Published in final edited form as:

New Dir Child Adolesc Dev. 2019 May ; 2019(165): 73–90. doi:10.1002/cad.20288.

Connections between Reading Comprehension and Word-Problem Solving via Oral Language Comprehension: Implications for Comorbid Learning Disabilities

Lynn S. Fuchs, Douglas Fuchs, Pamela M. Seethaler, Laurie E. Cutting, and Jeannette Mancilla-Martinez

Vanderbilt University

The Vanderbilt Learning Disabilities Innovation Hub, funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development, addresses a vulnerable, understudied, and underserved subgroup of the learning disabilities population: students with comorbid difficulty in two critical areas, reading comprehension and math word-problem solving. This form of learning disability occurs frequently (Landerl & Moll, 2010; Mann Koepke & Miller, 2013), and as Koponen et al. (2018) observed, half of children with poor performance in one domain also have difficulty in the other domain.

Moreover, students with such comorbidity experience worse outcomes in each area than do peers with difficulty in only one of these domains (Cirino, Fuchs, Elias, Powell, & Schumacher, 2015; Willcutt, Petrill, et al., 2013), and comorbidity is associated with inadequate response to generally effective intervention (Fuchs, Fuchs, & Prentice, 2004). Nonetheless, the problem of co-occurring reading and math difficulty is understudied: The literature is small; most studies are descriptive; and most investigations focused on reading and math difficulty define comorbidity in terms of lower-order skill: calculations and word reading. In this article, we refer to difficulty across reading comprehension and word-problem solving as *higher-order comorbidity*.

Students with higher-order comorbidity also represent an especially vulnerable learning disability subtype for two reasons. First, reading comprehension is a strong predictor of quality of life, financial security, and life expectancy (Batty, Kivimaki, & Deary, 2010; Meneghetti, Carretti, & De Beni, 2006; Ritchie & Bates, 2013; Taraban, Ryneason, & Kerr, 2000). Limited reading comprehension decreases access to content knowledge and undermines learning during and after formal schooling. Second, word-problem solving is the best school-age predictor of adult employment and wages (Every Child a Chance Trust, 2009; Murnane, Willett, Braatz, & Duhaldeborde, 2001), and it represents a major emphasis in almost every strand of the math curriculum from kindergarten through high school. So word-problem solving difficulty limits school as well as occupational success. It is therefore highly problematic that schools struggle to provide students with intervention in more than one domain. Typically, reading intervention takes priority over math intervention, which

leaves students with comorbid reading and math learning disability without the math intervention they require to succeed.

In this article, we discuss the Vanderbilt Hub's approach to studying students with higher-order comorbidity. In the first segment of this article, we describe a framework that connects reading comprehension and word-problem solving development via oral language comprehension, and we establish connections between oral language comprehension and reading comprehension (Catts, Hogan, & Adolf, 2005; Gough & Tunmer, 1986; Peng et al., in press) and between language comprehension and word-problem solving (Bernardo, 1999; Fuchs, Geary, Compton, Fuchs, Hamlett, Seethaler, & Bryant, 2010a, 2008; Van der Schoot, Bakker Arkema, Horsley, & Van Lieshout, 2009). This first segment provides the basis for the article's second segment, focused on the Vanderbilt Hub's innovative approach for investigating connections between reading comprehension and word-problem solving via language comprehension. This study tests a theoretically-coordinated framework for scaffolding performance in both high-priority domains of academic development, while exploring disaggregated effects for boys versus girls and for native and non-native English speakers.

Framework

Reading comprehension and word-problem solving differ in some transparent ways. For example, most reading passages, because they are more extended than the typical word problem, make stronger demands on inferencing and background knowledge than occurs with word problems. On the other hand, in word problems, representing the text is not the final goal. Instead, students answer the word problem's question, which requires representing the text with a number sentence that includes a missing quantity, deriving the mathematical result, evaluating whether the answer is computationally reasonable and correct, and communicating the solution (Jiménez & Verschaffe, 2014).

Even so, based on theories of reading comprehension, discourse processing, and word-problem solving (Perfetti, Yang, & Schmalhofer, 2008; Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007; Verschaffel & De Corte, 1997), representations of texts, including reading passages and word-problem statements, necessarily have three components. The first involves constructing a coherent microstructure and deriving a hierarchical macrostructure to capture the text's essential ideas. The second component is the situation model, which requires supplementing the text with inferences based on the reader's prior knowledge. With the third component, the reader derives a problem model or schema to match the passage's or word-problem statement's content.

Kintsch and Greeno (1985) posited that although the comprehension strategies, the nature of required knowledge structures, and the form of resulting structures, inferences, and problem models differ by task, the general features of this process apply across stories, informational passages, and word problems. Reading passages and word-problem statements alike require individuals to build the propositional text structure, inference, and identify schema, and this processing makes strong demands on reasoning and working memory. In reading passages or word-problem statements, the child processes the propositional text base to sequentially

fill the slots of a model that evolve over the passage. This involves coding relevant objects, actors, and actions (as well as quantities for word problems), across segments of text, while re-sorting information as new ideas alter hypotheses about the situation and the schema.

Because the processes by which stories and informational text are understood more thoroughly (e.g., Perfetti, Yang, & Schmalhofer, 2008; Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007) than is the case for word-problem solving, we illustrate text comprehension processes in the context of word problems. Note, however, that the Vanderbilt Hub and its Project study address text comprehension and word-problem solving in equal measure and in parallel ways.

Consider the text processing required for a combine word problem (Part 1 plus Part 2 equals Total or $P1 + P2 = T$): *Joe has 3 marbles. Tom has 5 marbles. Tom also has 2 balls. How many marbles do the boys have in all?* A low-risk child processes sentence 1's propositional text base to identify that object = marbles; quantity = 3; actor = Joe; but Joe's role = to be determined (TBD). This is placed in short-term memory. In sentence 2, propositions are similarly coded and held in memory. In sentence 3, *balls* fails to match the object code in sentences 1 and 2, signaling the number 2 as perhaps irrelevant; this is added to memory. In sentence 4, the question, the quantitative proposition *how many marbles* and the phrase *in all* cues the child to identify the combine schema; assign the role of superset (Total) to the question; assign subset roles (Parts 1 and 2) to the TBDs in memory; and reject 2 balls. Filling in these slots of the schema triggers a set of problem-solving strategies.

With typical school instruction, children gradually construct the combine schema on their own, just as they devise their own strategies for handling the demands on reasoning and working memory that this text processing, problem-solving sequence involves. Errors are viewed as failures (a) to produce the intended mental representations with respect to the three components in preceding paragraph or (b) to manage demands on reasoning and working memory. Such demands are well documented for reading comprehension (e.g., Berninger et al., 2010; Eason, Goldberg, Young, Geist, & Cutting, 2012; Swanson, & Jerman, 2007) and word-problem solving (e.g., Fuchs et al., 2010a, 2010b).

Unfortunately, children with reading comprehension or word-problem solving difficulty fail to discover schemas on their own, and demands often exceed their reasoning and working memory capacity. Direct skills intervention (in reading comprehension or word-problem solving) for students with reading comprehension or word-problem solving difficulty explicitly teaches step-by-step strategies to help children derive the intended mental representation and formulate connections among the propositional text base, the situation model, and the schema (or model) in ways that reduce reasoning and working memory demands.

For example, schema-based word-problem solving tutoring (Fuchs et al., 2009, 2014) explicitly teaches at-risk children step-by-step strategies that begin with identifying word-problem statements as combine, compare, or change schema. Then children are taught to build the propositional text structure. Schema-based word-problem solving tutoring facilitates connections among the situation model, schema, and productive solution

strategies by making these connections explicit, while reducing demands on reasoning and working memory.

More specifically, with schema-based word-problem solving tutoring, the child RUNs through the problem: Reads it, Underlines the question in which the object code (marbles) is revealed, and Names the explicitly taught (combine) schema. This prompts the child to write the combine meta-equation, $P1 + P2 = T$ (Part 1 plus Part 2 equals Total). The child then re-reads the problem statement and while re-reading, writes replacements for P1 and P2 (quantities for each relevant “part”) and crosses out irrelevant objects and numbers. This reduces the burden on reasoning and working memory and provides the equation for problem solving. This in turn prompts the counting-up adding strategy (also taught in schema-based word-problem solving tutoring). Word-problem solving and reading comprehension interventions that compensate for reasoning and working memory demands with explicit skills instruction, such as schema-based word-problem solving tutoring, have proven effective in improving reading comprehension (D. Fuchs et al., in press; Jitendra, Hoppes, & Xin, 2000; Williams, Hall, & Lauer, 2004; Williams et al., 2014) or word-problem solving (Fuchs et al., 2014; Fuchs et al., 2009).

More pertinent to Vanderbilt Hub and the present article, Kintsch and Greeno (1985) and Rapp, van den Broek, McMaster, Kendeou, and Espin (2007) further posited that competent performance in each domain also relies heavily on language comprehension processes. As per Kintsch and Greeno, in word-problem solving, children “understand important vocabulary and language constructions prior to school entry” (p. 111) and “through instruction in arithmetic and word-problem solving, learn to treat these words in a special, task-specific way, including extensions to ordinary usage for terms (e.g., *all* or *more*) to more complicated constructions involving sets (*in all* and *more than*)” (p. 111). In reading comprehension, *because* or *therefore* acquires special meaning within cause-effect passages to prime readers to search for and connect consequences with trigger events.

The assumption is that students have the necessary language comprehension abilities to understand text and problem statements to derive appropriate problem models. Yet, assuming children with limitations in language comprehension will learn to treat domain-specific words in a special task-specific manner through school exposure to reading comprehension and word-problem solving tasks is tenuous, and this may be particularly so for non-native English speakers (Mancilla-Martinez & Lesaux, 2010; 2011) and other at-risk and diverse populations.

In the case of word problems, Cummins, Kintsch, Reusser, & Weiner (1988) computationally modeled errors with two types of defects: incorrect math problem-solving processes versus language comprehension processing errors. Correct problem representation depended more on language comprehension, and changing wording in minor ways dramatically affected accuracy. To illustrate how word-problem solving taxes language comprehension, consider this combine problem: *Joe has 3 cats. Tom has 5 dogs. Tom has 2 plants. How many pets do the boys have in all?* Objects in this text increase demands on language comprehension for assigning roles for the propositional text structure (despite similar demand for inducing the schema), due to more sophisticated representations of

vocabulary involving taxonomic relations at superordinate levels and subtle distinctions among categories (dogs + cats = pets; plants are not pets). All this suggests that instruction focused on language comprehension processes as well as the mathematical aspects of word-problem solving is required within tutoring, with an explicit focus on strengthening word-problem language for building propositional, situational, and schema representations. These ideas apply equally well in the domain of reading comprehension.

For this reason, the Hub's innovative approach involves embedding reading comprehension-language comprehension instruction within reading comprehension direct skills instruction and embedding parallel word-problem solving-language comprehension instruction within word-problem solving direct skills intervention. Before explaining that approach, we briefly describe some recent studies examining connections between reading comprehension, word-problem solving, and oral language comprehension.

Some Recent Studies

Some prior work examining concurrent relations between reading comprehension and word-problem solving suggest an association. For example, Vilenius-Tuohimaa, Aunola, and Nurmi (2008) reported substantial shared variance across reading comprehension and word-problem solving when controlling for foundational reading skill. Swanson, Cooney, and Brock (1993) identified reading comprehension as a correlate of word-problem solving while controlling for working memory, knowledge of operations, word-problem propositions, and calculation skill. Boonen, van der Schoot, Florytvan, de Vries, and Jolles (2013) found that reading comprehension had medium to large relations with word-problem solving. Although this relation was not evident at the word-problem item-level in Boonen, van Wesel, Jolles, and van der Schoot (2014), the authors indicated that their word-problem items did not involve the semantic complexity that warrants strong reliance on reading comprehension.

Cirino, Child, and McDonald (2018) extended the concurrent literature by longitudinally assessing the role of domain-specific and general predictors in kindergarten and multiple types of reading and mathematics outcomes in first grade. The correlation between first-grade reading comprehension and math problem solving was .67. After partialling all 11 predictors, the correlation decreased to .21, which corresponds to an R^2 value of .04. This suggests commonality in the underlying sources of variance contributing to reading comprehension and word-problem solving. Surprisingly, however, language was differentially predictive of math problem solving compared to reading comprehension. This may be due to the age level of the participants, because first-grade reading comprehension relies more heavily on word reading than vocabulary knowledge (Garcia & Cain, 2014).

Also relying on a longitudinal design, Fuchs, Fuchs, Compton, Hamlett, and Wang (2015) assessed second graders early in the year on general language comprehension, working memory, nonlinguistic reasoning, processing speed, and foundational reading and math skill. At the end of the year, the children were assessed on word-problem specific language, reading comprehension, and word-problem solving. Path analytic mediation analysis indicated the effect of general language comprehension on reading comprehension was

entirely direct, whereas the effect of general language comprehension on word-problem solving was partially mediated by word-problem specific language comprehension. Yet, across both domains, effects of working memory and reasoning operated in parallel ways. These findings are in line with Kintsch and Greeno (1985), who suggested that operating on word problems and conventional reading passages require parallel processes that tax language comprehension, working memory, and reasoning.

More recently, Fuchs, Gilbert, Fuchs, Seethaler, and Martin (2018) extended this literature by testing effects of initial reading comprehension using a broad-based measure of reading comprehension (*Gates–MacGinitie Reading-Comprehension* [MacGinitie et al., 2002]), on year-end word-problem solving. We examined the specificity of effects by contrasting the contribution of the Gates to later word-problem solving against Gates’s effects on later calculations. Based on studies indicating (a) shared concurrent variance between reading comprehension and word-problem solving (Boonen et al., 2013, 2014; Swanson et al., 1993; Vilenius-Tuohimaa et al., 2008), (b) substantially similar patterns of cognitive and linguistic predictors across reading comprehension and word-problem solving (Fuchs et al., 2015), and (c) shared but some distinctive predictive patterns for word-problem solving versus calculations (Fuchs et al., 2008; Swanson & Beebe-Frankenberg, 2004), we hypothesized that the effects of Gates are stronger on word-problem solving than on pure calculations. Conversely, we expected simple, initial arithmetic skill to predict year-end, more complex calculations more strongly than either of the year-end word-problem measures.

More highly relevant to the Vanderbilt Hub’s focus, we also explored the role of start-of-year language comprehension in word-problem solving while controlling for start-of-year Gates performance. Consistent with Kintsch and Greeno (1985) and given studies documenting connections between language comprehension and reading comprehension (Catts, Hogan, & Adolf, 2005; Gough & Tunmer, 1986; Peng et al., in press) and between language comprehension and word-problem solving (Bernardo, 1999; Fuchs et al., 2010a, 2008; Van der Schoot et al., 2009), we expected the effects of start-of-second-grade language comprehension to be stronger on both end-of-second-grade word-problem solving outcomes than on calculations.

On one hand, we found that language comprehension strongly and uniquely predicted later word-problem solving. We also found that Gates performance was a strong predictor of later word-problem solving. On the other hand, we found that Gates was not a specific predictor of word-problem solving (i.e., it also predicted later calculations), which raises questions about what general measures of reading comprehension actually assess. (A discussion of this finding is beyond the scope of the present article. See instead Fuchs et al., 2018.)

More pertinently, finding a stronger role for language comprehension in word-problem solving than in calculations, while controlling for effects of reading comprehension (which is expected to share variance with language comprehension and therefore compete with language comprehension as a predictor of word-problem solving), strengthens prior evidence for the importance of language comprehension within word-problem solving. Moreover, a common role for language comprehension across word-problem solving and

reading comprehension represents an important connection between the two academic domains

A Theoretically-Coordinated Framework for Synergistically Improving Performance in Both High-Priority Domains of Academic Development

Finding that the cognitive, linguistic, and academic predictors of word-problem solving are separable from those involving pure calculations, while finding a stronger role for language comprehension in word-problem solving over calculations, also indicates that word-problem solving is connected to reading comprehension. At the same time, the literature convincingly demonstrates the critical role language plays in reading comprehension (e.g., Catts et al., 2005; Gough & Tunmer, 1986; Peng et al., in press). Together, this suggests an important role for reading comprehension instruction within word-problem solving instruction as well as the need for a focus on language instruction in improving performance in both domains.

For word problems, a strong focus on language includes but is not limited to word-problem-specific vocabulary and syntactic knowledge (e.g., understanding the distinction between *more than* and *then there were more*; that the cause and effect in change word-problem solving may be presented in either order within word-problem statements). Such an approach is consistent with recent calls (Catts & Kamhi, 2017; Ukrainetz, 2017) to intimately connect an instructional focus on oral language to specific reading comprehension task demands, even as that instruction targets the subset of learners with language deficits for such embedded language comprehension instruction.

An integrated approach with a deliberate focus on the reading comprehension demands of word-problem solving and the language that connects reading passage and word-problem processing may also include methods to assist students in constructing explicit text-level representations, generating text-connecting inferences, retrieving general as well as math-specific background knowledge, and integrating that knowledge with information in text-level representations (Perfetti et al., 2008; Rapp et al., 2007; Verschaffel & De Corte, 1997). All this is in the service of building the situation and the problem model or schema of the reading passage or word problem statement.

In this vein, the Vanderbilt Hub's research project innovatively tests whether the effects of conceptual scaffolding designed to connect reading comprehension, word-problem solving, and language comprehension may ultimately provide direction for a theoretically coordinated approach for simultaneously improving performance across reading comprehension and word-problem solving. This includes, for example, addressing cause-effect informational text structure (a topic typically reserved for reading comprehension) in conjunction with change word problems (in which an event serves to increase or decrease a starting amount, thereby creating a new ending amount) or connecting compare-contrast informational text structure (again, a topic typically reserved for reading comprehension) in conjunction with word problems that compare quantities.

Testing effects of an approach that is designed to focus on reading comprehension and word problems in coordinated fashion would extend theoretical understanding of both domains.

This line of work is potentially important for three additional reasons, as discussed at the beginning of this article. First, students with comorbid learning disorders across reading comprehension and word-problem solving represent an especially vulnerable subset of the learning disabilities population; reading comprehension is a strong predictor of quality of life, financial security, and life expectancy (Batty et al., 2010; Meneghetti et al., 2006; Ritchie & Bates, 2013); and word-problem solving is the best school-age predictor of later employment and wages (Every Child a Chance Trust, 2009; Murnane et al., 2001). Second, students with concurrent difficulty perform lower in each domain than students with difficulty in just one academic domain (Willcutt et al., 2013). Third, schools experience substantial challenges in providing students with intervention on more than one academic domain. Because reading often takes priority over math in the early grades, many comorbid students receive reading intervention as they fall further behind in math. A coordinated approach for addressing reading comprehension and word-problem solving would alleviate this logistical problem.

In the Vanderbilt Hub's study, we randomly assign second-grade children with comorbid difficulty across reading comprehension and word-problem solving to three study conditions. The first condition focuses on conceptual scaffolding on reading comprehension with an embedded focus on language comprehension that spans reading comprehension and word-problem solving. The second condition provides conceptual scaffolding on word-problem solving with an embedded focus on language comprehension that spans word-problem solving and reading comprehension. The third condition is a business-as-usual control group (the classroom and interventions schools typically provide). This study ran its first cohort of participants during the 2017–2018 academic year. At the time of this publication, the study was still in progress.

The study's specific aim is to test what we refer to as the higher-order comorbidity hypothesis: Language comprehension plays a critical role in reading comprehension and word-problem solving and provides direction for understanding higher-order comorbidity, thus offering a coordinated approach for improving both outcomes and lending support for the validity of reading comprehension and word-problem solving comorbidity as an LD subtyping framework.

We ask two questions. The first is whether conceptual scaffolding on one academic domain with an embedded focus on language comprehension that spans both academic domains (reading comprehension and word-problem solving (conditions 1 and 2) produces aligned and reciprocal advantages over the control group. We expect aligned effects favoring reading comprehension scaffolding over control on reading comprehension outcomes and favoring word-problem solving scaffolding over control on word-problem solving outcomes. More central to the comorbidity hypothesis, we also hypothesize reciprocal effects, with stronger performance over control for embedded language comprehension within reading comprehension on word-problem solving outcomes and with stronger performance over control for embedded language comprehension within word-problem solving on reading comprehension outcomes. Our second question is whether aligned and reciprocal effects in part occur indirectly, via improved understanding of the language of reading comprehension

or the language of word-problem solving. We hypothesize indirect effects via the aligned form of domain-specific language comprehension on *both* outcomes.

Thus, our focus on language comprehension is the vocabulary and syntax addressed in the reading comprehension and word-problem solving scaffolding. This focus maps onto prior studies documenting relations of vocabulary and syntax with various forms of mathematics. For example, Hornburg, Schmitt, and Purpura (2018) found that preschoolers' mathematical language was more strongly related than general expressive vocabulary to word-problem performance and other numeracy skills. Chow and Ekholm (2019) identified concurrent relations between receptive syntax and addition operations and understanding at first and second grade. Gjicali, Astuto, and Lipnevich (2019) examined longitudinal relations between language and numeracy skills in predominantly high-poverty children. Children were 1–4 years when language skills were assessed; 4–7 years when number skills were assessed. Language comprehension was indirectly related to number identification and number relations via oral counting.

Exploratory Hypotheses and Development of a Neuroimaging Paradigm

We also consider two exploratory issues to provide insight into the robustness of effects and to address issues of diversity and inclusiveness: whether aligned and reciprocal effects for comorbid students differ for boys versus girls or for non-native English speakers versus native English speakers and whether pretest English proficiency among non-native English speakers moderates intervention effects.

Across studies on the mathematics performance for girls versus boys, performance differences between males versus females appear to increase with three variables: as grade level increases, with more complex mathematics demands on visual-spatial resources, and among higher-achievers (Stoet, Bailey, Moore, & Geary, 2016). On this basis, we do not expect a main effect for girls versus boys in second-grade students with comorbid learning disability. Our exploratory issue is, however, about an *interaction*: whether the pattern of word-problem solving scaffolding effects differs for boys versus girls. We did not locate any study disaggregating word-problem solving intervention effects for boys versus girls. Because differential effects of word-problem solving intervention for girls versus boys have been tested infrequently if at all, we examine scaffolding effect sizes for boys versus girls to explore the robustness of effects.

In reading comprehension intervention research, the issue of differential effects for girls versus boys also has received little attention. Here, we also did not locate any intervention study separating effects. In a synthesis, however, Suggate (2016) reported a correlation between percentage of boys in the studies and outcome (outcome was aggregated across reading constructs, i.e., it was not specific to reading comprehension). The correlation was $-.15$ at posttest; $-.31$ at follow up (favoring girls). As with word-problem solving, because few relevant analyses are available and none for comorbid samples, we examine effect sizes for boys versus girls to explore the robustness of effects.

The literature on differential word-problem solving or reading comprehension intervention effects for non-native English speakers versus native English speakers is similarly thin. It fails to provide the basis for hypotheses, especially for comorbid non-native English speaking samples. Yet, the school-age population of non-native English speakers is growing rapidly (National Center for Education Statistics, 2017; McFarland et al., 2017), and databases reveal a main effect, in which non-native English speakers' math and reading performance falls substantially below that of native English speakers (National Center for Education Statistics, 2017). Moreover, in this population, studies document the relation of vocabulary and/or syntax with word-problem solving (e.g., Foster, Anthony, Zucker, & Branum-Martin, 2019; Méndez, Hammer, Lopez, & Blair, 2019) and reading comprehension (Mancilla-Martinez & Lesaux, 2017; Nakamoto, Lindsey, & Manis, 2008; Proctor, Carlo, August, & Snow, 2005).

It is of theoretical and clinical importance to explore (a) whether the pattern of effect sizes differs for non-native English speakers versus native English speakers for comorbid children and (b) a pattern of moderation in which the relation between English proficiency and performance is expected to be less strong with embedded language comprehension instruction in word-problem solving scaffolding and in reading comprehension scaffolding than in control. This is because language comprehension-embedded scaffolding is designed to compensate for poor language comprehension. We note that the Hub's Project is not powered for formally assessing these robustness and diversity questions, but our hope is that it will provide insight into whether effects for English language learners differs from effects for monolingual counterparts.

A final component of the Hub's work is development of a neuroimaging paradigm to capture the brain mechanisms that underlie connections among reading comprehension, word-problem solving, and language comprehension. Development of a paradigm may provide the foundation for future studies focused on how the brain mechanisms associated with language comprehension serve as a potential link between reading comprehension and word-problem solving.

In Sum

The overall hope is that the Vanderbilt Hub's Project will impact science by (a) deepening understanding about language comprehension as a process involved in higher-order comorbidity; (b) providing theoretically-guided and empirical bases for the link between reading comprehension and word-problem solving; (c) strengthening support for the validity of this form of comorbidity as a learning disabilities subtyping framework; and (d) providing insight into the robustness of this approach (by gender and English proficiency status). Also, our focus on scaffolding language comprehension within reading comprehension and word-problem solving tutoring provides a platform for transdisciplinary work across learning sciences, second language learning, learning disabilities, and developmental psychology. This is critical because evidence is growing that language comprehension difficulty contributes to poor responsiveness to reading comprehension or word-problem solving intervention among students with developmental learning disabilities (e.g., Catts et al., 2008; D. Fuchs et al., in press).

In sum, the Vanderbilt Hub's science is innovative in four important ways. First, we focus on an especially vulnerable subset of the learning disabilities population, which is understudied, may suffer from disproportionately poor reading comprehension and word-problem solving outcomes and may have a distinctive set of cognitive deficits: students with comorbid difficulty with reading comprehension and word-problem solving. Second, with this understudied population, we adopt an innovative approach: conceptual scaffolding across language comprehension and one academic domain, with parallel structure what is required in the second academic domain. If this approach reveals improved performance in both academic domains, it would offer an innovative direction for treating this understudied, vulnerable population. Third, the Hub's study provides the most stringent test to date on the connection among language comprehension, reading comprehension, and word-problem solving. Fourth, our exploratory issues address the robustness of effects as well as diversity and inclusiveness. The long-term goal of this proof-of-concept science is to impact clinical practice by offering an innovative direction aimed at improving learning for this understudied, vulnerable population.

Acknowledgments

This research was supported by 2 P20 HD075443 and Core Grant HD15052 from the Eunice Kennedy Shriver National Institute of Child Health & Human Development to Vanderbilt University. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health & Human Development or the National Institutes of Health.

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