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The Role of Phonology and Language in Learning to Read

by Margie B. Gillis and Louisa Moats

We, the editors of this issue of *Perspectives*, were each fortunate to have been mentored by eminent language and reading researchers early in our careers. Many of the researchers and scholars who shaped our thinking were associated with the Haskins Laboratories at Yale University, where seminal work in understanding reading was taking place. Isabelle Liberman, her husband Alvin Liberman, their colleague Donald Shankweiler, and many of their associates and graduate students, formulated the phonological core-deficit hypothesis now considered to be central to explaining both typical reading development and reading difficulties.

But how did they arrive at their novel and profound insights about the relationship of speech to reading? Up until the 1970s (and even today), many psychologists and educators believed that reading was primarily dependent on visual perceptual abilities, visual short-term memory, and/or general cognitive characteristics such as mental processing speed. Proposing that printed word recognition depended primarily on specific linguistic processes, especially at the phonological level of language, was a revolutionary idea. Explaining why phoneme awareness was elusive, that phonemes were obscured by the characteristics of speech, and that humans were not "wired" for the level of linguistic awareness demanded by reading, were pivotal discoveries. These discoveries, however, evolved gradually, through a series of painstaking experiments that began with the goal of developing a reading machine for the blind.

A short history of the Haskins work follows here, as it places the articles in this issue in historial perspective.

The Evolution of Speech Research at Haskins Laboratories

Work on a reading machine for the blind. Haskins Laboratories was founded in 1935 by Dr. Caryl Haskins, a biophysicist and a pioneer in radiation biology who was joined by Dr. Frank Cooper, an electrical engineer. The lab's history of being a multidisciplinary community of researchers "was created for basic research and research training in certain pioneer areas which involve several scientific disciplines" (Shankweiler & Fowler, 2015, p. 80). In 1944, to prepare for the consequences of World War ll, the Office of Scientific Research and Development suggested that Haskins join the Committee on Sensory Devices to help conduct research on the development of a reading machine for the blind. Dr. Alvin Liberman, a psychologist, joined the Haskins team in 1944 and collaborated with Cooper to design a reading machine that would convert optical patterns in print (orthographic symbols) to acoustic signals.

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This reading machine would potentially improve the Optophone, a device invented in 1912 that scanned text and generated a series of tones which could be used by a blind person to identify letters. The hope was to develop a more efficient machine that could increase the speed of the existing device.

A failed experiment. Researchers from Haskins were unsuccessful at creating accurate sound alphabets, because at the time, Cooper and Liberman believed that speech comprised "discrete alphabet-like acoustic segments for phonemes" (Shankweiler & Fowler, 2015, p. 82). In the course of their experimentations, they discovered "that the letter sounds merged auditorily; they did not maintain their discrete identities" (Shankweiler & Fowler, 2015, p. 83). As Shankweiler and Fowler's article describes in detail, the researchers' failed experiments "revealed large regions of ignorance of human perceptual capabilities and had broad repercussions for cognitive science" (Shankweiler & Fowler, 2015, p. 79). Though the term coarticulation wasn't used at the time, Cooper and Liberman were discovering the fact that speech is very different than other codes. In their own words, "the acoustic signals for words provide many fewer 'distinct elements' than do words in Morse code" (Shankweiler & Fowler, 2015, p. 83). Cooper's and Liberman's final report for the Committee on Sensory Devices included their principal conclusion that "a successful reading machine must present its information in word-like units, not letter-by-letter" (Shankweiler & Fowler, 2015, p. 84).

New ideas to explore. Although these early Haskins researchers didn't determine that the output of a reading machine had to be speech, they did consider the idea that speech has "a special *kind* of complex acoustic structure" (Shankweiler & Fowler, 2015, p. 84) and began to explore a new tool that made speech visible—the sound spectrograph. This instrument provided a visual record of the auditory signal that shows the frequency composition and acoustic structure of speech. These new explorations led to the development of a complementary device that reconverted the visible pattern of a spectrograph into a sequence of speech sounds. Invented by Cooper, the Pattern Playback machine tested "their hypotheses about how the acoustic signal specifies the phonetic segments of syllables, words, and sentences" (Galantucci et al, 2006, p. 3). According to Shankweiler's historic account, "this line of research proved pivotal, serving indeed to shift the direction of Haskins research toward the investigation of speech as a special kind of acoustic signal reflecting in critical ways how it is produced" (Shankweiler & Fowler, 2015, pp. 87-88).

Studying speech for its own sake and the motor theory of speech perception. Shankweiler and Fowler describe another important discovery in the history of speech research—"that the speech signal is nothing like an acoustic alphabet, but rather is an 'encoded' signal as a result of coarticulatory overlap of gestures…and appears to put speech perception in a category of its own" (Shankweiler & Fowler, 2015, p. 89). Hence, these findings related to speech's acoustic signals and how sounds are coarticulated supported the need to study speech—both perception and production—for its own sake. As the research on speech evolved, the connections between perception and production were studied, which led Liberman and his colleagues to develop a motor theory of speech perception. This theory "claimed that listeners use highly context-dependent acoustic speech cues to recover speech motor invariants that they proposed mapped more directly to phonetic segments than did the acoustic cues" (Shankweiler & Fowler, 2015, p. 94). In subsequent years, the motor theory was developed further by several Haskins' researchers, including Ignatius Mattingly, a linguist, who suggested that speech *perception* depends on the brain's ability to *produce* speech.

Connecting speech and reading research. Dr. Donald Shankweiler, a neuroscientist, joined the Haskins team, continuing the research on speech and the hemispheric lateralization and the biological specialization for language. This line of research led Shankweiler to partner with Dr. Isabelle Liberman, a cognitive psychologist, to answer questions about reading development and reading disability. Their first research together, exploring the types of errors children made when they read aloud, led them to discover that these errors were linguistic rather than visual—that is, words were misread when they had overlapping phonetic features. Further exploration on their part prompted Isabelle Liberman's seminal paper published in the *Bulletin of the Orton Society* in 1971. In it she states that "the sounds of speech are (instead) a very complex code. In this complex code, information about successive phonemic segments is transmitted simultaneously, not successively in strings as it is in the written language" (Liberman, 1971, p. 59). She concludes the paper making the following points: 1) "We cannot have language without speech but we can and do have language without a written form that can be read… 2) we need something more in the way of a conscious, cognitive analysis of the phoneme structure of language if we are to read" (Liberman, 1971, p. 64).

These ideas developed into the concept of phonemic awareness as a metalinguistic skill that underlies the ability to decode words—a finding that Dr. Reid Lyon, director of the reading research program at the National Institute of Child Health and Human Development, considered one of the most important scientific discoveries of the 20th century. As Isabelle Liberman and Shankweiler continued their research on the role that phonemic awareness plays in learning to read, they proposed the phonological core deficit hypothesis to explain why some children have difficulty learning to read. They explained that learning to read requires the individual to map the written word to the spoken word and as such, is a linguistic process. This finding provided the motivation for decades of research that led to more recent research on neurocognitive processing.

Shankweiler and Fowler conclude their historical account saying, "Today, 70 years after the faltering beginnings of the reading machine project, Haskins Laboratories is best known for its pioneering research on speech and reading, but it also deserves to be known for the pioneering work on the reading machine that stimulated these developments" (Shankweiler & Fowler, 2015, p. 95).

Progress in Understanding Speech and Reading: The Articles in This Issue

Each of the articles to follow builds on the Haskins researchers' foundational insights into the nature of reading. That reading is "parasitic on speech," as Al Liberman often remarked, is the unifying theme of this issue.

In the first article, David A. Kilpatrick argues that phonemic proficiency, not simply phoneme awareness, underlies the development of fast, accurate, recognition of words in print. He emphasizes that advanced phonemic manipulation skills, performed without undue mental effort, are what enable automatic word recognition. Phoneme proficiency also underlies our ability to decipher and remember new printed words, and, together with letter-sound proficiency, allows the self-teaching required for independent word learning. He suggests that assessments have more explanatory and predictive value if phonemic proficiency is directly measured, and that explicit instruction in advanced phonemic skills should continue until students are fluent readers.

Jeannine Herron and Margie B. Gillis review evidence that the encoding process—translating speech into print—is an often overlooked but essential strand in foundational literacy instruction. The authors contrast a speech-to-print instructional approach with more traditional and common print-to-speech instruction. They summarize evidence, including a study of their own, that a spelling component in decoding programs increases the lessons' effectiveness, and argue that speech-to-print instruction strengthens neural connections between phonological, orthographic, and semantic processing systems more effectively than instruction that focuses first and primarily on print decoding. A helpful table is used to contrast the sometimes subtle differences in approaches.

Brandy Gatlin-Nash, Lakeisha Johnson, and Ryan Lee-James describe and discuss the challenges of language and reading faced by nonmainstream dialect speakers of English. Referring to a growing research base that illuminates the associations between dialect use, oral language development, and poverty, the authors summarize major theoretical frameworks for understanding the influence of dialect on learning to read, especially with regard to phonological differences in this population. Citing concrete examples of how dialect may interfere with academic language learning, the authors offer helpful guidance on how to support and instruct dialect speakers in the classroom. The article includes citations of several innovative curricula developed for language-minority children, and emphasizes the importance of teachers understanding language processes and language differences so that they can address these differences constructively.

Finally, Rouzana Komesidou and Tiffany P. Hogan describe the ways in which early manifestations of potential reading difficulties can be observed in preschoolers. The authors point out that precursors of both aspects of the Simple View of Reading—word recognition and language comprehension—can be measured and observed before students encounter formal reading instruction, and can be deliberately nurtured in therapeutic and educational settings designed for early intervention. Warning signs of delayed or problematic language in preschoolers are described and illustrated, as well as the longitudinal, predictable consequences that early phonological, semantic, or syntactic language delays have on later word recognition or reading comprehension problems.

In retrospect, Haskins Laboratories' profound discoveries about the connections between speech, language, reading, and literacy have shaped everything about the way we currently describe, identify, classify, and treat reading development and disorders. The articles in this issue of *Perspectives,* while proposing refinements in current assessment and instruction practices, reflect and honor that enduring legacy.

References

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