Grammar as a Laboratory Science

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To those for whom the term is significant at all these days, the word "grammar" usually evokes memories from childhood in which a teacher intones obscure terms like "relative clause" and "participle", practices the mysterious art of "diagramming sentences", and tries to explain why most of what we say in day-to-day speech is either incorrect, improper, or at the very least misleading. It is hard to believe that, until quite recently, the study of grammar enjoyed a central and well-accepted role in education, a status gained with the establishment of the classic liberal arts curriculum in the late Middle Ages. Grammar was, along with Logic and Rhetoric, one of the subjects in the Trivium: the core group in the seven arts. The importance of the "Big Three" is reflected in our modern term *trivial*, which originally applied to knowledge regarded as so basic that it required no argument. Any educated person could be assumed to know it.

In an earlier time, studying grammar primarily meant studying the grammar of Latin and Greek, and was justified on those grounds. Access to the classical languages meant access to the root cultures of the West, their literature and science. Even regarded in and of themselves, Latin and Greek were viewed as "special languages": models of clarity, logical organization, intellectual subtlety, economy of expression, and so on. Studying how these languages worked was viewed as something very close to studying the principles of logical, coherent thought itself. When modern languages were analyzed, it was always on the model of Latin or ancient Greek.

The study of grammar no longer enjoys its privileged position, largely because the original arguments for that position have simply collapsed. The time when educated persons could attend only to the classics is long since past us. Furthermore, we know now that Latin and Greek are, by any reasonable standard, very typical human languages: in no way more clear, more logical, more subtle than, say, Greenlandic Eskimo or Samoyed. Those old rationales for studying Grammar are gone now. So is the relevance of Grammar entirely behind us too?

No. In the last three decades, under the revolutionary influence of Noam Chomsky, grammar has been reborn in a very different setting. Grammar has re-emerged as a science that investigates the structure, properties and principles of construction of natural language, one that pursues these questions with the same rigorous methodology found elsewhere in the study of natural phenomena. And although the study of grammar will never regain its former place of highest honor in the curriculum, there are a variety of features that argue for its return to the schools as a science subject. In this article I will discuss some these features, and highlight a project at the State University of New York at Stony Brook (SUNY - Stony Brook), which seeks to teach grammar as science using an innovative set of software tools. Before coming to that matter, however, I want to briefly take note of a basic perspective on natural language that frames this discussion.

1.0 Language as a Natural Object

Human children, from a very early age, appear to be attuned to the distinction between "natural objects" and "artifacts". In an interesting series of experiments, Cornell psychologist Frank Keil shows that whereas very young children judge the identity of objects based largely on superficial features, at a definite point kids begin to realize that certain kinds of objects have an inner essence that may be sometimes hidden or obscured. For example, Keil observes that before the age of 2.5, children will identify a black cat that has been painted to look like a skunk as a skunk; whereas after this age they identify a black cat painted to look like a skunk as a painted cat, and not a skunk. They realize that being a skunk is more than looking like a skunk: the true identity of an object may be concealed by appearances.

Interestingly, in making this transition, children seem to draw an important distinction between natural objects, like cats and skunks, and artifacts. Although they judge a painted cat to be a cat nonetheless, they understand that an old coffee pot which has been modified into a birdfeeder is now really a birdfeeder. In other words, they see that whereas natural objects are what they are, and have their own defining properties, artifacts are whatever we make them to be, as a matter of convention.

Human natural language can be viewed in both these ways: as artifact or as natural object; and how we view it strongly shapes our reaction to the facts that language presents us with. Languages have been seen (especially by anthropologists and language teachers) as an aspect of culture, similar to other basic human activities and traditions like tool-making or agriculture. Languages are taken to be the products of human imagination and development: created by humans, taught by humans, and learned by humans. They are cultural artifacts possessing the properties and obeying the rules that we bestow on them. Under this view, the patterns or regularities we find in natural language are basically just matters of convention. Like the bird-feeder, the language is what we've made it to be, and there is nothing further to say.

But language can also be viewed as a part of the natural world. In a series of highly influential works, Noam Chomsky of the Massachusetts Institute of Technology has argued that human language is more correctly viewed as a natural object, analogous to a limb or a bodily organ. True, language arose in the course of human history, but it was no more invented or developed by humans than arms and lungs. Rather language-ability evolved, like other species-specific properties. Likewise, although languages develop in the course of human ontogeny, they are neither taught to, nor learned by children, anymore than children are taught to grow arms or learn to have hearts. Rather, humans speak and in so doing provide the environment - the "nutrition", to use a Chomskyan metaphor - in which language can grow and develop in their children.

Under this perspective, languages become objects of the natural world much like quasars or spinach leaves. They are entities whose properties and structure are to be determined by naturalistic investigation. Accordingly, when we are faced with a certain pattern or regularity in linguistic facts, we do not put them aside as matters of convention, rather we start to seek around for a "law" or principle that predicts the pattern and suggests an explanation. And we realize that the explanation may well be hidden to us.

We can illustrate this point with a simple example. Consider the alternation between the two prepositions *in* and *on*, when we use them to talk about entering some means of conveyance, like a car or bus. We say "I got in the car", but we say "I got on the bus"; likewise, we say: "I put so-and-so in a taxi", but "I put so-and-so on a plane":

(1) **in:** car, taxi, truck, limo, van, elevator, rocket
on: plane, ship, subway, train, bus

Even in this small case, we feel the pull of our two perspectives. On the one hand, we are inclined to brush these facts aside feeling "Oh that's just the way we happen to say things. It's just a matter of convention". But as we begin to turn it over in our mind, we start to wonder whether there isn't some sort of implicit rule or principle we are following after all, and hence some subtle difference between the types of conveyance (or our way of viewing them) that the contrast points to. Perhaps we might conjecture that, their actual shapes notwithstanding, items in the first category are conceptualized by us as some sort of generalized "container" that encloses objects in moving them, whereas items in the second category are seen as some form of generalized "platform" that supports objects in moving them (like a conveyor belt). We might even go on to construct additional examples in order to test whether this hypothesis is correct.

Inquiring in this way, we are probing for some sort of law of the mind according to which we divide up the world. There is a hidden principle that we are trying to discover. This latter perspective is at the core of modern linguistics: in looking at natural languages we seek to understand what their fundamental parts are, and how these parts are organized both within a language and across languages. From this perspective, Linguistics becomes a chapter in natural science.

2.0 Linguistics as a School Science Subject

Science, by its nature, involves a constantly changing and developing body of knowledge. In the contemporary world, that knowledge develops and changes with such speed that even the brief periods that individuals spend in the school system suffice to see old scientific views discarded and new ones arise. Because of this fact, many recent educational initiatives have stressed the need for science teaching to develop understanding of the *practice* of scientific inquiry, and not just its current results. If students are to escape a passive dependence on experts, with its tendency toward uncritical acceptance, they must come to understand how scientific knowledge is acquired, and, indeed, how to derive it themselves.

Development of scientific thinking in learners of all ages involves mastery of a set of interlocking skills: classification and categorization of data, formulation and testing of hypotheses, counterfactual reasoning ("what if..."), pattern detection, integration of experience into a whole. While these skills are largely independent of content, in the sense that they are involved in all inquiry that we would term "scientific", certain domains appear to offer advantages as educational media. As a number of researchers (starting with Keyser (1970)) have pointed out, linguistics shows a variety of features that appear to make it a very promising instrument for the teaching of scientific inquiry.[1]

First, there is the sheer accessibility of the subject matter, both in its data and the theories developed to analyze them. Unlike many other phenomena of scientific interest, language is accessible <u>in</u> <u>depth</u> without slow and arduous processes of data collection, and without the aid of calculus-level mathematics or complex technical apparatus. The basic data of linguistics - well-formed and ill-formed sequences of speech sounds (phonology), well-formed and ill-formed sequences of words or morphemes (syntax), and the meanings of various words and phrases (semantics) - can be produced freely by any competent speaker of a human language. As a result it becomes possible, even with very young children, to proceed rather swiftly from data collection to the central intellectual processes of science: hypothesis generation, pursuit of evidence for or against a given hypothesis, and reflection on why a given hypothesis might be expected to succeed or fail.

Second, there is the intrinsic interest of the subject matter. Although young people have a natural interest in all aspects of their surroundings, the linguistic environment is known to be privileged in this respect. Modern developmental studies have shown that children are biologically "attuned" to natural language; as a matter of genetic endowment they are, in a sense, natural linguists. The result is an intrinsic interest in language manipulation - a fact evidenced, for example, by the universality of language games. When this interest is mobilized, young people show a strong affinity for language study. Linguistics can mobilize this affinity in the teaching of scientific inquiry.

Third, there are certain social factors that contribute to make linguistics a desirable medium for science instruction. The fact that its data are accessed largely through introspection means that linguistics is fully accessible to students with physical limitations that might otherwise present a significant barrier to learning (blindness, gross motor impairment, etc.). Furthermore, linguistics is also a highly "gender neutral" domain. Studies have consistently shown that verbal abilities in young women equal (and even marginally exceed) those in young men; and because linguistics is a young discipline, no developed stereotypes exist for who is a canonical "language scientist". Efforts that have already been made to introduce linguistics in the middle school curriculum have also shown that the subject matter is a highly "cooperative" medium of instruction. Again, since access to data is rapid and limited only by ingenuity, students can participate as a group in the formulation and testing of theories in a way not duplicated, for example, in the study of physical principles or biological organization, where resort to experiment often results in only a few individuals participating fully.

Fourth, linguistics is a natural "bridge" discipline between the sciences and the humanities. Because its subject matter - language - is integrally connected with so many areas in the humanities and arts, linguistics offers a natural means to reach students not otherwise considering science as an area of study. Linguistics offers an excellent route for introducing such students to the principles of scientific method and reasoning, enhancing the prospect that they will explore other areas in the science curriculum.

3.0 The *Grammar as Science* Project

The *Grammar as Science* Project at SUNY Stony Brook is attempting to exploit some of the attractive features of linguistics just enumerated. GAS represents a joint effort by Stony Brook Linguistics and Computer Science to develop curricula in the specific areas of grammar (syntax) and linguistic meaning (semantics). In addition to teaching students formal linguistic theory, the project aims to foster scientific research skills and to develop the central intellectual processes of science.

The concrete task of GAS is to create sophomore-level courses in syntax and semantics that will be accessible to students from a wide variety of backgrounds. At the heart of each course is an innovative software application tool that allows the students to explore the subject matter in a graphical and interactive way. The tool for studying grammar is called *Syntactica*, and its companion tool for studying linguistic meaning is called *Semantica*

The development of these tools responds to a basic challenge that arises in teaching the subject matter, especially for students with little technical background. Modern linguistic theory attempts to model the (largely tacit) knowledge that speakers have of their language. This knowledge is standardly viewed as a formal system that computes over linguistic representations. Accordingly, modeling and exploring linguistic knowledge is a matter of modeling and exploring computational systems. Given this orientation, core courses in linguistics programs like Stony Brook's stress the understanding and mastery of deductive technique much like that involved with proofs in logic and mathematics. Linguistic hypotheses take the form of rules and principles that are evaluated by tracing their deductions and interactions with other rules and principles, through potentially complex derivations, and across a potentially broad range of linguistic expressions. As in other disciplines where formal reasoning is important, development of these skills lends itself very well to computer-assisted instruction (CAI). CAI allows students to proceed through the material systematically at a self-tailored pace, and in a way that provides immediate feedback at each step. When the user-environment is graphical, this permits the additional benefit of presenting abstract ideas in a concrete, easily-visualized form.

To give a more concrete idea of how this works in practice, let me describe some typical contexts where *Syntactica* and *Semantica* are used.

3.1 Syntax and *Syntactica*

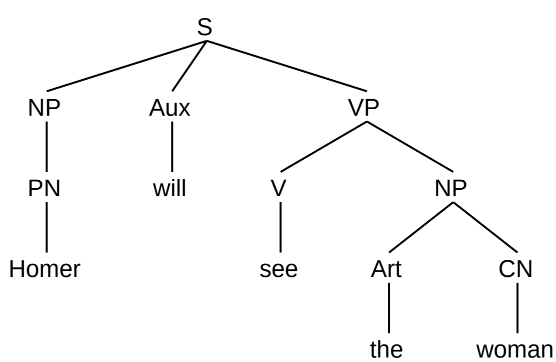
Syntax is traditionally conceived of as the study of how sentences are structured from parts. Syntacticians study the categories of these parts (parts of speech), their form, linear ordering, interdependence, and grouping in various constructions. A syntactic theory can be thought of as a formal system for assigning structural descriptions to sentences. This system takes the form of a collection of rules or principles.

One simple formal device for assigning structural descriptions is context-free **phrase structure rules**. A phrase structure rule is a rule that states the category and linear arrangement of expressions. Example phrase-structure rules are given in (2):

(2)	S	→	NP	Aux	VP	PN	→	*Homer*
	NP	→	PN			Art	→	*the*
	NP	→	Art	CN		CN	→	*woman*
	VP	→	V	NP		V	→	*see*
						Aux	→	*will*

The first rule in the lefthand column can be read as saying that a sentence (S) can consist of a noun phrase (an NP) followed by a verb or predicate phrase (a VP). The next rule is read as saying that an NP can consist simply of a proper noun (PN). The next is read as that an NP can consist of an article (Art) followed by a common noun (CN). And so on. The rules in the righthand column identify the parts of speech of basic words. The first rule says that *Homer* is a proper noun. The second says that *the* is an article. And so on. Rules like these assign an implicit structure to sentences, and this structure can be conveniently represented by means of a tree diagram. For example, the rules in (2) assigned the tree diagram in (3) to the sentence *Homer will see the woman*:

(3)

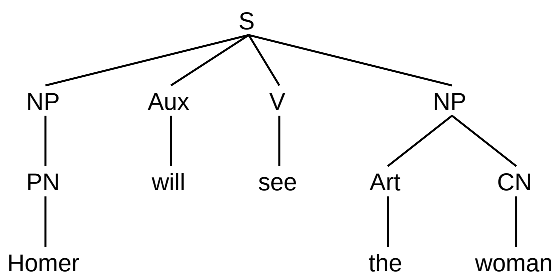


Syntactica is used to make concrete the notion of a grammar as a formal device, and also to lift a certain calculative burden from the user. The application provides a simple interface for inputting grammar rules, for viewing the structures that they assign to expressions. The first screen shot (fig-1) shows a typical kind of session. The user has entered rules in the Rules window at the left, and loaded them into the TreeViewer window at the right. The user then types in a sentence (in this case, the sentence *Homer will see the woman*) and clicks the BuildTree button. Syntactica attempts to build a tree diagram for the sentence according to the rules that have been entered. If appropriate rules have been formulated and entered correctly, then a tree diagram is computed. If not the user gets an error message, and must go back, revise the rules, and try again. The notion of a grammar as a formal system that generates or fails to generate an output thus takes on a very tangible character.

One thing students grasp very quickly in the context of generating analysis trees for sentences is that, for any given collection of sentences, it is easy to come up with different sets of rules assigning different structures. For example, if we replace the rules in (2) with the ones in (4), our sentence *Homer will see the woman* gets the alternative analysis tree in (5):

(4)	S	→	NP	Aux	V	NP	PN	→	*Homer*
	NP	→	PN				Art	→	*the*
	NP	→	Art	CN			CN	→	*woman*
							V	→	*see*
							Aux	→	*will*

(5)



Note that in the first tree the verb (*see*) and its object (*the woman*) form a **constituent** group of category VP, whereas in the new tree, they don't. *Syntactica* is used to aid students in grasping differences between structures, as we illustrate with fig-2. The application allows the user to have more than one rule set open at the same time, and hence to move back and forth between alternative rules for a given sentence, inspecting the differences of structure that result.

Of course, having alternative grammars for a data set inevitably raises the question as to which of the grammars is correct, and if so, how we tell. Here again you might feel the pull of our two ways of thinking about language mentioned earlier. On the one hand, you might be inclined to think there is no fact of the matter. "It's all convention anyway, so it really doesn't matter which set of rules we choose." On further reflection, however, you begin to wonder whether in fact one tree mightn't be more correct than another. Perhaps there is some way of deciding between the representations - other data suggesting that one of the tree structures is superior, etc..

In fact there do appear to be data pointing toward one tree versus the other. Take our example *Homer will see the woman*. Notice that certain reorderings of the words in this sentence produce an acceptable result, as shown in (6), whereas other reorderings of the sentence are quite unacceptable, as shown in (7):

(6) a. The woman, Homer will see.
(As in: "The woman, Homer will see. The man, Homer will ignore.")
b. See the woman, Homer will
(As in: "Homer said he will see the woman, and see the woman Homer will.")

(7) a. *See the, Homer will woman.
b. *Will see, Homer the woman..

A natural account of the difference - one that has been much-explored in the linguistics literature - is that the possibilities for reordering depend on how words are grouped together within a sentence. Specifically it has been proposed that reordering only affects sequences of words that cohere together in a single group: that reordering only affects **constituents**. Notice now that if this principle is accepted, it gives us reasonable grounds for preferring tree (3) over tree (5). Only in the former tree do both of the reordered expressions (*the woman*) and (*see the woman*) form a constituent. Only this tree predicts <u>both</u> of the reordering possibilities in (6).

Once again *Syntactica* can be used to help visualize the relevant points concretely. Reorderings like those in (6) are standardly taken to result from a syntactic operation of movement that can be applied to a tree to yield another tree. *Syntactica* allows such transformational operations to be performed by simple point and click operations. For instance, the second example in (6) can be derived from the tree for *Homer will see the woman* by:

- clicking on the VP node that dominates *see the woman*, (fig-3)
- clicking on the Left-Adjunction operation in the Transforms panel (fig-4)
- clicking on a target position for movement (here, the S node). (fig-5)

Syntactica performs the operation of attaching or adjoining the VP to the left of target phrase (fig-6). Using operations of this kind, students can rapidly inspect what reordering possibilities are available for a given tree, and what kinds of movements must be used to obtain them. Such exploration forms the basis for arguing which kind of tree is correct for a given clause.

This discussion gives a rather simplified example of the use of *Syntactica*., but the basic features of its use are nonetheless clear. *Syntactica* lifts a certain computational burden that arises when determining representations from rule sets in somewhat the same way that a calculator lifts the computational burden of graphing functions in beginning calculus. The derivation crunching is done by the machine. The task of the student is then to analyze these computational results and make sense of them. In performing these operations *Syntactica* (like the calculator) does none of the genuine analytical work. The responsibility for determining what the correct representation should be, and what rules are needed to derive it, remains where it should be: squarely in the hands of the user. *Syntactica* functions simply as a "grammar workbench" for building, testing, comparing, and refining syntactic rules and representations.

3.2 Semantics and *Semantica*

The use of *Semantica* in semantics classes at USB is partially similar to the use of *Syntactica* in syntax classes. One crucial function of *Semantica* is as a derivation calculator, although what is calculated is not structures, but rather interpretations. Semanticists study the meanings of words, and the rules and principles by which those meanings combine to give the content of larger phrases (including sentences). In executing this idea in a precise way, modern semantics adopts a leading idea from logic and modern philosophy, according to which the meaning of a sentence is identified with the conditions under which it is true (its **truth-conditions**). Under this conception, the semantic theory of a language becomes a theory of the axioms and principles tacitly known by its speakers that yield truth-conditions for its sentences.

We can illustrate this general idea with a simple example sentence *Max is behind House1*. Suppose we represent the truth conditions for this English sentence using the logical notation in (8). This correctly states that the sentence *Max is behind House1* is true if and only if (abbrev. "iff") the individual max stands in the behind-relation to $house_1$:

(8) *Max is behind* $House_1$ is true iff behind(Max, House1)

A semantic theory for English would contain a set of axioms and principles from which this result follows. (9a)-(9d) are candidates for such a theory. Here "Val(α,β) iff ... " is to be read "α is a semantic value of β if and only if ...":

(9)	a. Val(x, *Max*)	iff	x = Max
	b. Val(x, $House_1$)	iff	x = House1
	c. Val(<x,y>, *is behind*)	iff	behind(x,y)
	d. Va(t, N_1-V-N_2)	iff	Val(<x,y>, V) & Val(x, N_1) & Val(y, N_2)

According to (9a), the semantic contribution or value of the name *Max* is just the individual Max: the word refers to the person. Similarly (9b) says that the word *House1* refers to the object $House_1$. According to (9c) the predicate *is-behind* is true of pairs of things <x,y>. In particular it holds of a pair <x,y> just in case the first individual x, is behind the second individual y. Finally, according to (9d), a sentence consisting of a noun (N_1) followed by a predicate (V) followed by another noun (N_2) is true just in case the individuals designated by N_1 and N_2 are related to each other in the way specified by the predicate. The result in (8) follows from (9a)-(9d) by simple substitutions. To extend this approach to the grammar of English as a whole, we would expand the class of lexical items (words) and syntactic configurations treated, but the basic procedure would remain the same.

Once again, *Semantica* functions as a derivation calculator, or workbench, which helps students to investigate a formal theory of this kind. The application provides a graphical interface for inputting interpretation rules and for viewing the truth-conditions that they assign to trees. Fig-7 shows a typical *Semantica* session. The user has entered interpretation rules in the window titled "Configurations". He or she then has then loaded these interpretation rules into the TViewer window and asked *Semantica* to compute truth-conditions for *Max is behind House1* according to those rules.

Just as different grammar rules yield trees in Syntactica, different semantic rules yield different truth-conditions. For example, compare fig- 7 and fig-8. If you look closely at the latter you'll see that the truth-conditions for *Max is behind House1* are the ones shown in (10a) rather than the ones given in (10b). That is, we get man1 in place of max. This is because the rule that the user has entered for the word *Max* is not the one in (9a) but rather the one in (11). Different rules, different truth-conditions.

(10) a. behind(Man1, house1)
b. behind(Max, house1)

(11) Val(x, *Max*) iff x = Man1

As we saw, in syntax we can check the correctness of a set of grammar rules by examining the structures that those rules assign, and by looking for further evidence for or against those structures. In semantics we can check the correctness of a set of interpretation rules by examining the truth-conditions that those rules assign, and by considering whether truth and falsity are correctly predicted in candidate situations. For example, in judging whether our theory had assigned the correct truth-conditions to a sentence like *Everyman is standing between some house and some tree*, we would want to check situations containing men, houses and trees, and see whether the truth-conditions correctly predict truth in situations where our intuitions tell us the sentence is true.

Semantica incorporates this function in the form of a universe window that displays small model worlds, containing a cast of characters that the user constructs. *Semantica* allows the user to check the truth of a given sentence against a given model world. The application takes the sentence under the truth-conditions that are generated by the user's rules, and matches it against the facts of the world.

To illustrate this look at fig-9. This figure shows *Semantica* with a universe window open on screen. The "world" of this universe are 7 x 7 square plain whose top-to-bottom orientation corresponds to a back-to-front direction. The user here has constructed a cast of characters that includes a man, a woman, a house, a butterfly, two kinds of trees, and a storm. After creating the cast, the user can distribute instances of these kinds of objects in the world. For example the current world contains a single man, woman and house, a couple of butterflies,. a stand of tree, and a line of storms in the upper right. The system "knows about" a number of different kinds of spatial relations like 'behind', 'before', 'left_of', 'right_of', and 'between'. In particular, then,it knows how to evaluate whether the sentence *Max is behind* $House_1$ under the truth-conditions that we stated earlier. With *Max* referring to the individual Man1, the sentence comes out true in this world.

As in the case of our discussion of *Syntactica*, this example and discussion of *Semantica* is simplified. There is considerably more functionality in the program than what we show here. However the basic point is again clear. *Semantica* functions as a tool by which students can construct, run, test, check and revise semantic theories. It furnishes a useful platform is which to develop skills in scientific theorizing within the specific domain of linguistics.

Some Results and Lessons

The courses in the *Grammar as Science* project are now two years old. The syntax course employing *Syntactica* has been offerred twice, and the semantics course employing *Semantica* is now in the middle of its second trial. Although we are still in the process of developing formal assessment instruments, the preliminary, anecdotal evidence is positive.

We have, furthermore, derived a number of general lessons about the process of recasting a traditional lecture class and adopting a more exploratory, lab-based course model.

- Introducing tools of this kind entails an additional learning burden on the student, particularly in the initial portion of the course.

Our courses now require both mastering new content material as well as a new computer application. It takes some time to become fluent with the applications, and hence for their value as tools for exploring the subject matter to become natural and clear.

- The lab-format demands a considerably heavier time commitment than a traditional lecture-based course, both in terms of preparation and support.

For a courses of the kind instituted at Stony Brook to be effective, we have found that students must be instructed carefully in the use of the new tools. They cannot be simply turned loose with them, and left to manage as best they can. In our courses , this has entailed not only the use of a graduate student teaching assistant, even for classes as small as 20 students, but also one or more undergraduate student lab assistants, generally recruited from past semesters in the course. Although we initially thought that computer-assisted instruction might reduce the need for instructor support, in in fact quite the contrary turned out to be true.

- The use of exploratory tools produces opportunities for students to work together cooperatively that were not present in the lecture format.

We have found that the assignment of exercises that must be worked in a lab of networked computers not only furnishes students with a natural reason for gathering outside of class, it also provides additional avenues for helping and communicating with each other. Debugging of grammars and semantic rules, coming up with data to test alternatives, is very easy to do in a setting where students can work together in front of a single monitor, or send results and rule sets quickly across a network. Furthermore the use of undergraduate student assistants seems to facilitate the process..

- The use of exploratory tools of the kind developed in GAS produces a high level of engagement by students.

As we have noted, the task of producing rules that generate trees or interpret trees correctly takes on an objective and very concrete character in the context of getting a machine to produce a desired result. Students appear to find this setting both personally challenging, but also, in some important sense, nonjudgmental. This latter dimension seems particularly important for students whodo not view themselves as "science-" or "analytical-types". In general we have found that students often appear to be captured by working on a problem in this way, spending long hours on problems that they do not report spending before.

The project is currently in the process of preparing course materials for the two courses described here. Also in planning is a workshop where the results and methods that have been developed in the Stony Brook project can be communicated to a wider audience of linguists and grammar teachers. We look forward to the time when grammar has shed its old image as the dry, dusty study of long-departed languages, or an excercise in determining proper standards of verbal behavior. We look forward to a time when grammar is correctly seen as the study of one of the most interesting and intricately constructed objects in the natural world: human language.

Notes

1 For studies in a variety of educational settings that explore the teaching of science and scientific methodology through linguistics, see Chomsky et al (1985), Carey et al (1986), Carey et al (1988), Hale (1975), Honda (1995), Keyser (1970) and White Eagle (1983).

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