SPECIFIC LANGUAGE IMPAIRMENTS: IN SEARCH OF DIAGNOSTIC MARKERS AND GENETIC CONTRIBUTIONS

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A selective overview of the diagnostic criteria for the condition of specific language impairment (SLI) is provided, followed by a summary of new prevalence findings showing an overall prevalence rate of 7.4% for kindergarten children. The search for a grammatical marker of SLI is described, involving an Extended Optional Infinitive Stage which is characterized by limited knowledge of tense-marking grammatical forms, whereas much of the grammar is apparently robust. This stage is not evident in a matched group of children with Williams syndrome. The close relationship between SLI and dyslexia is examined, followed by a brief summary of the evidence in support of an inherited contribution to SLI. A succinct discussion of brain/behavior studies of SLI is provided. The close relationship between the condition of SLI and socioemotional development is explicated, with implications for diagnosis, interpretation, and treatment. A section on future directions notes the strong parallels in the science of dyslexia and the science of SLI and calls for further work on diagnostic markers, carried out in prospective longitudinal studies, as a way of furthering our understanding of the etiology of SLI, dyslexia, and other conditions, such as Williams syndrome, where language impairment is implicated or spared. © 1997 Wiley-Liss, Inc.

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A hallmark accomplishment of young children’s development is the emergence, between one and two years of age, of language. Around this time, children typically begin to use words and simple sentences and this quickly mushrooms to a fully-formed grammatical system. It has long been known that certain conditions can impair or delay the emergence of the linguistic system and/or the full actualization of an adult grammar. Among those conditions are intellectual limitations, hearing loss (which affects verbal grammar but not sign grammar), severe socioemotional disturbances, or extreme environmental deprivation. When these conditions do not apply, the general expectation is that language will appear unimpeded, on schedule, and subsequently develop in the expected way. This expectation is not always met, however.

Some children who do not show other developmental impairments nevertheless do not acquire language within the expected time frame and instead show a protracted period of language development, even for the most fundamental grammatical properties. This condition is known as specific language impairment (SLI), where the “specific” implies an impairment that is specific to language, without evidence of other clinical conditions. It is often described as “nonsyndromic” insofar as it exists independently of other known clinical syndromes.

Although the cause of this unexpected variation in language aptitude is unknown, recent discoveries point toward an inherited contribution. Because available means of testing genetic effects demand precise criteria for identification of affected individuals, the search for possible genetic influences has sharpened the long-standing clinical interest in diagnostic methods. Furthermore, genetic studies require accurate estimates of prevalence in the general population. With a possible genetic etiology in the background, significant scientific advances are appearing in the areas of diagnosis, prevalence, and family or twin studies. At the same time, there are lively disputes about the proper interpretation of the nature of the impairment, issues of comorbidity are under reexamination, and neurobiological findings are emerging that are of considerable interest.

The summary that follows is necessarily selective and cannot do justice to the full scope of findings and interpretations that appear in the literature. For more comprehensive reviews, see Watkins and Rice [1994] and Leonard [1997]; for discussions of relevant issues regarding genetics and SLI, see Rice [1996]; for diagnosis of SLI, see Aram et al. [1992], Tomblin et al. [1996]; for assessment methods, see Cole et al. [1996]; for other reviews, see Bishop [1992], Johnston [1993], and Leonard [1987].

CONVENTIONAL GROUPINGS FOR DIAGNOSIS AND DESCRIPTION

The diagnosis of SLI typically incorporates exclusionary as well as inclusionary criteria. On the exclusionary side, there is general consensus that impairments of hearing, intellectual development, motor speech development, socioemotional disturbances, and frank neurological symptomatology are excluded. Typically, a history of acquired language deficit, subsequent to neural trauma of some sort, is also excluded from this diagnosis.

There is less agreement about possible inclusionary criteria. The conventional means of identification involves low

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performance on standardized tests of language development. The proper criterion for determination of "low performance" is a matter of debate. One possibility is an unexpected discrepancy between language performance and nonverbal intellectual performance, as advocated by Stark and Tallal [1981] and Tallal [1988], and adopted by the DSM-IV [1994]. This definition has been questioned for theoretical and methodological reasons and found to have limited prognostic or etiological utility [Arrieta et al., 1992; Bishop, 1994; Cole and Fy, 1996; Lahey, 1990]. The alternative criterion is that of chronological age referencing, which has widespread clinical application and is preferred by the critics of the nonverbal IQ discrepancy criterion [cf. Tomblin et al., 1996].

Language development is often described in terms of modalities (i.e., expressive skills that involve the production of language in the form of words, sentences, and conversational speech; and receptive skills that require comprehension of words and sentences). This allows for a definition of SLI in terms of relative performance on expressive and receptive tests [cf. DSM-IV, 1994]. The distinction between expressive and receptive abilities has prognostic utility, in that preschool children with a combined profile (i.e., both expressive and receptive deficits) are less likely to "outgrow" their problem than are children with expressive-only deficits [cf. Thal et al., 1991], they benefit less from intensive preschool language intervention [Rice and Hadley, 1995], and their families report a higher level of affected family members [Spitz et al., 1997].

Another important distinction is the difference between speech and language impairment. Speech impairments can involve the pronunciation of sounds and syllables and prosodic contours. Typically, speech impairments lead to restricted intelligibility because of the distortion or omission of the expected sound patterns of words and sentences. Speech problems can be attributable to underlying rules and representations for the sound system of the native language (i.e., a phonological deficit) and/or to motor control problems affecting the articulator (i.e., a neuromotor deficit) or a breakdown in learned pronunciation patterns. Language impairments involve word meanings, grammatical structures and related principles and rules, and/or sociofunctional uses of language evident in such uses as carrying out a conversation or relating a story. Although the relationship between speech and language is intricate, at the same time it is possible that one dimension, but not the other, can be affected. The theoretical import of this distinction is of great significance, in that it sheds light on possible modularity of the underlying mental representations that control processes and principles of speech and language. Furthermore, it is highly probable that different neural pathways and cortical mechanisms are responsible for speech vs. language, so it is very important to be sure the surface impairments are carefully specified when examining underlying neural and cortical processes. In order to restrict the scope of this paper, I will focus on language impairments. Readers interested in learning more about the extensive literature on speech impairments can find helpful reviews in Shirberg and Kent [1982] and Stoeck-Gammon and Dunn [1984].

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NEW PREVALENCE FINDINGS

Although 7.4% of kindergarten children are affected with SLI, they are likely to be undetected in the general population. Prevalence refers to the proportion of individuals within a given population who are affected by a particular condition. The uncertainty about diagnostic standards contributed to uncertainty about the prevalence of the condition of SLI. In 1990, the NICHD issued a call for an epidemiological study of SLI to determine the prevalence of this condition in a representative sample of kindergarten-age children. Tomblin and colleagues [in press] carried out the study, utilizing a chronological age discrepancy criteria [Tomblin et al., 1996] for performance on a standardized language test, the Test of Language Development-2: Primary [Newcomer and Hamill, 1988]. The resultant overall prevalence rate is 7.4%; 8% for boys and 6% for girls. Although some variation in prevalence appears as a function of race and parental socioeconomic status, the interpretation is complicated by parental education, which is associated with the background variables as well as with the diagnosis of SLI. In comparison with previous findings and general assumptions, these data show a somewhat higher than expected prevalence, particularly for girls. According to parental report, only 29% of the children failing language testing had previously been identified as affected. It appears that the majority of affected children most likely remain unidentified in the general population.

With regard to performance on language testing, Tomblin [1996a] reports that 80% of the children showed deficits on expressive as well as receptive subtests. He concludes that the variance in language performance is attributable to one primary dimension of language having to do with the child's underlying proficiency, as opposed to particular limitations associated with traditional performance modality differences.

One area of language, however, did prove to be especially troublesome for children with SLI. Their performance was lowest on subtests that assessed grammatical performance, in contrast to the domains of vocabulary and narration, which also fell within clinical levels but at higher performance levels than was evident for grammatical subtests. Thus, there is evidence of a selective deficit in grammatical development, a possibility explored in more detail in a following section.

An important and surprising finding was that the association of speech and language impairments was far less than expected: 25% of the children with SLI also had some form of a speech sound disorder (as compared to 18% of the control children). The phi coefficient of association of SLI and phonological disorder shows a weak association of .06. Thus, the large majority of children with SLI show language impairments without accompanying speech impairments.

Well-designed prevalence studies allow for examination of possible biases in clinical selection practices. Considered as a collection of findings, the new epidemiology results suggest that the population of children with SLI who are identified and receive intervention services in all probability underrepresents children without speech impairments who have receptive language impairments as well as expressive impairments, and this bias may be gender-selective, with girls less likely to be detected than boys.

SIGNIFICANCE OF A POSSIBLE GRAMMATICAL MARKER OF SLI

While the psychometric approach to diagnosis is well suited to the objectives of an epidemiology investigation, it has very important limitations as a scientific tool. First, it is difficult to relate test performance to current theoretical or
be regarded as an Extended Development Theory of specific language impairment. Within this view, the underlying grammar of children with specific language impairment is undifferentiated from that of unaffected children; some unknown factor causes language acquisition to start slowly. Under some readings of the Extended Development Theory, children should be expected to “outgrow” the early problem. Perhaps this is what happens in many children identified as Late Talkers (i.e., who have expressive-only impairments), who “catch up” with their age peers around school entry [cf. Rescorla and Schwartz, 1990; Thal et al., 1991].

The standing question has been whether or not the grammar of children with this condition differs in interesting ways from the profile expected for younger levels of language acquisition.

There have long been hints, however, that something more is at stake. It has been recognized for some time that in English certain morphemes are more likely to lag behind, especially a small set of verbal affixes—for example, third person singular -s in she talks [Lahey et al., 1992; Leonard et al., 1992; Rice, 1994; Rice and Oetting, 1993], regular past tense in she talked [Bihop, 1994; Leonard, 1987; Oetting and Horohov, 1997; Marchman and Weismer, 1994], and, although it has been relatively neglected for some time, the forms of BE (BE is used here to refer to the set of morphemes that appear as forms of to be, i.e., am, is, are, whether used as copulas, e.g., he is happy, or auxiliaries, e.g., he is running), as in she is talking and she is happy [Ingram, 1972].

NEW EVIDENCE OF SELECTIVE DEFICITS IN GRAMMATICAL TENSE

Recent developments in linguistic theory have expanded what is known about the expression of finiteness in sentence structures and how children come to know these linguistic properties [cf. Waxler, 1996]. Briefly, an obligatory property of every sentence in English (and most other languages) is the need to express grammatical tense and subject/verb agreement. This property is literally known to every reader of this page, although typically people are unaware that this knowledge exists. It can be seen in the following pairs of sentences, where the “a” form is the adult grammatical clause and the “b” form is ungrammatical because finiteness is not expressed. In the “b” version, grammatical tense-markers on the verbs are omitted (omissions are indicated by parentheses). The asterisk prior to a sentence indicates it is ungrammatical.

1. a. Patsy walks.
   b. *Patsy walk(s).
2. a. Yesterday Patsy walked home after work.
   b. *Yesterday Patsy walk(ed) home after work.
3. a. Patsy is walking.
   b. *Patsy (is) walking.
4. a. Patsy is happy.
   b. *Patsy (is) happy.
5. a. Patsy did not work today/does Patsy work today?
   b. *Patsy (did) not work today/(does) Patsy work today?

These sentences illustrate the use of third person present tense singular -s, past tense -ed, BE copula and auxiliary forms, and DO auxiliaries. Note that although the grammatical forms differ with regard to surface properties (i.e., some are free-standing morphemes and some are affixes), they share a common underlying property, that of marking finiteness. Notice that although the set of morphemes are referred to as marking “grammatical tense,” this is not the same as knowing the difference between past and present events; it refers to the need to mark either present or past tense in a clause and to follow the set of rules that govern where tense can be marked. This involves knowing that finiteness is allowed only once per clause. This can be seen in instances such as 6a and 6b, where 6b illustrates the fact that if third person singular present tense appears after the subject, in the finiteness-carrying position, it cannot appear later in the verbal complement.

6. a. Patsy makes him talk.
   b. *Patsy makes him talks.

The grammatical forms that mark finiteness are of interest because young children acquire them without explicit instruction in their use, they can contribute little semantic information to the clause, and they follow relatively intricate rules about where and how finiteness can be marked. They are also obligatory in all clauses and young children come to know them very early on.
My colleagues and I have investigated the use of finiteness markers in children affected with specific language impairment with promising results [Rice et al., 1995; Rice and Wexler, 1996a,b; see Hadley and Rice, 1996, and Cleave and Rice, 1997, for further details about the acquisition of BE]. The main findings are these: Unaffected children are at adultlike levels of obligatory use of this set of morphemes between the ages of 3;6 and 4;0. That is to say that almost all their sentences (90–95%) would be of the "a" type; when they were younger they would sometimes generate sentences of the "b" type. They virtually never generate sentences like 6b and they very rarely make errors of subject-verb agreement, as in 7a,b:

7. a. *Patsy are walking.
   b. *They walks home.

The conclusion is that in this un instructed but nevertheless complex area of grammar, children behave like adults before they go to school. In sharp contrast, children diagnosed as receptive/expressive SI in the year before kindergarten are much more likely to generate sentences of the 1–5 "b" type than are children of the same age or children of the same general level of language acquisition who are 2 years younger and matched for length of utterances. On average, 5-year-old children with SLI use the target morphemes about 30% of the time, whereas age controls use them about 95% of the time and 3-year-old children use them about 60% of the time. The findings are very robust, evident across different means of measurement and different individual grammatical forms (see Rice and Wexler [1996b] for details about individual measures, means, and distributions for each of the groups). In the available data, from about 40 affected children, 40 age controls and 40 younger language controls, a criteria based on grammatical tense-marking would successfully identify the affected children (i.e., sensitivity levels above 90%) and successfully identify the unaffected children (i.e., selectivity levels above 90%). The emerging conclusion is that grammatical tense is a likely "gold standard," where adult-like, nearly 100% performance is expected before school age and children who do not show this ability are clearly affected. Clearly, there are implications for the development of measurement methods targeted at grammatical tense.

A follow-up longitudinal study of 20 receptive/expressive children with SLI, 20 younger language-matched controls, and 20 age controls reveals that it is not until after 7 years of age that the affected children manage to close in on the adult grammar in their use of grammatical tense in simple sentences. Thus, it appears that children with SLI require more than three additional years to master a grammatical principle that is known by unaffected children before they go to school. Figure 1 shows the children's performance on a composite grammatical tense measure, collapsed across the grammatical forms illustrated in items 1–5 above, across spontaneous and elicited measures. The dotted lines at the top constitute the normative growth curve, showing the expected levels of performance of unaffected children. In comparison, the solid curve at the lower right shows the children in the SLI group, who require a much longer period of time to master this part of grammar.

Now let us return to the notion of an extended development view of SI. Some aspects of the affected children's performance look very much like the grammars of younger unaffected children. Interestingly, children with SLI are very unlikely to make mistakes such as those illustrated in 6b or 7a,b above. In English, children's grammatical errors are very likely to be the omissions illustrated in items 1b–5b above. Because German-speaking children with SLI are far less likely than English-speaking children to drop tense marks, it is probably not accurate to conclude that the omissions seen in English data can be interpreted as universal tendencies to drop forms. Instead, the way grammatical tense appears in different languages will determine the kind of nonadult-like forms that affected children will use, as predicted by current linguistic theories [cf. Rice et al., in press (a), Clahsen, 1991]. The conclusion is that in many respects the grammars of affected children are remarkably intact. Other grammatical morphemes follow a course of acquisition much like the younger control group. Children with SLI do not differ from their younger language controls in their acquisition of plurals, as in "two clocks" or in other verbal affixes, as the "-ing" in "running." For example, if we were to note the accuracy of plural use the use of -ing during the period of time reported in Figure 1, the accuracy levels would be consistently high, around 90%, for all three groups of children. This is important because it shows that the deficit is not a general one of "drop all little unstressed grammatical markers." Instead, within the morphological domains measured the deficit is restricted to a certain group of grammatical markers and associated grammatical principles. The conclusion, then, is that while extended development is evident, something more interesting is happening, in which certain areas of grammar can be selectively delayed in acquisition. This composite picture of grammatical strengths and weaknesses has come to be known as an extended optional infinitive (EOI) stage [Rice et al., 1995; Rice and Wexler, 1996a,b; cf. Wexler, 1996; Rice, in press].

In effect, the EOI theory is a highly enriched version of an extended development view of SI, in which observed empirical facts are highly consistent with developmental facts (as expected), the predictions are independently drawn from models of adult grammar, new empirical evidence is brought to bear, grammatical functions are identified that are impli-
Table 1. Group Descriptors for the Comparison of Children with Specific Language Impairment, Children with Williams Syndrome, and Unaffected Children

<table>
<thead>
<tr>
<th>Group</th>
<th>SLI</th>
<th>3N</th>
<th>5N</th>
<th>WMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean length of utterance</td>
<td>3.48</td>
<td>3.57</td>
<td>4.53</td>
<td>3.35</td>
</tr>
<tr>
<td>Intelligence testing</td>
<td>96</td>
<td>109</td>
<td>106</td>
<td>60</td>
</tr>
<tr>
<td>Chronological age (in months)</td>
<td>58</td>
<td>36</td>
<td>60</td>
<td>91</td>
</tr>
<tr>
<td>Third person spontaneous</td>
<td>35%</td>
<td>61%</td>
<td>88%</td>
<td>83%</td>
</tr>
<tr>
<td>-ed past spontaneous</td>
<td>22%</td>
<td>48%</td>
<td>92%</td>
<td>85%</td>
</tr>
<tr>
<td>BE spontaneous</td>
<td>47%</td>
<td>70%</td>
<td>96%</td>
<td>91%</td>
</tr>
</tbody>
</table>

cated in a clinical marker of SLI, and adult-like grammatical knowledge is confirmed [for extended discussion, see Rice and Wexler, 1996a,b]. This is not to argue that the EOI stage is the only clinical marker to be found in the grammar of children with SLI. Other differences, yet to be identified, are probable. The contribution of the EOI theory is to establish that such clinical grammatical markers can be predicted and detected.

**GRAMMATICAL DEFICITS ARE NOT FULLY PREDICTED BY INTELLECTUAL STATUS**

Perhaps an EOI stage is characteristic of any condition in which language delay is apparent. This would be interesting to know because if this is true it would suggest that tense-marking is one symptom of children whose language emerges late and follows a slow trajectory of acquisition. Perhaps this symptom may emerge any time there is risk for language development (i.e., any time the edusory conditions listed above are not met).

Children with Williams syndrome present interesting comparison profiles. These children are known to have significant intellectual limitations and to have a late appearance of language. By adolescence and young adulthood, however, their grammatical abilities are strong relative to their general cognitive abilities. It is possible, given their early language delay, that children with Williams syndrome also show grammatical tense as a clinical marker.

This possibility was examined in a recent comparison of the performance of children with SLI and children diagnosed with Williams syndrome [Rice et al., unpublished data]. In this study, the two clinical groups were matched for equivalent length of utterance, around 3.4 morphemes. This yielded different levels of cognitive performance, where the Williams syndrome group was, on average, at an IQ level of 60, whereas the SLI group average was 96. The Williams syndrome group were older, with a mean age of 91 months, whereas the SLI group was an average of 58 months. There were two control groups of unaffected children, one at age 36 months, matched for mean length of utterance, and another at age 60 months.

The interesting outcome is that the Williams syndrome group of children performed almost as well as the 5-year-old control group, with performance at the level of 83-91% on the target morphemes, in striking contrast to the SLI group performance levels of 22-47%. The findings are summarized in Table 1. Essentially, the Williams syndrome children, with much lower cognitive abilities, are functioning very near adult levels on tense-marking. The conclusion is that children with Williams syndrome know that tense-marking is obligatory at a time when their general language development is comparable to that of children with specific language impairment who do not know that tense-marking is obligatory.

These findings suggest that it is important to distinguish between conditions that lead to a delayed onset of general language acquisition followed by an extended period of development and conditions characterized by specific grammatical limitations. Williams syndrome is probably one of the former and specific language impairment is probably one of the latter. Furthermore, an important point is that highly formal grammatical competencies can be surprisingly robust in conditions characterized by limited general intellectual competencies.

At this early point in our understanding of the ways in which grammar develops, and the proper way to describe language abilities, careful study of the "natural experiment" cases, such as the comparison of SLI and Williams syndrome children, will be important for sorting out the extent to which certain language abilities are "bound up" with other, more general abilities. As noted by Miller [1996], a diagnosis of mental retardation does not bring a uniform language profile across affected individuals. Children with Down syndrome are likely to show extreme syntactic deficits, whereas children with fragile-X are not. An examination of their performance on the tense-marking morphemes could yield further interesting evidence about the extent to which particular grammatical competencies are spared or affected when more general intellectual deficits are present.

**CLOSE RELATIONSHIP OF SLI AND DYSGLEXIA**

It is generally recognized that there is a close relationship between SLI and dyslexia. Briefly, this is evident from two perspectives. One is the prospective generalization that preschool children with SLI are very likely to encounter later difficulties with reading [cf. Catts, 1993; Menyuk et al., 1991; Scarborough and Dobrich, 1996; Silva et al., 1985]. The other perspective is a concurrent one; once reading instruction begins, children with language-based disorders are at high risk for reading disorders [cf. Lyon and Chhabra, 1996; Scanlon and Vellutino, 1996]. The reasons for this relationship are beyond the scope of this paper. What is relevant here is to point out that the existing literature on dyslexia may be highly relevant for understanding the condition of SLI, to the extent that children are identified on the basis of a reading disability who may currently have or previously have had an undiagnosed language impairment. This bears especially on investigations of etiological factors, such as genetic contributions, which posit an inherent individual difference in aptitude. It is also relevant that the two areas of study have faced similar definitional issues, involving considerations of exclusionary and inclusory criteria. Dyslexia investigations have benefited from a convergence on precise definitions and prospective longitudinal studies to validate definitions [cf. Lyon and Chhabra, 1996]. For similar reasons, the study of specific language impairments is in need of precise means of identification that can be validated via longitudinal studies.

**STRONG INDICATORS OF AN INHERITED CONTRIBUTION TO SLI**

There is now a set of converging findings that point strongly in the direction of a genetic basis of SLI. Much of the relevant evidence and discussion of issues can be found in Rice [1996]. The evidence comes from twin studies and studies of family history, based on reported
The pattern of familiality can be illustrated by findings from a recent study of the families of receptive/expressive children with SLI studied in our lab [Rice et al., in press (b)]. The results are summarized in a composite pedigree, shown in Figure 2. In this figure, the proband is shown in a hexagon at the bottom. In this figure, the proband is a child with SLI. The unique contribution of this study is that the probands were children who were known to show an EOI stage of grammatical development. Following the conventional procedures, we asked the parent(s) of the child if other members of the family had a history of speech or language impairments. What are reported in the circles (for females) and squares (for males) are the proportions of the fathers, for example, who were reported to be affected. The findings contribute the first evidence of positive family histories tied to a particular grammatical deficit. This is also one of the few studies with evidence about extended family members (e.g., grandparents, aunts, uncles, and cousins) as well as nuclear family members (parents and siblings). Note that the affectedness of brothers is 26%, sister, 29%. This compares to 3% and 4%, respectively, for control children. Recall that the population estimate is 7.4%. So it can be seen that the rates of affectedness are much higher for siblings of SLI probands than for control probands. Also note that Tomblin estimated 21% for affected nuclear family members of SLI probands; the figure for this study is 22% (78% for controls). Although the details vary somewhat from study to study (for example, the affectedness rates for mothers of children with SLI in this study is somewhat lower than in other studies), the point is that findings are quite consistent across studies.

The behavioral evidence is very encouraging, but nevertheless inconclusive. Definitive findings require evidence at the molecular level, in a demonstration of gene–behavior associations. The fact that a quantitative trait locus on chromosome 6 has been discovered for dyslexia is very promising [Cardon et al., 1994; see Smith et al., 1996, for discussion], in light of the strong association between specific language impairments and dyslexia. It is reasonably plausible that a nontrivial number of the individuals included in the genetic studies of dyslexia are unidentified cases of specific language impairment. The two conditions may in fact share a common, inherited etiological component. On the other hand, there is reason to be guarded in our expectations about identification of a molecular linkage to SLI. The big challenge is the definition of the phenotype [see Rice, 1996, for detailed explications of the issues]. The methods of genetic analyses require precise specification of the behavioral symptomology across a wide age range of affected individuals. It remains to be seen if the eclectic tasks of conventional language tests will yield the necessary precision, or if more specified measures, such as grammatical tense markers or auditory processing measures [cf. Stark and Tallal, 1988], are required. There are powerful interpretive and practical advantages for measures with obvious linkage to the surface symptoms of language impairment.

**LITTLE IS KNOWN OF THE BRAIN–BEHAVIOR LINKAGE IN SLI**

Studies of the cortical correlates of specific language impairment are in the early stages. Although there is an extensive literature documenting the correlations of brain anatomy and functioning for adults who suffer language loss secondary to trauma or disease, very little is known about the brains of children and family members who display symptoms of SLI. Inspired by previously reported neuroanatomical findings from adult dyslexics, Plante and colleagues [1996] used MRI scans to examine perisylvian structures for possible asymmetries. They report that six out of eight boys, ages 4 to 9 years, with known language impairment showed an asymmetry of perisylvian structures. Whereas left-greater-than-right asymmetry is evident in the general population, these children showed an average-sized left perisylvian area paired with an atypically large right perisylvian area. This study was followed by a study of families of four of the language-impaired children. In the family members, there was an imperfect correspondence between the behavioral status and the brain findings. For most of the family members, those who showed language impairments, the expected asymmetry appeared. Yet there were such asymmetries in unaffected individuals and affected individuals were without the characteristic pattern of asymmetries. Attempts to identify such correlations encounter many possible sources of unexplained variation, which are discussed with great clarity by Plante [1996]. Similar challenges exist for the PET methodology, as laid out by Poeppel [1996]. We must look to new methods and new technologies for definitive findings about the brain/behavior connection in individuals with SLI.
RELATIONSHIP BETWEEN SLI AND SOCIOEMOTIONAL DEVELOPMENT

The relationship between SLI and socioemotional development is complicated by possible social consequences of limited language competence.

For some time it has been observed that children with language impairments tend to have social limitations in the form of emotional/behavioral problems. Studies of the socioemotional behavior problems of children with language impairments and studies of the language limitations of children diagnosed with socioemotional behavior disorders converge on a likely co-occurrence rate between the two disorder categories as somewhere around 50–70%. This can lead to the assumption that the two disorders spring from a common causal factor, characterized by an underlying social deviance of some sort. There is an alternative possibility, which became clear in a series of studies in which preschool children with SLI were studied in a classroom setting which included children who were learning English as a second language as well as typically developing native-English-speaking control children. One set of findings revealed that children with limited language competencies adjust their verbal interactions with peers and adults in the same way, whether they are second-language learners or children with SLI. They are less likely to initiate conversations with their peers and are more likely to rely on the adults in the room for verbal interactions. In short, they tend to “pull back” from verbal interactions with peers [summarized in Rice, 1993]. Follow-up studies found that children with SLI and children learning English as a second language were equally likely to have low social status among their peers; children with good verbal abilities were the ones nominated by the children in the classroom as preferred playmates [Germer et al., 1994]. Another study showed that adults, including teachers and speech/language pathologists, were likely to assume that children with speech/language impairments, relative to children with typical speech and language, were less intelligent, less socially mature, and less likely to succeed in school, and their parents were less well educated and of a lower social class [Rice et al., 1993]. Finally, a recent longitudinal study [Redmond et al., in press] collected ratings of socioemotional development from kindergarten and first grade teachers and mothers for a group of 22 children with SLI with known grammatical deficits as compared to a control group of 21 unaffected children of the same age. Among the findings were the following: Teachers, but not parents, rated the children with SLI as having more behavioral problems than age controls; only one child with SLI was clinically identified for a possible socioemotional disorder by both parental and teacher ratings across both time samples.

Considered collectively, the results across the several studies point in the direction of a Social Adjustment model which plays out in the following way: young children with SLI early on adjust their verbal communication to compensate for their relative lack of skill in their interactions with other children and unfamiliar adults; this adjustment gets construed as social immaturity and leads to restricted opportunities to build friendship networks in the preschool years; these consequences in turn lead to adult judgments of limited aptitude for school which can lead to further reactions on the part of the child which are more evident in school settings or around unfamiliar adults than with family members. There are three take-home points here. One point is that current measures of socioemotional development may be invalid for children with language impairments in that items are not independent of the language status of the child, and the tests are insensitive to the social adjustments that accompany limited language skill. The second point is that interpretations of the underlying etiologies can be obscured if social behaviors and language ability are conflated. The third point is that treatment planning can overlook the primacy of language aptitude if the surface symptoms are construed as socioemotional deficits alone.

FUTURE DIRECTIONS

In some ways the current status of scientific investigation of the condition of SLI can be compared to earlier times in the study of dyslexia. There are similar concerns of diagnostic criteria, disputes about the proper interpretation of the surface symptomology, and a strong interest in genetic contributions. It is highly relevant that scientific progress in the study of dyslexia accelerated when these issues were harnessed by working definitions and interpretations that a number of investigators could work with [cf. Lyon and Chhabra, 1996]. That is a plausible goal for investigations of SLI, although not yet achieved.

On the other hand, the phenomenon of language acquisition has some distinctively unique properties that are unlike other kinds of achievements. Consider the grammatical distinctions discussed above. The set of grammatical rules that mark finiteness in clauses are not explicitly taught to children; yet children come to know them at adult-like levels before they go to kindergarten. In fact, most adults cannot articulate this set of rules and yet they follow them in their conversations and in their writing with highly predictable accuracy. In fundamental ways this is an area of development in which invariant performance is expected. With only minor exceptions it is not possible for speakers of the language to elect to use the rules just part of the time and forego them at other times. Simply put, adherence to the rules is expected. Individuals who do not follow the rules show unexpected variance. In the case of individuals with SLI, there is no apparent explanation for this variation. In comparison, reading is a skill learned via a very explicit instructional schedule and variation in achievement across individuals is expected.

Our primary means of diagnosis of SLI, as well as dyslexia, relies on psychometric methods in which individual variation is maximized. An important implication of the investigation of grammatical markers, described above, is that it may be possible to develop diagnostic methods that tap into the core linguistic competencies where variation is not expected. If no variation is expected, then a valid “gold standard” can be identified. Although this work is in the early stage, the comparison of children with SLI with children with Williams syndrome suggests a strong potential for clarifying different conditions of language impairment. In effect, there may be children with “selective grammatical impairment” whose intellectual development is unaffected and children with intellectual limitations who do not show “selective grammatical impairment.”

The point here is not to suggest that one means of diagnosis should be advocated over another. What is needed are careful evaluations of complementary means of diagnosis, carried out in longitudinal studies that bridge early and late periods of acquisition. Just as the study of dyslexia benefited from large-scale investigations of the predictors of reading achievement and the validation of diagnostic categories, so the study of SLI could benefit from similar investigations and would in all probability contribute to what is known about reading acquisition, socioemotional development, and other cognitive capacities as well. In the context of modern genetics, such investi-
REFERENCES