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Introduction

Advances in Specific Language Impairment Research and Intervention: An Overview of Five Research Symposium Papers

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Purpose: This article provides an overview of five papers appearing together on the topic of "Advances in Specific Language Impairment Research and Intervention," which was the 2019 program in an ongoing series of research symposia presented at the Annual Convention of the American Speech-Language-Hearing Association.
Method: The article provides a historical context for the set of papers, then a short summation of each paper's content, followed by the identification of overarching themes and working conclusions.
Results: Each paper provides summations of empirical results, and some papers provide new empirical evidence.
Conclusion: The papers collectively highlight six points: (a) Children with specific language impairment (SLI) are likely to be unidentified among their age peers. (b) There is great need for better identification of children with SLI across developmental levels. (c) Progress is evident toward a better understanding of causal pathways, as examined across different research designs involving comparison of children with typical language acquisition to children with SLI and other possibly co-occurring atypical conditions. (d) Measuring multiple dimensions of language brings enhanced informativeness, with differing outcomes for differing dimensions. (e) Replicated research findings require precision of methods in order to reduce unexplained error variance especially when defining groups. (f) Accurate identification of children with SLI is the first step toward a sound treatment plan for SLI and reading disorders as well.
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Under the leadership of Margaret Rogers, Chief Staff Officer for Science and Research at the American Speech-Language-Hearing Association (ASHA), there is an annual research forum offered at the time of the Annual Convention, funded by competitive grant support provided by the National Institute on Deafness and Other Communicative Disorders (NIDCD) and documented by follow-up publications within a year of the Convention. In Spring 2015, planning began for the research forum reported in the following papers on the topic, "Advances in Specific Language Impairment Research and Intervention." The first step was the recruitment of a panel of active researchers with a history of funding from the National Institutes of Health (NIH), encompassing a range of topics adding to our knowledge of specific language impairment (SLI). Each of the panelists/contributing authors carry out a program of investigation of children with SLI, consisting of multiple studies exploring multiple dimensions of SLI over different ages of children.

SLI is defined by the NIDCD (2019, para. 1) as "a communication disorder that interferes with the development of language skills in children who have no hearing loss or intellectual disabilities. SLI can affect a child's speaking, listening, reading, and writing." The causes of the condition of SLI are unknown. The reference group for identification of children with SLI is a same-age group of typically developing children whose language acquisition is seemingly effortless, around the world, across many languages. The causal sources of this ubiquitous human ability are also not known beyond a general conclusion that they are related to children's brain development and opportunities to communicate with people. There is a common assumption that language acquisition is easy for all healthy children, barring extreme limitations or mitigating circumstances. For example, a renown scholar of children's language acquisition once wrote in an important book on the topic, "In general, language acquisition is a stubbornly robust process; from what we can tell there is virtually no way to prevent it from happening short of raising a child in a

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barrel" (Pinker, 1984, p. 29). The same author later adjusted that perspective, recognizing the existence of SLI as a likely inherited condition leading to difficulties in language acquisition (Pinker, 1994, p. 48).

The point here is that studies of children with SLI invariably straddle what is known about language acquisition in two groups of children: typically developing children, as compared to apparently typically developing children who nevertheless lag behind their same-age peers in language acquisition. This reciprocity contributes to new knowledge about possible causal pathways for universal human language acquisition (shared robustness) as well as vulnerabilities in language acquisition (unexplained departures from typical expectations). Informativeness can be further enhanced with research designs involving comparisons with strategically selected groups of atypical children, such as young children at risk for future SLI, children with social (pragmatic) communication disorder or S(P)CD, children with attention-deficit/hyperactivity disorder (ADHD), children with reading disorders, and children with low nonverbal intelligence. Such comparisons bring valuable insights about the timing of early language acquisition, possible differences in developmental change for children with and without SLI, and the extent to which other atypical developmental conditions are independent of SLI (suggesting nonshared causal pathways and potentially discrete developmental mechanisms underlying language acquisition).

Across the papers included in the forum, group comparison studies clarify linguistic details in the identification of relative ease or difficulty of acquisition among the various linguistic elements to be mastered. For example, one paper in this collection focuses on what young English-speaking children need to know to generate diverse simple sentences and avoid grammatical errors. Another question across papers is whether the components of linguistic systems (e.g., speech, vocabulary, syntax, morphosyntax, narratives, and social pragmatics) in children with SLI or clinical comparison groups are synchronized across elements in the same way as children with typically developing language or whether some components are more likely to lag behind other components. Studies of instructional methods shine light on possible teaching strategies that could be used to enhance the rate of acquisition in children with SLI to close the gap with their age peers. Such studies also provide essential information about how to benchmark training methods for children with SLI relative to their age peers whose language acquisition is ahead of children with SLI, following the educational practice of grouping children by age for instruction. These issues are among the ones in the papers reported in this research symposium. Highlights from each of the papers within the SLI research forum are briefly summarized here, in order according to a developmental progression, from gestation to elementary school age reading levels.

The topic of the first paper (Rice, 2020) literally begins with gestation, in investigations of twin pairs of children defined by their biological relationship—that is, monozygotic (MZ) versus dizygotic pairs (DZ). Comparisons of language acquisition between twins and singletons inform us of biological/developmental risks associated with twinning, and comparisons of children within twin pairs inform us of the relative contributions of shared environment versus shared genes as indexed by heritability estimates. Comparison of heritability estimates across multiple dimensions of language, speech, and nonverbal cognition provides indications of possible causal pathways across elements of language and cognition. A population base sample provides evidence of the extent to which low levels of nonverbal IQ and language variables overlap or diverge (e.g., revealing the existence of children with low nonverbal IQ who nevertheless have language levels equivalent to their age peers) and possible change over time in a longitudinal study. Key outcomes reveal the value of the differences in empirical measures that index levels of performance (i.e., how children differ in their score levels) versus how empirical measures are associated with each other (e.g., if co-twin MZ children are more like each other than co-twin DZ children, or if there is an association between a child's score on a language assessment with their score on a nonverbal IQ assessment). The third key outcome is that language is composed of dimensions that can be measured separately, such as speech versus vocabulary versus grammar, with different dimensions revealing different outcomes. The indices of multiple levels of performance reveal differences between twins and singleton children during the early period of language acquisition, such that twins are at risk for delay in reaching language milestones. The indices of within–twin pair associations reveal moderate to high levels of heritability for speech and language, although the size of the heritability estimates varies by linguistic dimension, age, and whether it is calculated as heritability of a clinical group (such as SLI) or across the full sample of twins (all children regardless of clinical status). Results from this study indicate that the relationship between nonverbal IQ and speech and language measures is not straightforward and that the classic clinical definition of SLI brings different outcomes than those from a nonspecific language impairment (NLI) group that includes children with clinical levels of nonverbal cognitive impairments. Heritability of language replicates from 2 to 16 years on measures of grammar and vocabulary, although the pattern of heritability does not replicate across SLI and NLI groups in a longitudinal study at ages 4 and 6 years, cautioning us about the need to keep these groups separate when examining potential underlying causal mechanisms. Overall, the outcomes of the reported twin studies add support to the generalization that language acquisition and language impairments are each heritable, with additional details needed regarding heritability of grammar, vocabulary, and nonverbal IQ. Greater precision in outcomes is evident when language impairment is differentiated from low levels of nonverbal IQ, suggesting some degree of independence in causal pathways for SLI versus NLI. Outcomes have implications for theoretical models of genetic effects on language, suggesting the need to incorporate recognition of timing effects in the start of language acquisition and in growth over time in childhood.

The second paper (Hadley, 2020) focuses on early stages of language acquisition in toddlers as they begin to generate sentences, comparing toddlers developing language typically and toddlers at risk for SLI. The methods of investigation are precise, sentence-focused analyses of children's spontaneous utterances, informed by linguistic perspectives and high standards of empirical analyses. Analytic outcomes are literally at the level of individual words as well as carefully specified interpretations of intended syntactic structures. The sentence-focused framework predicts that children's early verb vocabulary will be more strongly associated with later grammatical outcomes than early noun vocabulary, and first-person subjects (i.e., "I") lead the way for diverse simple sentences versus third-person subjects (e.g., "she" or "he"). Conversely, reliance on first-person subjects for necessary sentence diversity could be diagnostic of a young child at risk for SLI as a preschooler. A review of previous studies in the author's lab is provided, encompassing data from ages 21, 24, 27, and 30 months. In addition, new descriptive analyses of archival data from ages 30, 33, and 36 months are reported. Key outcomes are as follows: Documentation of precise methods of assessing sentence diversity to chart how this linguistic growth occurs in toddlers and a strong case for how individual differences in the developmental patterns of emerging sentences are candidates for methods of identifying SLI early in children's development, as well as providing important documentation of the ways in which children with typical language acquisition build their early sentences.

The third paper (Leonard & Deevy, 2020) focuses on the possible role of verbal memory on word learning and retention in children with SLI, whose risk for problems with word learning are well documented. Although it is apparent to most parents that early word learning is a rapidly accelerating process, as well as to every teacher that a child's readiness for reading instruction requires the expected vocabulary size by school age, the exact ways in which children accomplish the rapid growth without explicit tutoring are not well documented. Further, by the time children enter school, any vocabulary instruction they receive is usually incidental to a focus on new content. There is a great need for precise information about exactly how to teach new words to children, with identification of methods that would be beneficial for young children with SLI and their same-age peers with typical development. The third paper reviews outcomes of a program of experimental studies investigating the role of retrieval practice in experimental settings for learning novel words under different retrieval conditions, comparing preschool-age children with SLI and their same-age peers with typical development. Four logically related experimental studies are reported, with outcomes summarized in detail. With the caveat that if future experimental refinements support the findings, the interpretive and clinical implications are that repeated spaced retrieval activities in naturalistic clinical settings and educational activities could help children with SLI acquire new words to add to their vocabulary. If this proves to be the case, it would be a significant addition to instructional methods. Such detailed experimental training studies inform our understanding of typically developing children's language acquisition as well as children with SLI.

The fourth paper (Redmond, 2020), addresses the issue of possible co-occurrence of SLI (Stark & Tallal, 1981) with ADHD, as compared to two other operationalizations of idiopathic language disorder, in an analysis of the study sample compiled by his lab's program of investigation of SLI and ADHD. The three definitions were classic SLI (Stark & Tallal, 1981), the recent criteria for developmental language disorder (DLD; Bishop et al., 2017), and the criteria of the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM5; American Psychiatric Association, 2013) definition of language disorder. Another category of communication disorder must also be considered, that of S(P)CD, as defined and included in the recent DLD criteria. The key outcome is that the amount of overlap between ADHD and language impairment diagnostic groups varied according to the criteria for language impairment: Co-occurrence of language impairment and ADHD was 2% under the DSM5 definition of "language disorders," which separates language disorder from the S(P)CD designation, whereas co-occurrence increased to 22.3% under the broader DLD criteria, which includes S(P)CD as well as cases of NLI. The SLI designation yielded 16.9% co-occurrence. It is of interest that the presence of pragmatic symptoms exerted a stronger influence on observed co-occurrence rates than low nonverbal abilities. These outcomes are clearly relevant to research aimed at sorting out the co-occurrence of SLI with other clinical conditions as well as clinical practice decisions involving eligibility for services, risk for co-occurring conditions, and determination of treatment goals.

The fifth paper (Adlof, 2020) addresses the possible overlap of SLI and dyslexia. A review of definitions and inclusionary and exclusionary criteria is provided, followed by a review of the intersection/overlap of the two disorders, focusing on language, working memory, and academic achievement. The detailed comparisons of groups of children with SLI-only, dyslexia-only, and SLI + dyslexia versus neither SLI or dyslexia across different outcomes supports the conclusion that SLI and dyslexia are separate disorders, yet frequently co-occur. Children in the SLI + dyslexia group are likely to have the most severe deficits. The results support the need for further studies in how to differentially identify children with SLI and children with dyslexia, such that it is not assumed that the presence of one condition entails the presence of the other, although both confer risk to academic achievement. The paper concludes with advocacy for screenings of oral language at school entry as well as screenings of dyslexia as precursors to response-to-intervention (RTI) methods for identifying children with dyslexia, a method heavily weighted toward word-reading skills.

Collectively, the papers address overarching themes and working conclusions. One is the need for identification of affected children across developmental levels. This objective requires precise knowledge of language acquisition

in children developing typically for indications of unexpected variance such that some children, for no apparent reason, are lagging behind age expectations. The identification of accurate clinical markers of SLI in children across age levels is an ongoing and important research goal. Detailed linguistic analyses of early sentences are promising for the challenging toddler period of dynamic language development, a time of wide variation across children. Screenings at school entry are needed for identification of children with low levels of language acquisition and/or early reading skills to avoid delayed detection of children when intervention should already be underway.

A second theme is a focus on causal pathways and the extent to which language impairment is independent of other developmental disorders. The situation is complicated by cases of clinical co-occurrences that may appear to confirm an expected pattern that does not hold up in population-ascertained samples. Although some may assume that children with SLI are just not very smart (or were raised in a barrel), recent twin studies document the independence of low nonverbal IQ and language impairments. There is evidence of heritability for both, albeit heritability is stronger for speech and language variables. In studies of singleton children, SLI can overlap with some other disorders (e.g., dyslexia, ADHD), yet no consistent evidence for a single shared causal pathway has emerged, as reported in two papers in this collection. At the same time, it is good to keep in mind that studies of twin children indicate moderate to high heritability for language—higher for analyses investigating heritability of SLI as compared to estimates of heritability across all children in a sample. It is possible that the ways in which children with SLI differ from most children will be an age-dependent part of the causal pathway, perhaps related to underlying timing mechanisms for the onset of language acquisition in early childhood.

A third theme is the need to consider the multidimensionality of language. Across the papers, there is a focus on the particular dimensions of language of interest for the purpose of the investigation, ranging from first words, first sentences, word learning in experimental conditions, precise morphosyntactic and grammatical elements, composite language scores across elements, and language adjustments for social uses. Across the papers' outcomes, one conclusion is that it matters which linguistic element is operationalized in a study. Language is complex, multidimensional, and age-dependent in children, and precise measurement is required.

A fourth theme is the need to reduce unexplained error variance, especially in the definition of groups. This is most explicit in the paper comparing ADHD co-occurrence with three different definitions of language impairment (Redmond, 2020). If the definition of *language impairment* was loosely defined in a way that any of the three possible definitions could be used to place a child in the "language impairment group" (i.e., identified according to the classic SLI criteria, the DSM5 criteria, or the DLD criteria), this combined criterion would generate a larger group size than a more conservative definition. Note that under such a broad definition, it would be possible to miss the distinctive contribution of S(P)CD and low nonverbal IQ. The conclusion could be quite misleading, due to unexplained error variance (i.e., unidentified sources of spurious overlap in causal pathways for ADHD and language impairments), which could work against the identification of real overlap or real independence—a first step for understanding possible shared or unique causal pathways. Note, also, that such a broad definition of language impairment could undermine replicability of outcomes across studies, because the samples could vary considerably in the proportion of children with or without S(P)CD or children with or without very low levels of nonverbal IQ. Another example is evident in the paper on dyslexia and SLI (Adlof, 2020). The paper highlights that predictors differ for dyslexia and SLI: Poor phonemic awareness is associated with dyslexia more than SLI, whereas SLI is more likely to be associated with grammatical weakness. Regarding nonverbal IQ, studies of SLI and dyslexia aimed at understanding causal mechanisms could have benefited from nonverbal IQ cutoff levels to arrive at the generalizations. Common cut-point levels could avoid increased error variance attributable to the effects introduced by increased shared variance of low nonverbal IQ with SLI and dyslexia than is evident among the variables when all children have nonverbal IQ levels clearly within typical range. Much of the current literature focuses on SLI or dyslexia, not studies of comorbidity. It will be important to conduct studies in which measures of language, reading, and nonverbal IQ are collected from the same children in a large population–based sample. Methods of analyses in the twin studies (Rice, 2020) generate outcomes most likely to replicate across studies within one lab or across different labs if the measurement methods are precise, including criteria for differentially grouping children as language impaired with or without low nonverbal IQ. Note, it is valuable to also include the children in the population who have low nonverbal IQ with co-occurring language skills within or even above typical range. In summary, the point here is that control of unexplained variance in the grouping variable can be enhanced by using cutoffs for low performance, preferably at the same level for language and nonverbal IQ, which, in the case of low nonverbal IQ, is also likely to screen/avoid children with undiagnosed neurological conditions (Stark & Tallal, 1981).

A common theme across the papers is concern with clinical issues related to identification of children with SLI, across a wide age span. Evaluation of diagnostic definitions or clinical markers are addressed in four of the papers (Adlof, 2020; Hadley, 2020; Redmond, 2020; Rice, 2020). Two of the papers focus on intervention methods (Adlof, 2020; Leonard & Deevy, 2020), and a third paper addresses intervention in the literature review (Hadley, 2020).

Collectively, the papers here are consistent with a robust scientific commitment to better understand how to account for unexpected individual differences in language acquisition in children with SLI who seem to have

the essential prerequisites, how to identify them, and how to provide effective treatment to help enhance their language abilities in a time when language is vital to the well-being of children and adults. In turn, studies of children with SLI increase our knowledge of language acquisition in general, the underlying causal pathways, how language unfolds over a developmental trajectory, and our knowledge of how nonlinguistic cognitive or social abilities are associated (or not) with language acquisition. The papers in this collection provide valuable new information and replicate findings reported in the many valuable precedents in our scientific literature on the condition of SLI.

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