

# Language Without Rules

A curious speech disorder raises questions about the genetics of grammar

By BRUCE BOWER

**M**edia reports in 1992 announced the discovery of a gene that regulates the ability to learn grammar. Editorial writers and humorists immediately pounced on the claim. Scientists will promote genes for spelling and neatness next, intoned one incredulous commentator. Pity the throngs of grammar-gene-deprived teenagers, who consider “bummer” and “awesome” complete sentences, another wrote.

But an inconvenient fact lurked behind these jibes: Scientists had not wrung a

K clan often seem as if they speak English as a second language. Words come slowly, often after careful planning of what to say. They encourage others to help them complete sentences and avoid situations that force them to speak.

“This disorder appears to involve a genetic factor or factors,” says linguist Myrna L. Gopnik of McGill University in Montreal, who directs the K family study. “For the first time, we have a chance to get direct evidence about the biological basis of language acquisition.”

Efforts to decode the inner workings of this derailed discourse, known as specific language impairment (SLI), or developmental dysphasia, have intensified in recent years and attracted psychologists, linguists, speech-language pathologists, and educators. Although many of them view SLI as at least partly inherited, a widely accepted definition of its core features remains elusive.

Clinicians diagnose SLI when children exhibit difficulty speaking their native language in the absence of any apparent cause — low intelligence, brain damage, hearing defects, emotional problems, or lack of exposure to adult talkers.

Some theorists see SLI as a broad syndrome encompassing problems in grammar, language learning, and reading. Others posit a narrower disturbance of either the ability to construct basic grammatical rules or to distinguish key speech sounds. Another question involves whether children displaying SLI learn to speak using strategies dictated by their condition or acquire language just as other children do, but at an agonizingly slow pace.

**P**ublished descriptions of SLI, originally called congenital aphasia, appeared as early as 1872, points out J. Bruce Tomblin, a speech-language pathologist at the University of Iowa in Iowa City. But systematic inquiry into the nature and causes of the condition emerged only in the past 20 years, he says.

SLI may afflict as many as 1 in 20 children and about twice as many boys as girls, Tomblin told the American Association for the Advancement of Science (AAAS) annual meeting in February. He bases these estimates on language testing of 1,300 Midwest public school kinder-

gartners.

As the K family illustrates, SLI usually persists into adulthood, Tomblin adds. In a study of 35 young adults with documented SLI in childhood, all displayed marked language problems compared with same-age controls who encountered no problems in learning to speak, he reports. The adult legacy of SLI sketched by Tomblin and his coworkers includes a frequent failure to comprehend sentences spoken by others and a tendency to talk in ungrammatical bursts.

Evidence of a genetic influence on SLI comes from family and twin studies. In a multigenerational study of 45 families, each already known to have a child with SLI, nearly one-quarter of the relatives received a diagnosis of SLI after language testing, Tomblin says. An unpublished survey of more than 600 Canadian families conducted by McGill’s Gopnik finds that, when SLI runs in a family, it affects about one in four individuals.

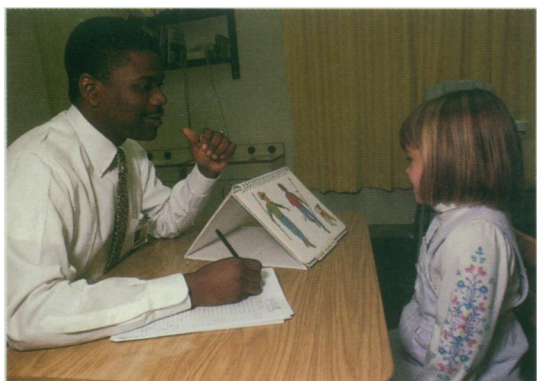
Preliminary evidence, gathered in independent studies by Tomblin’s group and an English team, further indicates that SLI affects identical twins (who share the same genes) far more often than fraternal twins (who share, on average, half their genes).

SLI may come in two forms, one that reflects a strong genetic influence and one that results from poorly understood environmental factors, according to both Tomblin and Gopnik.

One or more genes may influence either general thinking abilities involved in language learning or specific brain systems dedicated to speech, Tomblin holds. Either way, this mechanism probably boosts the likelihood of both SLI and severe reading problems, he argues.

In contrast, Gopnik views SLI — at least in its genetically influenced form — primarily as a disturbance of an innate ability to construct grammatical rules that guide language learning. Noam Chomsky, a linguist at the Massachusetts Institute of Technology, has argued for more than 35 years that universal grammatical rules make possible the dizzying array of human languages. Cases of SLI provide a natural experiment with which to test his argument, Gopnik contends.

Elaborating on Chomsky’s work, psycholinguist Steven Pinker of MIT holds that most English speakers learn regular word forms by applying mental rules



American Speech-Language-Hearing Association

*Intensive language testing helps to identify cases of specific language impairment.*

“grammar gene” out of microscopic strands of DNA. They had, in fact, tracked a speech disorder through three generations of the “K” family and suggested that a single gene somehow disrupts the ability of these intelligent, well-adjusted people to converse normally. The hypothetical gene, according to researchers, may orchestrate proteins that either specifically target or inadvertently jam brain circuits that endow speech with grammatical structure.

Affected K family members — 16 of 30 children and adults living in England — knit words into an awkward, confusing patchwork. For example: “I walking down the road” or “Carol is cry in the church.” When telling a story, they nearly always allude to others with nouns rather than pronouns (for instance, referring to “the man” rather than to “he” or “him”).

Grammatical rules taken for granted even by preschoolers prove foreign to the 16 K offspring; therefore, after seeing a picture of an imaginary animal called a “wug,” they do not know that “wugs” refers to more than one “wug.”

Language-impaired individuals in the

(such as adding "s" to indicate plural or "ed" to denote past tense) and learn irregular word forms by memorizing them (for instance, remembering to use "sang" for the past tense of "sing").

Unpublished data on SLI sufferers who speak English (K family members), Japanese, and Greek suggest that speech splinters in similar ways in diverse languages, Gopnik says. Language-impaired individuals fail to realize that sentences must include an indication of tense, lack internalized rules for tailoring words to signify tense, and often cannot get elements of a sentence to link up meaningfully.

As an example of the last problem, one SLI patient shown the sentence "The boy eats three cookie" said it needed this correction: "The boys eat four cookie."

Pronouns cause confusion and are avoided, Gopnik holds. They turn up occasionally in statements such as "It's a flying finches they are."

SLI adults use memory strategies to mask their grammatical weaknesses, but the underlying problem remains, Gopnik adds. For instance, they know from experience to say "walked" for the past tense of "walk" and "hands" for the plural of "hand" but cannot apply past tense or plural rules to nonsense words. Yet children as young as age 3 succeed easily on such tests, noting that if "I prame" today, then "I pramed" yesterday.

Mabel Rice, a speech-language pathologist at the University of Kansas in Lawrence, agrees that problems with grammar lie at the heart of SLI. But children grappling with this disorder may grope and stumble through the same stages of language learning that other youngsters breeze through, Rice argues.

She and MIT linguist Kenneth Wexler reported at the AAAS meeting that a failure to indicate tense typifies SLI during childhood. They conducted language tests on 19 5-year-olds with SLI, as well as 20 3-year-olds and 21 5-year-olds displaying no language problems.

The SLI sufferers make the same mistakes in indicating tense as normally developing 3-year-olds, Rice asserts. These include leaving "ed" off the past tense of verbs such as "walk" and frequently omitting the verbs "do" and "be." A child in either group may say "She walking" instead of "She is walking" or "The bear want a drink?" instead of "Does the bear want a drink?" Yet on the rare occasions they decide to use those verbs, they do so correctly, Rice adds.

Youngsters typically learn to signify tense accurately by age 5, but SLI children may find themselves mired in the earlier phase of language development throughout the school years or beyond, she suggests. "The development of ordinary speaking, grammatical, and literacy skills can be viewed as an interaction between what is inherited and opportunities for practice," Rice contends. "For those with

SLI, ordinary amounts of practice may not be enough."

Other theoretical accounts of SLI appear in *Specific Language Impairments in Children*, edited by Rice and speech-language pathologist Ruth V. Watkins of the University of Illinois at Urbana-Champaign (1994, Brookes Publishing).

One proposal, by Laurence B. Leonard of Purdue University in West Lafayette, Ind., holds that SLI may derive from a difficulty in perceiving speech sounds used for marking past tense and plural.

These sounds, such as "s" for plural, get inserted at the end of words without the benefit of vocal emphasis or lengthening of the sounds by the speaker, Leonard argues. Children with SLI may hear a difference between, say, "knock" and "knocks" but find it hard to extract the final "s" sound from the stream of conversation for further consideration.

Another theory, described by Judith R. Johnston of the University of British Columbia in Vancouver, maintains that — contrary to the assumptions of many investigators — intellectual problems contribute significantly to SLI.

Studies by Johnston and others suggest

that SLI children engage in less mature and symbolic play (such as spontaneously using objects to represent something else in a game) than peers without language problems. Childhood SLI also appears linked to deficits on reasoning tasks and delays of 1 to 5 years in developing counting skills, according to Johnston.

Instead of relying on innate grammatical devices, children learn to speak a language by using general reasoning and thinking abilities to analyze the utterances that bombard them daily, the Canadian researcher asserts.

A related theory developed by cognitive psychologists over the past decade maintains that, given enough exposure to fluent speakers, children learn grammar and other elements of a language as critical connections get made within networks of brain cells. These scientists, appropriately called connectionists, attempt to simulate this process in computers that modify the way processing units work together following exposure to examples of present and past tense.

Whatever underlies SLI, the condition cries out for appropriate early speech and language training, Kansas' Rice says. "Many questions remain about SLI, but we know it's a handicapping condition in people's lives." □

## A few words from the brain

Scientists now have some intriguing clues to the brain's role in specific language impairment (SLI).

SLI appears linked to an altered development in the brain's right hemisphere, contends Elena Plante of the University of Arizona in Tucson. A magnetic resonance imaging (MRI) study directed by Plante finds an unusually large right perisylvian area — a strip of brain tissue involved in language processing — in eight boys diagnosed with SLI, compared to eight SLI-free boys.

MRI scans of 17 parents and children in four families, each with at least one language-disordered child, identified enlargement of the same brain region in 12 individuals, including several who speak without difficulty, Plante says. Thus, this anatomical feature may reflect an inherited biological risk for language impairment that sometimes lies dormant.

Elevated hormone concentrations may alter fetal brain development and contribute to SLI, Plante adds. A pilot study she directed reveals a moderately high rate of both poor language skills and right-perisylvian enlargement in children with a genetic condition that boosts testosterone.

Other data, presented at a meeting of the Cognitive Neuroscience Society in March, indicate that different brain structures regulate the use of regular

and irregular word forms. If the finding holds up, it fits with the theory that SLI results from a genetic jumbling of grammatical circuits in the brain.

Language testing of 23 adults suffering from Alzheimer's disease indicates that they produce the past tense of regular verbs almost perfectly (such as "walk" and "walked") but falter markedly on irregular verbs (as with "keep" and "kept"), contends MIT psycholinguist Michael Ullman. These volunteers often apply regular past tense rules to irregular verbs (saying "keeped," for instance).

In Alzheimer's disease, language areas toward the back of the brain's dominant (usually left) hemisphere suffer more damage than those at the front, Ullman says. The former regions may handle knowledge of irregular verbs, he theorizes. In contrast, 20 Parkinson's patients struggled with generating the past tense of regular verbs but handled irregular verbs much more easily, Ullman notes.

Parkinson's disease appears linked to damage of the basal ganglia, a brain structure implicated in habit learning in several studies of brain-damaged patients. The basal ganglia may play a key role in engineering both smooth muscle movements and a seamless injection of grammatically appropriate speech sounds into sentences, Ullman asserts.

— B. Bower