

The Role of Processing Limitations in Early Identification of Specific Language Impairment

This article considers how information regarding processing limitations in children with specific language impairment (SLI) might be extended to assist in early identification of toddlers at risk for language disorder. A brief review of the evidence for processing capacity limitations in SLI is provided, along with results from longitudinal studies of toddlers with late onset of language development. Preliminary findings are presented from an ongoing investigation of early lexical processing for 15 late talking toddlers and 15 controls whose performance was assessed on a novel word learning task. Assessment implications of a processing based account of language impairment are discussed. Key words: *assessment, cultural diversity, language disorder, language outcomes, late talkers, limited processing capacity, processing measures, specific language impairment*

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AS CLINICIANS KNOW, our clinical practices are constantly evolving in response to changing perspectives and new information. Within our field, models of language impairment, assessment, and intervention have traditionally been derived from theories of normal language acquisition and use (Craig, 1982; Evans, 1996b). Current theories of language disorder, in particular accounts of specific language impairment (SLI), parallel present theories of normal language and can be grouped broadly into either competence or performance-based models. This distinction between competence and performance was originally introduced by Chomsky (1957) to distinguish an idealized speaker's knowledge of grammatical rules (competence) from the speaker's real time processing of language (performance) which additionally

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entails nonlinguistic factors such as attention and memory.

Competence-based accounts of SLI assume that language impairments are reflective of problems in the children's underlying grammar (Clahsen, 1989; Gopnik & Crago, 1991; Rice & Wexler, 1996). These theories differ with respect to which aspects of the child's grammar are posited to be impaired. They are similar, however, in that they all focus on characterizing the child's underlying linguistic knowledge at any given point in development. Alternatively, performance-based accounts of SLI assume that the language difficulties are secondary to cognitive/information processing deficits. These accounts can be grouped broadly into those that presume a specific processing mechanism is responsible for language disorder in these children and those that presume generalized deficits in processing capacity. For example, some investigators propose that specific deficits in phonological working memory (Gathercole & Baddeley, 1990) or temporal processing (Merzenich et al., 1996; Tallal et al., 1996) underlie language impairment. Other investigators propose that generalized processing capacity limitations, such as slower speed of processing (Miller, Kail, Leonard, & Tomblin, 2001; Leonard, 1998) or restrictions in working memory capacity (Ellis Weismer, Evans, & Hesketh, 1999; Montgomery, 2000a,b), account for these children's problems in acquiring and using language. The specific mechanism accounts differ in terms of whether or not language-specific deficits would be expected—the phonological working memory account makes language-specific claims, whereas the temporal processing account has been interpreted as a more generalized inability

to process information of short duration regardless of modality (Tallal & Piercy, 1973a,b) or as a problem particular to processing rapidly changing acoustic cues in the speech signal (Merzenich et al., 1996). The accounts positing general information-processing deficits would necessarily implicate both verbal and non-verbal difficulties.

Given the known heterogeneity within the population of children with SLI, it is unlikely that a single deficit can explain the diverse pattern of language impairments observed (Bishop, Bishop, Bright, James, Delaney, & Tallal, 1999; Briscoe, Bishop, & Norbury, 2001; Ellis Weismer et al., 1999). Therefore, it is likely that for any given child or subgroup of SLI there may be multiple factors (e.g., rate of processing, phonological working memory limitations) contributing to the language disorder.

EVIDENCE FOR PROCESSING CAPACITY LIMITATIONS IN SLI

Across a wide range of linguistic and nonlinguistic domains, a consistent pattern has emerged. It indicates that children with SLI evidence breakdowns in language processing, in the form of linguistic trade-offs and/or decreased accuracy and latency of responding, when task demands exceed their processing capacity. Evidence based on language sample data indicates that children with language disorders exhibit various types of linguistic trade-offs suggesting capacity constraints (Bishop, 1994; Evans, 1996a; Namazi & Johnston, 1996; Nelson & Kamhi, 1984; Panagos & Prelock, 1982; Prelock & Panagos, 1991). For example, these children are more likely to make speech production errors and to omit words in longer, more grammatically complex

sentences (Panagos & Prelock, 1982; Nelson & Kamhi, 1984). At the discourse level, increased morphological omission and decreased syntactic complexity have been observed in the first utterance of the turn (the point at which discourse processing demands are the greatest) as compared to subsequent utterances produced by children with SLI (Evans, 1996a; Evans, Viele, & Kass, 1997). Although Masterson and Kamhi (1992) reported no differential patterns of trade-offs for school-age children with normal language and those with language-learning disabilities, Namazi and Johnston (1996) found that children with SLI made a disproportionate number of morphological errors compared to controls matched on mean length of utterance (MLU) when producing utterances with high semantic complexity.

Limitations in processing capacity have been proposed to account for difficulties that children with SLI have in various aspects of comprehension and production on a variety of experimental tasks, including findings indicating: 1) reduced processing and storage of phonological information on nonword repetition tasks (Bishop, North, & Donlan, 1996; Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000; Gathercole & Baddeley, 1990); 2) inefficient fast mapping processes and poor novel word learning within sentences presented at fast speaking rates (Dollaghan, 1987; Ellis Weismer & Hesketh, 1996); 3) slow word recognition on lexical decision making and lexical monitoring tasks (Edwards & Lahey, 1996; Montgomery, 2000a; Windsor & Hwang, 1999a); 4) ineffective sentence comprehension processing (Evans & MacWhinney,

1999; Montgomery, 1995, 2000a,b); 5) decreased verbal working memory on a listening span task (Ellis Weismer, Evans, & Hesketh, 1999; Montgomery, 2000a,b); and 6) slower speed of processing of linguistic, as well as nonlinguistic, material (Johnston & Ellis Weismer, 1983; Miller et al., 2001; Windsor & Hwang, 1999b).

If we were interested in considering aspects of processing limitations in SLI that could be extended to the identification of toddlers at risk for language disorder, we would need to focus on relatively early stages of language development. One reasonable area to examine would be word learning abilities, since early vocabulary acquisition is one of the most salient aspects of language development at this stage. The initial phase of lexical learning has been characterized in terms of “fast mapping processes” (see Carey, 1978), in which the child rapidly constructs a representation of an unfamiliar word based on his or her first exposure to the word and its referent. This representation may include phonological, semantic, and syntactic information, as well as nonlinguistic information about the situational context. The initial representation is incomplete, but to the extent that it can be maintained, it can be modified with additional exposures. Thus, there are both conceptual and methodological reasons for investigating fast mapping processes since these processes are involved in initial stages of lexical learning and can be assessed in a play format that is “toddler friendly.”

Children with SLI have been shown to have substantial difficulty acquiring new words in studies employing both traditional and modified versions of the fast mapping paradigm (Dollaghan, 1987; Ellis Weismer & Hesketh, 1996; Rice, Buhr, & Nemeth,

1990; Rice, Buhr, & Oetting, 1992; Rice, Oetting, Marquis, Bode, & Pae, 1994). For example, Dollaghan found that preschoolers with SLI exhibited restrictions in fast mapping processes as evidenced by their difficulty naming a novel object after a single exposure to its label (“koob”), though they were able to comprehend the novel word and infer its referent. Dollaghan concluded that these findings did not provide evidence of an auditory perceptual deficit, but rather posited that the problem may entail either a storage deficit, involving difficulties with phonological coding, or a retrieval deficit in which phonological information is stored adequately but cannot be accessed in production. Rice and colleagues have found that children with SLI had difficulty acquiring unfamiliar words (e.g., “artisan”) in an incidental learning context, requiring more exposures than typically developing children to comprehend these words. In their investigations, Rice and colleagues have interpreted their results as failing to provide support for processing deficit explanations of these children’s word learning problems. For instance, Rice et al. (1994) argue that deficits in phonological working memory cannot account for their results, though they do find evidence of deficits in long-term memory (at least for verbs). On a novel word learning task in which presentation rate was varied, Ellis Weismer and Hesketh (1996) found that school-age children with SLI exhibited disproportionate deficits in production of novel words that had been presented at fast speaking rates compared to age- and language-matched controls. These investigators concluded that, while phonological memory deficits were implicated, there was additional evidence for either problems with association processes in-

involved in mapping the label to the appropriate referent or in retrieving the lexical item.

LINK BETWEEN SLI AND LATE ONSET OF LANGUAGE DEVELOPMENT

Children with SLI are known to display delayed onset and acquisition of language despite normal range development in other areas (see Leonard, 1998). A separate body of research has recently focused on late talking toddlers (see Ellis Weismer, 2000; Paul, 2000), prompted by an interest in variations in the range of normal language development, as well as by an interest in identifying toddlers with late onset of language who are at risk for subsequent language impairment. Late talkers have generally been identified on the basis of early restrictions in productive vocabulary, though some of these toddlers exhibit delays in other areas, including receptive language abilities and phonological skills (Paul, 1991; Rescorla & Ratner, 1996; Stoel-Gammon, 1991; Thal, Oroz, & McCaw, 1995). Longitudinal studies have found that approximately half of the toddlers with late onset of talking at 2 years catch up to their peers by age 3 and have no further language difficulties; these children have been designated as “late bloomers” (Paul, 1991; Rescorla, Roberts, & Dahlsgaard, 1997). Other late talkers, although making substantial gains in vocabulary development, continue to display delays in other aspects of productive language, including phonology, morphology/syntax, and narrative skills during the preschool period (Paul, Hernandez, Taylor, & Johnson, 1996; Paul & Riback, 1993; Rescorla & Schwartz, 1990). However, longer-term follow-up investigations have reported that

most late talkers meet normative expectations on traditional oral language and reading measures by elementary school (Paul, 1996, 2000; Paul, Murray, Clancy, & Andrews, 1997; Rescorla, 1993; Whitehurst et al., 1991). It is important to note, though, that when the late talkers are compared to peers matched on age, socioeconomic status (SES), and nonverbal cognition during the school-age period, they score significantly lower in several areas of language functioning than the children who had typical early language development (Paul, 1996, Rescorla, 1993).

The conclusion regarding positive outcomes for most late talkers presents an apparent paradox with respect to other research findings. Various studies have found that a substantial proportion of children who were identified as having a language disorder somewhat later in the preschool period display persistent language delay that may additionally be reflected in reading difficulties and problems with academic achievement (Aram, Ekelman, & Nation, 1984; Catts, 1993; Silva, McGee, & Williams, 1983; Silva, Williams, & McGee, 1987; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). Further, there appears to be a discrepancy between the prevalence of late talkers at 2 years of age (ranging from 10% up to nearly 15%) and the reports of high resolution rates of language problems, on the one hand, and recent prevalence data for SLI at kindergarten (7.4%) based on an epidemiologic study by Tomblin and colleagues (Tomblin et al., 1997). Since there is no evidence to suggest that children with SLI exhibit a regression of language abilities or typical early language development followed by an extended plateau, we must assume that most of the cases of SLI at

school entry evolved from late talking toddlers. One factor that may help to explain this apparent paradox is that not all of the children who are likely to develop SLI have been included in investigations of late talkers. In most of the studies, children with comprehension problems have been excluded either intentionally, so that the focus was solely on expressive language delay, or these children were inadvertently excluded through the application of normal range cognitive criteria using instruments that include verbal as well as nonverbal items as part of the cognitive assessment. Further, the range of SES represented in investigations of late talkers has been quite restricted and may not adequately reflect the total pool of children with SLI.

From a clinical standpoint, it would be extremely useful to be able to distinguish between toddlers whose language skills are likely to catch up to their peers and those who are at risk for subsequent language delay (later identified as SLI). A number of investigations have sought to determine predictors of language outcome in late talkers (Ellis Weismer, Murray-Branch, & Miller, 1994; Paul, 1996, 2000; Paul, Spangle-Looney, & Dahm, 1991; Rescorla & Schwartz, 1990; Rescorla et al., 1997; Thal, Tobias, & Morrison, 1991; Thal & Tobias, 1992; Whitehurst, Fischel, Arnold, & Lonigan, 1992). Short-term predictors at various points in development have been reported, but these differ across studies (see Ellis Weismer et al., 1994; Rescorla et al., 1997). Reliable predictors of long-term language outcomes continue to be rather elusive. Olswang, Rodriguez, and Timler (1998) have summarized findings from outcome studies of late talkers in an attempt to highlight converging evidence concerning

risk factors and predictors of change for the purpose of clinical decision making. For late talkers in the Portland sample ($n = 27$), Paul (2000) found that the best predictors of spontaneous language production at second grade were parent report of early expressive language abilities (Vineland Adaptive Behavior Scale; Sparrow, Balla, & Cicchetti, 1984) and SES. As will be discussed in the Implications for Assessment section, socio-demographic variables and ethnic/cultural background have often been found to interact with performance on traditional language assessment measures. Studies of toddlers with late onset of language have, for the most part, evaluated language skills on standard clinical assessment measures relative to normative expectations. Given the evidence for processing deficits in children with SLI, another option would be to examine early linguistic processing abilities in late talkers to determine whether these are useful, less culturally-biased predictors of later language outcomes.

PRELIMINARY PROJECT REPORT

In an ongoing longitudinal project, we are investigating the performance of children identified as late talkers at two years of age on language processing tasks that have revealed deficits in children with SLI and assessing whether these measures predict later language abilities. In this five-year study, the aspects of linguistic processing that are the focus of investigation include fast mapping processes involved in the initial phase of acquisition of novel words and morphemes (accuracy and latency), response to repeated exposures of novel language forms under contexts varying in cognitive load, and timing or accuracy/complexity trade-

offs in discourse processing. To date, we are nearing completion of data collection for the first phase of this project involving the lexical processing study.

Two groups of children are participating in this project, a group of late talkers and a group of controls matched on age, nonverbal cognition and SES. The late talkers were initially identified at two years of age based on parental report of low productive vocabulary (10th percentile and below) on the MacArthur Communicative Development Inventory (CDI) (Fenson et al., 1993). At 2½ years of age, we assessed children's language processing abilities on a novel word learning (fast mapping) task, as well as evaluated language knowledge using various standard clinical assessment measures. For the novel word learning task, children heard each of two nonsense words three times within a puppet play activity. This activity involved packing and unpacking a picnic lunch for several puppets. In this task, the two novel words (object labels) were presented along with two target familiar words. Children's production and comprehension of the novel and familiar words were assessed following the exposure phase. To probe production, children were asked, "What's this?" as the examiner held up an item from the picnic basket. Comprehension was assessed by placing all of the novel and familiar objects plus two foils in the basket and asking the child, "Can you get the _____?"

Given the evidence for processing deficits in SLI, our first question was to determine whether late talkers exhibited processing limitations on the novel word learning task. This task provides an experimental analog of the natural vocabulary learning process. We anticipated that children with

slow acquisition of vocabulary (as indexed by low CDI scores) would have greater difficulty learning novel words, given the same limited number of exposures (3), than typically developing children. Preliminary data are available for 15 late talkers and 15 controls who were closely matched on age, non-verbal cognition on the *Bayley Scales of Infant Development* (Bayley, 1993), and SES as indexed by mother's educational level. Analysis of children's performance revealed that the late talker (LT) group was as successful as the normal control group in their comprehension of familiar words, but significantly poorer in their comprehension of the novel words. For production, both groups had more difficulty with novel words compared to familiar words and the late talkers performed worse than the controls across word types. The lack of interaction between language ability and word type (novel vs. familiar) for production was likely due to the relatively low accuracy levels that both groups exhibited on this portion of the task (12% and 28% accuracy for the late talkers and typically developing toddlers, respectively). Given the higher accuracy levels on the comprehension portion, a secondary preliminary analysis of response latency was completed. Results of this analysis indicated that comprehension latency on correct responses for novel words was significantly longer for the late talkers than for the controls, but not significantly different for familiar words. Taken together, these findings support the contention that late talkers, as a group, demonstrate limitations in fast mapping processes involved in the acquisition of novel words.

The specific nature of these limitations in fast mapping is yet to be determined. It may be the case that the difficulties that the LT

group exhibited in comprehending and recalling novel words stem from less proficient phonological coding processes involved in converting acoustic information into phonological forms for rehearsal and storage; this type of problem has been proposed to underlie working memory limitations in older children with SLI (Gillam, Cowan, & Marler, 1998). Assuming that it is likely that late talkers devote a relatively large amount of cognitive resources to phonological processing, they may additionally have trouble coordinating the processing and storage functions required by this task (see Montgomery, 2000a). It may also be the case that association processes involved in mapping the novel labels to the appropriate referents are deficient. This type of problem would show up as mislabeling errors—matching one novel word target with the wrong novel object—rather than problems in retaining the phonological strings. When data collection for the entire sample is complete, error analyses may provide some insights into these alternatives. Although the present findings do not point to particular deficits in lexical retrieval processes for the LT group (in that both groups were similar in their poor production of novel words), further research employing different task demands may yet reveal that retrieval deficits play a role in fast mapping difficulties of late talkers. If late talkers have weak phonological representations for the novel words or are inefficient in their ability to link the phonological string with the referent, this could result in both less accurate and slower responses. There is no evidence that these late talkers have a generalized slowing deficit based on comprehension latency for familiar words; thus, the longer latencies for the LT group on the novel words

may be an outgrowth of problems in phonological coding and/or association processes that limit their ability to process and store this information.

The second question that we addressed pertained to the relationship between children's performance on the linguistic processing task and their language knowledge as assessed by the standard clinical measures at 2½ years of age. For the same subset of late talkers discussed above, a significant correlation was observed between lexical processing and static assessment performance. Specifically, late talkers' production of novel words was positively correlated with vocabulary production on a second CDI ($r=.54$) administered at 2½ years, as well as the expressive scale of the Preschool Language Scale (PLS-3) (Zimmerman, Steiner, & Pond, 1992) ($r=.61$). If the limited processing capacity account of language impairment is to have any explanatory usefulness in terms of potential causal factors, there should be a significant relationship between processing limitations and language deficits as typically diagnosed by measures of language knowledge. However, since we assume that processing measures tap something beyond extant language knowledge, we would expect only moderate (rather than high) correlations across these different types of measures.

Although we are not yet at a point in this project that allows us to answer our third question regarding prediction of language outcomes, we can report some initial findings. Data for 24 children (17 typically developing children and 7 children who had been identified as late talkers at age two) were examined at the 3½ year assessment. In order to consider the relationship between processing abilities at 2½ years and

language scores on standardized measures at 3½ years, we split the sample into two roughly equal groups based on their production of novel words at 2½ years: 1) children who demonstrated poor novel word learning, correctly producing only 0/6 to 1/6 targets and 2) those with better novel word learning abilities who produced 2/6 to 4/6 targets correctly. All seven of the late talkers fell into the first subgroup of children with poor novel word learning skills, along with six of the 17 typically developing controls. The total scores on the PLS-3 and scores on a test of morphology, the Word Structure subtest of the Clinical Evaluation of Language Fundamentals-Preschool (CELF-P) (Wiig, Secord, & Semel, 1992) at 3½ years were significantly lower for children evidencing poor novel word learning abilities at 2½ years than for those demonstrating better fast mapping skills. If the results from this small subset are representative of the total sample, it would suggest that this lexical processing task is sensitive to later language learning difficulties; however, the task lacks specificity in that some children with typical language according to standardized tests also perform poorly on it (though they tend to score in the low normal range on those tests). It may be the case that processing measures in combination with standard clinical measures will prove to be good predictors of later language functioning, especially if an assessment of processing abilities is incorporated into the overall evaluation of outcomes at 3½ years. We are continuing to explore this issue since further data are obviously needed to adequately address the question of whether early processing abilities can assist in the prediction of outcomes for children with late onset of language development.

IMPLICATIONS FOR ASSESSMENT

Clinical implications of a limited processing capacity account of SLI have been explored elsewhere with regard to treatment (Ellis Weismer, 1996, 1997, 2000). For the purposes of this discussion, therefore, we would like to focus on assessment implications stemming from performance-based accounts of language impairment in which processing capacity limitations are purported to play a role.

There are some clear differences between performance-based and competence-based models of language disorder that translate into different types of assessment measures. Competence-based models view language knowledge as static, abstract, contextually-free representations. These traditional approaches of assessing language through the use of standardized tests or naturalistic language sampling, are descriptive in nature and do not speak to potential etiology. Alternatively, processing models focus on real-time comprehension and production of language and may provide insights into the nature of the underlying mechanisms involved in language disorder. The extension of this theoretical distinction from a research arena to clinical application has recently been explored in several investigations by Campbell, Dollaghan and colleagues (Campbell, Dollaghan, Needleman, & Janosky, 1997; Dollaghan & Campbell, 1998) in which they contrasted children's performance on processing-based versus knowledge-based assessment measures. Within this context, these investigators have defined psycholinguistic processing as, "the mental operations required to manipulate linguistic units (Campbell et al. 1997, p. 520)." Processing-dependent as-

essment measures have included tasks such as nonword repetition and a verbal working memory measure in which children must answer true/false (questions) while simultaneously recalling the last word in each of a set of sentences. Knowledge-dependent assessment measures consist of standardized language tests that draw heavily upon a child's experience and vocabulary knowledge.

This distinction has particularly important implications for assessing language skills in culturally and linguistically diverse populations. Campbell et al. (1997) evaluated the performance of typically developing children from minority and majority backgrounds on processing- and knowledge-dependent measures. The findings of this study revealed that minority children scored significantly lower than children from majority backgrounds on the comprehensive knowledge-dependent measure, but that there were no differences between the subgroups of children on the three processing-dependent measures. Given these findings, Campbell et al. argued that processing measures such as nonword repetition may provide a culturally non-biased evaluation of language impairment. Several subsequent studies have supported this claim. Dollaghan and Campbell (1998) found that cultural influences on nonword repetition performance for school-age children with language disorders were minimal. In fact, mean scores for children from different ethnic/cultural backgrounds were nearly identical. Further, they reported that the nonword repetition task was considerably more effective than a traditional language test in classifying children according to their current treatment status. In a subsequent study, Ellis Weismer and colleagues (Ellis Weis-

mer et al., 2000) further investigated the diagnostic utility of nonword repetition performance as an index of language disorder for a large, population-based (rather than clinically-referred) sample of school-age children. Results from this study confirmed that nonword repetition is a culturally non-biased measure of language processing that can assist in identifying language impairment regardless of a child's background.

There are different ways of indexing language abilities, with some evaluation techniques being more sensitive to cultural variation than others. Most standardized language tests in this country are geared toward use of standard English dialect, as well as the majority culture background in terms of experience (world knowledge) and social knowledge of test taking situations. Standardized tests vary among themselves in the degree to which performance is affected by a child's background. Nonstandardized measures such as language sampling also have been shown to demonstrate sensitivity to sociodemographic variables (Dollaghan et al., 1999). For children who are not from the majority culture, standardized measures designed specifically from that particular cultural or linguistic background are generally not available and similarly we lack comprehensive norms for minority children's performance on language sampling measures.

Based on the studies to date, which are admittedly quite limited in number, various processing measures involving novel (non-words) or real words/sentences have not resulted in differential responsivity across children from varying backgrounds. Therefore, use of processing measures may offer an advantage over some of the other available approaches for diagnosing disorder in

culturally and linguistically diverse populations. On the other hand, it could be argued that these processing measures have stripped away the very essence of the "linguistic code" that is critical to assess and, in fact, primarily evaluate executive function or language neutral abilities such as attention and memory that are common to all human processing of linguistic material. Whereas processing measures are relatively language neutral, traditional standardized measures might be viewed as language specific to the extent that they reflect language knowledge required to communicate within a particular cultural and linguistic group.

There are reasons to consider the potential importance of information gained from the combined use of language processing measures, along with traditional clinical status measures. While processing measures may be more useful in distinguishing between language difference and disorder for children from minority backgrounds, standardized tests can provide an indication of children's ability to code switch, which can be important to determine with regard to their ability to succeed within the majority linguistic/communicative expectations in educational and vocational settings. Some combination of cultural, environmental, and physiological factors may be contributing to language problems; the addition of processing measures to standardized tests may help determine whether the observed language difficulties reflect problems in knowledge of the ambient language, integrity of the basic mechanisms underlying language learning, or a combination of these variables. For all children, processing measures offer an index of the implementation of language skills in real-time communicative contexts that can be a useful adjunct to information gained

from knowledge-based measures concerning the inventory of vocabulary or grammatical forms that the child has mastered.

The use of processing measures not only adds another dimension to our assessment of developing language abilities, it has important implications in terms of how variability in children's performance is viewed. From the perspective of a processing-based assessment model, the goal is to look at changes in performance under differing task demands. Variability would be expected as a function of factors such as familiarity of information to be processed, linguistic complexity of the forms, and degree of communicative/social pressure within the situation. As cognitive resources are stressed, trade-offs in accuracy and/or timing would be anticipated across linguistic domains within an utterance or across larger units of discourse (such as conversational turns). Both accuracy levels and latency of responses are important to consider within this type of assessment approach, as difficulties may become especially apparent with respect to the efficiency with which the child is able to access and utilize linguistic knowledge. In discussing this issue, Lahey and Bloom (1994) have similarly suggested that timed tasks can be an important part of the protocol used to identify children who have, or are at risk for having language learning problems.

Static, knowledge-based language measures provide us with a binary notion of children's language abilities (i.e., it is determined that they either evidence knowledge of a particular linguistic rule or not). What we gain from a processing-based assessment is an understanding of the nature of that linguistic knowledge in terms of the strength of representations and richness of connections, which impacts on the flexibil-

ity of use of various forms. For example, we may observe a child to use particular morphological forms within a spontaneous language sample but correct use of these same forms is likely to be less consistent when the child attempts to incorporate new vocabulary into his/her productions. Similarly, we would expect that a sentence formulation task using highly familiar words should result in longer, more syntactically complex responses than one involving less familiar vocabulary. According to a limited capacity model of language processing, this pattern of trade-offs would be expected for all children; however, disproportionate decrements in performance should be apparent for children with language impairment. That is, we should see a larger gap between best and worst performances under varying task demands for children with language impairment compared to typically developing children (also see discussion of this point by Lahey & Bloom, 1994). The pattern of breakdown that occurs when we stress the system gives us valuable information about the extent to which the knowledge is robust or automatic and provides insights into factors that influence language processing for a particular child.

Finally, an exciting issue on the horizon relates to the use of processing measures for early identification of children at risk for language impairment and prediction of language outcomes. In several studies, processing-dependent measures have been found to be more sensitive to language disorder than standardized measures (Dollaghan & Campbell, 1998; Bishop et al., 1996). Therefore, it seems worthwhile to further investigate the utility of a processing-based approach in predicting later language abilities based on early performance on these

types of assessment measures. We might speculate that processing measures tap into essential, language neutral abilities underlying language acquisition. The language domains (lexical, morphological, syntactic, discourse) in which critical changes are occurring shift over the course of development, such that the nature of the language disorder may appear to be characterized by the most salient aspect of language acquisi-

tion at that point in development. Processing limitations may manifest initially as slow vocabulary growth at age two and subsequently as deficits in morphosyntax, discourse, or even written language problems in the later school-age years. A child's *relative* strength or weakness in processing abilities may cut across these areas and thereby provide a more consistent index of language facility over time.

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