al., 2014; Kendeou et al., 2008; Lepola et al., 2012; Tompkins et al., 2013)?

Addressing this question is critical to gaining insight about paths of influences. Recently, we began to address this question of direct and mediated relations among multiple language and cognitive skills – how these various language and cognitive skills are related to each other, and to listening comprehension. We used the multilevel representation framework – surface code, text-base, and situation model –, and hypothesized that different levels of representations would require different language and cognitive skills. For example, the surface representation is a lower level representation than the situation model, and therefore, would not require the same language and cognitive skills as for the situation model. Figure 1 shows our conceptualization about how foundational cognitive skills (e.g., working memory and attention), foundational oral language skills (vocabulary and syntactic/grammatical knowledge), and higher-order cognitive skills (inference, theory of mind, and comprehension monitoring) map onto the surface code, textbase, and situation model representations, adapting the comprehension process part of Perfetti's model (Perfetti & Stafura, 2014).

In this conceptualization, we hypothesized that working memory, attention, vocabulary, and syntactic knowledge are foundational language and cognitive skills needed for the surface representation, and that they provide input for establishing the textbase representation. Furthermore, elementary and potentially inaccurate propositions in the textbase representation have to be evaluated for accuracy and veracity, and inferences are needed to establish global coherence to ultimately establish the situation model (Kim, 2015, 2016). Therefore, comprehension

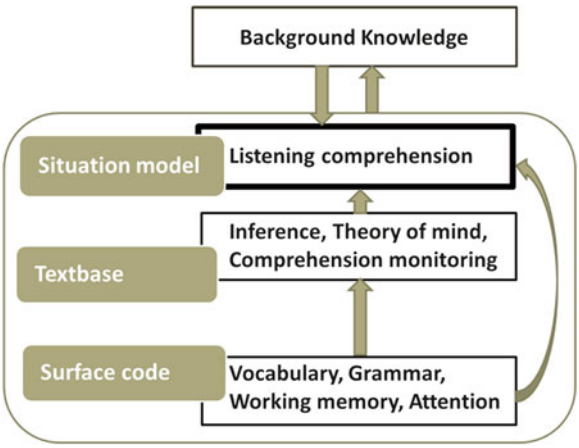

Fig. 1 Language and cognitive skills necessary for different levels of mental models (Adapted from Kim (2016). Printed with Permission)

monitoring would be involved to evaluate initial, local propositions, and inferencing and theory of mind would be involved to cross-check propositions and fill in missing information. Theory of mind, which is typically defined as the ability to infer others' mental states and predict behavior, was hypothesized to capture inferences about characters' intentions, thoughts, and emotions, which are critical aspects in comprehending narrative texts.

When we applied this model to data from Korean kindergartners, we found that the model fit the data very well and a large amount of total variance in listening comprehension, 74%, was explained (Kim, 2015). Working memory, vocabulary, and grammatical knowledge were all directly related to higher-order cognitive skills – comprehension monitoring and theory of mind –, which, in turn, were directly related to listening comprehension. In addition, vocabulary and grammatical knowledge were directly related to listening comprehension after accounting for theory of mind and comprehension monitoring. In a follow-up study with children in Grade 1, we found that an inferencing skill (i.e., the ability to identify missing information in the text drawing on background knowledge) and theory of mind made independent contributions (Kim, 2016). A similar pattern was found for English-speaking children in Grade 1 as well (Kim, under review).

In summary, findings from correlational studies indicate that multiple language and cognitive skills are involved in listening comprehension. Furthermore, not all the skills make direct contributions to listening comprehension, and instead some skills are indirectly related to listening comprehension. Although these studies are informative about potential targets to improve listening comprehension, they are correlational in nature, and thus, are limited in terms of causal inferences. Below is evidence from intervention studies.

5 Component Skills of Listening Comprehension: Empirical Evidence from Intervention Studies

Our literature review turned up only a limited number of empirical studies that targeted listening comprehension for children, including those with learning disabilities. In addition, the majority of studies targeted a single skill (e.g., syntactic knowledge) and few targeted multiple skills. In the review below, we included intervention studies that showed malleability of language and cognitive component skills of listening comprehension not only for children with learning disabilities but also for typically-developing children. Given that there is a chapter in this volume on vocabulary instruction, we focused on studies that targeted other component skills.

Vasilyeva, Huttenlocher, and Waterfall (2006) examined the effects of an intervention on children's comprehension of passive voice sentences. Seventy-two 4-year-old children were randomly assigned to conditions in which they listened to stories that contained mainly passive voice or active voice sentences. The same ten stories were adapted for use in both groups, and the stories also had pictures that supported children's comprehension of the text. The intervention lasted for 2 weeks, with groups of 7–11 children being pulled from the classroom every day for 20–25 min. They found that the group who listened to stories with mostly passive sentences rather than active sentences scored higher, on average, on a sentence comprehension task which included passive voice.

Guajardo and Watson (2002) examined the malleability of theory of mind. Preschool children were randomly assigned to a theory of mind training condition (n = 26) or a control condition (n = 28). In the training condition, the story teller told stories and highlighted the main story line and characters' thoughts and mental states explicitly. Children were then asked to explain story characters' thoughts and emotions, and were taught about the relation between people's thoughts and behavior. After 13–15 small group sessions of 10–15 min over the span of 5 weeks, children in the training condition outperformed those in the control condition on theory of mind tasks.

Kim and Phillips (under review) developed an intervention targeting comprehension monitoring in the oral language context. A systematic and explicit instructional routine for detecting inconsistency was developed for prekindergartners from low socio-economic families. Children in the comprehension monitoring condition heard sentences and short stories containing inconsistent information. One type of story was inconsistent against their background knowledge (e.g., Sharks live in trees). The other type was inconsistent within the story (e.g., Jane loves blue. She loves anything blue. Jane hates blue). After hearing a sentence or short story, children were then asked whether the sentence or story made sense to them, and the interventionist provided explanation and feedback. Sentences and stories had accompanying illustrations to facilitate comprehension. Instruction was provided in

small groups for 5 min a day for 4 days a week for 8 weeks. Results showed that children who received comprehension monitoring instruction performed better than those in the control condition (business as usual instruction) with a relatively large effect size ($d = 0.60$). These results suggest comprehension monitoring can be taught in the oral language context to prereaders.

Gillam, Gillam, and Reece (2012) examined the effects of a decontextualized language intervention (DLI) and a contextualized language intervention (CLI) compared to a control condition. The sample included 24 children aged 6 through 9 with language impairment (8 children in each condition). The CLI group listened to stories that were read aloud by the speech language therapist, answered questions about the stories, practiced using comprehension strategies such as comparing and contrasting and generating inferences, discussed narrative story structure, and discussed Tier 2 vocabulary words from the text. During the first session for each book the children listened to or read the story and discussed the new vocabulary words. Retelling the story and practicing specific grammatical targets were the foci for the second session. During the third session students created a parallel story that followed the story structure of the model text. The DLI group played card games from the No-Glamour series published by LinguiSystems. They practiced using similar skills as the CLI group, but the instruction was conducted without the context of a storybook. The No-Glamour cards focused on vocabulary, sentence complexity, and social language. The grammar cards were designed to point out specific grammatical targets (e.g. plurals) and prompt children to use the grammatical target in a discussion activity. The social language cards were designed to provide socially relevant scenarios for children to discuss as a group such as "Why do some people slurp milk shakes or other drinks through straws when there is almost nothing left?" The category/definition cards were designed to help children learn to detect "categories such as functions, attributes, associations, comparisons, compound words, synonyms, antonyms, multiple-meaning words, and absurdities." For example, children might discuss a prompt such as, "Does this make sense? An angry brush." Children in the control condition did not participate in any language interventions during the period of the study. The CLI and DLI groups met with the clinician three times per week for 6 weeks. Each session lasted for 50 min and included three to four students. The outcome measures included two tasks: the Clinical Evaluation of Language Fundamentals -4th Edition (CELF-4) recalling sentences subtest and the Test of Narrative Language (TNL; Gillam & Pearson, 2004) comprehension subtest. Results showed that the CLI group and the DLI group were not significantly different on either measure, and the DLI group was not significantly different than the control group on either measure. However, the CLI group performed significantly better than the control group with large effect sizes on the CELF-4 recalling sentences subtest ($d = 3.08$) and the TNL narrative comprehension subtest ($d = 0.93$).

Bianco et al. (2010) targeted multiple skills in their study. Their sample included 88 classrooms (in 88 different schools) and 1,273 4-year-old children in France. The intervention was conducted in small groups of four to seven students. Children were assigned to three different conditions: explicit instruction of multiple component skills, a story reading condition, and a phonological awareness training condition.

In the component skills condition, children were explicitly taught component skills of comprehension including detection of inconsistencies, necessary and logical inferences, situation model, and story structure. Children in the story reading condition heard stories read aloud multiple times and engaged in discussion of stories. Children in the phonological awareness condition received explicit instruction in phonological awareness. Interventions lasted 12–16 weeks per year. Depending on the cohort, some children received instruction for a year whereas others received 2 years of instruction. Results revealed that children in the component skill condition during both preschool and kindergarten outperformed children in the other two conditions on listening comprehension. The effect size of 0.40 was maintained for this group at the 9-month follow up.

6 Summary and Conclusion: How to Teach Listening Comprehension?

Studies have consistently shown that children's listening comprehension varies, and this variation is an important predictor of their reading comprehension and writing skills. The theoretical models and empirical evidence reviewed in this chapter suggest that listening comprehension is not a simple skill that children acquire easily. Instead, it requires acquisition and coordinated application of multiple language and cognitive skills. The good news is that these skills are malleable. As illustrated and detailed in Chap. 5, studies have shown that systematic and explicit instruction can improve children's vocabulary. Our review also suggests that although the number of studies was limited, syntactic knowledge, comprehension monitoring, inference-making, and theory of mind can be improved with intervention.

One challenge in listening comprehension instruction is how to teach these multiple language and cognitive skills in a limited school day. As educators all know very well, school days are already overloaded. The theoretical models described above and the practical constraints of school days indicate an integrated approach, incorporating these multiple skills in a lesson rather than targeting each skill in a separate lesson. For instance, good vocabulary instruction would include information about syntactic features of target words and their uses in sentences (Carlo et al., 2004). Existing reading comprehension lessons can easily incorporate these language and cognitive skills, and some already do incorporate skills such as vocabulary and inference-making (e.g., asking inference questions). In the oral language context for readers and prereaders, a similar approach can be used. For instance, bookreading is widely implemented in the classroom as a way of improving children's vocabulary and emergent literacy skills (see, for example, Justice & Ezell, 2002; Dialogic reading, Whitehurst et al., 1994). Bookreading can incorporate and target multiple language and cognitive skills systematically and explicitly. For instance, teaching a verb would involve not only meaning(s) of the verb, but also whether the verb requires an object or not, and how it is inflected in the text (third

person singular in the present tense, or past tense form). Furthermore, implicit questions requiring children to infer information either from an earlier part of the story or from their background knowledge can be asked systematically. For example, after reading the text "It was hot and humid. Bugs were buzzing around. How annoying, thought Rachel," the teacher may stop and ask a question "What season do you think it is in the story?" Theory of mind can be also incorporated into bookreading as characters' and authors' thoughts and emotions are an important part of narrative texts. Comprehension monitoring can be also taught during bookreading. At an appropriate point in a story, the teacher can stop and ask children about whether the story makes sense, and if not, why it does not. At other times, the teacher can stop during reading and ask a silly question that is inconsistent with the story content thus far. For instance, in the example story above, the teacher can state that "hmm… it must be winter in the story since it is hot and humid. Does this make sense?" and wait for children's responses.

As is clear from previous research, creating a language-rich environment is critical for children's language development (e.g., Dickinson, 2001; Hart & Risley, 1995) including listening comprehension. Therefore, targeting multiple language and cognitive skills should not be limited to planned lessons per se. Instead, language instruction should be embedded throughout the school day, exploiting teachable moments. For instance, when a child shares about what he or she did on the weekend, the teacher may find another way of expressing a sentence to improve syntactic knowledge. In addition, the teacher may ask seemingly silly questions that are inconsistent with the child's story, and remind them that stories have to make sense to the comprehender. In a similar vein, listening comprehension instruction should not be limited to classrooms. Ideally, these instructional approaches and strategies are shared with parents and caregivers so that they are implemented and extended in the homes.

A critical aspect of teaching these multiple language and cognitive skills is raising standards of coherence (van den Broek et al., 2005), or search-after-meaning (Graesser et al., 1994). Higher-order cognitive skills (e.g., inference-making) are effortful and strategic processes, and thus, may not be employed, even if the child has the ability, unless the child sees a need or has a desire for establishing global coherence. Thus, an important part of higher-order cognitive skill instruction is raising standards of coherence – raising awareness that 'stories or sentences they hear should make sense to them,' 'it is important to understand character's or author's goals, thoughts, and emotions,' and 'stories do not tell us everything and therefore, comprehenders should fill in information.' Being aware of these ideas will require instruction for many children – children do not spontaneously monitor their comprehension of oral texts (Kim & Phillips, 2014; Markman, 1977).

Improving listening comprehension takes a prolonged time, and thus, instruction should be long-term throughout multiple years. As multiple language and cognitive skills contribute to listening comprehension, developing and coordinating these skills are not likely to occur in a short time span. Like vocabulary (Snow & Kim, 2006), we argue that listening comprehension is a large problem space. That is, a component skill of listening comprehension such as vocabulary is expansive, and

continues to grow throughout the life time, and so would listening comprehension skill. This is in contrast to a confined or constrained skill (Paris, 2005) or mastery skill such as acquiring alphabet letters, which has a limited number of units to be learned, and can be taught to mastery in a relatively short time.

Finally, it is important to note that the involvement of multiple language and cognitive skills in listening comprehension has important implications for assessment – these multiple language and cognitive skills should be included in an assessment battery diagnosing children's difficulty with listening comprehension. This would allow precise diagnosis of potential areas to be targeted in instruction/intervention.

In closing, evidence indicates that improving listening comprehension is no small task, but requires explicit and systematic instruction beyond vocabulary. Explicit instructional attention to vocabulary, syntactic structure, inferences, character's thoughts and emotions, and comprehension monitoring is needed. Despite emerging evidence, however, our understanding is limited about the best approaches to teaching these multiple skills to children, including children with learning disabilities, and thus, future research efforts are needed.

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Best Practices in Writing Instruction for Students with Learning Disabilities

Amy Gillespie Rouse and Steve Graham

Abstract In this chapter, we discuss effective instruction for improving the writing quality of students with learning disabilities (LD). First, we outline common differences between the writing of students with LD and that of their peers who do not have LD, establishing the aspects of writing that are especially challenging for students with LD. Next, we present instructional practices that have a proven track record of improving the writing of students with LD in grades 1–12. These practices were drawn from a recent meta-analysis that we conducted (Gillespie A, Graham S, Except Child 80(4):454–473, 2014). In the meta-analysis, four types of writing instruction proved to be effective for students with LD: (a) strategy instruction, (b) dictation, (c) goal setting, and (d) process writing. We discuss these four types of writing instruction in detail, with examples of how teachers can incorporate them into their classrooms. In addition, we highlight other promising types of writing instruction found in the meta-analysis that did not have enough studies to calculate summary effect sizes and types of writing instruction found in other meta-analyses. Finally, we highlight points to consider when implementing our instructional recommendations, with emphasis on critical components of teacher instruction, such as modeling and guided practice, which should be incorporated with the effective types of writing instruction outlined in this chapter.

Keywords Writing • Instruction • Learning disabilities • Meta-analysis

A recent report from the National Center for Learning Disabilities (NCLD; 2014) indicated 66 % of students with learning disabilities (LD) spend 80 % or more of their school day in general education settings. We find this statistic exciting and promising, but also think it presents a challenge to general and special educators. Often in general education classrooms, written products are the primary means

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by which teachers measure students' knowledge, content mastery, and progress (Graham, 2006). Yet, we know that many students with LD struggle with multiple aspects of writing. To effectively prepare students with LD to meet the demands of the general education environment and to prepare them to demonstrate what they know on classroom and high-stakes assessments, general and special educators must meet the challenge of providing evidence-based and effective writing instruction to students with LD.

With effective writing instruction, students with LD should be better prepared to meet increasing academic demands and better able to demonstrate their knowledge and understanding of subject matter, regardless of where their academic needs are being met. Furthermore, we hope that by providing effective writing instruction to students with LD, these students are given the opportunity to see themselves as competent and capable writers who can use writing as the powerful tool it is, both inside and outside of school.

1 Common Writing Challenges for Students with Learning Disabilities

Better writing instruction should be developed with an understanding of the common challenges with writing faced by students with LD. We know based on previous research that the writing behaviors and written products of students with LD often appear quite different from those of their peers without disabilities. We summarize these writing differences below, organizing common writing challenges for students with LD around five areas: planning, content generation, revision, transcription, and motivation. We encourage teachers to keep these writing challenges in mind as they think about the effective approaches to writing instruction outlined in this chapter and as they begin to consider what works best for the students with LD they teach.

1.1 Planning

Planning, including thinking of ideas, setting goals for a writing task, and organizing information for writing, is a critical step in the writing process. Yet, students with LD spend considerably less time planning for writing than their peers without disabilities (Graham & Harris, 2003). In fact, even when specifically prompted to spend time planning in advance of writing, students with LD spent less than one minute doing this (MacArthur & Graham, 1987). Research shows that time spent planning correlates with writing quality and that expert writers often revisit plans

throughout the writing process to make changes and make sure they are meeting their writing goals (Graham, 2006). Typically, students with LD not only fail to plan before writing but they also fail to consider goals for organizing and writing their texts (Graham, 1990; Troia, 2006).

1.2 Content Generation

It is likely students with LD tend to skip planning when given a writing task because of the basic approach they commonly use when writing. Research shows that students with LD often rely on a knowledge telling approach to writing (Graham & Harris, 2003) that is characteristic of young, novice writers (Bereiter & Scardamalia, 1987). When given a writing task, students with LD typically think of it as a task of content generation. They produce as much text as possible, based on what they know about the writing topic and writing genre. Each sentence or idea produced fuels the next idea, until the student with LD runs out of ideas or meets the page length requirement for the assignment.

The result of this content generation tactic is typically a list of ideas or events that has little organization or adherence to the text structure of the writing genre in which the student with LD is composing (De La Paz, 2007). Using this technique for generating writing content also constrains the length of written products produced by students with LD. Compared to their peers without disabilities, students with LD generate less text when writing, likely because they list ideas without much detail or elaboration (Graham & Harris, 2003).

1.3 Revision

Because students with LD tend to view writing as involving a single process (i.e., content generation), they often fail to make substantive changes to their texts when asked to revise. Instead, most students with LD carry out the revising process as a proofreading activity, making surface-level edits involving legibility, spelling, punctuation, and mechanics (Graham, MacArthur, & Schwartz, 1995). Often, students with LD do not understand the recursive nature of the writing process and fail to realize that the writer should conjointly consider the text, its meaning, and clarity for the intended audience (in addition to the mechanical and legibility concerns they tend to address). In fact, when asked what constitutes "good writing", students with LD emphasized form over content more often than their peers without disabilities (Graham, Schwartz, & MacArthur, 1993).

1.4 Transcription

Difficulties with handwriting (or typing) and spelling further constrain the content and length of texts produced by many students with LD. Students with LD tend to write and type slowly and experience difficulty with spelling (Graham, Harris, & McKeown, 2013). When focused on forming letters properly or accessing letter-sound knowledge to spell words correctly, students with LD have less room in working memory to devote to the content, meaning, and organization of their written texts (aspects that are also overlooked in the limited knowledge telling approach to writing as well as the limited revising process described in the section above). Also, when transcription is especially difficult and cumbersome, students with LD may be unable to write quickly enough to record all of their thoughts and ideas before they forget them (Baker, Gersten, & Graham, 2003; Graham & Harris, 2003). This may be a familiar scenario for teachers who have witnessed a student with LD who has a lot of great ideas for their text, but writes or types so slowly that the ideas for the composition are lost in the transcription process.

1.5 Motivation

It is probably of little surprise to the readers of this chapter that with the cognitive overload, fatigue, and frequent failures students with LD experience when writing, they commonly show low motivation for completing writing assignments. Not only can the task of writing appear daunting for students with LD, given their lack of knowledge and strategies for approaching and completing writing assignments, but also repeated failures with writing can cause students with LD to develop negative beliefs about their ability to write (Harris, Graham, Mason, & Friedlander, 2008). When given a writing task, students with LD may avoid or refuse to complete it altogether because they lack the strategic knowledge or know-how for completing it, lack confidence in their writing abilities, or both of these.

In teaching writing to students with LD, therefore, it is important that these students receive high quality writing instruction that is likely to work. As a result, we wrote this chapter for elementary, middle, and high school teachers of students with LD to describe research-based techniques for providing writing instruction to their students and for addressing common writing challenges. We present four effective types of writing instruction supported by research for students with LD in grades 1 through 12 (a majority of the research focused on grades 4 through 8). We also highlight several other types of writing instruction that appear promising for students with LD. Finally, we provide some helpful tips for teachers to consider when implementing any of the effective types of writing instruction described in this chapter in their own classrooms.

2 Effective Writing Instruction for Students with Learning Disabilities: Research-Based Recommendations from a Meta-analysis

Meta-analysis is a statistical technique for summarizing findings across multiple research studies that examine the same or similar topics. With meta-analysis, the effect or impact of an intervention or instructional technique can be combined and compared across studies and reported in a meaningful way that allows for examination of patterns or trends in research findings (Lipsey & Wilson, 2001). Because we were interested in identifying effective instructional practices for teaching writing to students with LD, we chose meta-analysis to examine the patterns or trends in research studies already published on this topic (Gillespie & Graham, 2014).

Meta-analysis was particularly useful for our purpose here because studies, even those on the same topic, rarely all use the same measurement tools to test students' performance (Lipsey & Wilson, 2001). For example, in our meta-analysis (Gillespie & Graham, 2014), 15 studies used strategy instruction to improve the writing quality of students with LD. However, across these 15 studies, researchers reported students' writing performance using many different measurement tools and writing assessments (e.g., holistic rating scales, state assessment rubrics, analytic rating scales). With meta-analysis, the *effect size* is used to summarize study findings across all of the variables and assessments used in different studies. Using effect sizes, we were able to summarize research findings from multiple studies, even when they did not use the same measurement tools or assessments of students' writing skills.

For a single research study in the meta-analysis we conducted, the effect size represents the difference in the average writing quality score for a group of students with LD who received a particular type of writing instruction and a group of students with LD who did not receive that type of writing instruction. When we found at least four studies examining the same type of writing instruction, we averaged individual effect sizes from each study to calculate a summary or average effect size for that particular type of writing instruction. For instance, thinking back to the strategy instruction example above, we calculated 15 individual effect sizes for each of the 15 studies of strategy instruction. Then, we averaged those individual effect sizes together to summarize the effects of strategy instruction on the writing quality of students with LD across all of those studies. These average effect sizes are what we used to identify best practices for writing instruction in this chapter. A general rule of thumb for interpreting effect sizes is: effect sizes of .20 are small, effect sizes of .50 are medium, and effect sizes of .80 are large (Lipsey & Wilson, 2001).

To gather the studies for our meta-analysis (Gillespie & Graham, 2014), we conducted an extensive search of all research studies that measured the effects of writing instruction on the writing quality of students with LD. We limited the search to include only studies involving students in grades 1 through 12 with documented LD. Studies with kindergarten students were not included because typically students are not identified as having a learning disability until later grades (Fletcher,

Coulter, Reschly, & Vaughn, 2004) and measures of writing quality are extremely rare in interventions involving kindergarten students (Graham, McKeown, Kiuhara, & Harris, 2012). We also included only those studies that measured students' writing quality after a particular type of writing instruction was provided. Writing quality was chosen as the outcome of interest because it provides broad measure of writing performance, based on a reader's judgment of the content and form of a student's written text, including factors such as ideation, mechanics, organization, vocabulary, and voice or tone (Graham & Perin, 2007). Our search was also restricted to those studies involving research methods and reporting results that allowed for calculation of effect sizes. Lastly, we did not include studies examining the effects of word processing instruction on the writing of students with LD, as this topic was summarized in a recent meta-analysis (Morphy & Graham, 2012), and found to be effective with these students.

Our search yielded 43 studies that met all of our criteria (Gillespie & Graham, 2014). Thirty-seven of the studies had positive effect sizes, meaning students with LD who received a particular type of writing instruction demonstrated better writing quality, on average, than students with LD who did not receive that type of writing instruction. Most studies involved students with LD in the upper elementary and middle school grades (i.e., grades 4 through 8); three studies involved students with LD in the primary grades and five studies involved high school students. In the studies we reviewed, teachers and researchers delivered writing instruction in a variety of settings, including: (a) resource classrooms, (b) special education classrooms, (c) general education classrooms, and (d) after school programs.

We categorized the 43 studies according to the type of writing instruction provided to students with LD. Six types of writing instruction had enough studies to calculate an overall or average effect size (i.e., 4 or more studies of that type of writing instruction): (a) strategy instruction (15 studies), dictation (6 studies), procedural facilitation (6 studies), prewriting (5 studies), goal setting (4 studies), and process writing (4 studies). All of these average effect sizes were positive. Four of the six types of writing instruction had average effect sizes which were significantly different than zero, meaning we could be confident that the effect sizes were not due to chance or error but due to the actual effectiveness of each type of writing instruction. We describe these four types of effective writing instruction below, with general information about each type of writing instruction and the studies as a whole (e.g., grade level of students, where the instruction was delivered, duration of instruction) for that type of writing instruction. We also include a specific description of one study to serve as an example of each type of effective writing instruction. Readers who are interested in more examples can refer to Gillespie and Graham (2014) and to the original articles referenced in the meta-analysis.

It is also important to note, the four effective types of writing instruction are ordered by total number of studies, not by effectiveness. In fact, effect sizes cannot be compared between the different types of effective writing instruction reported here. So, readers should not assume that the type of writing instruction with the largest average effect size is a better choice for their classroom than another effective type of instruction with a smaller effect size. As we recommend in later sections

of the chapter, teachers should consider the appropriateness of each type of effective writing instruction for their students, for their classroom, and for the learning objectives they want their students to meet.

2.1 Research-Based Recommendation 1: Strategy Instruction

Teach students with LD strategies for planning, writing, editing, and revising compositions.

- Average effect size = 1.09
- Students in grades 4–10
- Used in resource classrooms, special education classrooms, and after school programs
- Ranged from 1 week to 7 months
- Used with expository, narrative, and persuasive genres

Because we had more than ten studies of strategy instruction, we were able to calculate and compare effect sizes for particular types of strategy instruction. We found that studies using Self-Regulated Strategy Development (SRSD; Harris et al., 2008) had larger effects (average effect size = 1.33) than studies using other types of strategy instruction (average effect size = 0.76). SRSD differs from other types of strategy instruction in that students receive explicit instruction in genre-specific strategies (e.g., a strategy for including all elements of a good story) or strategies for general writing activities (e.g., revising, word choice) through a series of criterion-based lessons. With SRSD, the teacher models writing strategies and provides scaffolds until students learn to use writing strategies independently. The teacher also models self-regulation, so that students learn to monitor their own progress in learning and using writing strategies. The six stages of SRSD are: (1) Develop background knowledge, (2) Discuss it, (3) Model it, (4) Memorize it, (5) Support it, and (6) Independent Performance. For more information about each stage of instruction, consult the book *Powerful Writing Strategies for All Students* (Harris et al.,) and read the example study described next.

Example Study: Troia and Graham (2002) Grades 4 and 5, Narrative Writing

Students reviewed the elements of a good story using the acronym SPACE (Setting, Problems, Actions, Consequences, Emotions). Then, the teacher introduced the mnemonic STOP and LIST (Stop, Think Of Purposes, and List Ideas, Sequence Them) and modeled how to use STOP and LIST to help her plan for writing a story, drawing students' attention to the effectiveness of the strategy for planning. In the second instructional session, the teacher asked students to rehearse STOP and LIST for memorization purposes. Also, the teacher modeled how to plan for writing another story using STOP and LIST. In session 3, students continued rehearsing STOP and LIST with a goal of memorizing the mnemonic. Then, the teacher showed each student an evaluation of his or her own story writing before

learning the STOP and LIST strategy. This evaluation included six components: a score for each of the five story elements (i.e., SPACE: Setting, Problems, Actions, Consequences, Emotions) in a student's story as well as a score for overall quality. Next, the students and teacher discussed how knowing STOP and LIST could help students write better stories. The teacher also taught students that self-regulatory behaviors, such as paying close attention, devoting effort, and persisting through difficulties, would help them learn to use STOP and LIST effectively for planning to write stories.

For the fourth session, students continued to rehearse the STOP and LIST strategies so they could commit them to memory. In this session, the teacher and students collaboratively planned for and wrote a story using STOP and LIST. Then, they evaluated their collaborative written product using the same evaluation scale used in session 3 (i.e., five story elements and a rating for overall quality). The group discussed how using STOP and LIST helped them to plan for and write a better story than the stories they produced before learning STOP and LIST. In session 5, students had to recall STOP and LIST from memory with 100 % accuracy. Then, the teacher and students wrote another collaborative story using the STOP and LIST strategies and again evaluated the story using the 6-component rubric.

In session 6, students used STOP and LIST to write stories independently, with assistance from the teacher as needed. The teacher evaluated each of the stories using the 6-point rubric. In the last session, students wrote a story using STOP and LIST independently and again, the teacher evaluated their stories using the rubric. Throughout the sessions, the teacher reminded students of other contexts in which they could use STOP and LIST and had them practice applying STOP and LIST in such situations (e.g., planning for a birthday party, planning to do a science project).

Duration Seven instructional sessions (average length of session was 75 min); sessions were criterion-based, meaning students could not move to the next session until they had met the teacher's predetermined learning goals for that stage of instruction.

Instructional Considerations When using SRSD for writing strategy instruction, teachers should plan for individual variation in how students proceed through the stages of strategy learning and application. Because SRSD is based on mastery learning (i.e., students proceed through the lessons and stages of instruction at their own pace, only moving to the next lesson or stage of instruction when they are competent and capable), students will likely proceed at different rates. Additionally, students may require repetition from previous stages of instruction (e.g., vocabulary used when writing in a particular genre) as reminders and review even when they are in later stages of learning a writing strategy. Teacher should plan for the stages of strategy instruction to be recursive (Harris et al., 2008).

2.2 Research-Based Recommendation 2: Dictation

Teach students with LD to dictate their compositions into a tape recorder or to a scribe.

- Average effect size = 0.55
- Students in grades 2–8
- Used in resource classrooms
- Ranged from 1 to 3 days
- Used with narrative and persuasive genres

Example Study: Lane and Lewandowski (1994) Grades 7 and 8, Narrative Writing

The teacher gave students a picture prompt and asked them to compose a story about what they thought was happening in the picture, what they thought had already happened in the picture, and what they thought would happen next in the picture. The teacher also reminded students to take time to think about their stories before they began composing. When each student was ready to begin composing, he or she spoke the story aloud, recording it with a tape recorder. Later, the teacher transcribed each orally produced story.

Duration One instructional session (average length of session was 6.5 min per student to record the orally produced composition)

Instructional Considerations Although dictation is a relatively low-cost instructional practice in terms of planning time or expenses for classroom materials, teachers need to consider the time it will take to teach their students how to properly use an audio recording device. Teachers should also plan for the time it will take to transcribe each student's orally produced composition, or plan for teaching students to transcribe their own dictated compositions.

2.3 Research-Based Recommendation 3: Goal Setting

Teach students with LD to set goals for their written compositions. Studies involved goals for including specific genre elements and goals for revising compositions.

- Average effect size = 0.57
- Students in grades 4–8
- Used in resource classrooms and general education classrooms
- Ranged from 2 to 6 days
- Used with narrative and persuasive genres

Example Study: Ferretti, Lewis, and Andrews-Weckerly (2009) Grades 4 and 6, Persuasive Writing

The teacher asked students to write a letter about whether or not students should be given more out-of-class assignments (i.e., homework). Then, the teacher provided students with a list of several goals for their writing: (a) clearly state your opinion, (b) provide two or more reasons to support your opinion, (c) explain why your reasons are good reasons for your opinion, (d) state that other people may have a different opinion than yours (i.e., counterargument), (e) provide two or more reasons people might use to back up the opinion that is different than yours, (f) explain why these reasons are not good reasons to support a differing opinion, and (g) write a conclusion to summarize your opinion on the issue.

Duration One instructional session (45 min)

Instructional Considerations As implemented in the studies reviewed for our meta-analysis (Gillespie & Graham, 2014), goal setting required relatively little instructional time or preparation for the teacher. Teachers may also want to consider having students learn to develop their own goals for writing and practice monitoring their own progress toward achieving those goals. Personally created goals for writing may be more meaningful to students and thus more motivating.

2.4 Research-Based Recommendation 4: Process Writing

Teach students to proceed through the stages of the writing process (plan, draft, edit, revise, publish) while incorporating sustained time for writing for authentic purposes and mini-lessons to address writing skills.

- Average effect size = 0.43
- Students in grades 1–5
- Used in resource classrooms, special education classrooms, and general education classrooms
- Ranged from 2 to 10 months
- Used with multiple genres

Example Study: Clippard and Nicaise (1998) Grades 4 and 5

The teacher began each instructional session with a short mini-lesson on some aspect of writing, as dictated by students' needs and areas of writing difficulty at that particular point in time. For a majority of each instructional session, students wrote about self-selected topics and participated in ongoing cycles of the writing process (i.e., plan, draft, edit, revise, publish). Students also held short writing conferences with their peers or with the teacher to get feedback for revising and editing their written compositions. The teacher devoted a short time each session for students to share in-progress or completed pieces of writing with the class. When a student finished a piece of writing, he or she published it and the teacher put it on display in the classroom and school libraries.

Duration Four instructional sessions per week (60 min each) for 7 months

Instructional Considerations Compared to the other types of effective writing instruction discussed in this chapter, process writing is likely the most time consuming in terms of the effort it takes to set up and run an effective process writing classroom. Although the investment is obviously worth it, teachers should be prepared that process writing may require considerable changes to the way they teach writing (e.g., sustained time for writing, instruction that is dictated by students' needs as they arise, students proceeding through phases of the writing process at their own pace, teaching classroom norms to facilitate group sharing of written products).

2.5 Other Findings on Effective Writing Instruction for Students with LD

We found nine other types of writing instruction in our literature search, but each type had fewer than four studies, so we could not calculate average effect sizes for these types of writing instruction. Of the nine additional types of writing instruction, the following six types had positive effect sizes in one or more studies: instruction to increase writing motivation (three studies); multi-component writing instruction (two studies; e.g., Six Traits model, genre elements instruction, and strategy instruction combined); collaborative writing (one study); creativity training (one study); self-evaluation using a rubric (one study); and adding strategy instruction to process writing (one study).

We should also note three prior meta-analyses in which researchers reported findings about effective writing instruction for students with LD. In a meta-analysis of 26 SRSD studies, Graham and Harris (2003) found students with LD in grades 4–8 who were provided writing strategy instruction using the SRSD method had better writing quality (average effect size = 1.14) than students with LD who did not receive SRSD instruction. Also, Gersten and Baker (2001) found 13 studies reporting positive effects of writing instruction on the writing quality of students with LD in grades 1 through 9. Across these effective studies, they reported three components were critical for effective writing instruction for students with LD: (a) teachers should provide explicit teaching of the steps involved in the writing process, (b) teachers should provide explicit teaching of the text structures associated with different writing genres, and (c) teachers or peers should provide extensive feedback on the quality of the writing of students with LD throughout the writing process (Gersten & Baker, 2001). Morphy and Graham (2012) found nine studies reporting positive effects of word processing on the writing quality of students with LD. In these studies, students with LD who used basic word processing programs (five studies) or who used basic word processing programs and received instructional support to do so (four studies) produced higher quality written compositions than students with LD who wrote compositions using pencil and paper (Morphy & Graham, 2012).

3 Points to Consider When Implementing Effective Writing Instruction

Although we conducted an extensive search for research studies to include in our meta-analysis, the 43 studies we found only tested 15 different types of writing instruction. We know there are many other possibilities for teaching writing that have not been tested or reported in ways that allow for the calculation of effect sizes. Keeping that in mind, teachers should understand that the recommendations offered in this chapter do not constitute a writing program or curriculum. Instead, our suggestions are for the most effective types of writing instruction for students with LD that have been reported by researchers. Therefore, we encourage teachers to incorporate our suggestions for effective writing instruction into their existing literacy routines and practices, considering what type of effective instruction makes the most sense for their students and what type of effective instruction works best for the writing skill or procedure being studied. For example, teaching students to dictate compositions into a tape recorder does not align well with a lesson on learning to compose responses to timed writing prompts. However, teaching students a writing strategy for responding to timed prompts might be a better instructional match. In addition, teachers should consider the following when implementing the recommendations we suggest in this chapter.

3.1 Differences in Effect Sizes

The four types of effective writing instruction for students with LD reported in this chapter varied in average effect sizes. Although it may be tempting for teachers to prioritize the types of instruction with larger average effect sizes over those with smaller effect sizes, this is not advisable. In fact, the relative impact of strategy instruction, dictation, goal setting, and process writing compared to one another is not possible, as we did not report on studies that made these direct comparisons. Therefore, as we suggested above, teachers should use the four types of effective writing instruction in ways that are best suited to their students needs and their instructional goals, regardless of their effect size. Teachers should also think of ways that the four effective types of writing instruction might be used in combination. Although a combination of strategy instruction, dictation, goal setting, and process writing has not been tested (or at least not reported), it is possible that two or more of these effective types of writing instruction would complement each other well when used in conjunction with a teacher's other classroom practices for teaching writing.

3.2 Motivation to Write

As explained at the beginning of the chapter, students with LD often struggle with various aspects of the writing process. Repeated struggles and failure with writing can lead to negative attitudes and little motivation to complete writing tasks (Baker et al., 2003). Therefore, we encourage teachers to design their writing instruction in ways that increase students' motivation to write. Although we did not have enough studies to report summary effects for writing instruction involving motivation, we describe here best practices based on the literature reviews and practical guidelines published by others on increasing students' motivation for writing.

First, teachers should try to make writing tasks as authentic and interesting as possible for students with LD (Boscolo & Gelati, 2007). To increase students' interest, teachers should consider having students with LD choose their own topics to write about (as is characteristic of process writing) and complete writing tasks that connect to their own background knowledge and experiences whenever possible. Second, teachers should instruct students with LD in ways that highlight the usefulness and impact of the writing skills they are learning (Graham & Harris, 2003). Teachers should show their students with LD that by learning new writing skills and procedures they are becoming better writers. By seeing their own progress (through graphing their own performance or examining previous writing samples completed before they learned new skills), students with LD will be more likely to attribute their successes to their own efforts, not outside factors, and thus more likely to persist with writing tasks. Third, teachers should control writing task difficulty for students with LD, making sure they assign challenging writing assignments but not ones that are so difficult students with LD may decide they are insurmountable (Troia, 2006).

3.3 Explicit Instruction

Similar to Gersten and Baker's (2001) finding that students with LD need explicit teaching of the steps involved in the writing process, we found in our meta-analysis (Gillespie & Graham, 2014) that explicit teaching is critical for writing instruction to be effective for students with LD. When we re-examined the studies we reviewed, we looked specifically at those studies designed to help students with LD learn to use a specific writing process, such as planning or revising. We compared studies involving instruction in a writing process (all strategy instruction studies and one prewriting study) to those involving minimal or no instruction in a writing process (all procedural facilitation studies and four prewriting studies). Our definition of *instruction* was relatively lenient; we required studies to include at least two sessions that included: (a) teacher modeling of the new writing skill or procedure,

(b) guided practice as students learned to use the writing skill, and (c) a goal for students to use the writing skill on their own. Studies involving minimal to no instruction were those where teachers gave students with LD a procedure or aid to use during the writing process (e.g., graphic organizer for planning, cue cards to remind the student to include elements of a story) but they did not provide direct instruction (as described above) for at least two sessions. Even with this relatively low level requirement for instruction, we found that the summary effect size for studies that involved teacher instruction in how to use a new writing skill or procedure (ES = 0.93) was significantly larger than the summary effect size for studies that involved little to no instruction in how to use a new writing skill or procedure (ES = 0.22). This finding has implications for implementing any of the effective writing instruction reviewed in this meta-analysis.

When using any of the four effective types of writing instruction discussed in this chapter, teachers should provide sequenced instruction, instructional scaffolds, and guided practice for their students with LD to learn to use the writing skill or process independently. Based on our meta-analysis (Gillespie & Graham, 2014), simply providing students with LD with a procedure to use while writing or cues to remember specific writing elements is not enough. To have a strong impact on the writing quality of students with LD, teachers must use evidence-based writing practices coupled with explicit instruction. This makes sense, given the difficulties students with LD tend to have when writing (discussed at the beginning of the chapter). Targeted instruction and instructional scaffolds teach students with LD critical writing skills (e.g., prewriting teaches students with LD the crucial skill of planning before writing, strategy instruction teaches students with LD essential components of writing genres which aid with written organization). Perhaps more importantly, systematic instruction and practice sessions likely provide the repetition and review students with LD need to internalize new writing skills, and hopefully learn to generalize them to future writing opportunities.

4 Conclusions

Knowing common writing challenges as well as information about the types of writing instruction shown to have positive effects for students with LD, we hope general and special educators alike are better prepared to meet the challenge we identified at the beginning of this chapter: providing evidence-based and effective writing instruction to students with LD. We again encourage teachers to incorporate the evidence-based instruction we outlined in the chapter with the writing practices they have already found to be effective for their own students with LD. We remind teachers that effective writing instruction for students with LD is best delivered explicitly, with consideration of students' engagement and motivation throughout instructional planning and implementation. Lastly, we encourage teachers to stay up-to-date with research on writing instruction for students with LD, so that when effect size data is published for other types of writing instruction they can consider adding new instructional practices to their repertoires.

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Language and Literacy Interventions for ELs with LD: Two Steps Forward, One Step Back

Sylvia Linan-Thompson, Hermelinda Cavazos, Laura McFarland, and Julie Martinez

Abstract In the last 15 years there has been a proliferation of research with English learners (ELs), but limited research on ELs with learning disabilities or difficulties. Much of the research is in reading and with Spanish-speaking ELs in the primary grades. Thus, there is evidence and consensus to guide reading instruction for Spanish-speaking ELs with reading difficulties, but little in the other content areas, for older ELs, or those who speak a language other than Spanish as their first language. This chapter will present empirically supported instruction for ELs with literacy related learning disabilities or difficulties, promising practices in those areas that have a less robust research base and areas for future research.

Keywords English learners • Language interventions • Reading interventions • Writing interventions • Learning disabilities • Language development • Literacy development

During the 2010–2011 school year English learners (ELs) represented 10 % of students in public schools (U.S. Department of Education & National Center for Education Statistics, 2014). With the increase in number of English learners in the last 15 years, intervention studies that include English learners have also increased. However, there are considerably fewer studies that include ELs with special needs even though they account for 9 % of ELs (U. S. Department of Education,

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Rehabilitative Services, & Office of Special Education Programs, 2007; Zehler et al., 2003). A review of the literature on reading interventions for English learners with a specific learning disability in reading, revealed, as has been noted by others (August & Shanahan, 2006; Klingner, Artiles, & Méndez Barletta, 2006; Moore & Klingner, 2014; Orosco & O'Connor, 2014), that there is a dearth of research on reading interventions for English learners with learning disabilities (LD). Similarly, research on effective interventions to improve the writing performance and oral language of ELs with LD is sparse. This gap in the literature results in limited guidance for teachers on how to provide effective reading interventions to ELs with LD (Orosco, 2010; Orosco & O'Connor, 2014).

Given the lack of research that includes this population of students, research with monolingual students with LD can serve as a starting point (August et al., 2006). Recent research has found that ELs with LD in reading exhibit the same deficits in decoding and comprehension as their non-EL peers (Geva & Massey-Garrison, 2013; Lesaux & Kieffer, 2010) and ELs with writing difficulty, similar to their monolingual peers, exhibit difficulty with both the composing process and mechanics of writing (Fitzgerald, 2006). Many of the practices that are effective for monolingual students with LD are also effective for ELs with LD. They are (a) the use of explicit and systematic instruction, (b) the use of learning strategies, (c) the use of graphic organizers, (d) hands-on activities, and (e) peer mediation (Gersten et al., 2007; Swanson, Hoskyn, & Lee, 1999).

However, we must proceed with caution when generalizing the findings of research conducted with monolingual students with LD to ELs with LD because not all interventions that are effective for monolingual students are necessarily effective or appropriate for ELs (Klingner & Edwards, 2006; Klingner, Sorrells, & Barrera, 2007; Moore & Klingner, 2014). As an example, Denton, Wexler, Vaughn, and Bryant (2008) found that middle school ELs with severe learning disabilities did not benefit from a research-based comprehensive reading intervention. Lack of language proficiency may have contributed to students' lack of progress. Therefore, researchers should heed Moore and Klingner's (2014) suggestion that when selecting an intervention, we ask ourselves whether interventions have been proven effective for subpopulations of students such as ELs.

Currently, we do not have enough evidence to differentiate instruction based on language because we do not know how different levels of language proficiency interact with learning disabilities (Klingner & Artiles, 2006), though it is clear that modifications to instruction that facilitate understanding of content in addition to instruction specifically designed to develop students' oral and written language is necessary. Callahan (2005) found that programs for secondary ELs that focused solely on reading resulted in lower academic outcomes when compared to programs that integrated reading, writing, listening, and speaking in academic content areas. This chapter reviews effective language and literacy practices for ELs with LD and those who struggle learning to read and write.

1 Language Interventions for ELs with LD

English learners acquire English at varying rates creating a challenge for educators whose goal is to provide these students with appropriate and equitable access to the English curriculum (Sanford, Brown, & Turner, 2012). As a group, ELs with learning disabilities begin school with smaller English vocabularies and are likely to experience more difficulty developing academic language than their monolingual peers since they are less likely to hear and use English outside of school. In addition, students with limited vocabulary are likely to continue to face challenges in understanding text as they progress through the grades (Biancarosa & Snow, 2004; Kieffer, 2010; Rand Reading Study Group, 2002). Explicit attention to vocabulary development (Bos & Anders, 1990; Filippini, Gerber, & Leafstedt, 2012; Sanford et al., 2012; Cisco & Padrón, 2012) and academic language instruction (Calderón, Slavin, & Sánchez, 2011; Carlo et al., 2004; Kim & Linan-Thompson, 2013; Sibold, 2011; Spies & Dema, 2014) is essential for linguistically diverse students to succeed academically. English learners with LD are likely to need more time and more intensive interventions to develop English. These supports can be delivered in the general education classroom or as supplemental interventions.

Using a variety of approaches, researchers have investigated the impact of vocabulary interventions on ELs' vocabulary development. Research investigating vocabulary interventions for ELs has been conducted in a number of settings, including whole class (Filippini et al., 2012) and small group or individual instruction (Bos & Anders, 1990; Fillippini et al., 2012; Kim & Linan-Thompson, 2013; Nelson, Vadasy, & Sanders, 2011) and has included ELs with learning disabilities (Bos & Anders, 1990) as well as those identified as being at risk for learning difficulties (Fillippini et al., 2012; Kim & Linan-Thompson, 2013; Nelson, Vadasy & Sanders, 2011). Root word vocabulary (Nelson, Vadasy & Sanders, 2011) as well as semantic and morphological knowledge (Bos & Anders, 1990; Fillippini et al., 2012) have been the foci of vocabulary interventions with ELs. Self-regulation strategies have also been taught in conjunction with explicit vocabulary instruction to examine its effectiveness (Kim & Linan-Thompson, 2013).

Vocabulary instruction at the semantic level helps students determine relationships among words and encourages metacognitive processes related to language development (Bos & Anders, 1990). Bos and Anders (1990) examined the effect of two interventions, semantic mapping (SM) and semantic feature analysis (SMA) that were paired with interactive learning strategies on students' vocabulary learning and reading comprehension. Semantic mapping required students to create a hierarchical relationship map using vocabulary words related to a concept whereas semantic-feature analysis provided a means for examining the relationship between the vocabulary word and essential content concepts. Students in both conditions exhibited short and long term vocabulary acquisition and comprehension. However, students in this study were not able to transfer their understanding to a written recall task.

While Bos and Anders compared two semantic interventions, Filippini and colleagues (2012) examined the value of adding morphological awareness or semantic relationship instruction to a phonological awareness intervention. In the semantic relationship condition, students identified, categorized, and classified semantic features. Students in the morphology condition identified and manipulated morphemes to build words. Students in these two conditions were compared to a control group that received only the phonological awareness intervention. Both treatment groups outperformed the control group on vocabulary acquisition. Nelson et al. (2011) also taught students root words. They selected high frequency decodable words and included direct definition instruction and activities to process the word as well as spelling and blending practice in the intervention. Intervention students outperformed control students on measures of root word vocabulary and word reading and gains were maintained 6 months post-intervention (Vadasy, Nelson, & Sanders, 2011). These three studies demonstrate the effectiveness of interventions that focus on specific aspects of vocabulary, semantic knowledge or morphological awareness on ELs vocabulary growth.

Self-regulation in the context of learning refers in part to the ability of a learner to set reasonable goals, choose effective strategies to accomplish those goals, monitor ones' performance, self-motivate and persevere toward the completion of the task, and evaluate the product of ones efforts. Kim and Linan-Thompson (2013) examined the effect of adding self-regulation strategies to explicit instruction of science vocabulary. Four third grade ELs with learning difficulties were provided vocabulary instruction which included; (a) activating prior knowledge, (b) a student-friendly definition, (c) explanation of the word meaning using science context, (d) activities that increased word acquisition and (e) a review of the new vocabulary. During the intervention phase, self-goal setting and reviewing the word with self-monitoring of performance were added. Students performed significantly higher in the intervention and maintenance phases than in the baseline phase on receptive and expressive vocabulary measures, indicating the positive effect of self-regulation on science vocabulary learning. Furthermore, student interviews were conducted to gain an understanding of the students' perspectives. Students indicated that self-regulation strategies were helpful and that knowing the strategies bolstered their academic confidence.

Researchers recognize that explicit and strategic vocabulary development is crucial for ELs and those experiencing academic struggles regardless of whether the target words are content based or academically essential (Bos & Anders, 1990; Calderón et al., 2011; Carlo et al., 2004; Filippini et al., 2012; Kim & Linan-Thompson, 2013; Nelson et al., 2011; Sanford et al., 2012; Sibold, 2011; Spies & Dema, 2014). Explicit instruction of words is effective when students need to learn a set of words for a specific lesson. Whereas, strategy instruction provides students with tools that will allow them to use these word learning skills when reading new texts and completing tasks in the other communicative domains. Finally, devoting deliberate blocks of time to vocabulary development may be challenging during whole class instruction as there are several other areas of reading development that are equally vital to student achievement (Filippini et al., 2012). Still, efforts to

provide adequate vocabulary development across the curriculum in general classroom instruction or as pull-out interventions should be further explored.

2 Reading Interventions for ELs with LD

Although, ELs with LD benefit from comprehensive reading instruction, they will also need support to access the general education curriculum (Genesee, 2006), with English language development, and support in developing literacy in their native language (Klingner, Boelé, Linan-Thompson, & Rodriguez, 2014). To increase the likelihood of success, reading interventions used with ELs should ensure that the language used in instruction is comprehensible, that it is meaningful, contextualized, and understood by ELs (Herrera & Murry, 2005; Krashen, 1991; Rodriguez, 2009) and that students are provided opportunities to produce oral and written language (Swain, 2005). Other instructional modifications and adaptations that support ELs include additional time to process information and complete tasks, simplified directions, audio and visual supports, and peer tutoring (Klingner et al., 2014).

2.1 Effective Reading Instruction

ELs with LD benefit from many of the same practices that are effective for monolingual students with LD when language considerations are taken into account. Beginning reading instruction should target the five components of reading: phonological awareness, phonics, fluency, vocabulary, and comprehension (August & Shanahan, 2006) and should be taught explicitly and systematically (Gersten et al., 2008). Reading instruction for ELs should also incorporate listening, speaking, reading, and writing activities in the language arts and the other content areas and should explicitly teach metacognitive skills (Carrasquillo & Rodríguez, 2002; Coelho, 2004; Enright & McCloskey, 1988; Fillmore & Snow, 2000). Other practices that have proven beneficial when providing reading instruction to ELs include the use of graphic organizers and visuals, pre-teaching of key vocabulary words, connecting instruction to students' everyday lives and cultural backgrounds, and providing multiple opportunities for ELs to collaborate with peers, including native English speaking peers (Coelho, 2004).

2.2 Intervention Studies with ELs with LD

Four studies examined the effect of reading instruction for ELs with LD. Participants in these four studies ranged from K-8th grade. Findings indicate that many of the same intervention strategies used for monolingual English students have been found

effective for ELs with LD. The use of direct explicit, systematic instruction was found effective for ELs with LD (Gyovai, Cartledge, Kourea, Yurick, & Gibson, et al., 2009; Haager & Windmueller, 2001; Klingner & Vaughn, 1996; Saenz, Fuchs, & Fuchs,, 2005). Direct instruction has been effective in teaching phonological awareness and phonics skills (Gyovai et al., 2009; Haager & Windmueller, 2001) and reading comprehension (Klingner & Vaughn, 1996; Saenz et al., 2005). Instructional adaptations to reduce extraneous language, increase student responses, and reinforce correct responses were used to scaffold students' limited English skills. All of the students made significant gains in reading supporting the use of supplemental explicit, systematic reading interventions for ELs, with attention given to the native language and English development when providing intervention in English to ELs.

Other reading intervention strategies found effective for this population include reciprocal peer tutoring followed with partner reading (Saenz et al., 2005) and reciprocal teaching combined with cooperative learning (Klingner & Vaughn, 1996). These two studies combined the use of cooperative and collaborative learning to help ELs learn from peers. When providing reading interventions to ELs, specific attention to the native language and English language development is recommended (Gyovai et al., 2009; Haager & Windmueller, 2001) because although ELs may improve reading skills, they will need a strong English language base to develop full literacy (Haager & Windmueller, 2001).

2.3 Interventions with ELs Who Are Struggling Readers

Ten studies conducted with ELs who were struggling readers in first to fifth grade add to the research conducted with ELs with LD. When combined, they provide strong evidence for the implementation of early intervention in reading using explicit and systematic instruction (Linan-Thompson, Vaughn, Prater, & Cirino, et al., 2006; Vaughn, Cirino, et al., 2006; Vaughn, Linan-Thompson, et al., 2006; Vaughn, Mathes, et al., 2006) that is sustained, intensive (Calhoon, Al Otaiba, Cihak, King, & Avahs, et al., 2007), and direct (Gerber et al., 2004; Healy, Vanderwood, & Edelston, et al., 2005; Kamps et al., 2007; Linan-Thompson et al., 2006; Moore-Brown, Montgomery, Bielinski, & Shubin, et al., 2005; Santoro, Jitendra, Starosta, & Sacks, et al., 2006; Vaughn, Cirino, et al., 2006; Vaughn, Linan-Thompson, et al., 2006; Vaughn, Mathes, et al., 2006). Furthermore, interventions for ELs with LD should incorporate English language development (Haager & Windmueller, 2001; Linan-Thompson et al., 2006; Vaughn, Cirino, et al., 2006; Vaughn, Linan-Thompson, et al., 2006; Vaughn, Mathes, et al., 2006). Some students who develop appropriate reading skills in the early grades begin to fall behind when they encounter more challenging content (Compton, Fuchs, Fuchs, Elleman, & Gilbert, 2008; Leach, Scarborough, & Rescorla, 2003; Kieffer, 2010; Lipka, Lesaux, & Siegel, 2006). Within this group of students, ELs are more likely than non-ELs to experience difficulty beyond third grade (Kieffer, 2010). In

addition to accurate and fluent decoding skills, successful readers demonstrate an understanding of language structures, and text structures and genres. They also have broad background knowledge and well-developed vocabulary (Rand Reading Study Group, 2002) explaining why the majority of ELs that struggle with reading have difficulty with fluency, vocabulary and comprehension (Francis, Rivera, Lesaux, Kieffer, & Rivera, et al. 2006), areas where more research is needed.

Although the intervention studies presented reveal some practices that are effective with ELs with reading difficulties, more research is needed to identify interventions that are appropriate for ELs with LD since students vary not only in their language proficiency but also in their ability to learn (Moore & Klingner, 2014) therefore, we should avoid drawing conclusions or overgeneralizing the effects of reading interventions for ELs with LD without first validating the practices with ELs with similar characteristics (Artiles, Trent, & Kuan, 1997; Artiles, Rueda, Salazar, & Higareda, et al., 2005).

3 Writing Interventions for ELs with LD

Writing development is intricately related to the development of oral language and reading (Berninger, 2008; Shanahan, 2006). There is evidence that writing instruction and practice facilitate and strengthen students' reading (Graham & Hebert, 2011). Despite the role of writing in developing literacy, the research on writing instruction has historically focused on secondary-aged students based on an assumption that children sequentially learn to read before they learn to write (Berninger, 2008). The "process writing" movement of recent years has encouraged a focus on writing instruction in the primary grades. Nevertheless, this approach is criticized as being based more on teacher philosophy or belief than on empirical evidence (Berninger, 2008; Pritchard & Honeycutt, 2006). Without the addition of explicit instruction, it has been found ineffective for students with LD and those who struggle with writing (Gillespie & Graham, 2014; Graham & Sandmel, 2011).

At this time there are few studies to suggest what works in improving writing outcomes for ELs with LD or ELs who struggle with literacy. Three empirical studies reported the effects of interventions on writing outcomes for ELs with LD in grades K-12 (De La Paz & Sherman, 2013; Monroe & Troia, 2006; Viel-Ruma, Houchins, Jolivette, Fredrick, & Gama, et al., 2010) and one included ELs with LD but data were not disaggregated (Early & Saidy, 2014). Despite the scarcity of research, there is some evidence to support explicit strategy instruction with this population. Of the four studies, the three that targeted revision strategies to improve the quality of writing demonstrated the most promising results. Researchers used strategy instruction (De La Paz & Sherman, 2013; Monroe & Troia, 2006) and direct writing instruction (Early & Saidy, 2014) to teach students to revise text. Viel-Ruma et al., 2010 used direct instruction to examine the effects of the Expressive Writing program.

Strategy instruction aims to increase student competency with various aspects of the writing process through the explicit teaching of writing strategies (e.g., brainstorming, drafting, and revision strategies) combined with the self-regulation strategies necessary to successfully engage in the process itself (e.g., perseverance and motivation). The effects of strategy instruction are often observed by examining the quantities and qualities of text revisions as well as improvements in the qualities such as content and organization of the text. Each of the three studies reviewed investigated the effects of an intervention in which both procedural revision strategies and self-regulation strategies were explicitly taught. De La Paz and Sherman (2013) and Monroe and Troia (2006) used self-regulation strategies. De La Paz and Sherman used explicit strategy instruction targeting the revision process using the Self-Regulation Strategy Development approach (see Harris & Graham, 1999) while Monroe and Troia employed multiple strategies, including strategies for planning, revising, and self-regulating.

De La Paz and Sherman (2013) studied the impact of Self Regulation Strategy Development (SRSD) on the quality of revisions of sixth grade students at a dual language charter school. Writing is a particularly complex process requiring strengths in self-regulation and executive function. Throughout the process of composition, students must maintain a simultaneous focus on several elements including organization, audience and purpose, mechanics, content, and coherence. The SRSD intervention was delivered in successive phases incorporating elements of effective instruction, including developing background knowledge, explicit teaching of new knowledge and skills, modeling with think aloud, guided practice with feedback, and independent practice. Strategy instruction additionally included coping and motivational strategies (self talk) to promote perseverance. Intervention students with LD made meaningful revisions to increasingly larger chunks of text, increasing the overall quality of their written essays and these gains were maintained for 1 month following the intervention. Monroe and Troia (2006) also studied the effects of multicomponent intervention that included strategies for planning, revising and self-regulation on students' persuasive essays. ELs with LD who received strategy instruction outperformed those who did not, even though the latter started with higher pre-intervention performance. Although the quality of treatment students' persuasive essays improved, the effects did not transfer to a different writing genre (creative narrative writing). The authors concluded that typical classroom instruction involving process writing would be enhanced by strategy instruction, especially for students who have writing difficulties. They also argued that multicomponent strategies such as the ones they taught may be more appealing to classroom teachers than single component strategy instruction.

Explicit instruction in writing without particular attention to revision and/or self-regulation strategies yielded mixed results. Viel-Ruma and colleagues (2010) investigated the effects of the Expressive Writing program on the writing quality and quantity of 6 high school students with LD, three of whom were Spanish-speaking English learners. The intervention used direct instruction to address writing mechanics, sentence writing, paragraph and story writing, and editing. The researchers examined changes in Correct Word Sequence (CWS), text length, and overall

quality of the writing as measured by the Spontaneous Writing portion of TOWL-3. Some gains were evident in CWS and text length but performance was too variable to draw any conclusions regarding the effectiveness of the approach for students with LD, including ELs with LD.

Early and Saidy (2014) investigated the effects of a multicomponent feedback approach to revision based on the conceptualization of writing as both a socially mediated and a cognitive/motivational process. The intervention incorporated direct writing instruction, model texts, self-led revision, and peer revision to improve students' competence at making substantive revisions to their argumentative essays. Although, treatment students made significantly more revisions in the developing argument category than control students, no significant effects were found for any of the other revision categories. Further, results were not disaggregated for ELs with LD or other disabilities, however they comprised half of the treatment group.

The results of these investigations corroborate much of the writing research conducted on monolingual populations with LD and suggest that ELs with LD and their monolingual peers may respond similarly to writing interventions shown to be effective. A number of meta-analyses examining the effects of interventions on the writing skills of students with LD have demonstrated that students with LD benefit from explicit instruction in handwriting and sentence construction (Datchuk & Kubina, 2012) and in writing strategies and metacognitive self-regulation strategies throughout the writing process (Gillespie & Graham, 2014). Less effective are interventions targeting grammar and conventions, as well as process-oriented writing instruction, the predominant instructional approaches historically used in general education (Berninger, 2008; Datchuk & Kubina, 2012; Gersten & Baker, 2001; Gillespie & Graham, 2014; Graham & Perin, 2007; Graham & Sandmel, 2011; Rogers & Graham, 2008).

4 Conclusion

The number of ELs in public schools is expected to continue to increase in the next 10 years. As a group they are not faring well and ELs with LD are particularly vulnerable. In this chapter we examined interventions that sought to improve students' language and literacy skills. Similar to other reviews (e.g. Gersten et al., 2007) we found that explicit instruction, strategy instruction, and self-regulation strategies support student learning across the three areas examined. The small body of research in each area precludes other generalizations. The area with the least research was language. Research in this area is needed because we know that language impacts learning and ELs begin school with smaller English vocabularies than their monolingual peers. We also need to understand the interaction between language proficiency and disability. This is critical not only for instruction but for accurate referral into special education. Given the importance of language in reading comprehension (National Reading Panel, 2000; Rand Reading Study Group, 2002) and how difficult it is for children who begin school with small vocabularies to overcome that

deficiency (Anderson & Nagy, 1992; Hart & Risley, 1995; National Reading Panel, 2000), this is an area of critical need. There is research being conducted with typically developing ELs that may prove useful. For example, morphology instruction has been shown to impact the reading comprehension skills of typically achieving Spanish-speaking ELs (Kieffer & Box, 2013; Kieffer & Lesaux, 2010) but its effect on ELs with LD is unknown.

Beginning reading instruction continues to be the best-researched area but even in this area there are only five studies that included ELs with LD. The majority of the research comes from interventions conducted with ELs who were struggling with reading. It is fortuitous that many of the practices found to be effective for students who are struggling are also effective for students with LD providing educators guidance. However, this may only apply to beginning reading. There is little intervention research with ELs with and without disabilities addressing reading comprehension and vocabulary development in upper elementary and secondary school and in writing. Finally, to better serve this group of students, more research is needed in a number of areas including ELs with LD from different language groups, in secondary, and in the different content areas.

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A Research-Validated Program for Improving At-Risk Students' Fraction Magnitude Understanding, Word-Problem Solving, and Explanations

Amelia S. Malone*, Lynn S. Fuchs, and Douglas Fuchs

Abstract In this chapter, we describe a research-validated Tier II intervention program designed to prevent at-risk students from developing significant difficulty with fractions. We provide an overview of the instructional strategies used to improve at-risk students' fraction magnitude understanding (i.e., comparing fractions, ordering fractions, and placing fractions on the number line), word-problem solving (i.e., multiplicative reasoning), and explanations (i.e., verbally explaining how to compare fraction magnitudes). We discuss each instructional strategy incorporated within the program to enhance these outcomes and explain how they can be effectively implemented to improve students' understanding of fractions. We conclude by discussing results from 4 years of intervention research testing the efficacy of the program. At-risk students who participated in the intervention program outperformed at-risk classmates receiving fraction instruction in the general education classroom on assessments of fraction magnitude understanding (i.e., number line estimation), calculations, released fraction items from the National Assessment of Educational Progress, multiplicative-reasoning word problems, and verbal explanations of magnitude comparisons.

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Students who struggle with mathematics require early intervention to prevent future failure with more complex mathematics concepts (Gersten et al., 2009; U.S. Department of Education, 2008). One mathematics topic particularly difficult for students is fractions (e.g., Brown & Quinn, 2007; Wu, 2001). (In this chapter, the term *fraction* refers to common fractions presented with a numerator and denominator.) For example, on the 2013 National Assessment of Education Progress (NAEP; U.S. Department of Education, 2013), 40 % of fourth-grade students were unable to identify the largest of four unit fractions. These difficulties continue in the secondary grades. On the same assessment, 65 % of eighth-grade students were unable to explain that $\frac{1}{2}+\frac{3}{8}+\frac{3}{8}$ was greater than 1. Fraction instruction typically begins in third or fourth grade, and developing conceptual understanding of fractions is a major focus of the fourth-grade curriculum (e.g., Common Core State Standards [CCSS], 2013). Two forms of conceptual understanding are hypothesized to be foundational for developing competence with fractions – part-whole (i.e., defining a fraction as a part of one whole) and magnitude (i.e., emphasizing the cardinal size of fractions; Hecht & Vagi, 2010). However, prior intervention research on fractions has largely focuses on part-whole understanding and procedures (e.g., Butler, Miller, Creham, Babbit, & Pierce, 2003; Cramer, Behr, Post, & Lesh, 2009), rather than magnitude understanding. In addition, instruction in the U.S. typically emphasizes part-whole understanding, and measurement understanding is often assigned a subordinate instructional role in U.S. classrooms (Hecht et al., 2003; Siegler, Thompson, & Schneider, 2011).

Proficiency with assessing fraction magnitude is fundamental to conceptual understanding (e.g., CCSS, 2013; National Mathematics Advisory Panel, 2008; Siegler et al., 2011). But as indicated by NAEP (2013) data, many students struggle with this topic. An improvement in magnitude understanding (i.e., the ability to order, compare, and place fractions on the number line) is hypothesized as key to improving students' conceptual understanding of fractions (e.g., Geary et al., 2008). However, previous to the series of studies summarized here, no intervention research has tested the effects of explicitly teaching magnitude understanding to improve students' conceptual understanding of fractions.

In this chapter, we describe instructional strategies used in a series of four randomized control trials testing the efficacy of a Tier II fraction intervention, focused on magnitude understanding, for improving at-risk students' conceptual understanding of fractions. These teaching strategies focus on explicitly teaching how to assess fraction magnitude using number lines (rather than simply defining a fraction as a part of a whole). (The instructional strategies described in the chapter are packaged as an intervention manual called *Fraction Face-Off*! [Fuchs, Schumacher, Malone, & Fuchs, 2015].) See (Fuchs, Schumacher, et al., 2013, Fuchs, Schumacher, et al., 2014, Fuchs, Malone, et al., 2015, Fuchs, Schumacher, et al., in press) for additional information specific to each study.

The following sections include a description of the student sample included in the four studies along with an overview of the assessments used to determine whether at-risk students in the intervention program outperformed comparable at-risk students who received general education instruction and, in many cases, also received school intervention. This is followed by an overview of the uniqueness of the intervention along with a description of the instructional strategies used in the program. In the program description, we outline the topics taught week-by-week in the core program (all tutored students received the core fractions program), followed by a description of multiplicative reasoning word-problem solving strategies (used in the Year 3 and Year 4 studies only) and ways to enhance students' explanations for assessing fraction magnitude (used in the Year 4 study only). We then provide an overview of results and a discussion of results from these four intervention studies, which provide support for the efficacy of the program for students at-risk for developing mathematics difficulties. Finally, we outline limitations and directions for future research..

1 Method

1.1 Participants

In the four studies, we defined risk as performing below the 35th percentile on a measure of whole number knowledge (i.e., the Wide Range Achievement Test – 4th Edition (Wilkinson, 2008)). (Because fourth grade is typically the first year of intensive focus on fractions, students' fraction knowledge is not sufficient for screening). At-risk students were then randomly assigned to intervention or control.

Each year, the project included approximately 240 fourth-grade students (ages 8–10) from 12 to 15 schools. The demographic profile of each of the samples was as follows: >50 % African American, <25 % Hispanic, <20 % White, <5 % other; <10 % identified with a learning disability; and approximately 90 % of students received reduced or free lunch. The mean IQ score was approximately 90 (estimated from the WASI Vocabulary and Matrix Reasoning subtests of the *Wechsler Abbreviated Scales of Intelligence*; Wechsler, 1999). Students were, on average, in the 28th percentile on a measure of oral comprehension (Listening Comprehension subtest of the *Woodcock Diagnostic Reading Battery*; Woodcock, 1997) and in the 46th percentile on the *Test for Word Reading Efficiency* (Rashotte, Torgesesn, & Wagner, 1999).

Students in the control group received their mathematics instruction in the general education classroom. In general (based on the textbook used and teacher report), classroom instruction emphasized the part-whole interpretation with little instruction (if any) on teaching how to assess magnitude with number lines. Many teachers reported that they largely focused on procedural methods for assessing magnitude (e.g., cross-multiplying).

1.2 *Fraction Measures*

We used five measures to index various dimensions of fraction performance. To assess students' ability to estimate fraction magnitude, we administered the *Fraction Number Line* (Hamlett, Schumacher, & Fuchs, 2011, adapted from Siegler et al., 2011). Students' ability to estimate fraction magnitude has been found to be a strong predictor of general mathematics achievement (e.g., Siegler et al., 2011). This computer number line test requires students to place 20 proper fractions, improper fractions, and mixed numbers on the 0–2 number line. Scores reflect estimation accuracy.

Fraction Calculations, from the *Fraction Battery-2012*-revised (Schumacher, Namkung, Malone, & Fuchs, 2012), assesses students' competence in adding and subtracting fractions, as appropriate at fourth grade. The test includes 12 addition and 12 subtraction problems – half with like denominators and half with unlike denominators.

The next fraction measure includes 19 released items from the NAEP (U.S. Department of Education, 1990–2009). Problems include published easy, medium, and hard problems at the fourth-grade level and the easy problems at the eighth-grade level. NAEP represents a generalized index of fraction knowledge, including part-whole and magnitude understanding. In this way, it indexes fraction knowledge that dominated control group instruction (part-whole knowledge) and intervention group instruction (magnitude knowledge).

Multiplicative Reasoning Word Problems (Year 3 and Year 4 only), from the *Fraction Battery-2012*-revised (Schumacher et al., 2012), index students' ability to problem solve with six word problems requiring division and six word problems requiring multiplication to solve.

Explaining Comparing Problems (Year 4 only), from the *Fraction Battery*-revised (Schumacher, Namkung, Malone, & Fuchs, 2013), indexes students' ability to verbally explain how to compare fraction magnitudes. Three of the nine comparison problems have the same numerator, three have the same denominator, and three have different numerators and different denominators (where one fraction is ½). Students first place the greater than or less than sign between the fractions (1 point per problem). Then they use words and/or pictures to explain why their answer makes sense (up to 5 points per problem): 2 points for explaining what the numerator means (i.e., number of parts), 2 points for explaining what the denominator means (i.e., size of parts), and 1 point for providing an accurate picture to back up their answer. See Figs. 4, 5, and 6 for example sound explanations.

2 Unique Features of *Fraction Face-Off*

The intervention program is unique in two important ways. First, the program focuses on the relative magnitude of fractions rather than the part-whole interpretation, which dominates instruction in U.S. classrooms. As already mentioned,

instruction in the control group focused on part-whole interpretation and procedural methods for assessing magnitude (e.g., cross-multiplying) (Fuchs, Schumacher, et al., 2013, Fuchs, Schumacher, et al., 2014, Fuchs, Malone, et al., 2015, Fuchs, Schumacher, et al., in press). However, teaching procedures without concepts likely leaves students confused and unable to judge the accuracy of their answers (Kilpatrick, Swafford, & Findell, 2001; Rittle-Johnson & Siegler, 1998), as both conceptual and procedural knowledge are important for developing an understanding of fraction magnitude (e.g., Rittle-Johnson, Siegler, & Alibali, 2001).

Second, the intervention program addresses each of the seven design principles outlined by Fuchs et al. (2008) for effective Tier II interventions: (a) instructional explicitness, (b) instructional design to minimize the learning challenge, (c) a strong conceptual basis for procedures taught, (d) drill and practice, (e) cumulative review, (f) progress monitoring, and (g) on-task behavior motivators. Instruction is explicit and lessons incorporate scaffolding to carefully break down concepts. Tutors provide a high level of instructional guidance as students progress from basic to advanced understanding of a concept. Each lesson incorporates modeling, guided practice, independent practice, and a discussion of errors if necessary (all key components of scaffolding, e.g., Archer & Hughes, 2011). In this way, the intervention program anticipates students' misconceptions by precisely defining concepts.

The comparing strategies used throughout the program are conceptually based. Tutors use instructional tools (e.g., fraction tiles/circles, number lines) to support understanding of these comparing strategies. Because previous research supports an iterative process of developing conceptual and procedural knowledge (e.g., Rittle-Johnson et al., 2001), the intervention comparably emphasizes both concepts and procedures but delays the introduction of procedures until concepts are taught and practiced. For example, the intervention program emphasizes the conceptual basis for comparing fraction magnitudes by teaching children comparing strategies that precisely define the difference between thinking about the number of parts (i.e., same denominator) or the size of the parts (i.e., same numerator) to compare fractions. This stands in contrast to immediately teaching a procedure (e.g., cross-multiplying) to compare fraction values, which fails to provide a conceptual framework for why the procedure works (e.g., Hecht & Vagi, 2010; Kilpatrick et al., 2001; Rittle-Johnson & Siegler, 1998).

Consistent systematic practice ensures students have ample time to master each of the strategies taught. The denominators of the fractions presented during tutoring are restricted to halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths, which minimizes the learning challenge for these struggling students (as many of these students have difficulty with basic facts and multiplication). Once all the comparing strategies are introduced, students independently practice new concepts and review all previously taught material. Tutors monitor students' progress by checking work and requiring students to verbally explain strategies they used to complete problems. For students who cannot explain answers, tutors reteach concepts to mitigate misconceptions.

The intervention program also incorporates a systematic behavior management system to ensure students remain on task and work hard. Students are held accountable for their behavior at random intervals (with a timer) during tutoring. If students fail to self-regulate their behavior and remain on task or do not produce accurate work, they do not earn fraction money (pretend money) to use for prizes.

3 Description of Intervention

3.1 Core Program

The core program consists of 36 lessons, delivered three times per week for 12 weeks. Topics include comparing fractions, placing fractions on the number line, ordering fractions, and fraction calculations.

Week 1 Lessons 1–3 focus on fraction vocabulary (i.e., *fraction*, *unit*, *numerator*, *denominator*, *proper fraction*, *improper fraction*, *equivalent*) and developing an understanding of what a fraction represents. The following definitions reflect the language tutors used to define fraction vocabulary. A *fraction* is a number that describes exactly how many parts of something there are. A fraction indicates parts of a *unit*, or one whole thing. A unit must be divided into *equal* parts. To have equal parts, all of the parts must be the same size. A fraction has a numerator and a denominator. The *numerator* refers to how may equal parts there are in the fraction. The *denominator* refers to how many equal parts the unit is divided into. The numerator and denominator work together to make the fraction. A fraction, with its numerator and denominator, is one number.

A *proper fraction* is a fraction less than one. An *improper fraction* is a fraction equal to 1 or greater than 1 (improper fractions greater than 1 and less than 2 are introduced later in the tutoring program). A fraction equal to 1 has the same numerator and the same denominator. A fraction equal to 1 has all of its equal parts and is the whole unit. *Equivalent* is a fancy word for equal. Fractions that are equivalent tell us about the same amount.

Once tutors introduce foundational fraction vocabulary, they focus on demonstrating the principle that when a unit is divided into more equal parts, each part gets smaller. Many students struggle with the notion that a smaller denominator indicates the unit is divided into larger parts. Although the focus of tutoring was assessing relative magntiudes of fractions, initial instruction focuses on students' prior knowledge by teaching comparing fraction amounts using part-whole and equal-share interpretations, using manipulatives and number lines to emphasize this concept. Unit fractions (i.e., fractions with 1 in the numerator) are introduced first.

For example, in Lesson 2, tutors use fraction circles (i.e., halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths) to visually demonstrate that a unit divided into more equal parts (e.g., comparing twelfths with halves) has smaller

parts. This is introduced and reinforced with a sharing example: "If we pretend the unit is a cookie, would I rather share the cookie with two people or twelve people if I want the bigger piece?" Looking at the fraction circle pieces, students can visually see that ½ is greater than 1/12. Tutors then introduce the greater than and less than signs and teach students how to place the signs between fractions accompanied with the fraction circle pieces, and then abstractly on a worksheet. This sharing example is reinforced with fraction tiles in Lesson 3, and tutors relate the sharing example with number lines.

Week 2 In Lessons 4–6, manipulatives are faded and students learn how to compare fractions using prompt card rules. Students practice comparing fractions with the same denominator, the same numerator (both unit and non-unit fractions), and fractions equivalent to 1. The "Compare Card" outlines steps for each of these comparison types.

If the fraction have the same denominator, students refer to the rule "bigger numerator, bigger fraction." Tutors explain that if two units are divided into the same number of parts (i.e., same denominator), the parts are the same size. The fraction with more same size parts is bigger, so the numerator helps the student decide which is the bigger fraction. If the fractions have the same numerator, they refer to the rule "fewer parts, bigger fraction." Tutors build upon the equal-shares example and explain that if a unit is divided into fewer parts, or not as many parts, each of the parts is bigger. Because they have the same number of parts in the fraction (i.e., same numerator), the size of the parts helps them decide which fraction is larger. If the fractions have different numerators and different denominators, students first ask themselves if they are equivalent. At this point in the program, students only know how to identify fractions equivalent to one-whole. They must explain why each of the fractions is equivalent to one-whole (i.e., each fraction has the same numerator and denominator). Each of these Compare Card rules is reinforced using number lines and fraction tiles/circles to show why they work.

Week 3 Lessons 7–9 introduce using ½ as a benchmark fraction to assess magnitude. These lessons focus on understanding what ½ means and how to easily identify fractions equivalent to ½. Students first learn how to write equivalent fractions for ½ using multiplication. In Lesson 8, tutors introduce the "Doubling Rule," which states that if double the numerator is equal to the denominator, the fraction is equivalent to ½. The Doubling Rule is used throughout the program to provide students an easy way to identify whether a fraction is equivalent to ½. Tutors then introduce a new rule on the Compare Card for students to compare fractions with different numerators and different denominators when one fraction equals ½. For example, when comparing 5/8 and ½, students identify that the two fractions have different numerators and different denominators and that one fraction equals ½. They are then prompted to use the Doubling Rule to rewrite ½ to have the same denominator (e.g., 4/8) so they can use the same denominator rule to compare the fractions (i.e., bigger numerator, bigger fraction).

Week 4 In Lessons 10–12, tutors introduce placing one fraction on the 0–1 number line using the 0–1 Number Line Card. When students first learn how to place fractions on the number line, ½ is marked in the middle. Tutors reinforce the idea that placing fractions on the number line is just like comparing fractions. The 0–1 Number Line Card first asks students to identify ½. Students point to ½ (this helps them later on in the program, when ½ is removed from the number line), and identify which side is less than ½ (i.e., the left-hand side between 0 and ½) and which side is greater than ½ (i.e., the right-hand side between ½ and 1).

After students learn to identify ½, the 0–1 Number Line Card prompts them to "compare the fraction to ½ and write L or G." Students write an "L" underneath the fraction if it is less than ½ or a "G" if it is greater than ½. Students identify whether the fraction they need to place on the number line has the same numerator as ½, or if they need to rewrite ½ to have the same denominator using the Doubling Rule. They then compare to ½ and place the fraction on the less than side or the greater than side. At this point in the program, tutors do not focus on exact placement of the fraction. Rather, students are only required to decide whether the fraction is less than or greater than ½.

Week 5 In Lessons 13–15, tutors introduce placing two fractions on the 0–1 number line, followed by an introduction to ordering fractions from least to greatest. For placing two fractions on the 0–1 number line, students follow the same steps on the 0–1 Number Line Card and decide if each fraction is less than ½ ("L") or greater than ½ ("G"). If both fractions are less than ½ ("LL") or greater than ½ ("GG"), the card prompts students to place two marks on the appropriate side of the number line and then compare the fractions to one another to decide the order of magnitude. This introduces students to the idea of exact placement of fractions on the number line. That is, if two fractions are less than ½, the bigger fraction goes closer to ½ on the less than side whereas the smaller fraction goes closer to 0 on the less than side.

Students then learn how to order three fractions from least to greatest using the same strategies outlined on the Compare Card and 0–1 Number Line Card. Tutors introduce the Ordering Card, which is almost identical to the Compare Care. Students decide if the fractions have the same denominator, the same numerator, or different numerators and different denominators. If the fractions have the same numerator or denominator, they can order the three fractions right away. If all of the numerators and denominators are different, students learn to compare each fraction to ½ to decide if it is less than or greater than ½. When ordering is first introduced, the problems all have ½ as one of the fractions to make it easier to compare to ½. Just like the 0–1 Number Line Card, students write an "L" underneath the fraction if it is less than ½; a "G" underneath if it is greater than ½; or an equal sign if the fraction is ½. They can then easily order them from least to greatest.

Week 6 In Lessons, 16–18, tutors link comparing fractions, placing fractions on the number line, and ordering fractions. This link is a crucial point in the program. Tutors solve each type of magnitude comparison problem with the same fractions and discuss how each of these things is the same. Each requires students to think

about how big or small a fraction is using the same steps. This is followed by a review of all concepts taught thus far, and an introduction to improper fractions and mixed numbers greater than 1 and less than 2.

Week 7 In Lessons 19–21, students learn how to convert improper fractions to mixed numbers and vice versa. An additional prompt card aids them in doing this. To convert an improper fraction to a mixed number, tutors emphasize that because an improper fraction is greater than 1, students must subtract 1 to help them rewrite it as a mixed number. Students first write a fraction equal to 1 with the same denominator next to the improper fraction. Then, they subtract. They then add the whole number 1 to the resulting proper fraction to get a mixed number. (Note: Although the program never introduces improper fractions greater than 2 in the program, students can repeat the first step until their answer is a proper fraction and add the proper fraction to the number of "wholes" they subtracted). The prompt card for changing mixed numbers to improper fractions reverses these steps with addition.

Students then practice making these conversions and learn how to place fractions on the 0–2 number line. Tutors introduce the 0–2 Number Line Card. The steps parallel that of the 0–1 Number Line Card, but require students to first think about whether the fraction is less than 1 (i.e., proper), or greater than 1 (i.e., improper or mixed). If the fraction is improper, they must first convert it to a mixed number before placing it on the number line. Once students decide which side of 1 the fraction goes on, they use the same steps as before to decide whether the fraction is greater than or less than ½ or greater than or less than 1 ½.

Week 8 Lessons 22–24 are review. Students practice comparing fractions (proper, improper, mixed), placing fractions on the number line (0–1 and 0–2 number lines), and ordering fractions from least to greatest. No new topics are taught.

Week 9 In Lessons 25–27, students learn how to add and subtract fractions with like and unlike denominators. At first, all problems with unlike denominators have ½ or 1 as one of the fractions to rewrite, as these are the fractions students are fluent in converting. Students also learn to rewrite their answer if it is improper (change to mixed), equal to ½ (reduce), or equal to 1 (reduce). Guided and independent practice during this week focuses on all topics taught, similar to the previous week.

Week 10 In Lessons 28–30, students learn how to write equivalent fractions for 1/3, 1/4, and 1/5 using multiplication. This skill is incorporated into comparing fractions and adding/subtracting fractions with unlike denominators. During this week, ½ is removed from the 0–1 number line and ½ and 1 ½ are removed from the 0–2 number line. At this point, students should be fluent in identifying where ½ (0–1 number line) and ½ and 1 ½ (0–2 number line) are on the number line. They follow the same steps on the Number Line Card.

Week 11 In Lessons 31–33, students continue learning how to write equivalent fractions with multiplication. This week focuses on the rewriting equivalent fractions for 2/3 and 3/5. These fractions are then incorporated into comparing problems and

addition/subtraction with unlike denominators. Students continue to practice all topics taught during guided and independent practice.

Week 12 Lessons 34–36 are also review. Students participate in the "Fraction Championship." They spin a spinner that directs them to complete a type of problem (comparing fractions, placing fractions on the 0–1 or 0–2 number lines, ordering fractions, adding/subtracting fractions, or converting an improper fraction to a mixed number or vice versa). Problems are divided into easy, medium, and hard problems and students earn points for accurately completing each problem. Students then practice all topics on guided and independent practice. The student with the most points at the end wins the championship.

3.2 Multiplicative Reasoning Word-Problem Solving Strategies

Year 3 and Year 4 tested the effects of teaching how to solve multiplicative reasoning word problems. This occurred in a 5–8-min word-problem warm-up activity. "Splitting" problems require division (e.g., Jessica has three cakes and cuts each cake into thirds. How many pieces of cake does Jessica have?). "Grouping" problems require multiplication (e.g., Natalie wants to make four necklaces for her friends. For each necklace, she needs one half yard of string. How many yards of string does she need?). Instead of teaching procedural methods for multiplying and dividing fractions (which is not a curriculum focus in fourth grade), tutors teach students to think about the following: (a) what the story is about; (b) what is known and unknown in the story; (c) whether the story talks about cutting, dividing or splitting something (i.e., splitting problems) or grouping things together (i.e., grouping problems). Once students can identify this information, the tutor teaches them to label information in their word problem, draw a table to organize the known information, solve the problem, and attach the appropriate label to the numerical answer.

Instruction begins with Splitting Problems (Week 3). Tutors teach students to first identify what is unknown in the problem, then identify the units and the size of the pieces and label them "U" and "S." The tutor then teaches students how to organize this information in a table to numerically solve the problem. Instruction focuses on how to identify a splitting problem with language such as "cut," "divide," or "split," along with extending students' understanding of the underlying problem type by changing the word problem structure and vocabulary. See Fig. 1 for an example solved splitting problem.

In Week 6 of the program, tutors introduce Grouping Problems (Lesson 16). The problem-solving structure is similar to that of Splitting Problems, but students identify the number of items and the size of each item and label them "I" and "S" (rather than units and size in Splitting Problems). This distinction captures the notion that in Grouping Problems, the word problem starts with something small (i.e., the size of the pieces), and requires grouping the items (or the pieces) together to figure out

Splitting Problem Example

U S

Blake has 2 lemons. He cuts each lemon into thirds. How many pieces of lemon does Blake have now?

2 U	$\frac{1}{3}$ S
1	$\frac{1}{3}+\frac{1}{3}+\frac{1}{3}$
1	$\frac{1}{3}+\frac{1}{3}+\frac{1}{3}$

Answer: 6 pieces of lemon

Fig. 1 Example solved splitting problem

Grouping Problem Example

S I

Manny needs $\frac{1}{3}$ quart of potting soil for each plant. He has 7 plants to plant. How many quarts of potting soil will Manny need?

$\frac{1}{3}$ **S**	
7 **I**	$\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{3}$

Answer: $2\frac{1}{3}$ quarts of potting soil

Fig. 2 Example solved grouping problem

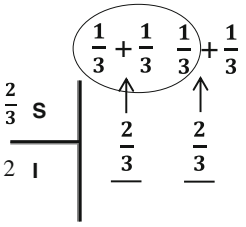
the answer. The table students learn to draw to organize known information and solve the problem also captures this distinction. See Fig. 2 for an example solved grouping problem.

In Week 8 of the program (Lesson 22), instruction focuses on teaching students how to distinguish between the two problem types. This includes a discussion that not all word problems are Splitting or Grouping problems and students must think about what the story is about before identifying a strategy for solving the problem. The problems also become more difficult at this point in the program. For example, Grouping Problems include non-unit fractions, which increases the steps students must complete before solving the problem (see Fig. 3).

Grouping: Non -Unit Fractions

S I

Ray needs $\frac{2}{3}$ cup of flour to make a loaf of bread. He's making 2 loaves of bread. How many cups of flour does Ray need?



Answer: $1\frac{1}{3}$ **cups of flour**

Fig. 3 Example solved grouping problem with non-unit fractions

3.3 Enhancing Students' Explanations for Comparing Fraction Magnitudes

Year 4 tested the effects of teaching students how to explain why one fraction was greater than or less than another fraction. This occurred during a 5–8-min explanation warm-up activity. The explanation component begins in Week 3, after which foundational fraction vocabulary and basic magnitude comparisons are taught. The explanation condition includes instruction in three types of comparison problems: same denominator, same numerator, and different numerators and different denominators (one fraction equals ½). Tutors introduce same denominator problems first (Lessons 7–12), followed by same numerator problems (Lessons 13–18). Lessons 19–24 include a series of activities to teach students the distinctions between explanations for same denominator versus same numerator problems. Tutors then introduce problems with different numerators and different denominators (one fraction equals ½; Lessons 25–27), followed by a review of all problem types (Lessons 28–36).

For all problem types, the explanation problem-solving sequence includes the following: (a) write what is known, (b) draw the fractions, (c) label the picture to show how to solve it (i.e., label fractions, label parts, and circle the bigger amount), and (d) write the answer and why the answer makes sense. Tutors first provide a rationale for why each step is important and model what students should think about and write for each problem-solving step by. After modeling, tutor and students practice solving problems together.

For the first step (i.e., write what is known), tutors instruct students to write whether the fraction pairs have the same denominator ("same D"), the same numerator ("same N"), or different numerators and different denominators ("both diff"). For the second step (i.e., draw the fractions), tutors emphasize that a good fraction drawing includes the following: (a) drawing two units the same size (i.e., start and end at the same place), (d) dividing each unit into the appropriate number of parts (i.e., the denominator), (c) ensuring that all of the parts within each unit are the same size, and (d) shading the appropriate number of parts (i.e., the numerator).

For the third step (i.e., label picture to show how to solve it), tutors instruct students to think about three things. First, label each fraction drawing with its appropriate value. Second, label the parts. For same denominator problems, the phrase "same size parts" indicates that each unit is divided into the same number of parts. For same numerator problems, the phrase "bigger parts" indicates that the fraction with fewer parts has bigger parts. For problems with different numerators and different denominators (one fraction equals ½), tutors instruct students to first rewrite ½ so both fractions have the same denominator. After rewriting ½, tutors emphasize the importance of updating the picture by showing how ½ is equivalent to the rewritten fraction. For example, if the problem requires students to rewrite ½ as 4/8, tutors show students how to then divide the unit into eight equal parts to show that ½ is equivalent to 4/8. In this way, students can see that finding a common denominator allows them to compare fractions with the same size parts. The comparison problem then parallels a same denominator problem. Third, circle the larger fraction.

For the final step (i.e., write the answer and why the answer makes sense), tutors teach students to write a short sentence to show that they understand why the circled fraction is greater. A good sentence includes information about both the number of parts and the size of the parts. For same denominator problems, the sentence "more same size parts means bigger fraction" captures an understanding that when two units are divided into the same number of parts (i.e., the same denominator), the fraction with more parts is bigger (e.g., 5/8>1/8). This sentence also applies to comparison problems with different numerators and different denominators (when one fraction equals ½). Once students rewrite ½ to have a common denominator, the explanation problem parallels a same denominator problem. For same numerator problems, the sentence "same number of parts, but fourths are bigger than eighths" captures an understanding that when two fractions have the same number of parts (i.e., same numerator), the size of the parts indicates which is greater. See Figs. 4, 5, and 6 for example solved problems for each problem type.

In Lessons 19–24, instruction focuses on discriminating between explanations for same denominator versus same numerator problems. In these six lessons, tutors solve a same denominator and same numerator problem side by side. Tutor and students discuss distinctions between the two problem types, which center on what students should write when they think about the number of parts versus the size of the parts to explain why one fraction is greater. Tutors highlight the differences between the two problem types. For same denominator problems, each unit is divided into the same number of parts (i.e., same size parts). This stands in contrast to same numerator problems, where each unit is divided into a different number

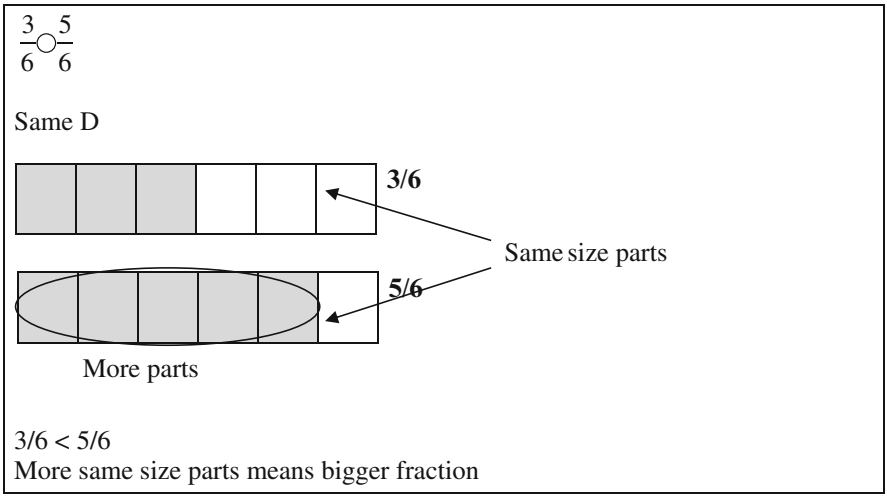


Fig. 4 Example sound explanation for same denominator problem

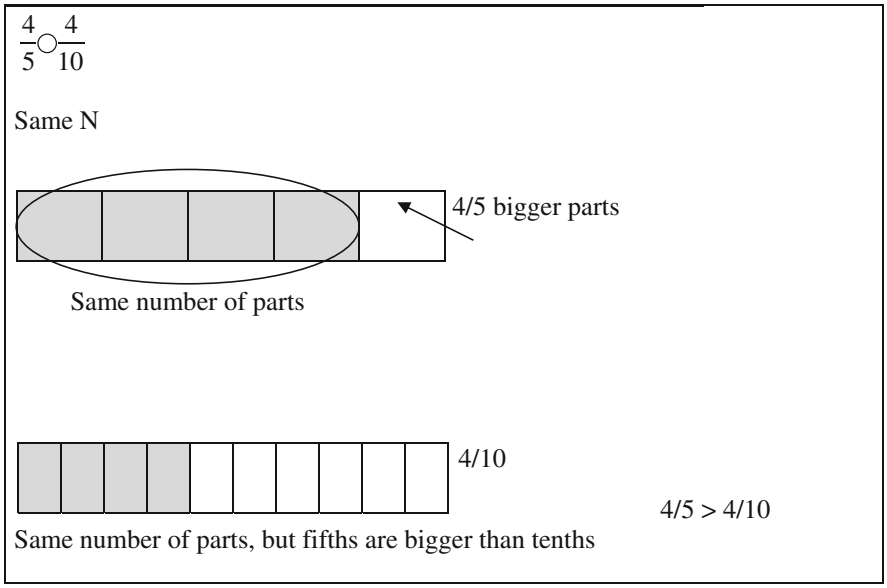


Fig. 5 Example sound explanation for same numerator problem

of parts (i.e., different size parts). For same denominator problems, one fraction has more parts shaded than the other fraction, whereas same numerator problems have the same number of parts shaded. Tutors also highlight the different explanation sentences for why the answer makes sense.

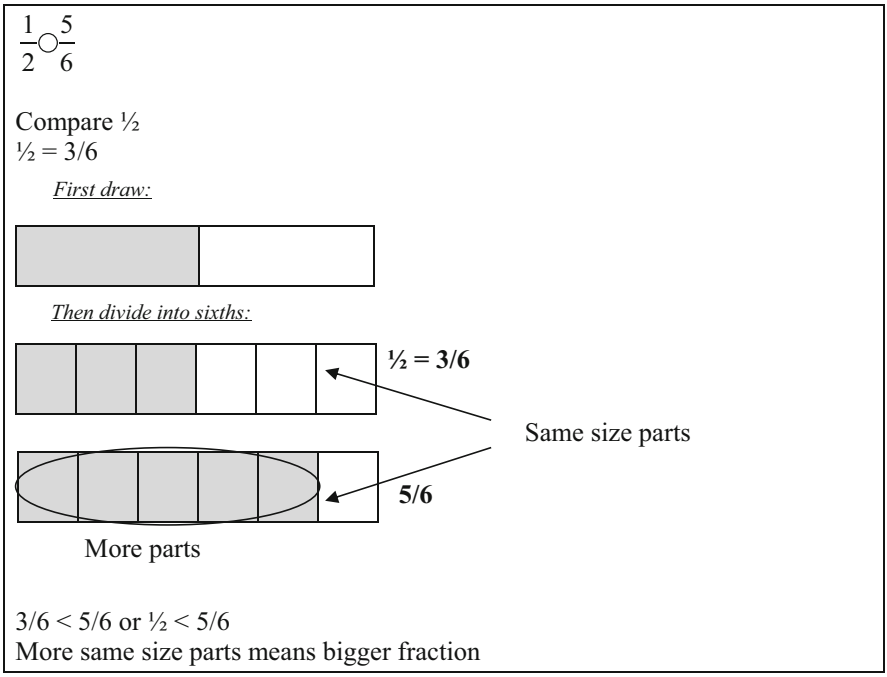


Fig. 6 Example sound explanation for different numerator, different denominator (one fraction equals ½) problem

4 Overview of Results

See (Fuchs, Schumacher, et al., 2013, Fuchs, Schumacher, et al., 2014, Fuchs, Malone, et al., 2015, Fuchs, Schumacher, et al., in press) for a detailed description of study methods and results. Each year, at-risk students who participated in the intervention program significantly outperformed at-risk students receiving the schools' standard fraction instructional program. This was the case on *Fraction Number Line*, *Fraction Calculations*, *NAEP*, *Multiplicative Reasoning Word Problems* (assessed only in Year 3 and Year 4), and *Explaining Comparing Problems* (assessed only in Year 4). In the four intervention studies, effect sizes (ESs; comparing intervention to control) were large, ranging from 0.63 to 1.09 for Fraction Number Line, 1.17–2.50 for Fraction Calculations, and 0.49–0.92 for NAEP. The ES for Multiplicative Reasoning Word Problems was also large (1.14 for Year 3 and 1.20 for Year 4) as was the case for Explaining Comparing Problems in Year 4 (1.18).

Given that the primary goal for early intervention for students with mathematics difficulties is to narrow the achievement gap between them and their peers, it is important to note that the intervention program also effectively reduced the achievement gap between at-risk students who received the intervention versus their

not-at-risk classmates. In fact, in some instances, the at-risk intervention group outperformed the not-at-risk group. Data were collected for not-at-risk classmates on group measures: Fraction Calculations, NAEP, and Multiplicative Reasoning Word Problems (Year 3 and Year 4). For all these measures, the intervention significantly reduced the achievement gap, whereas the achievement gap widened for at-risk students who received the standard school program. Most notably, the achievement gap completely diminished for both Fraction Calculations and Word Problems (Year 3 and Year 4), and at-risk students surpassed their not-at-risk classmates on these measures.

5 Discussion

Fraction Face-Off! is a validated Tier II intervention. The program described in this chapter explicitly teaches students how to assess fraction magnitude with conceptual comparing strategies to compare fractions, order fractions, and place fractions on the number line, while addressing each of the seven design principles outlined by Fuchs et al. (2008) for effective Tier II intervention. Findings indicate that when interventions integrate state-of-the-art understanding about a mathematics domain (such as fractions) with strong instructional design, important benefits can be realized in dramatically boosting the performance of students at-risk for developing mathematics difficulty.

Rather than relying on procedural methods for assessing magnitude (e.g., cross-multiplying – which dominated instruction about fraction magnitudes in the standard school program), the program explicitly defines vocabulary, concepts, and strategies, which helps to anticipate students' misconceptions and remediate errors if necessary. The program emphasizes the conceptual basis for comparing fraction magnitudes by teaching children comparing strategies that precisely define the difference between thinking about the number of parts (i.e., same denominator) or the size of the parts (i.e., same numerator) to compare fractions. Across 4 years of intervention research, the fraction intervention has shown to effectively boost at-risk students' conceptual understanding of fractions. That is, students who received the intervention outperformed at-risk students who did not receive the intervention. In addition, the achievement gap between at-risk and not-at-risk students diminished for Calculations and Word Problems and significantly decreased for NAEP.

This supports previous research, which suggests that increasing conceptual understanding of mathematics topics has a greater influence on the development of correct procedures than the other way around (e.g., Rittle- Johnson & Alibali, 1999). Even though the intervention spent little instructional time on addition and subtraction, for example, the intervention program produced superior achievement on fraction calculations. This is likely due to intervention students' increased capacity to determine whether a procedure makes sense (e.g., Rittle-Johnson & Alibali, 1999; Wu, 2008). For example, rather than expect students to independently recognize

that a unit fraction with fewer parts (e.g., ½) is greater than a unit fraction with more parts (e.g. 1/8), students learn a same numerator rule (e.g., fewer parts, bigger fraction) to recognize this comparing pattern. For comparisons with different numerators and different denominators, students compare each fraction to ½ (a benchmark fraction) to assess relative magnitude. This stands in contrast to the schools' standard fraction program, which spends a greater amount of time on procedures (e.g., cross-multiplying) and part-whole understanding.

Of course, each study has limitations. Two important limitations are outlined that pertain to all four studies described in this chapter. First, we relied on analysis of the textbook(s) used in the district where the study took place, along with teacher report, to determine that the instructional emphasis in the classroom was part-whole understanding and procedures. We did not conduct live observations to code how fractions were taught in the classroom. However, given the strong positive effects favoring the treatment group, we are reasonably convinced that focusing on magnitude understanding in an explicit intervention has dramatic effects for students at-risk for developing mathematics difficulty. Second, magnitude understanding should not be viewed as incongruent with part-whole understanding. Both are important to increasing students' conceptual understanding of fractions. In addition, other interpretations of fractions should also be considered when devising interventions. The division interpretation, for example, requires students to understand that a fraction, a/b, is the resulting number obtained by dividing a by b (e.g., Wu, 2008). The division interpretation is related to magnitude, but future research should investigate whether addressing fraction as division (concurrently with magnitude) adds value to an intervention designed to increase students' conceptual understanding of fractions.

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Working Memory and Strategy Instruction in Children with Learning Disabilities

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Abstract The purpose of this chapter is to review some of the instructional research completed in our lab related to improving memory performance in children with reading and/or math disabilities. We review studies that focus on (1) the effects of strategy knowledge and strategy training on the working memory (WM) performance as a function of dynamic testing conditions, (2) transfer effects as a function of direct training on WM tasks, and (3) the effects of strategy training on problem solving and transfer measures as a function of variations in working memory capacity.

Keywords Reading disabilities • Working memory • Strategies • Strategy knowledge

Memory is the ability to encode, process, and retrieve information that one has been exposed to. As a skill, it is inseparable from learning and academic functioning. Individuals deficient in memory skills, such as children with learning disabilities (LD), would be expected to have difficulty on a number of academic and cognitive tasks. In addition to memory performance being linked to performance in several academic (e.g., reading) and cognitive areas (see Swanson & Ashbaker, 2000, for review), it is a critical area of focus in the field of LD for three reasons. First, it reflects applied cognition; that is, memory functioning reflects all aspects of learning. Second, several studies suggest that the memory skills used by students with LD do not appear to exhaust, or even to tap, their ability, and therefore we need to discover instructional procedures that capitalize on their potential. Finally, several intervention programs that attempt to enhance the overall cognition of children and adults with LD rely on principles derived from memory research. This chapter selectively reviews our attempts to improve memory performance in children with

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LD in reading and/math. Because of the vastness of the topic (see Swanson & Stomel, 2012; Swanson & Zheng, 2013, for a comprehensive review of memory research on LD), however, we have limited ourselves to one aspect of memory: working memory. Working memory (WM) was selected because of it robustness in predicting academic achievement in children across a broad array of academic domains (Swanson & Ashbaker, 2000, for review). Further, WM plays a critical role in defining learning disabilities, as supported by studies demonstrating close links between measures of WM and measures of learning (see Swanson & Siegel, 2001a, Swanson & Siegel, 2001b, for a review). Prior to our discussion, however, we will operationally define four key terms: learning disabilities, WM, short-term memory (STM) and strategies.

1 Definition of Terms

Children with LD are defined as those individuals whose performance is in the normal range on standardized intelligence tests, but perform below the 25th percentile on standardized achievement measures of word recognition and/or arithmetic (see Geary, 2013; Siegel & Ryan, 1989, for rationale). These reading and/or arithmetic deficits are not due to inadequate opportunities to learn, general intelligence, physical or emotional disorders, but to basic disorders in specific psychological processes that are a reflection of neurological, constitutional, and/or biological factors.

Working memory is defined as a processing resource of limited capacity, involved in the preservation of information while simultaneously processing the same or other information (e.g., Baddeley & Logie, 1999; Engle, Tuholski, Laughlin, and Conway (1999). It is assumed that tasks that measure WM assess an individual's ability to maintain task- relevant information in an active state and to regulate controlled processing. For example, individuals performing WM tasks must remember some task elements and ignore, or inhibit, other elements as they complete task-relevant operations (e.g., Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). Working memory tasks typically engage the participant in at least two activities after initial encoding: (1) response to a question or questions about the material (or related material) to be retrieved and (b) the retrieval of sets of items of increasing difficulty. The first activity (question) serves as a distractor to the initial encoding of items, whereas the second activity taps storage. In contrast, tasks that measure STM typically involve situations that do not vary from initial encoding (e.g., Unsworth & Engle, 2007). That is, participants are *not* instructed to infer, transform, or vary processing requirements. In most cases, participants are simply asked to reproduce a sequence of items in the order they were presented.

Strategy instruction includes teaching an organized sequence of responses in order to deliberately help the participant access to information or to solve a problem. Strategy instruction guides the participant toward representing various stages

of information gathering (e.g., identifying what information is important) and processing (e.g., visual representation) (e.g., see Montague, Krawec, Enders, & Dietz, 2014).

2 Previous Training Studies

Previous research on improving memory performance in children with reading and/or math disabilities had primarily focused on STM performance. The most comprehensive quantitative review of STM research in terms of interventions for children with LD was published some time ago (O'Shaughnessy & Swanson, 1998), but did cover a 25-year period. The synthesis analyzed published studies that directly compared readers with LD to average readers on at least one short-term measure. The majority of studies reviewed in the synthesis involved 3rd through 6th grade students. Effect sizes (ESs) were computed for each experiment to reflect the relationship between the mean memory score of the learning disabled group (reading disabled in this case) as compared to the mean memory score of the average achieving. Negative values for ES represented poorer STM performance in the learning disabled group (e.g., an ES of −.50 suggested that the mean score of students with LD was ½ standard deviation below the mean score for normally-achieving students). For comparisons, an ES magnitude of 0.20, in absolute value, is considered small, 0.50 is moderate, and 0.80 is considered large (Cohen, 1988).

The important findings of the synthesis were as follows:

1. The overall mean ES for studies that provided strategy instructions (e.g., rehearsal and sorting items into groups) for verbal stimuli was −0.54; which was lower, but not much, when compared to studies that did not provide instructions (ES = −0.71). This indicates that although STM performance of students with LD improved with training in cognitive strategies, their performance was still well below that of average readers.
2. The LD group performed more poorly on tasks requiring memorization of verbal information in comparison to the average achieving group (an overall mean ES of −0.68).
3. Short-term memory tasks that required readers with LD to recall exact sequences of verbal stimuli, such as words or digits, immediately after a series was presented, yielded a much greater overall mean ES (ES = −0.80) than nonverbal serial recall tasks (ES = −0.17). Thus, compared to average readers, the relative serial recall performance of students with LD in reading was much poorer with verbal material than it was with nonverbal stimuli.
4. Memory tasks that involved the auditory presentation of verbal stimuli resulted in an overall mean ES of −0.70, while those that involved a visual presentation of verbal stimuli resulted in an overall mean ES of −0.66. Thus, the inferior verbal memory performance of students with LD appears unrelated to the modality in which a stimulus is received.

In summary, this quantitative analysis of the literature indicated that children with LD are inferior to their counterparts on measures of STM, even under strategy conditions. Although the link between STM functioning and achievement seems like a promising avenue for intervention research in children with LD, the advantage of such a focus is questionable since the correlations between short-term memory and achievement have generally been poor (Swanson, 1999a; Swanson & Ashbaker, 2000; see Swanson, Jerman, & Zheng, 2010, for a review). One of the reasons for these poor correlations is that STM, as reflected on digit span tests, is sensitive to rehearsal, grouping, and recognition of patterns that are idiosyncratic to digits, whereas these elaborate strategies are probably not generalized in cognitive tasks like reading.

Thus, we have attempted to direct our intervention studies to measures of WM because it is viewed as an active memory system directed by a central executive. This is important because the central executive can become a focus of instruction and influence on academic performance. We now review three lines of our research linking academic and WM interventions in children with LD.

2.1 Strategy Knowledge and Working Memory

Although the research is fairly clear that children with LD in reading and/or math fail to implement memory strategies spontaneously and efficiently (see O'Shaughnessy & Swanson, 1998), the research has been unclear, however, as to whether such children's knowledge base about strategies is deficient and/or if such children can be taught to use strategies on WM tasks to improve performance. The general importance of strategy knowledge has been shown in the child development research on meta-memory (see Swanson & Stomel, 2012, for review). While this research has mapped the strategy development of normal achievers, the relationship between strategy knowledge and its influence on actual memory performance in children with LD is less clear. For example, Swanson (1993) compared strategy knowledge between children with and without LD. Although children with LD (either in reading and/or math) were inferior in WM span scores to average achievers, Swanson found that strategy knowledge did not vary significantly between ability groups. He also found that some strategies were selected more often than others (showing that strategy choices were not random) and the strategy choices matched the demands of the task (also see Swanson, Kehler, & Jerman, 2010).

To illustrate our intervention studies that attempt to link strategies with WM performance, we will briefly review our testing procedures. Like several of our studies, WM tasks are presented under various conditions to enhance overall performance. One of the most common procedures we have used is to scaffold feedback under cued conditions (referred to as dynamic testing in our studies) in order to enhance performance to the participant's maximum span length. Cues helped the participant's

reinstate the memory trace and/or retrieve forgotten items. The cueing conditions are designed to maximize processing efficiency by bringing an individual's WM performance to an asymptote level. The number of cues to achieve asymptote level serves as an indirect measure of processing efficiency (i.e., fewer cues relate to greater efficiency). The WM tasks are also presented at the asymptotic level (the maximum span length established with cues) but without cues. This condition includes the **same** WM tasks that matched each participant's highest WM span level. Thus, each participant is presented items calibrated to their asymptotic level of WM performance. This calibrating allows for the assessment of processing constraints beyond the learning of items. The ability to maintain a high level of performance without cues serves as an indirect index of demands on WM capacity.

The logic for the conditions is as follows (also see Swanson, 1999, 2003, 2011). The noncued or initial condition reflects the baseline for each participant's self-initiated processes to access information. The cueing condition enhances the access to stored items by tailoring cues to help participants reinstate memory traces or to retrieve forgotten items from the initial (or baseline) conditions. Previous studies have shown that the cueing conditions improve performance by as much as 1 standard deviation (Swanson, 1992, 1993). This occurs because the systematic cueing procedures emphasize sequential processing strategies and thereby reduce the number of competing strategies employed. If the locus of WM problems in children with LD is in the retrieval phase, one would expect a reduction in ability group differences (children with and without LD) for this condition when compared to the initial condition. The highest level achieved under the cueing condition is readministered (referred to as the maintenance condition) using the *same* materials, but without cues to support performance. Calibrating this condition allows us to capture processing differences between groups beyond the learning of items. Because each participant is presented items calibrated to their asymptotic level of WM span, a decrement in performance relative to the cued condition is related to constraints in processing capacity.

In our most recent study (Swanson, et al., 2010), WM performance on these aforementioned conditions was compared between children with and without LD as a function of their selection of strategies. That is, after a stimulus set presentation for the WM tasks, but prior to actual recall, participants were asked to select the strategy they believe will help their retrieval. For the verbal WM task used in this study, the strategy selections were rehearsal, clustering, association, and elaboration. For the visual spatial WM task, the strategy selections were sectional (focus on recalling sections of a matrix), elemental (focus on key items), global (focus on the gestalt of the task) and backward processing (work backwards in reconstructing the patterns) strategies, respectively.

To illustrate further, we considered one of the verbal WM tasks administered: the *Digit-Sentence Span Task*. The purpose of this task was to assess the participant's ability to remember numerical information embedded in a short sentence. Prior to stimulus presentation, the participant was shown a figure (see Swanson, 1993, Figure 1) depicting four strategies for recalling numerical information. These strategies

were pictorial representations of rehearsal, chunking, associating, and elaborating of information. The general instructions for introducing the strategies were as follows:

> I'm going to read you some sentences that have information I want you to remember. All the sentences have to do with remembering an address, but I would like you to pay attention to all the information in the sentence because I will ask you a question about the sentence. After I present this information, and before you recall it, I will ask you to choose a strategy (for children under ten - the phrase, "A way of remembering the information" was used) that you think will best help you remember.

The experimenter then shows the child four pictures, each depicting a person thinking about using one of the four strategies (see Swanson, 1993). As the experimenter explained each strategy, they pointed to the picture that matched the description. The experimenter stated, "Some of the ways that may help you remember are: (1) saying the numbers over to yourself. For example, if I say '2-4-6-3 Bader Street', you would say to yourself '2-4-6-3' over and over again, or (2) you might say some numbers together in pairs. For example, if I say the numbers '2-4-6-3 Bader Street', you would say '24 and 63', or (3) you may just want to remember that the numbers go with a particular street and location. For example, if I say '2-4-6-3 Bader Street' you would remember that 2-4-6-3 and Bader Street goes together, or (4) you might think of other things that go with the numbers. For example, if I say -2-4-6-3' you might think 2-4-6-3 I have to go climb a tree."

After all strategies had been explained, participants were then presented item sets that included numbers in a sentence context. They were then told that they must recall the numbers in the sentence in order shortly after they select from (point to) a pictorial array representing the strategy that best approximates how he or she will attempt to remember the information. The range of recall difficulty was between 3 digits and 14 digits, and the dependent measure was the highest number of sets correctly recalled (range of difficulty 0–9).

Thus, the sequence of the steps for administration after the introduction was as follows: (1) The participant was orally read a sentence (the numbers in the sentence were presented at the rate of approximately 1 every 2 s), (2) the participant was asked a process question which required them to give the name of the street referred to in the target sentence (e.g., Bader street), (3) the participant was asked to select one of the four strategies that were represented pictorially that were most like the one they would use to remember the order of the street numbers, (4) the participant was asked to recall the numbers of the address in the order in which they were originally presented, and (5) if an error in recall occurred, the probe questions were implemented.

Probing procedures followed the following sequence: hints were provided sequentially based on the type of error, and ranged from least obvious hint (Probe 1) to the next explicit hint that facilitated recall of the answer. If probing did not elicit a correct response, the task was discontinued and the next task was administered. If a correct response did occur, the next set of items of increased difficulty was presented.

Consider the Probe Sequence for the item "2-4-6-3 Bader Street" and sample questions asked the participant if an error occurred:

1. The last number in the sequence was "3", now can you tell me all the numbers in order?
2. The first number in the sequence was "2", now can you tell me all the numbers in order?
3. The middle numbers in the sequence are "4" and "6", now can you tell me all the numbers in order?
4. All the numbers in order are "2-4-6-3", now can you tell me all the numbers?

For each set of items not recalled in the correct order or for items left out or substituted, the experimenter provided a series of hints based on the error that was closest to Probe 1. That is, probes went from the least obvious hint (Probe 1) to the next explicit hint that facilitated recall of the answer. Once the appropriate hint had been identified, based on the location of the error, probes were presented in order until the correct sequence was given.

Each child in our studies was tested individually. All items for the initial condition were administered until (a) a process question was missed, or (b) an error in retrieval occurred. If an error in retrieval occurred (a participant omitted, inserted, or incorrectly ordered the numbers, dots, related to the appropriate task), cues were administered. Cues were administered based on the type of error made (i.e., whether the error was related to recency, primacy, or middle items), and probing procedures continued until targeted items could not be recalled correctly. After WM tasks were administered under initial and gain or cued conditions, the examiner readministered the same items for the highest successful set (highest item established under gain conditions) for each task. The general instructions for these maintenance conditions were, "These items were presented to you earlier, I want to see what you can remember this time without hints."

There are three general findings in this line of intervention research. First, children without LD outperformed children with LD across all WM conditions (initial, gain, maintenance). Second, no differences emerged between groups in their knowledge of strategies or the number of probes needed to improve WM performance.

Finally, the results suggested the locus of group differences were best predicted by measures that show demands on WM capacity (maintenance conditions) rather than measures of strategy stability or processing efficiency.

Obviously, there are at least two limitations to this line of research when it comes to designing a further intervention. First, only declarative knowledge was compared between the two ability groups. Declarative knowledge was not linked to procedural knowledge. That is, children were asked to choose from a menu of strategies that they believed would best help them retrieve previously presented information, but there was no indication of the extent to which the strategies selected were actually employed. It may be that the measures of strategy selection provided in these tasks were not fine-tuned enough to access children's understanding of the use of a systematic approach to memory tasks.

Second, although WM span of children with LD (reading disabilities in this case) can be significantly improved upon (via the scaffolding of cues); there was minimal evidence that such procedures reduced the variance between ability groups. In fact, the mean effect sizes across the conditions were comparable between the ability groups. That is, a key assumption in assessing the positive effects of strategy training studies is that the variance between the two groups will be reduced. Such has not been the case in many of our studies.

In general, this line of research provides us with little evidence that strategy knowledge underlies the relationship between WM and achievement. More specifically, although we can bolster WM performance with scaffolding (probing) procedures, the direct interplay between strategy knowledge, stability of strategy choices, and strategic procedures (probing) designed to bolster WM performance, is unclear.

2.2 Direct Strategy Training

A promising alternative to the aforementioned line of research of trying to uncover the link between general strategy knowledge and WM performance, is to "directly train" WM performance and determine if such training has influence on an academic domain. With WM training, the goal is "not" to train additional processes in the sense of strategies, such as the mnemonics or rehearsal, but instead to train the WM system directly. In one of the few studies on the effects of training on the WM performance in children, Klingberg et al. (2005) found that when children with ADHD were exposed to a computerized WM training program that significant improvements emerged on measures of verbal and visual-spatial memory and complex reasoning (Raven Colored Progressive Matrices Test) relative to the control conditions. Improvements in WM and their links to reasoning were attributed to activities of the central executive system (e.g., response inhibition; Unsworth, 2010). Thus, Klingberg and colleagues (Klingberg et al., 2005; Klingberg, Forssberg, & Westerberg, 2002) showed that WM training (computer program referred to as CogMed) for children diagnosed with ADHD lead to improvements on the training task as well as to some positive aspects on tasks unrelated training. However, the study did not address whether the treatment effects moderated or influenced the covariation between WM performance and academic performance. Further, there was no significant influence of WM training on measures of academic performance.

Experiment 2 of Swanson et al. (2010) was a study we carried out in an attempt to train WM performance in children with LD but with a primary problem in reading. The hypothesis under investigation was whether children with LD (children with low WM spans) benefit more from strategy instruction than children without LD (children with high spans) because they are more likely to experience greater processing constraints on WM tasks than children without LD. The competing hypothesis was that although strategy training may improve performance in children with LD, it plays a minor role in reducing the variance between WM and reading performance.

For this study, children with LD were selected from special education classrooms for children with LD. Participants were fifth and sixth grade students from a low income Elementary School from a large urban southern California school district. School district records reported that children had Wechsler IQ's in the normal range, but word reading scores below the 15th percentile on either the Wide-Range Achievement Test or the Woodcock Reading Mastery Test. For this study, children were randomly assigned to clinical trials that involved rehearsal training or a control group. Rehearsal training was selected as the instructional condition because this could be easily taught and some studies have found positive outcomes related to these strategies for children with LD. Rehearsal training was also selected because Swanson (1995) found in his standardization study (N = 968) on the Digit-Sentence Task, that participants who selected a rehearsal strategy (in contrast to clustering, association, and elaboration) yielded significantly higher span scores than those participants selecting other strategies.

The training task was *modified* version of the Turley-Ames and Whitfield (2003) operation span task. The operation span test assessed WM span by having participants solve simple math problems while remembering unrelated to-be-remembered (TBR) words that followed each math problem. After each simple addition or subtraction operation, a TBR word was visually and orally presented for later recall. All words were below children's reading level by two grades. Operation-word sequences were presented in five parts: (a) a number from 1 to 18, (b) an addition or subtraction sign, (c) a number from 1 to 18, (d) "= ____." When the "d" part of the operation was presented, the participant read the math problem aloud, reported an answer, and the experimenter recorded the participant's answer. After providing an answer for the math problem, the TBR word was revealed for 5 s and read aloud by the participant. Operation-word sequences were presented in increasing set size.

In order to check for transfer of strategy instruction effects, pretest and post-test performance on children's adaptation (Swanson, 1992, 2013) of Daneman and Carpenter's (1980) Listening Sentence Span Task was administered. The Listening span task required the presentation of groups of sentences to be read aloud, for which children tried to simultaneously understand the sentence contents and to remember the last word of each sentence. Transfer measures also included administration of the reading comprehension and math computation subtests from a high stakes test (California's Standardized Testing and Reporting measure).

Two important findings occurred. First, the results showed that rehearsal training significantly improved performance on the target (Operation span) and a transfer measure (listening span) for both reading groups. Second, the correlations between reading and WM were comparable at both pretest and post-test within groups and the difference between groups was greater at post-test than pretest. Thus, the results did not support the hypothesis that strategy training reduced the variance (performance gap) between reading groups.

In summary, we have briefly reviewed two lines of intervention research designed to improve WM performance in children with LD. Both lines of research showed that WM performance can be improved upon. Children with LD benefited significantly in WM performance as a function of scaffolding (probing) instruction as well

as direct strategy instruction (e.g., rehearsal). Despite the positive effects of strategy training on children's WM performance, however, the results do not provide strong support for the assumption that the relationship between WM and LD is related to declarative or procedural knowledge of strategies. Neither cued nor rehearsal training conditions allowed children with LD to improve their WM performance on par with children without LD. We now review our third line of research that focuses on WM as a moderator between strategy instruction and treatment outcomes.

2.3 Working Memory Capacity and Strategy Interactions

Our more recent intervention studies have been directed towards focusing on an academic domain (word problem solving) that mixes strategy instruction as well as training of WM within the curriculum (e.g., Swanson, 2014; Swanson, Lussier, & Orosco, 2013; Swanson, Moran, Bocian, Lussier, & Zheng, 2013, 2014). Based on our earlier work, we assumed that because children with math disabilities (MD) experience WM difficulties (e.g., Fuchs et al., 2014; Swanson, Jerman, & Zheng, 2008), their low WM may have direct consequences on the effectiveness of cognitive strategy interventions. That is, from an aptitude-treatment perspective, some strategies are more advantageous than others based on a child's WM capacity. In this current line of work we hypothesize that the availability of ample WM resources is an important precondition in determining whether strategy training will be successful as well as which strategies are preferred. This is because strategies are resource demanding. As a consequence, children with relatively smaller WM capacities (WMC) may be easily overtaxed by certain strategies, which may even lead to poor learning outcomes after training.

Our hypothesis is in line with the cognitive load theory (e.g., Sweller, 1988, 2005), whose central tenet is that instruction should be designed in alignment with the learners' cognitive architecture, which consists of a limited-capacity working memory system. Because information has to pass through working memory before it can be consolidated into long-term memory, the limited capacity of WM can be considered the bottleneck for learning. Thus, individuals with MD but relatively higher WMC are better able to utilize cognitive strategies than children with lower WMC. This is because strategies rely on declarative representations and serial cognitive processes that require large amounts of WMC (e.g., Anderson, 1987), and the utilization of cognitive strategies that have been recently acquired imposes demands on WMC.

We have completed several studies that have investigated the role of strategy instruction and working memory capacity (WMC) on problem solving solution accuracy in children with and without MD (Swanson,, 2014; Swanson, Lussier, et al., 2013; Swanson, Moran, et al., 2013, 2014). In our more recent study, children in grade 3 (N = 199) with and without MD were randomly assigned to one of five conditions: materials + verbal strategies (e.g., underlining the question), materials + verbal + visual strategies, materials + visual strategies (e.g., correctly placing

numbers in diagrams), materials-no overt strategies, and an untreated control. The Materials only condition (MOC) was implemented to test whether training, related to increasing irrelevant propositions within the instructional materials, had a unique contribution to solution accuracy independent of explicit strategy instruction. Treatment conditions involved systematic increases in the number of irrelevant sentences for solving word problems across 20 instructional sessions.

For these studies, training involved teaching children explicit instructions regarding verbal strategies that directed children to identify (e.g., via underlining, circling) relevant or key propositions within the problems, visual strategies that required children to place numbers into diagrams, and a combined strategy condition that combined both verbal and visual strategies. The outcome measures included word problem solving performance on norm-referenced measures. Consistent with reviews that have identified key components related to treatment effectiveness (e.g., Gersten et al., 2009), each strategy training session involved explicit practice and feedback related to strategy use and performance. Also, because warm-up activities related to calculation have been found to be effective in problem solving interventions, this component was also included in all training sessions. The cognitive intervention sessions focused on directing children's attention to the relevant propositions within word problems related to accessing numerical, relational, and question information, as well as accessing the appropriate operations and algorithms for obtaining a solution (Mayer & Hegarty, 1996). Instructions to focus on relevant information for solution accuracy in the context of increasing distractions (e.g., related number of irrelevant propositions (sentences) within word problems) were embedded within lessons. This is an important component because difficulties in controlled attention have been found to underlie some of the cognitive deficits experienced by children with MD (e.g., Censabella & Noël, 2008; Passolunghi, Cornoldi, & De Liberto, 2001).

Our studies are unique, however, in that we directed children's attention within the experimental conditions to the relevant propositions and irrelevant propositions within word problems. That is, instructions were embedded within each lesson that directed children's attention to relevant propositions within word problems while concurrently increasing the number of irrelevant propositions. Our rationale for this activity is as follows. First, children with MD have difficulties with controlled attention (inhibiting irrelevant information; see Marzocchi, Lucangeli, De Meo, Fini, & Cornoldi, 2002), and therefore strategies must be directly taught to help such children attend to relevant information within the context of irrelevant information. Second, previous research from national assessments indicate that elementary children find it extremely difficult to discriminate relevant from irrelevant facts in word problems, and therefore, this discrimination problem would be especially acute in children with MD. Third, differentiating information that is relevant to a given task from irrelevant information is a fundamental property of learning. The mechanisms that underlie such differentiation play a key role in mental problem representation (e.g., Kintsch & Greeno, 1985). Thus, merely providing problems with only relevant propositions for solution (as done in the majority of school curriculum materials) do not teach children with MD to discriminate the relevant parts of a problem.

Previous work shows that children with MD engage in "number grabbing", which consists of selecting numbers from text without regard to the number's relationship to the problems meaning (see Cook & Rieser, 2005 for discussion of this strategy). To avoid number grabbing, children are directed to consider relevant information in the context of irrelevant information (i.e., competing semantic and numerical information). Fourth, our design of the intervention curriculum was based on findings that word problem solving is significantly predicted by text comprehension (e.g., Swanson, Cooney, & Brock, 1993), and to create an accurate mental model of text comprehension, both relevant and incidental propositions were considered. Finally, training that includes gradual increases in competing information within the context of relevant information has been suggested as one means to improve controlled attention in working memory (e.g., Holmes, Gathercole, & Dunning, 2009). Our approach is also based on research showing that a "key" mechanism that underlies WMC is controlled attention; that is, an individual's ability to access and process relevant information in the context of interfering information (Engle et al., 1999).

In general, our studies have yielded two important findings. First, visual strategy conditions yielded significantly higher outcomes on normed referenced post-test problem solving measures relative to other conditions for children with MD, but these effects were isolated to those children with higher WMC. Second, our studies have yielded transfer to WM (operation span in this case) and calculation measures (e.g., Swanson 2014; Swanson, Moran, Lussier, & Fung, 2014). Effect sizes between treatment (visual-spatial strategies) and control conditions have been substantially larger on measures of operation span than measures of problem solving and calculation. In fact, the majority of effect sizes are in the moderate range for measures of problem solving and calculation (0.50–0.63), but in the high range on measures of operation span (e.g., 2.62 for children with MD, 1.09 for average achievers). Thus, the results were particularly robust towards improving operation span performance, but were only moderately successful on measures of problem solving and computation accuracy.

In summary, perhaps the approach we took to enhance transfer by embedding WM demands (load) within the curriculum may be a promising avenue in future intervention research for improving WM. It is important to note that no studies that we are aware of have shown that strategy training within an academic domain (word problem solving) directly influences WM or vice versa (e.g., see Holmes et al., 2009, discussion of the sleeper effect). We are actively pursuing this line of research (WM+ web site at Graduate School of Education UCR)

3 Summary

In general, our studies have shown that WM can be improved upon in children with LD. However, our studies have not shown that directly training WM directly influences performance on academic measures, such as reading and math. Some of our studies have found some generalization to nontargeted related processes (operation

span measures), but WM training has not been shown, at this point, to make substantial improvements on important classroom tasks such as reading comprehension and/or math performance. However, we do find that direct training on academic measures (problem solving in this case) that include elements of WM function (inhibition of irrelevant information) yield positive outcomes related to calculation and WM tasks that were not part of the training. Our more recent focus suggests that WMC may be best viewed as a moderator of academic outcomes under strategy conditions. In the area of word problem solving, the results suggest that solution accuracy for children with LD (math disabilities in this case), relative to the control condition, improved problem solving accuracy substantially as a function of cognitive strategy training for those with relatively higher WMC. The major implication of our more recent findings is that WMC may account for why some children benefit from strategy instructions and others do not.

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Training of Cognitive Control in Developmental Disorders: Pitfalls and Promises

Lilach Shalev, Natalie Kataev, and Carmel Mevorach

Abstract Attention and executive functions play a significant role in different types of learning. Recent studies had shown that attention skills are greatly malleable. Specifically, a number of studies have evaluated the benefit of cognitive treatments aimed at improving attention and executive functions of children with Attention Deficit/Hyperactivity Disorder (ADHD). Although several studies did not find positive far transfer effects (such as planning, selection of an appropriate strategy) in children with ADHD, more recent studies, which targeted simple attention and/or executive functions (such as, the ability to sustain attention over a long period of time, the ability to maintain information in working memory (WM)) showed encouraging effects. In summary, cognitive training as induced in different programs targeting specific neural systems mediating attention for children with developmental disorders has a promising potential to improve other skills of cognition and academic outcomes. However, in order to achieve this challenge it is essential to implement theory driven interventions, to strengthen the link between the core cognitive deficits of each developmental disorder and to apply principles of cognitive training.

Keywords Cognitive training • Developmental disorders • ADHD • Executive control • Near- and far-transfer

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Attention and executive control play a significant role in different types of learning, school readiness and academic achievements (Blair & Razza, 2007; Roderer, Krebs, Schmid, & Roebers, 2012; Stevens & Bavelier, 2012). Studies have shown that attention skills are greatly malleable; they are influenced by emotional and social environmental properties (Hackman, Farah, & Meaney, 2010) and can be improved by training (Neville et al., 2013; Posner & Rothbart, 2005; Shalev, Tsal & Mevorach, 2007). A core component of the cognitive system is attention, different functions of which can be impaired in different developmental disorders; however, the most prominent developmental disorder that is linked with impaired attention is Attention Deficit/Hyperactivity Disorder (ADHD). In this chapter, we will focus on working memory and attention training in ADHD, though it is important to note that attention and/or working memory deficits characterize different disorders, hence different types of cognitive training are relevant for other developmental disorders as well.

1 Attention Deficit/Hyperactivity Disorder (ADHD)

ADHD is characterized by inappropriate levels of inattention, and/or hyperactivity-impulsivity (American Psychiatric Association [APA], 2013) which result in poor academic skills, often accompanied by conduct problems and emotional liability (Barkley, 2006; Massetti et al., 2008). It is one of the most prevalent childhood chronic behavioral disorders, with an estimated prevalence of 3–7 % in children (American Psychiatric Association, 2013). Various studies that aimed at identifying the core deficit of ADHD provided evidence showing heterogeneity of cognitive profiles among individuals with ADHD (Coghill, Seth, & Matthwes, 2014; Lukov et al., 2014; Nigg, 2006; Sonuga-Barke, Bitsakou, & Thompson, 2010; Tsal, Shalev, & Mevorach, 2005; Van Hulst, De Zeeuw, & Durston, 2015). Therefore, from a neurocognitive point of view, ADHD is best conceptualized using multiple-pathways models which refer to several different etiologies that may lead to similar behavioral manifestations (e.g., Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Nigg, 2005; Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005; Pennington, 2006; Tsal et al., 2005; Willcutt et al., 2010; Willcutt, Sonuga-Barke, Nigg, & Sergeant, 2008). There are various theoretical models of ADHD, yet all the models agree that a deficit in executive control characterizes at least some of the individuals with ADHD (e.g., Barkley, 1997; Sonuga-Barke et al., 2010; Tsal et al., 2005).

2 Attention and Cognitive Control

Contemporary theories in cognitive neuroscience characterize the human attentional system as comprised of several distinct attention networks which include both bottom-up and top-down components (Corbetta & Shulman, 2002; Fan, McCandliss, Sommer, Raz, & Posner, 2002; Parasuraman, 2000; Petersen & Posner, 2012;

Posner & Petersen, 1990; Tsal et al., 2005). Based on Posner and Petersen (1990) influential theory of attention networks, Tsal and his colleagues developed a version which was adapted to ADHD (Lukov et al., 2014; Shalev, Tsal, & Mevorach, 2007; Shalev et al., In Press; Tsal et al., 2005). This model refers to four distinct functions within the attention regime: (a) sustained attention – the ability to allocate attentional resources to a non-attractive task over time while maintaining a relatively constant level of performance; (b) selective-spatial attention – the ability to focus attention on a relevant target while ignoring adjacent distracters; (c) orienting attention – the ability to direct attention over the visual or auditory field according to sensory input, and to disengage and reorient efficiently; (d) executive attention – the ability to control attention, and to resolve conflicts of information and/or responses. In other words, executive attention enables us to suppress irrelevant information and to process effectively the relevant information. While the above attention functions constantly interact, they act as separate (at least to a certain extent) cognitive modules. Thus, different cases of ADHD may result from a deficit in any of the attention functions (or any combination of deficits; Tsal et al., 2005). Children and adolescents with ADHD cope with various difficulties in every day functioning; however, very often the most negative effects of ADHD are reflected in school settings. In this vein, one of the fundamentals of successful academic performance is competent reading comprehension, which is frequently one of the major struggles experienced by individuals with ADHD (Stern & Shalev, 2013). It has been found that difficulties in sustaining attention on the text obstruct substantially its comprehension and the ability to report the main ideas among people with ADHD (Brock & Knapp, 1996; Ghelani, Sidhu, Umesh, & Tannock, 2004; Stern & Shalev, 2013).

3 Treatments in ADHD

The high prevalence of ADHD and its links to poor outcomes have led researchers to examine a wide range of treatment alternatives for individuals with ADHD, including medications, psychotherapies and biofeedback, to name a few. At present, ADHD is primarily treated with medications which can ameliorate many of the core symptoms such as attention problems, high hyperactivity and impulsivity but do not significantly improve cognitive control and executive functions in individuals with ADHD (Advokat, 2010; Chacko et al., 2014; Jarrett, 2013; Rapport, Orban, Kofler, & Friedman, 2013). Recent research had shown that the impact of medications is limited to short term effects (Currie, Stabile, & Jones, 2014; Langberg & Becker, 2012; Sharpe, 2014). Moreover, the two most frequent treatments in ADHD – medication and behavioral interventions, do not intrinsically provide patients with concrete strategies or skills for coping with associated functional impairments (Chacko et al., 2014; Shalev et al., 2007; Sonuga-Barke, Brandeis, Holtmann, & Cortese, 2014). After the termination of these treatments, no consistent changes were recorded in the neurocognitive measures (Dovis, Van der Oord, Wiers, & Prins, 2012; Jarrett, 2013). *Cognitive training*, on the other hand, does aim at

improving basic neurocognitive mechanisms that are related to academic skills, as well as to other skills that are impaired in ADHD. The next section will explore cognitive training, its principles, methods and applications.

4 Cognitive Training

Cognitive training can be classified into two main categories; one is the traditional cognitive behavioral therapy (CBT), the other is the direct intervention or process-specific approach (Kerns, Eso, & Thomson, 1999). In the context of ADHD, CBT is aimed at developing self-control skills and reflective problem solving-strategies that are presumed to be deficient in children with ADHD. Such training programs include self-instructional training, cognitive modeling, self-monitoring, self-reinforcement, cognitive and interpersonal problem solving (Abikoff, 1991). They seek to enhance internalization of self-regulating cognitive skills that might provide children with ADHD the means for more appropriate behavioral regulation, as well as facilitate academic functioning. Unfortunately, many studies (Abikoff, 1991; Abikoff & Gittelman, 1985; Bloomquist, August, & Ostrander, 1991) showed that cognitive-behavioral treatments do not significantly improve the behavior and academic performance of children with ADHD. A recent meta-analysis supported these conclusions (Washington State Institute for Public Policy, 2012). One possible explanation for the null-effect of traditional cognitive training is that it is directed at complex cognitive processes that may be unreachable in the presence of impairments in basic low-level attention functioning such as difficulty to stay focused 'on-task' (deficient sustained attention).

Other category of cognitive training – the process-specific approach – was introduced in the early 2000s and was directed at fostering the development of attention and/or executive functions rather than compensate for identified functioning weaknesses (Rapport et al., 2013). It involves direct training of neurocognitive functions through repeated practice, and since these are domain-general processes they are expected to show generalization to various every day functions. This transfer of skills is a major difference between the two approaches (Chacko et al., 2014). The process-specific approach may be implemented by either computerized or non-computerized methods. For example, Kerns and colleagues (1999) developed a non-computerized attention-training program called "Pay Attention!" that targets several attention components (selective-, sustained-, alternating– and divided attention) and aimed at ADHD children. The training program consists of a series of activities using illustrated playing cards and involves responding to stimulus features and to relations among stimuli. The comparison group was given a variety of academic computer based puzzles and games. The training program resulted in improvements in all attention components, especially selective attention, and in non-trained skills such as mathematical competence. Nonetheless, there were no differences in parent reporting between the groups, perhaps due to expectancy bias. More recent studies

that examined the "Pay Attention!" program have shown improvements in attention components in ADHD children as well as parent reporting of inattentive symptoms and self-reporting of the ability to focus (Tamm et al., 2010; Tamm, Epstein, Peugh, Nakonezny, & Hughes, 2013).

Diamond and colleagues (2007) investigated another example of a non-computerized cognitive training inspired by Vygotsky (1978), called "Tools of the Mind". This program aimed at developing cognitive control in normal preschoolers. It incorporates activities that promote executive functioning (e.g., telling oneself out-loud what one should do, dramatic play) and various aids to facilitate memory and attention. The control group was treated with another program, developed by the education department in north Canada (District's Version of Balanced Literacy) that covered the same academic content, but did not address executive functions development. "Tools of the Mind" resulted in significant improvements in executive functions as reflected in tasks that measure inhibitory control. It is worth noting that the program was not designed for children with developmental disorders, but rather for young children in general.

Another group of programs that seeks to directly train neurocognitive functions is computerized cognitive training. The development of personal computers has increased the scope of cognitive rehabilitation and training due to the ability to automatically record responses of the trainees, to give on-line precise feedback and to enable personalized pace of progress (Gianutsos, 1992). This automated computer exercise usually contains practice of a specific neurocognitive function by structured repetitions and feedback, which allow measurable improvements in near and far outcomes.

4.1 Working Memory Training: Cog-Med

Klingberg and colleagues (2002, 2005) and Klingberg (2010) developed a 5-week computerized working memory (WM) training called "Cog-Med", and examined its effect on children with ADHD aged 7–12 years. Cog-Med includes a set of WM tasks (both visual-spatial and auditory), starting at a low level of difficulty which gradually increases as a function of performance. Children received on-line feedback and accumulated points based on their performance. The authors found a significant treatment effect on visual-spatial and verbal WM, response inhibition, complex reasoning and reduction of ADHD symptoms according to parent ratings, both post-intervention and 3 months later. However, a recent review of the studies that investigated the utility of Cog-Med WM training in ADHD concluded that further research is needed to cope with substantial limitations of the previous studies such as utilization of non-equivalent active control intervention, too homogeneous groups and lack of measures of functional impairment (Chacko et al., 2013; Cortese et al., 2015).

4.2 Attention Training: Computerized Progressive Attention Training (CPAT)

The Computerized Progressive Attentional Training (CPAT) program is derived from the four functions of attention model (Tsal et al., 2005) that was described earlier in this chapter. The CPAT was developed for children with ADHD and focuses on training various components of attention (Shalev et al., 2007). The CPAT program is composed of four sets of structured tasks designed to uniquely activate the various attentional components described above (sustained-, selective-, orienting– and executive attention). Here too, trainees start in a low level of difficulty which gradually increases as a function of their progress. Another major characteristic of this training is the usage of tight schedules of feedback and accumulation of points which motivate the trainees and enable them to link between the effort they invest and the quality of their responses. In a study with children with ADHD, 8 weeks of CPAT training resulted in far transfer effects: significant improvements in academic performance (including reading comprehension and copying) and reduction of parents' reports of inattention. No significant similar improvements were observed for children in the active control group whose sessions consisted of standard computer games and game-like paper and pencil activities (Shalev et al., 2007). Yet, the specific underlying mechanism of the positive outcomes of the CPAT is still unknown. In a very recent study with adolescents with ADHD significant correlations were obtained between sustained attention and reading speed as well as reading comprehension. That is, the greater the impairment in sustained attention the lower the reading efficiency (Stern & Shalev, 2013). Based on these findings and on findings from a pilot intervention study, it is possible that neurocognitive training such as the CPAT, which targets, amongst other things, sustained attention and executive control, is expected to lead to improved ability to focus attention on a given task for a long period of time, and in turn, to better academic skills such as reading and writing efficiency. Obviously, further studies, including brain imaging studies, are required to reveal the mechanisms that underlie the positive outcomes that were recorded in the above attention training studies.

5 Near and Far Transfer of Cognitive Training

As was mentioned above, cognitive training is based on the assumption that training a particular neurocognitive process may yield improvements in other domains as well. In this context, cognitive training can be compared to physical training. For example, running regularly may improve the cardiovascular system and consequently produces improvements in an individual's ability to run (near transfer effect) but potentially could also advance improvements across other physical

activities, such as swimming or climbing the stairs (far transfer effects), that equally rely on the cardiovascular system (Kirk, Gray, Riby, & Cornish, 2015). The transfer of a trained to an untrained physical activity or cognitive process is beneficial due to the enhancement in general ability without having to perform a large variety of activities. In addition, these outcomes are also examined in short and long term occurrence. Jaeggi, Buschkuehl, Jonides, and Shahet (2011) had examined the far and near, short and long term effects of computerized working memory training program within elementary and middle school aged children. Their main purpose was investigating whether training children's WM skills could develop their general cognitive abilities, and the extent to which individual differences in training gain moderate short and long term transfer effects. The results of their study revealed that children that gained greater improvements during the WM training, had more significant improvements in fluid intelligence (defined as the ability to reason abstractly and solve novel problems) compared to control group and to children that improved the least. These progresses were retained 3 months after the training completed. Interestingly, the authors reported that the improved group of children ranked the WM training as more difficult and effortful, suggesting that improvement effect is related to its subjective difficulty. Future studies will have to identify other factors that influence the magnitude of near and far transfer effects.

6 Feedback: A Key Factor in Cognitive Training

One of the major issues in cognitive training in general and in the case of ADHD in particular is the need to recruit the child's motivation and to maintain high level of engagement throughout the intervention. This is a common obstacle among children with ADHD since many of them suffer from deficient ability to maintain attention on task during long periods of time (Nigg et al., 2005; Shalev et al., In Press; Stern & Shalev, 2013; Tsal et al., 2005) and it impedes their ability to stay focused on the training tasks and repeat them each training session. Hence, we suggest that a key factor in successful cognitive training is feedback that should elicit motivation, self-confidence and self-efficacy. In order to ensure the experience of positive feedbacks the task's difficulty and the pace of progress should be individually adjusted to the performance of the trainee. The role of positive feedbacks is threefold: first, in the cognitive level – to inform the child that s/he performed the task effectively (i.e., managed to focus attention in a limited area and ignore adjacent distractors, managed to inhibit impulsive responses, managed to cope with conflict etc.); second, in the emotional level – to encourage and gradually develop the child's self-confidence and self-efficacy; third – in the motivational level – to ensure that the child is engaged and to trigger his/her ambition. Thus, special thoughts should be dedicated to the schedule and the content of feedbacks.

7 Future Directions and Implications for Education

Given the encouraging, yet insufficient, empirical support of cognitive training as an efficient intervention to improve attention, cognitive control and executive functions, it is essential to broaden our efforts and to investigate the neural, cognitive, academic, social and behavioral outcomes of theory driven training programs for individuals with ADHD, as well as with other developmental disorders. Three very recent reviews concluded that neurocognitive treatment in ADHD is supported in basic neuroscience and encouraged researchers to further elaborate 'next-generation' neurocognitive training programs that will be specifically targeted at core neurocognitive deficits in ADHD and to improve the implementation of these interventions in order to strengthen their scope and to fulfill their important therapeutic potential (Chacko et al., 2014; Cortese et al., 2015; Sonuga-Barke et al., 2014). Theory driven neurocognitive training which will be precisely directed to improving various cognitive mechanisms that are impaired in ADHD, is indeed expected to produce improvements in cognitive, academic and behavioral functioning of children with ADHD. In order to achieve this precious goal and to accomplish both near and far transfer effects it is critical to include systematic and personally adapted tasks that are targeted at basic neurocognitive mechanisms such as the ability to focus attention on task and maintain consistent performance over a long period of time, the ability to suppress an inappropriate response, and the ability to cope effectively with conflicting information. Precise on-line feedbacks may play an important role in developing self-awareness and strengthen cognitive control not only in the setting of the training sessions but also in various everyday settings since it can teach children that feedbacks are informative and as such can serve as the 'engine' of learning. Another important future objective is to test whether different treatment components have differential outcome effects. The implementation of brain imaging techniques in future neurocognitive training studies will enable the identification of the neural substrates that underlie the positive changes in cognitive, academic, social and behavioral skills. In order to achieve this important goal, it is imperative to evaluate the effects of cognitive training not only by the performance in neuropsychological tasks but also by including academic, social and behavioral measures that will unravel whether the training yeilded near and far transfer effects. Finding a correlation between near and far transfer effects (for instance, between the change in sustained attention and the change in reading comprehension) will be of great importance since it will pinpoint the mechanism that triggers the generalization of positive outcomes. Furthermore, such investigations have the potential to detect the characteristics of children with ADHD who benefit the most from specific neurocognitive training. Hopefully, the studies that were briefly reviewed in this chapter along with future studies will soon demonstrate that neurocognitive training is an effective treatment for children with ADHD, both in terms of everyday functioning and of brain activity outcomes. Such findings will significantly impact further developing of neurocognitive interventions that will enable 'at risk' populations to improve their attention and cognitive control functioning, which in turn, will lead to

better academic, social and personal abilities. Effective neurocognitive training holds great potential in reducing the progressive gap between children with ADHD and typically developed children in school achievements as well as in other aspects of functioning and if successful may be applicable to other groups at-risk for academic, social and behavioral problems.

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New Directions in Preservice and Inservice Professional Development for Teaching Students with and Without Specific Learning Disabilities in Middle Childhood and Early Adolescence

Virginia W. Berninger and R. Malatesha Joshi

Abstract This chapter proposed evidence-based approaches to professional development of educators with focus on teaching writing as well as reading during middle childhood and adolescence to students with and without specific learning disabilities (SLD). Key features for both preservice and inservice professional development are considered. One key feature is grounding professional development in conceptual frameworks for all language systems (Language by Ear, Language by Mouth, Language by Eye, and Language by Hand), a multi-component language learning system, and domains of development (cognitive/memory, language, sensori-motor, attention/executive functions, and social emotional). An example of inservice professional development for developing morphological awareness as well as phonological awareness for teaching word spelling and reading for English, a morphophonemic orthography, is provided.

Keywords Evidence-based professional development for literacy instruction

1 Overview

Recently a major focus of evidence-based literacy instruction in the US has been early intervention for prevention. See Carreker and Joshi (2010) for discussion of how the shift from wait-to-fail to early intervention has made contributions to

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instruction, but not identification, of specific learning disabilities (SLD). Note that although we use the abbreviation SLD, which implies a single disorder, we use it as a general category including a variety of kinds of different learning disabilities, which can be differentiated from developmental disorders that do not involve, as SLD does, only a struggle with specific oral and written language or math skills in otherwise typically developing learners. Not all students respond well to early intervention, and multiple reasons can contribute to non-responding. Evidence-based literacy instruction for middle childhood and adolescence, especially after the transition to silent reading and increasing writing requirements, has been relatively neglected as has been professional development for teachers beyond the early, primary grades, for grade-appropriate oral and written language instruction in the upper grades.

This chapter first describes key features of instructional approaches that have been shown to be effective with upper elementary and middle school students with and without SLD, and then considers how these instructional approaches might be shared with teachers of middle childhood and adolescent students. As captured in the Peter Effect, which acknowledges that one cannot give what one does not have, teachers cannot share what they do not know (see Binks-Cantrell, Washburn, Joshi, & Hougen, 2012).

Towards the goal of sharing relevant knowledge with teachers, this chapter covers models for both *preservice and inservice professional development,* so that teachers are both well prepared when new to the teaching profession, and updated during their careers as they continue to refine their professional expertise as the educational context in which their practice evolves and knowledge expands. The preservice section focuses on foundational knowledge and applications to practice so that teachers have the necessary knowledge at the beginning of their careers to teach all children age-appropriate oral and written language skills. The inservice section focuses on translation science, creation of school-university partnerships, and interdisciplinary teamwork to support teachers continuing to learn from professional experience and advances in research.

However, in contrast to many professional development efforts in literacy, we cover not only on reading, as important as it is (e.g., Moats, 1999), but also (a) all four language systems—Language by Ear, Language by Eye, Language by Mouth, and Language by Hand (see Liberman, 1999, for first three and Fig. 1 for all four); (b) other systems that work with the language systems, each of which is multileveled (subword, word, syntax, and text units)—Sensory Input and Motor Output, Cognitive, and Social Emotional (see Fig. 1), and (c) the multi-component working memory architecture that supports language learning as the learner interacts with the social and physical environment and includes supervisory attention/executive functions (see Fig. 2) (Berninger, Raskind, Richards, Abbott, & Stock, 2008).

Thus, in contrast to other approaches that focus on single components, for example, phonological awareness, phonological decoding, or oral reading fluency, the evidence-based approach presented in this chapter for sharing with teachers is a *complex systems approach* that is relevant to teacher instruction and student learning across the curriculum during middle childhood and adolescence. See Berninger and Richards (2002) for teacher accessible principles for building neurologically and pedagogically complex, functional oral language, reading, writing, and math brain systems.

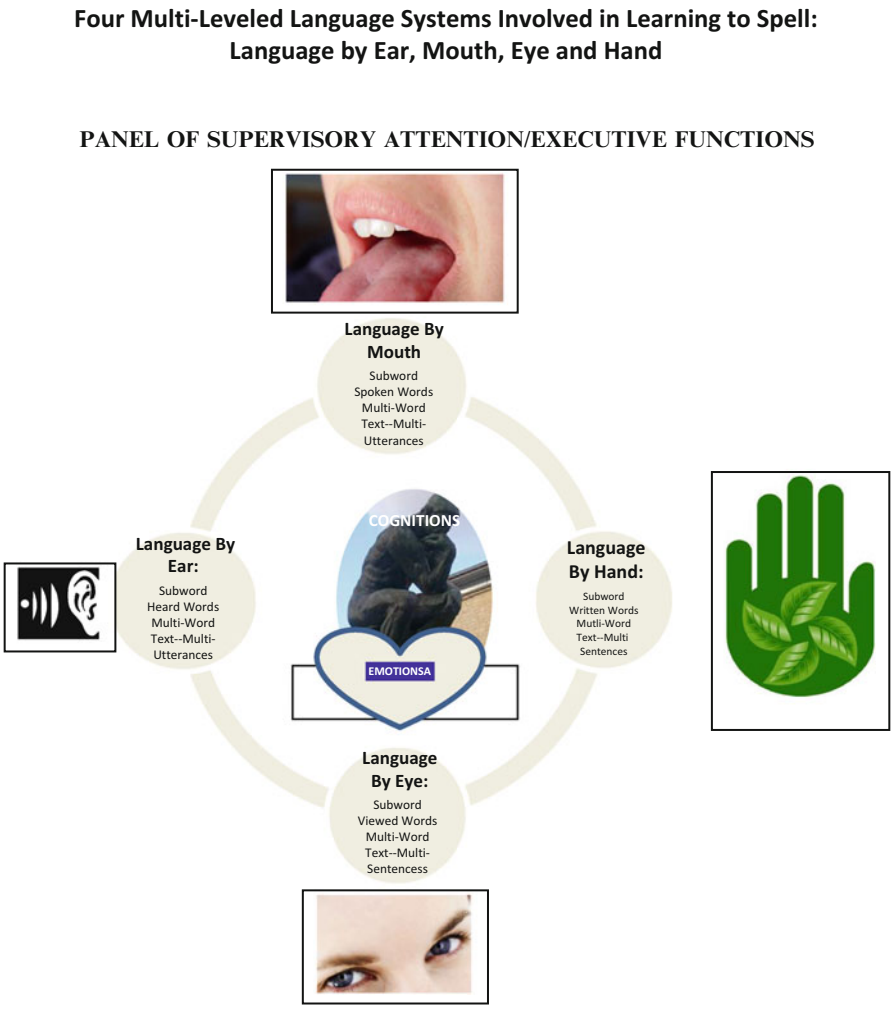

Fig. 1 University of Washington Learning Disabilities Center (V. Berninger) gives permission to Springer to reproduce this figure

2 What Is Known About Effective Instruction During Middle Childhood and Adolescence For Students with SLD

We illustrate with examples from the University of Washington (Seattle, WA, USA) Interdisciplinary Learning Disabilities Research Center studying families with a multi-generational history of dyslexia. Children and youth (grades 4–6 or 4–9) in

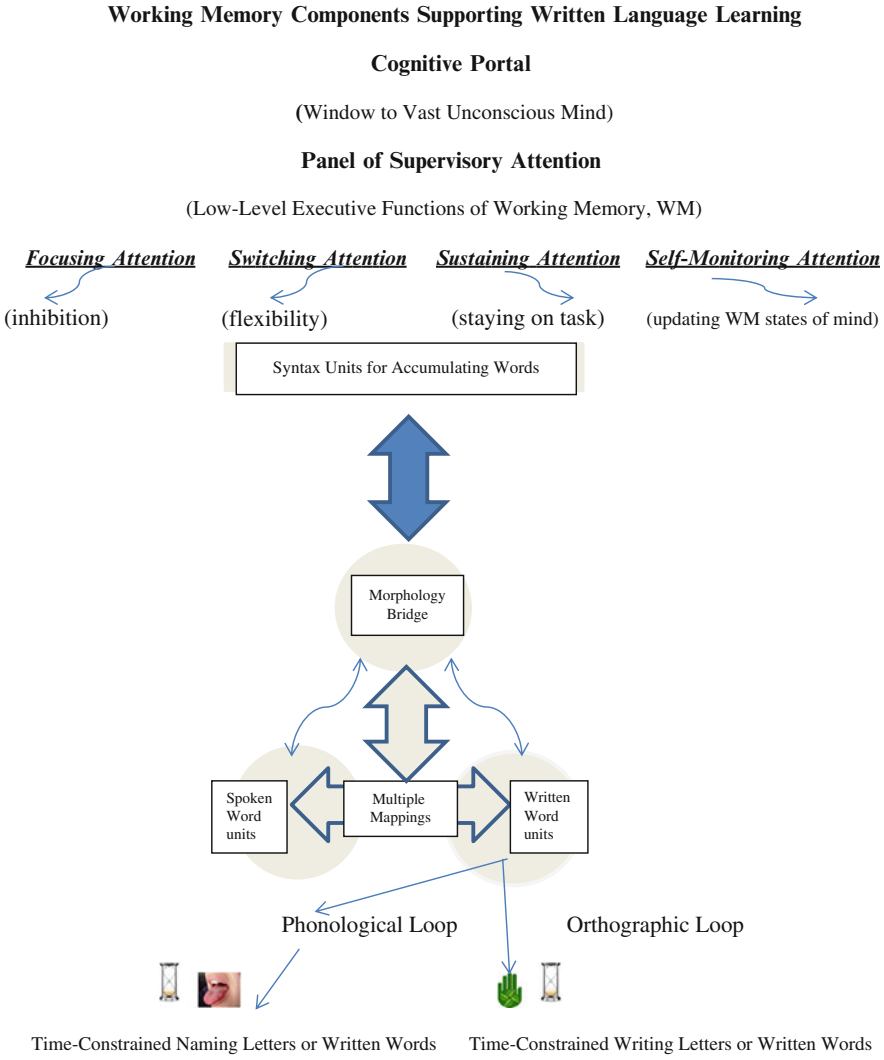

Fig. 2 (Permission granted to reproduce Fig. 9.2 from Interdisciplinary Frameworks (Berninger, 2015))

this family study who were diagnosed with dyslexia were invited to participate in summer treatment studies (first four studies, Berninger, 2000; Berninger et al., 2003; Berninger et al., 2008, Studies 1 and 2) or an after school treatment study (fifth study, Berninger, Lee, Abbott, & Breznitz, 2013). Not only did they improve significantly in reading and writing skills, but also brain imaging (only done with the first four studies) showed that their brains normalized compared to controls in regions associated with the trained reading and writing skills (for review, see Berninger & Richards, 2010). Collectively, these studies yielded knowledge we

wish to share with teachers to help them understand important principles in learning and teaching English and applying those principles to practice with students with persisting SLD during middle childhood and adolescence. Even students in grades four and above with persisting oral and/or written language problems show response to specialized, differentiated instruction in fourth grade and above (also see Aaron, Joshi, Gooden, & Bentum, 2008; Abbott and Berninger, 1999).

Include Instructional Activities for Language by Ear, by Mouth, by Eye, and by Hand in Each Lesson Close in Time to Make Connections It is not the case that some students are auditory learners and others are visual learners. All students have to learn the following, but those with SLD will need more explicit instruction to do so:

- listen to the sounds and meaning in heard words, syntax (structures for accumulating words in clauses), and text;
- produce sounds that go with graphemes (single letters or letter groups), say orally decoded words, and orally read sentences and connected text with accuracy, fluency, and comprehension;
- read words, syntax, and text silently with accuracy, fluency (smoothly in coordinated fashion with normal intonation), and comprehension, and
- write letters legibly and automatically, spell words accurately, construct syntactically acceptable sentences, and compose comprehensible text.

That is, they have to coordinate language with each of the end organs for receiving input from the environment and sending output to the environment. Oral language is not fully learned in preschool and is still relevant during school years, especially as students learn to understand teacher talk in academic register, which contrasts with informal conversational register, vocabulary specific to the content areas of the curriculum like math, and participate in oral discussions with and presentations to classmates. Moreover, not only reading but also writing is critical to academic learning, both in the early and upper grades. For a metaanalysis of studies showing how writing facilitates learning to read, see Graham and Hebert (2010). Although word reading and spelling are similar, they are not exactly the same (Ehri, 1997; Joshi, Treiman, Carreker, & Moats, 2008–2009; Olson, Forsberg, & Wise, 1994).

Considerable research over the past half century has shown that language is coded in memory, processed, and produced at multiple levels (or units) ranging from subword to word with multiple subword units) to syntax (multiple words in clause units) to text (multiple syntax and other multi-word units). Some students may have trouble with specific levels of language within language by ear, by mouth, by eye, and/or by hand and need individually tailored instruction aimed at those weaknesses. However, to create functional language systems, all levels of language have to be taught close in time so that they are coordinated with each other, just as the instruments in the orchestra or band have to function in concert to create music not noise. Thus, it is possible to provide differentiated instruction that meets the instructional needs of individual students with persisting SLD and at the same time

benefits all students by including instructional components aimed at all levels of language close in time to facilitate creation of connections among the multiple levels of language across complex functional language systems.

Include Instructional Activities that Require Coding and Processing for Heard and Read and Spoken and Written Words English is a morphophonemic orthography (Venezky, 1970, 1999), as are the orthographies of other languages as well (see Joshi & Aaron, 2006). Thus, teaching three kinds of linguistic awareness is essential during early childhood, middle childhood, and adolescence: *phonological awareness* (e.g., Aaron et al., 2008; Treiman, 1985), *orthographic awareness* (e.g., Berninger & Fayol, 2008; Pacton, Perruchet, Fayol, & Cleeremans, 2001), and *morphological awareness* (e.g., Carlisle, 1994; Carlisle & Nomanbhoy, 1993; Casalis, Cole, & Sopo, 2004; Leong, 2000; Nunes, Bryant, & Bindman, 1997). In addition to *POM POM linguistic awareness* (phonological-orthographic-morphological), also essential are instructional activities that facilitate *POM POM pattern analysis* of identity, positioning, and sequencing of subword elements (see Silliman, Bahr, & Peters, 2006): *phonotactics for sound elements* (e.g., Apel, Wolter, & Masterson, 2006; Bourassa & Treiman, 2001), *orthotactics for spelling elements* (e.g., Apel et al., 2006; Pacton, Fayol, & Perruchet, 2005), and *morphotactics for bases and fixes* (e.g., Pacton et al., 2005) For teacher accessible research knowledge and applications to instructional practice for POM POM linguistic awareness (reflections on linguistic cues) and pattern analysis, see Berninger and Fayol (2008).

Include Instructional Activities for Mapping Read and Spoken Words and Heard Words and Written Words The phonological, orthographic, and morphological codes, based on reflection and conscious linguistic awareness or implicit exposure and explicit pattern analysis are then interrelated (e.g., Fowler & Liberman, 1995). This process of interrelating phonological, orthographic, and morphological codes is called mapping. Just like two dimensional maps on paper can represent a three dimensional globe of the world, the codes for heard or spoken words and for read or written words can be interrelated to each other, but not necessarily in a one to one way. For example, correspondences can be created between one or two letters (graphemes) and phonemes (small sounds in syllables), between heard/spoken and read/written rimes (part of syllable when initial phoneme or phoneme blend is deleted), which are sometimes referred to as word families, and between accent patterns (relative stress of each syllable) and word spellings when suffixes are added to a base word. Correspondences can also be formed between two or three of the word level patterns (phonotactic, orthotactic, and/or morphotactic). Teaching multiple mapping procedures has been shown to be effective for word reading and spelling in students with persisting SLD beyond fourth grade (for review, see Berninger & Richards, 2010).

Moreover, the mapping procedures may work differently in the reading direction (written word to spoken word) than the spelling direction (spoken word to written word). Thus, the alphabetic principle for grapheme-phoneme correspondences should be taught in both the reading and spelling directions (Berninger, 1998; Berninger and Wolf, 2016). The phonological loop of the working memory archi-

tecture supporting language learning supports the naming of letters and associating sounds with letters in learning alphabetic principle in the oral reading direction. The orthographic loop of the same architecture supports writing the letters associated with the letter form in the mind's eye in memory. (See loops in Fig. 2).

It is a myth that English orthography is hopelessly irregular (i.e., opaque). If teachers and learners understand the multiple ways of mapping subword and word codes (alternations, that is, the small set of alternative ways to do so, and alternative directions from input to output for doing so, Venezky, 1995), English word reading and spelling becomes very predictable. Decoding and spelling words are no more unpredictable than vocabulary (mapping linguistic codes onto semantic, conceptual codes) in languages using diverse orthographies (see Stahl & Nagy, 2005). The multiple ways in which meaning can be mapped onto spoken and written words and vice versa explains why dictionaries appeared so late in human civilization. Also, alphabetic mapping was not the first way humans created written symbol systems for reading or writing (see Aaron & Joshi, 2006; Fayol, Alamargot, & Berninger, 2012, Chapter 1).

Include Assessment and Instructional Activities for Transforming Heard, Read, Spoken, and Written Words In a morphophonemic orthography, prefixes and suffixes can transform the heard/spoken or read/written base words. This transformation not only affects meaning of the base word but sometimes the part of speech (e.g., derivational suffixes that change a word from one part of speech to another and affect how a transformed word might fit syntax), spelling (whether letters are omitted or added after base before the suffix), and phonology (when phonology or pronunciation of the base word shifts when a suffix is added). See Nagy, Berninger, and Abbott (2006) for an assessment study illustrating these concepts. See Henry (2010) for examples of how the interrelationships among phonology, orthography, and morphology vary with word origin (Anglo-Saxon, Latinate/French, and Greek) and instructional activities for teaching these interrelationships.

Inflectional suffixes marking tense and number are common in the reading material in the first three grades. As outlined in Joshi et al. (2008–2009), morphological units of Latin based prefixes, suffixes, and roots can be introduced beginning in Grade 4 and taught systematically thereafter. See Nunes and Bryant (2006) for examples of instructional activities; see list compiled by Nagy of most frequent prefixes and derivational suffixes to use in instruction (Berninger and Abbott, 2003, Reproducibles, pages 4–58). Meaningful word parts such as *vis (supervision*), *spect (spectator), port (export, import),* and *audi (audience)* should be taught explicitly. In Grades 5–7, teach students Greek combining forms such as *phono (telephone), logy (biology), tele (telepathy),* and *thermo (thermometer),* which should be linked to vocabulary used in their math and science classes. In a study by Pittman, Joshi, and Carreker (2014), students in Grade 6 from a school attended by Africa American students and classified as 'academically unacceptable', were randomly assigned to control and treatment groups and were provided with spelling instruction involving the Latin base and root words and Greek combining forms for 8 weeks. There was a significant improvement in spelling performance; and the gain in spelling was retained even after 8 weeks post-instruction.

Avoid Doing Anyone Thing Very Long and Distribute Learning Activities Over Time Brains seek novelty. So avoid doing any one activity for very long and be sure to include instruction aimed at the subword, word, sentence and text levels within each instructional block to help students make connections. For example, POM POM linguistic awareness or pattern activities might be provided in a 5–10 min session, followed by mapping activities for alphabetic principle, word families, and/or morphology for 15–20 min, followed by 10–15 min of transfer activities to oral or silent word decoding or spelling with feedback, followed by 30–45 min of guided reading and/or writing of sentences and text. Of course, the actual time and nature of the activity will depend on the grade level(s) and instructional needs of a particular instructional group. Although a variety of activities, none of which lasts very long, should be provided within an instructional block, it is also the case that the instruction has to be systematically provided over many weeks and months. The effectiveness of distributed rather than mass practice is well established in instructional science. (See Richard Mayer's work on translational science in Berninger, 2015).

Teach for Reflection and Metalinguistic Awareness, Automaticity, Strategies, and Flexibility Instruction should prepare students for multiple ways of learning. POM POM linguistic awareness requires thinking about many aspects of language so as to become more conscious of linguistic cues in our heard, read, spoken, and written words. However, some skills should be taught in a way to become automatic so they do not require effort and free up limited working memory resources for the thinking parts of reading, writing, listening, and speaking. For example, once decoding becomes accurate, the goal for both oral and silent reading should be automatic word recognition which is not only fast, but also effortless (Lovett, 1987). At the same time effortful cognitive strategies will be needed for reading to comprehend and for composing for a variety of purposes. Thus, teachers also have to help students learn to be flexible, for example, during transitions throughout the school day, in approach to tasks with different skills sets and goals, and for applying multiple mapping strategies for word reading and spelling. See Cartwright (2008) for the role of flexibility in language learning.

Include Instructional Activities for Focusing, Switching, and Sustaining Attention and Self-monitoring Although learning benefits from explicit instruction and guidance provided by others (caregivers and teachers), it is also the case that learning requires self-regulation. Self-regulation strategies can be taught so that students can initiate, self-monitor, and sustain learning and behavior over time (see Posner & Rothbart, 2007). An important self-regulation skill for learning to read is focusing one at a time on each grapheme (one or two letters) that corresponds to a phoneme and then switching to the next grapheme in the word. One way to teach self-regulation for this is to guide children in rewriting a word to be decoded in alternating colors to focus attention on each sequential grapheme (one letter or letter group) and then associating a phoneme with each sequential grapheme. Important higher-

order executive functions for self-regulating the composing processing in writing include imagining, planning, translating, reviewing, and revising (Berninger, Swanson, & Griffin, 2014).

Include Instructional Activities for Play with Language Riddles and jokes and other forms of word play not only teach conscious reflection and flexibility but also provide comic relief that engages and supports language learners. See Spector (2009) for additional discussion and instructional recommendations.

Include Cognitively Engaging and Developmentally Appropriate Learning Activities Key to all the instructional interventions with students with SLD involving reading and writing was including hands-on, intellectually engaging science learning activities as well as language learning activities in each instructional block. These ranged from curriculum developed by science museum for learning about the brain to using writing to learn science or write science fiction, to linguistic science (solving word detective mysteries about language or creating a written syllabary to preserve the Cherokee language). Even if we worked on language skills typically mastered in the earlier grades, we did so in a grade appropriate way. Students in grades 4–9 thanked us for not "dumbing it down" as they perceived phonics instruction provided at school.

Include Hope Theme for Motivation Due to Chronic Failure All instructional interventions for students in grades 4–9 with persisting SLD had hope themes to make the point that others have endured struggles earlier in their lives and gone on to success. The first lesson set had an ongoing theme about Albert Einstein's early struggles with oral language (delayed talking in sentences) and school behavior and later successes in science. The second lesson set had an ongoing theme of Sherlock Holmes and John Watson's challenges as detectives in solving mysteries. The third lesson set featured Mark Twain, who was a sixth grade school dropout, but wrote the first book by typewriter. The fourth lesson set featured John Muir who early in life almost died in an industrial accident and went on to found the national park system in the United States. The fifth lesson set was organized around the story of Sequoyah, who at age 50 when he had a physical handicap, invented the writing system that recorded the oral Cherokee language.

Apply These Strategies Using Available Resources For the complete lesson plans that were based on the published research studies, see Berninger and Wolf (2009) and Berninger et al. (2003). These involve strategies that can be applied with a variety of instructional resources widely available in the schools, as explained in the lesson plans.

For Students Without SLD These instructional design principles were also implemented in the district wide program in which children were or were not randomly assigned to before or after school clubs and compared to these business as usual.

Those who participated in the clubs and received the evidence-based interventions validated in earlier studies with at risk, low achieving readers and writers in school settings outperformed those who did not in annual test of state standards.

3 Need for Research on Both Effective Instruction and Effective Professional Development

Much emphasis has been placed recently on research to generate evidence-based, effective instruction. However, insufficient emphasis has been placed on research to generate evidence-based, effective professional development for educators before and after they enter the profession.

4 Textbooks Used in Teacher Preparation

Relevant to what evidence-based professional development for teachers would entail, Joshi et al. (2009) evaluated textbooks used in teacher education. They found that the majority of the textbooks used in teacher preparation did not cover all the important topics like teaching handwriting, keyboarding, spelling, and composing. These skills are needed not only to complete classwork and homework but also to take the tests that evaluate whether students are meeting standards in place. In addition, they found factual errors. One such error involved statements that there are only 26 graphemes in English, when in fact English graphemes are more often two-letters than one letter and there are far more graphemes; exactly how many graphemes there are depends on whether only high frequency words of Anglo-Saxon or also of Latinate/French and Greek word origin (see Fry, 1996; Henry, 2010) are considered. Another error involved defining phonemic awareness as sound-letter correspondence. Phonemic awareness is becoming aware of the small sounds in heard words that correspond to the graphemes (one or more letters) in the alphabetic principle. That is, phonological and orthographic cross-code mapping is involved.

5 Disciplinary Knowledge Taught in Teacher Preparation

Moats (1999) astutely pointed out that teaching reading is rocket science, meaning that the linguistic science provides a scientific foundation for enabling teachers to launch students in learning to read. Moats (2014) emphasized the need for providing teachers with the necessary foundational knowledge of reading psychology, language structure, and pedagogy. In the current educational era, teachers are also held accountable for teaching writing, science, and math and also need necessary

knowledge for these content domains. In addition, there has been an explosion of foundational knowledge in many disciplines relevant to education in addition to linguistic science—cognitive science, instructional science, developmental science, brain science, and genetics. The challenge is not only how can these scientific foundations be made more accessible to preservice and inservice teachers, but also how can we create the interdisciplinary frameworks for more effective cross-disciplinary communication and collaboration in school and community settings? See Interdisciplinary Frameworks (Berninger, 2015), an initial step in doing so.

6 Preservice Professional Development: Foundational Knowledge and Applications to Practice

6.1 Foundational Knowledge

Foundational knowledge should be acquired both through courses taken outside and within Education Departments. Outside Education, preservice teachers should complete successfully courses in cognitive science, psycholinguistics, and developmental science within the psychology department and brain science and genetics in health sciences (Berninger & Richards, 2002). Within Education, preservice teachers should complete successfully coursework in instructional science and assessment-instruction links.

Instructional Science Basic foundational knowledge of language (Binks-Cantrell et al., 2012) should be expanded to include not only reading (through the eyes) but also aural language (listening through the ears), oral language (expression through the mouth), and written language (expression through the hand) and multi-level units of language within the language systems (Arfe, Dockrell, and Berninger, 2015). Writing instruction includes multiple components—handwriting, keyboarding, spelling, and composing. See Appendix for instructional resources that can be used for preservice and inservice professional development. Just because one can read with comprehension does not mean one can write effectively. Planning differentiated instruction (Aaron et al., 2008) and implementing instruction aimed at all levels of language close in time (Berninger & Abbott, 2003; Berninger & Wolf, 2009) require knowledge of how to assess the multiple levels within each level (subword, word, syntax, and text) of the four language systems, of, and of the interrelations of these levels within and across the four language systems (see Fig. 1). Assessment approaches for identifying students with dysgraphia (impaired handwriting), dyslexia (impaired word reading and spelling), and Oral and Written Language Learning Disability (OWL LD) should be taught and linked to planning differentiated, specialized instruction for each SLD within the general education program (Berninger, 2008, 2015).

7 Applications to Practice

Instructional Issues Related to Diversity Children should not be excluded from receiving differentiated, specialized instruction because they speak another dialect or language and are English language learners or are from a different cultural background or low socioeconomic groups (see Aaron et al., 2008; Berninger, 2015, Chapter 12). Pittman et al. (2014) showed that African American dialect speakers in sixth grade responded to differentiated spelling instruction for words of Latin and Greek origins, which are frequently used in upper grade text books. For benefits of adding culturally based education to evidence-based literacy instruction for Native Americans, see McCardle and Berninger (2015). Multi-cultural sensitivity should be a priority of all preservice teacher education programs.

Normal Variation Although some students have biologically based SLD, they do respond to specialized instruction. Yet normal variation is normal among students in general and teachers should be prepared for differentiating instruction for the individual differences they will encounter among all students. At a time when education is emphasizing evidence-based instruction for all, we should not ask "What Works?" but rather "What Works for Whom?" In order to answer that, progress should be monitored daily, weekly, monthly, and yearly in reference to curriculum in place in each classroom to evaluate whether individuals are learning; such evaluation of response to instruction for all students provides ecologically valid evidence for translation of research into educational practice. Preservice teachers should be taught how to collect such evidence, which is as important as annual testing yoked to state standards.

8 Inservice Professional Development

8.1 Issues Specific to Middle Childhood and Adolescence

Beginning in fourth grade issues requiring special attention include transition to silent reading, expanding writing requirements, increasing expectations for self-regulation for learning and behavior, and social emotional issues.

8.2 Issues Specific to SLD

Not all students who receive early intervention are treatment responders. Some show persisting signs of SLD. On the one hand, it is easy for adults and the affected students to give up hope. On the other hand, research shows they can still learn and often do respond to specialized, evidence-based instruction. However, there is no evidence that the pull-out special education programs are effective; rather

differentiated instruction is general education is more effective (Aaron et al., 2008). One goal of inservice professional development should, therefore, be teaching the interdisciplinary team in school settings how to do evidence-based differential diagnosis and treatment planning to design differentiated instruction that can be delivered in the general education classroom.

8.3 School-University Partnerships

Research has generated knowledge that has contributed to evidence-based educational practices. However, the challenges of translating research findings into practice in real world settings can be daunting. More input is needed from the voice of experience of classroom teachers providing instruction in classes averaging between 20 and 30 diverse students. So innovative approaches to inservice professional development are needed that include more (a) researcher-school partnerships, (b) interdisciplinary conceptual frameworks to guide and coordinate the work of multiple professionals with diverse disciplinary expertise, and (c) alternatives to 1 day workshops. One such alternative might be for an entire professional community to participate in the same professional development two to three times during a given school year, with opportunity to problem solve implementing and evaluating the application of what is learned in their own school.

9 Next Steps

In the US teachers and school districts are held accountable for the performance of their students on tests designed to assess whether students meet criteria for state standards. If they do not, there are financial penalties. We propose that instead of punishing the teachers (e.g., with job loss) or school district (withholding federal funds), the federal government should fund more preservice and inservice professional development for teachers (Berninger and Wolf, 2016) and research to evaluate the effectiveness of both kinds of professional development. We close this chapter with a brief summary of an exploratory study of inservice professional developmental that focused on phonological awareness and morphological awareness.

9.1 Inservice Professional Development to Disseminate Research

Participants Thirty six professional educators (mostly general and special education teachers in the public schools and some private practice tutors) from a variety of school districts in the state enrolled in university sponsored professional development in literacy during the summer that granted continuing education credits.

Pretest and Posttest Assessment At the beginning of the morning session the participants completed a survey of linguistic awareness knowledge, which assessed both phonological awareness (18 items) and morphological awareness (18 items). After participating in four professional development activities, they completed a posttest with the same phonological and morphological awareness items. The phonological items included questions about (a) how many phonemes corresponded to specific graphemes, for example, two letters standing for one phoneme (th) or for two blended phonemes (st), (b) whether the same grapheme stood for the same phoneme in different words (e.g., thumb and then), and (c) which graphemes or word families (rimes) could be used to spell the same given sound (e.g., o, aw, au, ough). The morphological items included (a) circling the inflectional suffixes and underlining the derivational suffixes in jabberwocky words (pseudowords with affixes and bases), and (b) differentiating the jabberwocky words with morphemes of Anglo-Saxon versus Latinate/French word origin.

Nature of the Professional Development The professional development activities engaged the professional educators in the same kinds of learning activities as had been used with students with SLD in grades 4–9. Instructional design principles included modeling, imitation, and turn-taking close in time to create automatic connections; listening and talking and looking and writing to create procedural knowledge; and transfer of coding and mapping strategies to decoding and spelling words.

The first professional learning activity required the educators to listen to an audiotape in which phonemes in isolation and in word context were pronounced. Then they were encouraged to say the phonemes in isolation and in word context. Finally, the tape was replayed for them to listen for auditory feedback for pronouncing the phonemes in isolation and in context. The second professional activity was to listen to and imitate six syllable types in English (closed, open, vowel teams, r- and l- controlled, -le, and silent e) and schwa syllables (with unaccented vowels). The third professional activity was to learning phonological-orthographic mapping first for alphabetic principle and then for word families. First the educators listened to the phoneme being pronounced and wrote all the possible ways to spell it with one or two letters in the alphabetic principle. Then they received auditory and written feedback to what was correct. Second they listened to rime unit being pronounced and wrote the word family that could be used to spell it (the multi-letter group after the initial phoneme or phoneme blend in the syllable). The fourth professional activity was a review of the high frequency morphemes of the language (prefixes and inflectional and derivational suffixes) and application of them to transforming words.

Findings Results were analyzed with repeated measures ANOVA with two within participant variables (tasks—phonological versus morphological awareness; and time—pretest to posttest). Both the two main effects and interaction were statistically significant: task, $F\,(1, 35) = 67.74$, $p < 0.001$ (partial eta squared 0.659); time, $F\,(1, 35) = 24.68$, $p < 0.001$ (partial eta squared 0.414), and task by time, $F\,(1, 35) = 13.08$, $p = 0.001$ (partial eta squared 0.272). For phonological awareness, at pretest

the mean was 15.64 (*SD* = 4.65), but at posttest was 16.44 (*SD* = 4.766). For morphological awareness, at pretest the mean was 4.00 (*SD* = 5.60), but at posttest was 8.97 (*SD* = 7.343). Clearly, the teachers came in knowing more about phonological than morphological awareness; however, whereas all the teachers improved over time, they showed larger relative gains in morphological awareness than phonological awareness but still scored higher on phonological awareness than morphological awareness at posttest.

10 Conclusions

Progress has been made in professional development of teachers regarding phonological awareness. Participating educators in the inservice professional development entered with a relatively high level of phonological awareness and not only maintained but also improved slightly, but significantly, in phonological awareness. However, they entered with relatively little knowledge of morphological awareness; and although after the professional development activities, they had improved and relatively more so than in phonological awareness, still their overall level of morphological awareness was substantially below their phonological awareness. Much work remains to provide inservice professional development for educators for teaching morphological awareness, and interrelating phonological, orthographic, and morphological awareness, pattern analysis, and mapping in students in middle childhood and adolescence.

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Appendix

Resources for Teaching Handwriting

1. Zaner-Bloser www.zaner-bloser.com/fresh/handwriting-overview.html
2. For Trademark instructional (manuscript and cursive) and assessment materials Slingerland®Institute for Literacy see www.slingerland.org
3. Benbow, M. (1990). *Loops and groups: A kinesthetic writing system*. San Antonio, TX: For cursive.
4. Rubel, B. (1995). *Big strokes for little folks*. Tucson, AZ: Therapy Skill Builders. For manuscript.
5. Berninger, V., & Abbott, S. (2003). *PAL Reading and Writing Lessons*. Lesson Set 3.

Resources for Teaching Typing (Explicit Instruction in Keyboarding)

1. Dr. E. Fry. *Keyboarding for Beginners*. Teachers' Creative Materials, Inc. www.teachercreated.com
2. *Ten Thumbs Typing Tutor* (tenthumbstypingtutor.com)
3. ***KEYTIME®*** www.**keytime**.com/ 5508 Roosevelt Way NE Seattle, WA 98105

Resources for Teaching Spelling

1. Fry, E. (1996). *Spelling book. Level 1–6. Words most needed plus phonics*. Westminster, CA: Teacher Created Materials, Inc. www.teachercreated.com
   Contains lessons with words and strategies for teaching children to spell high-frequency words alone and in dictated sentences and apply phonics knowledge to spelling. Provides placement test for placing children at their instructional level.
2. Bear, D. Ivernezzi, M., Templeton, S., & Johnston, F. (2000). *Words their way: Word study for phonics, vocabulary, and spelling instruction* (2nd ed.). Upper Saddle River, NJ: Merrill.
3. Dixon, R., & Englemann, S. (2001). *Spelling through morphographs*. DeSoto, TX: SRA/McGraw-Hill. Excellent program once students have mastered Fry program. McGraw Hill: *Spelling Connections* and *Spelling Mastery*.
4. Masterson, J., Apel, K., & Wasowicz, J. (2006). SPELL 2 Spelling Performance Evaluation for Language and Literacy (Spelling assessment software for grade 2 through adult; assessment linked to instruction). Learning by Design, Inc., Evanston, IL. http://www.learningbydesign.com

Resources for Teaching Composing

1. Carlisle, J. (1996). *Models for writing, Levels A, B, and C*. Novato, CA: Academic Therapy Publications. also WWW.HIGHNOONBOOKS.COM reproducibles for classroom use.
2. Nelson, N., Bahr, C., & Van Meter, A. (2004). *The Writing Lab Approach to Language Instruction and Intervention*. Baltimore, MD: Paul H. Brookes. Offers practical suggestions for teachers to use in scaffolding instruction for students with language learning disability.

Resources for Teaching Reading

1. Nunes, T., & Bryant, P. (2009). *Children's reading and spelling. Beyond the first steps*. Oxford UK: Wiley-Blackwell.
2. Carlisle, J. (2000). Vocabulary, Sentence, and Paragraph activities (analogies, using in another context, inferring from context, etc.) in *Beginning Reasoning and Reading*, *Reasoning and Reading Level One*, *Reasoning and Reading Level Two*. Cambridge, MA: Educators Publishing Service.

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