2

Grammatical symptoms of specific language impairment

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This chapter lays out a programme of investigation aimed at the identification of a clinical grammatical marker for the condition of Specific Language Impairment (SLI) in children (and adults), beginning with a description of the theoretical framework and predictions, followed by an overview of available evidence from longitudinal studies of affected and control children and from family history data that indicate a pattern of familiality (as would be expected for an inherited condition). It is argued that a primary benefit from this line of inquiry is that it helps further our understanding of "immature" language that may or may not be "outgrown" and possible causes of grammatical limitations. The chapter concludes with a discussion of the clinical implications of the grammatical marker and the promise of the marker for investigations of the etiology of SLI.

INTRODUCTION

A long-standing issue for researchers and clinicians is the question of how to identify young children with language impairments. Children with Specific Language Impairment (SLI) pose particular challenges because they do not show other developmental delays, and their immature language could be attributed to a simple delay in onset which they will subsequently "outgrow". At the same time, it has long been observed that children with SLI are very late in acquiring grammatical morphemes, a characteristic symptom thought to be a hallmark of the condition (cf. Bishop, 1997; Leonard, 1998). Although this observation has powerful clinical implications only recently have we come to appreciate the full import of the grammatical symptoms of SLI for identification purposes.

In addition to the obvious clinical implications, there is strong interest among researchers in the development of a clinical marker of...
condition of SLI that will accurately identify affected children, for the purpose of studying possible inherited contributions to the condition. Accurate and precise specification of the clinical symptoms of language impairment is essential for investigations of genetic factors, as well as for increasing our understanding of the nature of the language impairment and its relationship to other domains of competence, such as nonverbal intelligence.

This chapter provides an overview of the rationales, outcomes, and conclusions of a programme of research in which the grammatical symptoms of SLI are investigated as a clinical marker of the condition in young children. The content is laid out in the following sequence. The chapter begins with a discussion of what constitutes a clinical marker and how it differs from conventional standardised tests assessment. It is argued that the two approaches are complementary and both are essential for advancing our knowledge of language impairments in children. At the same time, grammatical symptoms offer a uniquely informative domain in which to focus our attention, for reasons of interpretive power as well as empirical advantages not available with conventional psychometric measurements. The basis for the interest in grammatical morphology is laid out, with a description of the Optional Infinitive stage of normative development of English-speaking children, and a discussion of the predictions to be evaluated with children with SLI. In the following section, a summary of recent empirical evidence is provided, including the long-term outcomes of preschool children with SLI in the domain of morphology, with illustrative growth curves and comparison to control children. Evidence of change over time for both production and grammaticality judgment tasks, it is argued, strongly points toward a problem in one specified underlying grammatical representation. Etiological information is then reported in the form of positive evidence of familiality, showing that the children with grammatical symptomology are more likely than control children to have family members with positive histories of speech/language impairment. The concluding section argues that the evidence is very promising for the existence of a clinical grammatical marker which differentiates affected from unaffected children. Furthermore, it is a marker that can be interpreted in terms of the development of language in unaffected children and progress toward an adult grammar. In effect, it helps further our understanding of "immature" language that may or may not be "outgrown", and possible causes of grammatical limitations. The final section discusses the clinical implications for the identification of affected children, possible treatment options, and the promise of a clinical grammatical marker for investigations of the etiology of SLI.

THE PSYCHOMETRIC APPROACH OF OMNIBUS LANGUAGE TESTS

Let us begin with an examination of the conventional means of assessment via traditional standardised omnibus tests, an approach referred to here as "psychometric" because of the underlying assumptions. A fundamental construct is the idea of variation across children in their language abilities. Virtually all of the currently available standardised language tests assume, for a given age, an underlying normal distribution of children on a general language dimension. This is based on the well-known bell-shaped curve (see Fig. 2.1). In this distribution, individuals are scattered along a range of performance levels such that a few people display very high values (along the right-hand side of the scale), and a few people exhibit very low values (along the left-hand side), and most (about 60%) score in the middle. Furthermore, the bell-shaped curve has well-known distributional properties, such that 16% of the people will score 1 SD or more below the mean; 2% will score 2 or more SD below the mean. For example, if we were to examine the size of children's vocabularies, we might say that 6-year-olds, we could expect that a few children would have a large number of words in their vocabularies, a few would have very few words, and most children would have a moderate number of words.

A related, and very important, notion is that children with SLI are those who fall at the bottom end of the normal distribution of language competence. This is a pervasive assumption, articulated most cogently by Leonard (1991, 1998). In essential ways, the low-normal interpretation views the problem as one of quantity rather than quality, as one where the affected child has less of a general language aptitude than that of unaffected children of the same development level (indexed by chronological age).

Positive uses of the psychometric approach

The psychometric approach has been, and will continue to be, a vitally important means of assessing and identifying children with language impairments. Let me provide two examples of recent, highly significant applications. One example is the utilization of standardised tests for recent epidemiological investigations that report updated prevalence figures for the condition of SLI. Tomblin et al. (1997) carried out a state-of-the-art study establishing that about 10% of children in kindergarten show this condition. This estimate is based on a psychometric definition of two or more of five composite language scores from the Test of Language Development-2 Primary (TOLD-2-P: Newcomer & Hammill, 1988; supplemented by a spontaneous sample narrative task) at least 1.25 SD below the mean expected for a child's age group (i.e. the 10th percentile or lower). The cut-off level was previously found to be compatible with clinical practices (Tomblin, Records, & Zhang, 1996). For the SLI diagnosis, the children also met conventional exclusionary criteria (i.e. performed within normal range on a nonverbal intelligence assessment and did not show other signs of neurological impairments, hearing loss, or clinical sociobehavioural impairments). A follow-up study by Sturberg, Tomblin, and McSweeney (1999) reported that in the overall population of 5-year-old children sampled, the co-occurrence of speech and language impairments was estimated as less than 2%, for the children with SLI, speech disorders were evident in approximately 5-8% of the children. So the psychometric method reveals that the prevalence of SLI in a 5-year-old sample of children is 7% and only about 5-8% of the children with language impairments showed clinically significant speech disorders.

A second example of the usefulness of psychometric methods is an investigation of the outcomes of childhood speech/language impairments for young adults. A recent study by Johnson et al. (1999) used a clinical criterion of performance below 1 SD on two language tests, the Peabody Picture Vocabulary Test–Revised (Dunn & Duan, 1981) and the Test of Adolescent Language–3 (TOL–3; Hammill, Brown, Larsen, & Wiederhold, 1994). Children were identified as language impaired if they scored below thr...
criterion level on both tests, or if they scored more
than 2 SD below the local mean on any TOAL–3
subtest. As with Tomblin et al. (1990), Johnson
et al. (1999) compared their psychometric criteria
to practitioner ratings, which led to a somewhat
more conservative criterion. The prevalence esti-
mate of SLI for their sample at age 5 years
was 10.5%, using the experimental criteria; when
adjusted by practitioner ratings, it dropped to
6.7%, very similar to that of Tomblin et al. (1997).
A second major finding was that the scores for
the children with language impairment at age 5,
relative to age expectations, were very similar
to their age-referenced scores at age 18-20 years.
In other words, the existence of a language impair-
ment in a young child is highly prognostic of a
relatively low level of language performance when
that child grows to become a young adult. This is
modulated by the finding that outcomes were
somewhat more favourable for individuals with
SLI than for individuals with concomitant sensory,
structural, neurodevelopmental or cognitive deficits.
These examples show that the use of psycho-
mometric methods, referenced to a normative dis-
tribution, allows us to determine such important
facts as the prevalence of SLI (about 7% in 5-year-old
children), the likelihood of concomitant speech
and language impairment (less than 2% in the
general population of 5-year-olds), and the long-
term prognosis (individuals are likely to retain
their relatively poor performance on language
assessment compared to unaffected individuals).

Limitations of the omnibus test/psychometric approach

These advantages notwithstanding, there are im-
portant limitations of the assumption of a normal
distribution. Let me enumerate the limitations
most relevant to this discussion. First, there is
no intrinsic criterion for where to draw the line
between “affected” and “unaffected”, shown on the
left in Fig. 2.1. Instead, a certain arbitrariness
is inevitable. Although investigators take care
to determine the cut-off points as judiciously as
possible, there remains considerable uncertainty
as to the “best” place to draw the boundary
between “affected” and “unaffected” (cf. Johnson
et al., 1999; Tomblin et al., 1997). To return to
the vocabulary example: how can we know who
does not know enough words? Who is “impaired”
in vocabulary development? Without an obvious
way to separate “normal” and “affected”, we may
false identify as affected those children who are
not affected, or we may falsely identify children
as unaffected who really have an underlying lan-
guage deficit. If the line is drawn at the 10th per-
centile, or at 1 SD below the age mean, a child
may fall a point or two on either side of the line,
with a few points determining “affectedness”.

A second limitation is that there is no obvious
way to interpret the actual test score in terms of
particular linguistic content. Because the tests are
constructed according to a general description of
language (e.g. “expressive” vs. “receptive” nodes,
or “vocabulary” vs. “grammatical morphemes”),
usually there are no clear indications of how to
translate a child’s score into particular linguistic
competencies that may or may not be affected. In
other words, one cannot know what to teach by
knowing a child’s standardised test score.

A third limitation is that it is not possible to
interpret a child’s performance relative to the
expected adult model of language, or a child’s level
of progress toward that level. There is no way to
determine if a child with a standard score of 85 is
mostly in line with an adult grammar or mostly
far away. With regard to marking age-related
progress toward a full language competence, “lan-
guage age” scores are sometimes reported. These
are the mean scores for a particular age group.
Therefore, a 5-year-old child whose score is the
same as the average for children of 3 years of age
is said to have a “language age” of 3 years. But
the meaning of this is unclear. There is no way
to know if the 5-year-old missed the same items
as the 3-year-olds. One must look very closely
to determine whether or not a gain of a few
items would raise a child’s “language age” from 3
to 4 years. The point here is that, although the
notion of a normal distribution is a vitally impor-
tant one for the identification of young children
with language impairments, it has important limi-
tations as it is implemented in omnibus language
tests.

A GRAMMATICAL MARKER APPROACH

Distributional properties

By their very nature, fundamental grammatical
rules do not follow a normal distribution across
individuals. For example, consider the rule for
duals: regular nouns that refer to more than
one must be marked with -s to denote plurality.
Under this rule, a phrase like (1) *thes three hill is
ungrammatical (here I will follow the convention
that utterances marked with an * are ungram-
matical). It is not something that speakers can
choose to ignore, or show only partial knowledge
of. It is obligatory. In like fashion, speakers must
insert a form of “be” in a sentence where a copula
is required (e.g. (2) She is walking, vs. (3) *she
walking). Likewise, the third person singular -s
morpheme is required in contexts such as (4) she
walks outside; (5) *she walk outside is ungram-
matical in Standard English. Other examples are:
(6) yesterday she walked outside; (7) *yesterday
she walk outside; (8) Does she like to walk? (9)
*She like to walk? Grammatical properties such
as these are understood by people who know
English. In order to work as a conventional language,
the community of users know these properties
and follow them. Grammar-users are not distrib-
uted as in a bell curve, instead they are all bunched
at the top end of the distribution, because they
know these grammatical principles.

Now let us consider children. It is well known
that by the time they go to kindergarten, chil-
dren can be expected to know the properties of
grammar illustrated above (i.e. rules for plurals,
the use of "be" forms, regular third person sin-
gular -s, regular past tense -ed, auxiliary "do"). But children do not show this knowledge at the
outset of their language, in their first simple sen-
tences. So we know children differ from adults,
and over time they come to be like adults in their
use of these grammatical properties. In order to
identify children with language impairments, we
must find those children who are not on their way
to the adult grammar in the expected time line.

In the areas of grammatical morphology
illustrated above, most 5-year-old children are
very much like adults. Figure 2.2 illustrates an
hypothesized distribution of 5-year-old children,
showing that most of them are at the upper levels
of adult-like performance. Consider the possibil-
ity that children with language impairments do
not know this part of the grammar by 5 years of
age. If so, they would cluster at the bottom of
the distribution, as shown by the cluster at the
left of Fig. 2.2, in the broken line. With these

![Figure 2.2](image-url)
distributional properties, grammatical limitations would offer distinct advantages for the identification of affected individuals, because individuals are expected to know the grammatical rules and to use them as an obligatory feature of a clause. If individuals apply the rules only some of the time, as if they were optional, those individuals would clearly differ from the expected levels of performance.

Clinical characteristics of a grammatical marker

A grammatical marker that followed the distributional properties of Fig. 2.2 (a bimodal distribution) instead of Fig. 2.1 (a normal, bell-shaped distribution), could have the following properties:

1. By a certain age, grammatical markers would show little variation across unaffected children. That is, children would show the adult grammar, or a close approximation of the adult grammar. They would know that certain grammatical morphemes are obligatory. They would cluster at the upper ends of the distribution.

2. Affected children would perform below the unaffected children. They would cluster at the lower ends of the distribution.

3. Because of this bimodal distribution of children, grammatical markers would have high levels of sensitivity and specificity. Sensitivity is the rate of identifying true cases of affectedness. Specificity is the rate of identifying true cases of unaffectedness. Just as we would want to have cancer testing with methods of high specificity and selectivity, we would prefer clinical methods with high accuracy for identifying true cases of language impairment that do not falsely identify unaffected children as having a language impairment.

4. The content of assessment would be meaningful for interpretation of a child's language deficits. It would be possible to see which grammatical knowledge was affected, which could in turn be used to plan intervention, to know what language competencies to teach.

5. The child's performance would be interpretable in terms of the adult grammar. It would be possible to see which gaps persisted as a child moved toward full grammatical competence.

6. Grammatical markers could persist over time. Long-standing grammatical differences would increase the likelihood that children could be identified, because they could be detected at different age levels.

A search for grammatical markers of SLI:
An extended optional infinitive

In the programme of research summarised here, investigation has targeted this question: Can we identify children with SLI because they are extremely slow in acquiring a part of the grammar that unaffected children are also slow in acquiring? Wexler (1994, 1996) identified tense-marking as a part of the grammar that is relatively slow to emerge in unaffected young English-speaking children. This period is known as an Optional Infinitive stage. This stage is interesting because new models of the adult grammar, such as Chomsky's (1995), focus on how this part of the grammatical system is crucial for the formulation of grammatical sentences across many languages. So there is a direct link between models of the adult grammar and children's grammar, which allows us which grammatical morphemes are likely to be affected and which ones are likely to be unaffected. One consequence is that we do not expect a pervasive grammatical limitation, but instead a constrained deficit. The verbal morphemes of interest are those illustrated above, in examples 2-9 (i.e., past tense. 3rd person singular -s, "be", and "do"). For this set of morphemes, our prediction is that, as shown above, the children can be expected to sometimes use them and sometimes omit them. We expect younger unaffected children to do this, but to move out of this immature grammar faster than the children with SLI, who seem to get stuck with an immature grammar for an extended time. Therefore, we call it an Extended Optional Infinitive (EOI) stage.

Findings

An important initial finding is that children with SLI have much lower levels of performance on tense-marking morphemes than do control children. Figure 2.3 shows the performance of two groups of 5-year-old children, one group of 37 children identified as expressive/receptive SLI, and a control group of 45 children of the same age (cf. Rice & Wexler, 1996a). The measure is the percentage correct for the obligatory use of the tense-marking morphemes (indexed here by a composite measure, summed across the different morphemes). Clearly, the SLI group falls below the 60% accuracy level, whereas the control children are at 80% or better. Only one child in each of the two groups moved across the border area. If the cut-off is set for 80%, 97% of the true cases are identified (sensitivity) and 98% of the true non-cases are identified (specificity). These are very encouraging findings, suggesting that it may be possible to identify young children with language impairments on the basis of certain grammatical morphemes.

We just completed the first longitudinal study of young children with SLI and control children, for the age range of 3-8 years, in this area of the grammar. Longitudinal evidence shows that the children with SLI remain behind their control groups throughout the period sampled, when they were 5 to 8 years of age. Figure 2.4 shows this pattern (cf. Rice, Wexler, & Henschberger, 1998). In this figure, the line on the lower left, beginning a 3 years and going to 8 years shows the growth in tense-marking for young unaffected children (N = 20), at the same mean length of utterance (MLU) as the SLI group (N = 21) at the beginning of the study. We can see that the younger control group reaches adult-like levels somewhere between 3.5 and 4.5 years. The consistency of performance across age levels is shown in the top line on the right, which is the unaffected age peer (N = 23) of the SLI group. These children maintain adult-like performance once they get to this level. On the other hand, the SLI group, the lower right curve is lower than the control children throughout the time of the study, and they continue to be lower at age 8 years. Although the unaffected children have been at adult level for years, the children with SLI continue to fall behind even in elementary school. There is no evidence that they "outgrow" their problem in this domain. Formal statistical analyses show that the pattern of growth is similar for the SLI group and the unaffected children, but the SLI group does not "catch up" with their peers.

Further analyses addressed the question of what factors may predict the growth curves in the tense-marking morphemes. Four predictors, which were measured at the first round of data collection, were evaluated. A child's mother's education was of interest because mother's education is known to be associated with the amount of talking to children (cf. Hart & Risley, 1995; Hoff-Ginsberg, 1998; Wells, 1985), which in turn is predictive of children's vocabulary development (cf. Hoff-Ginsberg, 1998; Hattenlocher, Haight, Bryt, Selzer, & Lyons, 1991). Although there was reason to expect that maternal education levels would positively predict grammatical development, there was also reason to question this expectation. In a separate sample of children who were followed from birth and assessed at age 4 years on their past-tense morphology, Rice, Spitz, and O'Brien (1999) found that maternal education did not predict performance on the tense measure although it was associated with vocabulary performance on the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn, 1981). The PPVT-R was also evaluated as a predictor of grammatical growth in Rice, Wexler, and Hershberger (1998), along with an estimate of the children's nonverbal intelligence (scores from the Columbia Mental Maturity Scales; Bergemister, Blum, & Hodge, 1972) and the child's mean length of utterance (MLU).

The result of the predictor analyses showed that growth in this linguistic domain is not predicted by a child's mother's education, a child's initial receptive vocabulary, or performance on nonverbal intelligence tests. In other words, a child's grammatical growth did not depend on initial vocabulary scores or nonverbal intelligence scores, or the education levels of his or her mother. A weak predictor (1% of the variance) was a child's initial MLU. Mostly, however, grammatical growth was not related to these predictors. These conclusions held for the children with SLI as well as the control children.

It is important to know that not all grammatical morphemes are affected in this way. For example, the acquisition of regular plural -s (as in "cats") is relatively unaffected, even though it is phonetically very similar to the third person -s verbal morpheme. Figure 2.5 shows the same age period for performance on plurals, where it is clear that this morpheme is quite stable during this time, and very near adult-like levels of performance, even for the SLI group. Thus, we can see that the problem is not a general one of being unable to acquire grammatical rules, nor is it likely that the children cannot perceive the difference in morphemes.

In the outcomes summarised so far, all the measures have required children to produce the target morphemes. Measures drawn from spontaneous samples and from experimental production probes show the same effect (cf. Rice, Wexler, & Cleave, 1995; Rice, Wexler, & Hershberger, 1998). If the limited production performance is attributable to underlying grammatical representations, it should be evident in children's understanding of the forms as well as their productions. In order to evaluate this corollary of the EOI theory, a set of grammaticality judgement tasks was developed, which evaluated children's judgements of sentences such as items 2–7 above. Essentially, we expected that the children with SLI who showed an EOI grammar would accept both the grammatical and the ungrammatical items. That is to say that children's judgements would parallel their productions, such that they would accept as grammatical the kinds of sentences they were likely to produce. A further implication addresses grammatical errors that children are unlikely to produce, such as "He am hurt". If children's judgements are guided by their underlying grammatical representations, and their representations, as predicted by the EOI model, do not allow such grammatical formulations, then they should regard these errors as ungrammatical, even though the grammatical errors are embedded in the middle of the sentence, in an unstressed position.

In order to evaluate their grammaticality judgements, the same children who participated in the longitudinal study were assessed, beginning at the third round of data collection, when the younger control group was 4 years of age and the SLI group and age control group were 6 years of age, and continuing for five subsequent rounds of testing, for a full two years of assessment. The study was reported in Rice, Wexler, and Redmond (1999).

Figure 2.6 shows the outcomes for the children's judgements of the utterances depicted in items 2–7 above, as indexed by an A' value which can be roughly interpreted as a percent correct in detecting grammatical versus ungrammatical sentences in which tense-marking is dropped, adjusted for children's bias to say that a response is "good". Note that this figure looks much like Fig. 2.4, showing the outcomes of composite tense-marking. The children with SLI perform at lower levels than the control groups throughout. At the same time that they are likely to accept utterances such as "He am hurt", they are less likely to accept other grammatical violations, such as "He is cought", or "He am hurt". This is shown in Fig. 2.7, for the SLI group, where the continuous line is for utterances such as 2–7 above, the small dotted line is for utterances with subject-verb agreement errors such as "He are hurt", and the large dotted line is for utterances with dropped progressive -ing, such as "he
is cough. The conclusion is that the protracted period of limited tense-marking for children with SLI is evident in grammaticality judgements as well as their productions. Further, just as their productions do not show affectedness for all morphology, their grammaticality judgments do not show uniform limitations across all kinds of grammatical violations.

As with the production data for the growth of tense-markers, there is reason to wonder about which factors predict change in grammaticality judgments over time. To investigate the predictors of the observed grammaticality judgment growth curves, Rice, Waxler, and Redmond (1999) replicated the analyses of Rice, Waxler, and Hershberger (1998), in which the predictors were maternal education, nonverbal intelligence, receptive vocabulary, and MLU. The outcomes showed strong replication of the modeling for the tense-marker growth curves: maternal education was not a predictor, nor were any of the other variables.

To summarize the outcomes of the programme of investigation described here, let us return to the clinical characteristics of a grammatical marker. As is shown by the findings, in a particular area of the grammar with known properties in the adult grammar (i.e., that of tense-marking and tense-related syntactic knowledge), early school-age children affected with SLI perform below unaffected peers, even below children two years younger. In effect, the findings show that the unaffected children cluster at the top levels of performance, as expected, whereas the affected children cluster at the low levels of performance. This leads to high levels of sensitivity and specificity, and the ability to identify affected children while being unlikely to falsely identify unaffected children. In this domain, we can see rather directly the exact nature of the children's grammatical deficits and how their performance relates to the target adult grammar, and their progress toward that level of performance. Furthermore, it is readily apparent that this narrowly defined deficit in their grammar can persist for a long time. A further property of a grammatical marker of SLI is that children's performance is not predicted by maternal education, nonverbal intelligence, or receptive vocabulary development. This fact points toward a relatively discrete linguistic marker of SLI, that grows independently of the environmental benefits attributed to maternal education, or the child's level of nonverbal intelligence, or the number of words understood.

It would be wrong to leave the impression that only tense-marking is to be expected as a grammatical consequence of an OI/Eoi period. The general theory underlying this programme of investigation also assigns a strong role to tense and agreement marking in the assignment of case. In English this shows up as case-marking on personal pronouns. Waxler, Schirke, and Rice (1998) carried out a detailed analysis of case-marking in the same samples of children studied in the tense-marking studies reported above. The main finding is that case marking is linked with subject-verb agreement marking, which is apparently also vulnerable in the children with SLI and the younger controls. For example, the adult grammar expects nominative case marking on subjects, as in "he cries". Children sometimes say "him" instead of "he", and children with SLI are more likely to make such case errors than are unaffected peers (Loeb & Leonard, 1991). Waxler et al. (1998), show that the likelihood of "him" as a subject is closely associated with whether or not the verb shows tense/agreement marking, such that "him cries" is much more likely than "he cries" or "he cry". Although the details of the interpretation further clarify the mechanisms for the tense/ agreement marking, they go beyond the scope of this chapter. Because more detailed model does not affect the generalisations laid out above, it will not be discussed further. The major point is that the properties of tense and agreement-marking are just now beginning to be more fully understood in adult languages. The OI/Eoi model does not rule out the discovery of additional linked properties, nor does it rule out the subsequent discovery of grammatical markers unrelated to the OI/Eoi stage. These matters remain for further inquiry.

**ETIOLOGICAL CONSIDERATIONS**

There is converging evidence that language impairments are heritable (cf. Rice, 1996). Early on, Rice and Waxler (1996b) argued that deficits in tense-marking, as a grammatical symptom of the condition of SLI, could be manifestations of underlying inherited language capacities that are less fully developed in individuals with SLI. If this is the case, then it would be expected that the families of children with grammatical symptoms of this sort would show a higher-than-expected occurrence of language impairments of this sort. Although there are a number of family studies that report a higher occurrence of affectedness of there is a member of the family known to have language impairments (cf. Rice, Haney, & Waxler, 1998; Tonblia, 1996), none of the previous studies documented that the target affected family member (the proband) had limited tense-marking ability. Rice, Haney, and Waxler (1998) investigated the families of the children studied in the longitudinal studies summarised above. In this sample, about 22% of the immediate family members (i.e., parents and siblings) of the probands reported a
positive history of speech/language impairments compared to 7% of the control children's family members (a percentage virtually identical to the population estimate of Tippin et al., 1997). So it is clear that one condition of a possible inherited language impairment is met (i.e. that it is more likely to appear in families where someone is known to be language impaired).

Rice, Wexler, and Henschberger (1998) and Rice, Wexler, and Redmond (1999) interpret the grammatical symptoms as evidence of an immature stage of a relatively discrete inherited grammatical ability. Recall that a major index of environmental influence, that of maternal education, does not predict growth in tense-marking, for either the observed production outcomes or for the closely related grammatical judgements tasks, for either the affected children or the controls. This points away from environmental influences and toward non-environmental contributions. Recall also that children's vocabulary scores did not predict grammatical growth for the target structures, nor did nonverbal intelligence. Considered together, these results point toward a differential weighting of etiological factors for vocabulary versus grammatical development, and a relative dissociation with nonverbal intelligence.

Studies of twins with SLI can shed some further light on this issue. Twin studies comparing identical (monozygotic) and nonidentical ( dizygotic) twins have established that there is a much greater likelihood that both members of the twin pair will be affected if they share their genes (i.e. if they are identical twins). Bishop, North, & Denan, 1995; Dale et al., 1998; Lewis & Thompson, 1992; Tomblin & Buckwalter, 1998). Dale et al. (1998) report that genetic contributions to early vocabulary development are much stronger for 2-year-old children at the bottom of the developmental distribution than for children in the upper range of performance, with a heritability estimate of 73% for the low-level group as compared to 25% for the higher level children. Conversely, the estimated environmental influence is 18% for the low group as compared to 69% for children with faster vocabulary growth. Dale et al. (1998) conclude that the children whose early vocabularies are small, compared to other children, in effect have a qualitatively different status than the children with more robust vocabularies; they are not just at the low end of the normal distribution. In other words, the emergence of first vocabulary items may function much like a clinical marker in affected children, although whether or not vocabulary status retains this marker function for older children remains to be seen. It may be that first vocabulary acquisition serves as a valuable indicator of the presence of children's language emerges late relative to unaffected children. Rice and Wexler (1996) likened the late emergence of language to a train that leaves the station late. What is not known the local emergence of certain grammatical markers, if we assume that what may be slow in unaffected children can be very slow in affected children.

Similar to the findings of Dale et al. (1998) with twins, Rice, Spitz, and O'Brien (1999) found, for their sample of sixty-nine 4-year-old children who were placed in an intensive care unit at birth, that the association of maternal education with the children's vocabulary scores was strong for children in the upper range of performance, but not in the lower levels of performance. Rice, Spitz, and O'Brien (1999) suggested that the more intense levels of language stimulation provided by more educated mothers can be helpful for children with relatively intact language learning mechanisms but may not be sufficient to facilitate language growth in children at biological risk. At the same time, neither maternal education or the families' social economic status was associated with children's performance on a measure of past tense, regardless of the relative level of performance by the children. Interestingly, there was no evidence of familiarity of speech/language or reading/learning impairments in the biological risk sample of Rice, Spitz, and O'Brien (1999). This is the first explicit evidence of the very reasonable assumption that biological risk and inherent risk can lead to similar symptoms from diverse etiologies.

Another twin study yielded findings congruent with the findings of Dale et al. (1998). Ganger, Pinker, Baker, and Chawla (1998) studied 76 pairs of twins, beginning at age 15 months. They reported that, in the range of normal development, vocabulary growth showed very small heritability whereas the appearance of first word combinations showed high heritability. They conclude that the sources of grammatical competencies required for first word combinations is more likely to be genetically influenced than is early vocabulary development.

What these findings suggest to me is the following. Although the picture is just beginning to come into focus, what seems to be emerging is the strong possibility that when we look carefully at different dimensions of language competency and patterns of growth, we will see etiological differences that work differently according to the language domainas investigated, and according to the relative levels of competency assessed. For both affected and unaffected children, the grammatical symptoms of tense-marking (i.e. the grammatical features of an OI/EOI stage), are not closely tied to environmental indices such as maternal education, even though environmental factors are implicated in vocabulary growth for unaffected children. At the same time, environmental enrichment may not be sufficient to accelerate limited vocabulary abilities in children with language impairments. This suggests that underlying inherited limitations may operate to depress the rate of language growth regardless of the child's environmental resources.

IMPLICATIONS FOR CLINICAL ASSESSMENT

As noted in the earlier section describing the psychometric approach of omnibus language tests, conventional language assessments - assuming an underlying normal distribution among the individuals who are assessed - yield vitally important information. Most simply put, there is no reason to discard these instruments. At the same time, there is high potential clinical value in the utilization of relatively constrained clinical markers in the domain of morphosyntax. These advantages can be seen in the identification of affected children, possible treatment options, and the promise of a clinical grammatical marker for investigations of the etiology of SLI.

Identification of affected children

In the current omnibus language tests, the selection of grammatical morphemes to be investigated is atheoretical, seeming to follow a descriptive-structural approach. In the OI/EOI model, the focus is on a small set of grammatical markers that have a common linguistic function, that of marking tense and subject-verb agreement. It is in this domain, for this linguistic function, that we can see clear delineation of affected from unaffected individuals. Note that the picture looks very different for the regular plural -s morpheme, which does not differentiate affected from unaffected individuals in the ages studied in those investigations reported here. For this reason, a test of morphology intermingled items designed to test plurals with items to test tense marking, the ability to identify affected children would be greatly affected.

Instead of trying to capture all dimensions of language competency in an identification instrument, there would be great value in targeting those dimensions that accurately identify affected children (i.e. show high levels of sensitivity), as well as unaffected children (i.e. show high levels of specificity). This could greatly improve the "hit" rate in determining who to regard as exhibiting SLI and who to regard as developing in a typical manner.

Of equal importance is the fact that a grammatical marker can be interpreted rather directly in terms of the adult grammar, expected levels of progress toward the adult grammar, and slowed growth curves. In testing terminology, a grammatical marker has high content validity, because the content of the testing can be readily seen and interpreted. To return to Figs. 2.4 and 2.6, it is clear that in the area of tense-marking there is an expected progression toward the adult grammar for children speaking English, and children with SLI can fall far behind in this progression.
of tense-marking, that unifies a set of surface morphemes that have different surface properties and diverse grammatical properties. For example, a very important insight to be derived from the OI/EOI model is that the function of the finite forms of "be" and "do" in English is to mark tense and subject-verb agreement (where the forms of "be" vary according to person and number marking on the subject, i.e. "am", "is" and "are"). These forms have unique properties as copulas or auxiliaries, and at the same time share properties with the third person singular present-tense marker, -s, and past-tense morphology as well. These underlying similarities are important to recognize in the planning of intervention, given that the set of morphemes seems so cohesive as children progress toward the adult grammar. The findings show that as children make gains in one of the target morphemes, they are likely to make gains in others as well. For this reason, it suggests that a practitioner would want to track development across the set of morphemes, and to train them as a related set.

Note that the morphemes do not share surface properties: "be" and "do" appear as individual syllable forms whereas past tense and third person singular present-tense forms appear as affixes on lexical verbs. This suggests that treatment approaches that are heavily dependent on manipulations of prosodic information or perceptual salience probably will not be a complete answer. Further, notice that the marking of grammatical tense applies to present tense as well as to the more familiar past-tense affixation. In English, present-tense marking appears with forms of "be" copula and auxiliary and "do" auxiliary (in questions) and the third person singular -s. Although there is often a tendency in intervention materials to think only of past-tense marking when tense is discussed, it is important to recognize the need to mark present tense as well, even though it does not add much semantic information to the utterance because the present-tense marking is generally assumed.

A crucial element of the OI/EOI model is the notion of "finiteness" (cf. Rice & Wexler, 1994; Wexler, 1996). "Finiteness" refers to verbs that show tense/agreement marking, and to the idea that such marking is restricted to certain sites in a clause. For example, in "she walked home", the verb "to walk" is finite, showing past tense. Note that in "she made the dog walk home", the verb "to walk" is nonfinite, which we can see by the following, "she made the dog walked home". The reason this is crucial is that children with SLI may omit tense-marking forms, but they are very unlikely to mark finiteness in an unlicensed site (cf. Rice & Wexler, 1996a; Rice, Wexler, & Hershberger, 1998; Rice, Wexler, & Redmond, 1999). Practitioners can observe whether children follow the underlying licensing constraints for finiteness-marking. If such errors do not occur, it would be appropriate to note this as part of a child's knowledge base; if such errors do occur, it would be important to follow up with further examination to see if explicit instruction is needed in where finiteness is allowed in a clause.

The investigations of grammaticality judgments (Rice, Wexler, & Redmond, 1999) suggest that even if children with SLI are able to increase their consistency of use of tense-marking forms, they may still regard omitted forms as an allowable option. This suggests that language intervention could benefit from a final phase of instruction in which children are given practice in making grammaticality judgements, with an emphasis on learning about the obligatory properties of tense-marking morphology. This could well prove to be an important transition phase for working with written forms of English, to look for omitted markers in text as well as spoken utterances.

A final implication for intervention is that, just as the set of tense-marking morphemes show an association at a given time during the period of 3-8 years of age, and an association over time, they are likely to be linked to other properties of the grammar. The current evidence points most directly at the assignment of case to personal pronouns. According to the findings of Wexler, Schütze, and Rice (1998), there would be good reason to teach case assignment in tandem with tense/agreement marking. The choice of "he" versus "him" is tightly linked with the choice of whether or not to omit third person singular -s, or the forms of "be" or "do". It may well enhance a child's use of each system (i.e. case-marking and tense/agreement marking), if those two systems are taught simultaneously.

It is perhaps somewhat ironic that although the grammatical limitations of children with SLI have been known for some time, we are now taking another look at this limitation and finding it to be both more subtle and more pervasive than perhaps we had realised. The contribution of the OI/EOI model, and the notion of grammaticality markers, is the recognition that it is crucial to define carefully the grammatical markers that are involved and their underlying grammatical functions, and to recognize that other forms such as plurals are not likely to be affected whereas case-marking may well be. The positive news is that the grammatical marker may be relatively constrained. The not positive news is that the limitation can persist for a very long time, and the full extent of the grammatical linkages is relatively unexplored.

Etiological information

In recent years, the advances in human genetics have brought a major shift in our thinking about the causes of language impairments in children. The likelihood of genetic contributions to language impairments is now widely accepted. The announcement of Fisher et al. (1998) of the identification of a particular gene locus for a family with speech and language impairments is a major breakthrough. At the rate of current inquiry, it is very likely that converging findings will be appearing from other investigators and other laboratories.

A grammatical marker is relevant in two ways for furthering our understanding of genetic contributions. First, it provides an interpretive window into the nature of the language impairment. The OI/EOI hypothesis is that there is an inherited contribution to grammatical acquisition, and that children who show a grammatical marker may well be children who have inherited a faulty mechanism for grammatical growth, that leaves them in an immature grammatical phase for an extended period of time. Because the grammatical symptoms seem to be relatively unlinked to other domains of language development, it may be that the grammatical marker arises from
different etiological sources than other symptoms of language impairment. Although this can seem to be a rather radical claim, let me note that until just recently it was assumed that speech impairments and language impairments were tightly linked, although that assumption is heavily challenged by new epidemiological findings of Shriberg, Tobiin, and McSweeney (1999). The clinical implication of a possible differential etiology is that some dimensions of language may be more resistant to intervention procedures than others. As noted above, there is reason to believe that general environmental input may be more facilitative for the development of vocabulary than for tense marking, although other findings suggest that the vocabulary effect may be lessened at the lower end of performance. This implies that practitioners should plan for a prolonged period of intervention for grammatical markers. It does not imply that grammatical deficits should be written off as hopelessly locked into an individual's deficit structure. Instead it means that the difficulty of learning in this area should be recognized and planned for, including the use of compensatory methods to prevent burn-out on the part of the person receiving intervention services.

The second reason that a grammatical marker is relevant for etiological studies is that the identification of affected genes, assuming that certain genes differ in individuals with language impairment, will be enhanced by a behavioural symptom that shows high sensitivity and specificity (cf. Rice, 1996). Because the grammatical marker described here shows the highest levels of sensitivity and specificity that I know of at present for the condition of SLI in young children, it is a very promising candidate for a clinical symptom that can be linked to inherited limitations. A number of investigations are under way to evaluate this prediction. Whether or not definitive answers can be found remains to be seen.

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