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Tiffany Hogan
University of Nebraska - Lincoln, thogan2@unl.edu

Jennifer M. Thomson
Harvard Graduate School of Education, thomsoje@gse.harvard.edu

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Future advances in the early detection of reading risk: Subgroups, dynamic relations, and advanced methodologies

Epilogue to *Journal of Learning Disabilities* Special Edition "Advances in the Early Detection of Reading Risk"

Tiffany P. Hogan
University of Nebraska–Lincoln

Jennifer Thomson
Harvard Graduate School of Education

Corresponding author – Tiffany P. Hogan, 318D Barkley Memorial Center, University of Nebraska—Lincoln, Lincoln, NE 68583; tel 402 472-3911, fax 402 472-7697, email thogan2@unl.edu

Six studies and 1 synthesis focused on early identification of reading impairment in this special edition. A familiar theme emerged: reading involves multiple subsystems that dynamically interact across development making *early* identification a 'moving target' (cf Speece, 2005). Based on the cumulative findings presented in this edition, we pose 5 key considerations for future advances in the early detection of reading risk: (a) attention to the definition of 'reading' and the heterogeneity of poor readers (b) longitudinal dynamic relations, (c) application of advanced, theory-driven methodology and statistical models, (d) early identification that leads to prescriptive early intervention, (e) early identification in a multi-lingual, multi-cultural population.

Attention to the Definition of 'Reading' and the Heterogeneity of Poor Readers

Comprehending text is a complex task that requires numerous coordinated skills. This complexity may explain why defining 'reading' can be equally complex. How one chooses to define reading is no trivial matter when the goal is to determine reading risk. The simple view of reading (Gough, Hoover, & Peterson, 1996; Gough & Tunmer, 1986; Hoover & Gough, 1990), described by Adlof, Catts, & Lee in this issue, states that reading is comprised of two components: word reading and language comprehension. Both skills are evoked to achieve adequate comprehension of text. A child who is missing one or both components will struggle to comprehend text (Catts, Hogan, & Fey, 2003; Van der Lely & Marshall, this edition). In our collection of manuscripts, reading was measured in varied ways and, by extension, so was 'reading risk'. Some measured 'reading' through word reading assessments (e.g., single words or connected text; van der Lely & Marshall, this edition; Liu et al., this edition; Corriveau, Goswami, & Thomson, this edition) or reading fluency measures (i.e., reading accuracy + speed; Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, this edition), whereas others measured reading with comprehension tests (Adlof, Catts, & Little, this edition) or a combination of word reading and comprehension measures (Smith, Roberts, Locke, & Tozer, this edition).

In general, subsystems that underpin word reading are different from those that underpin language comprehension (Catts, Adlof & Ellis Weismer, 2006). Thus, the predictors of reading risk will change according to the way reading is defined. This was highlighted by Ad-

lof and colleagues (this edition), in which reading comprehension defined 'reading' and subsequently reading risk in both 2nd and 8th grades. As predicted, the indicators of reading risk changed slightly from 2nd to 8th grade. In 2nd grade letter knowledge, sentence imitation, and phoneme awareness abilities were highly predictive of a child's reading risk, whereas in 8th grade grammatical completion added to predictive power.

Notably the composition of poor readers changed from 2nd to 8th grade: 42% of the children marked as poor readers in 8th grade were *not* poor readers in 2nd grade. The reverse was also true: approximately half of those who were identified as poor readers in 2nd grade were not poor readers in 8th grade. The changing nature of reading comprehension is one likely cause of poor reader instability and the resultant change in predictors of reading comprehension impairment from 2nd and to 8th grades. More precisely, the skills required to understand text change over time (Catts, Hogan, & Adlof, 2005): in the early grades, the ability to read text well is enough to bootstrap into texts that are simple narratives with commonly used words. However, in the later grades as texts increase in difficulty with less common words, more complex sentence constructions, and the less familiar expository text genre, more competence in language comprehension is required, whereas the amount of word reading skills needed to comprehend text seems to asymptote. In fact, language and reading comprehension are indistinguishable from each other in the later grades (Adlof, Catts, & Little, 2007).

If identification is in the early grades, predictors will be those that sub serve word reading, the skill most crucial for reading comprehension at that time. Alternatively, if poor readers are identified in the later grades predictors will reflect cumulative word reading knowledge and language comprehension skills critical for later reading comprehension. Van der Lely & Marshall (this edition) bring to light differential deficits in two clinical populations of children with reading impairments, those with dyslexia and those with specific language impairment (SLI). Simply stated, those with dyslexia have specific weakness in word reading/phonological processing with relatively intact language comprehension. Those with SLI evidence poor language comprehension with varied word reading skills (Catts, Adlof, Hogan, & Ellis Weismer, 2005). Following from the simple view of reading, in the early grades those with dyslexia who have deficient phonological processing/word reading will be identified as poor readers because reading comprehension relies mostly on word reading. At the same time, those with SLI with good word reading (SLI only; cf. poor comprehenders, Nation, Clark, Marshall, & Durand, 2004) will be missed *because* of their overt age-appropriate word reading skills. Notably, those with SLI have below average language comprehension in the early grades even if they score within normal limits on a reading comprehension test (Catts, Adlof, & Ellis Weismer, 2006). To accurately identify those at risk for reading impairment at early and later grades, both word reading and language/reading comprehension must be included as the 'reading' target. The most sensitive and specific measures for each at different time points are still unknown. The manuscripts in this special edition highlight a few possibilities; however more longitudinal work, similar to studies in this edition, is required to determine the measure(s) most likely to predict future word reading, language and reading comprehension or both.

Longitudinal dynamic relations

Learning to read words and comprehend text is a protracted developmental process. The diagnostic studies in this edition employed longitudinal datasets to reveal relations between early language and pre-reading skills and later reading development. Cumulative results show that early language and reading processes are dynamic, forming both direct and indirect relations with later reading development. For example, Torppa et al (this edition) found that early expressive vocabulary was both directly and indirectly related to early pre-reading measures such as phonological awareness and letter naming. Expressive vocabulary appears, "to tap the skills necessary to boost development of the acquisition of complex language skills, such as the ability to inflect words, or sensitivity to the phonological structure of spoken language." (Torppa et al., pg. XX). Hogan (this edition) describes lexical restructuring as an indirect way vocabulary acquisition influences word reading via phoneme awareness. Others in this edition focused on direct relations from early language to later reading. Smith et al. (this edition) found a direct relation between early speech production and later reading. In their study, babbling complexity was examined as a window into a young child's phonological knowledge. At 8 to 19 months, babbling was linked to later reading. Likewise, in Corriveau, Goswami, & Thomson (this edition) early rhythm accounted for later rhyme and phoneme awareness as well as growth of both skills in early childhood. Future investigations should continue to explore both indirect and direct links between early and later development drawing on sound theory while considering other potential external mediating factors such as home literacy experiences and school environment.

Advanced, theory-driven methodology and statistical applications

Stephen Gould wrote, "all fundamental scientific innovation must marry new ways of thinking with better styles of seeing." (1998, pg. 18). The studies in this edition showcase several new ways of thinking about early identification of reading risk. Cumulatively these new ways of thinking highlight the complex nature of reading comprehension by way of direct and indirect relations between early speech and language development and later reading outcomes. To continue to better identify reading risk early in development, we must employ also 'better styles of seeing' including more advanced statistical methodologies that allow us to better 'see' dynamic relations as reading processes change over time in heterogeneous populations of poor readers.

Item response theory (Hambleton, Swaminathan, & Rogers, 1991) and diagnostic category modeling (e.g., cognitive diagnosis models; Rupp, Templin, & Henson, 2010) are two advanced statistical methods that are particularly germane to the goal of improving early identification of reading risk. Item response theory provides item-level information about a child's latent ability. In a practical application of item response theory, tests may be constructed using items that are sensitive to a pre-set level of ability. If a child scores poorly on those sets of items, one would have confidence that the child would be at risk for future reading impairment. Theory should inform item selection as outlined in Hogan (this edition) and item data can also inform theory. Diagnostic category modeling is a form of confirmatory latent class models that characterizes the relation of observed responses to a set of categorical latent variables or traits. In this way a child could be categorized by his strengths and weaknesses in early reading skills helping to better classify heterogeneous groups of poor readers. Further, these models can provide predicted reading outcomes for a change in one or more traits allowing for greater specificity in targeted instruction. These advanced statistical methodologies do however require a large number of children for adequate statistical power. Thus, future work aimed at obtaining more sophisticated measures of early reading risk using these methodologies will likely require multi-site and multi-discipline collaborations.

Early identification that leads to prescriptive early intervention

The goal of this special edition was to identify early signs of reading risk with hopes of providing early intervention to stave off reading failure and the accompanying negative effects of reading failure. Identifying reading impairment as early as birth or soon after is a potentially tangible goal as researchers work to optimize the reliability of electrophysiological measures and post-natal universal screening tools. However, what will be the treatment recommendation if a child is identified with reading impairment (or more appropriately, "future reading impairment") at birth? Research is needed to build systematic, evidence-based support of treatments for those diagnosed *early*. Further, work aimed at early identification and subsequent intervention should determine predictors/factors that are malleable to treatment. For example, Adlof et al. (this edition) found that sentence imitation was a predictor of future reading comprehension deficits. At face value, a sentence imitation treatment goal does not have ecological validity for improving reading comprehension. Likewise, Torppa et al (this edition) found that mother's education is a good predictor of a child's future reading risk. Clearly it is not always the case that predictors of risk lead to readily malleable treatment targets.

Research is needed to determine treatment goals targeted at a child's specific strengths and weaknesses considering the many routes to reading comprehension deficiencies. Connor and colleagues (e.g., Connor, Morrison, & Katch, 2004; Connor, Morrison, & Petrella, 2004; Connor, Piasta, Glasney, Schatschneider, Fihman, Underwood, et al., 2009) showcase individualized treatment research by examining child x instruction interactions. Children received instruction in code-based instruction versus comprehension-based instruction based on pre-treatment reading abilities. Time on each task was also allotted per child. Cumulative findings show that matching a child's initial strengths and weaknesses to instruction time and goal was beneficial for long-term reading success. Inversely, a mismatch between a child's initial skill set and the instructional time and goal resulted in no progress in reading, or in some cases a decline in skills. Similar work is needed to determine malleable skills that, when improved through instruction, result in reading gains over time.

Early identification in a multi-lingual, multi-cultural population

The research reported in this special edition was not limited to an examination of English reading. Adding to a growing body of literature, two studies examined predictors of reading risk in children learning to read a language other than English, including reading Chinese (Liu et al., this edition) and Finnish (Torppa et al., this

edition). In both cases, predictors of reading risk were similar even though the languages spoken and read by the children in each study were different. However, these studies included children learning to read their primary language. More research is needed to examine the best set of predictors for those children learning to read two languages simultaneously or sequentially as the majority of children in the world are multi-lingual. Ziegler and Goswami (2005) highlight how the structure of one's language(s) may influence the process by which speech sounds are mapped to letters and letter patterns when children are learning to read. Multi-site, multi-country consortiums such as the ELDEL (enhancing literacy development in European languages; http://eldel.eu/welcome) are examples of collaborations established to reveal language-specific and language-general factors affecting literacy development and subsequent risk for reading impairment across languages.

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