

Language without Grammar*

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1. Introduction

Sentences have systematic properties. Subjects occur in a structurally higher position than direct objects. Only some word orders are acceptable. Verbs agree with certain nominals, but not others. Relative clauses are formed in particular ways. Reflexive pronouns have a narrowly circumscribed set of possible antecedents. And so forth.

It is pretty much taken for granted that such properties are best understood by reference to a mental grammar—a formal system of linguistic rules and principles that, in the words of Jackendoff (2002, p. 57), ‘describe patterns of elements,’ however abstractly. It is likewise widely believed that core grammatical properties are innately stipulated by Universal Grammar (UG)—a dedicated, faculty-specific system that includes categories and principles common in one form or another to all human languages.

In recent years, however, these beliefs have been called into question by the development of so-called ‘emergentist’ approaches to language which hold that linguistic phenomena are best explained by reference to more basic non-linguistic (i.e., ‘non-grammatical’) factors and their interaction (see, e.g., Ellis, 1998; Elman, 1999; MacWhinney, 1999; Menn, 2000; O’Grady, 2005). The purpose of this chapter is to outline how this sort of approach works and to illustrate its potential for the study of various classic problems in syntactic analysis.

The factors to which emergentists turn for their explanations vary considerably, ranging from features of physiology and perception, to processing and working memory, to pragmatics and social interaction, to properties of the input and of the learning mechanisms. The particular idea that I will focus on here, following the detailed proposal put forward in O’Grady (2005) and summarized in O’Grady (2001), is that the mechanisms that are required to account for the traditional concerns of syntactic theory (e.g., the design of phrase structure, pronoun interpretation, agreement, and so on) are identical to the mechanisms that are independently required to account for how sentences are

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processed from ‘left-to-right’ in real time. According to this view then, the theory of sentence processing simply subsumes syntactic theory.

This sort of approach offers a way to think about language without grammar. What it basically says is that language and languages are the way they are because of what happens when words with particular properties are assembled in real time in the course of actual speech and comprehension. A preliminary illustration of how this might work involves the design of sentence structure.

2. Structure building

I take as my starting point the widely held idea that at least two cognitive systems are central to language acquisition and use. The conceptual-symbolic system does the work of a lexicon, providing a list of formatives (words and morphemes) and their combinatorial properties. For instance, the lexical entry for *remain* indicates that it is a verb and that it has an argument dependency (requirement) involving a nominal to the left.

- (1) *remain*: V, <N> (e.g., *Problems remain*.)
 ←

In contrast, *study* is a verb with two argument dependencies, one involving a nominal to the left and the other involving a nominal to the right.

- (2) *study*: V, <N N> (e.g., *Mary studied Russian*.)
 ← →

Responsibility for the actual mechanics of sentence formation falls to a computational system, which operates on words and morphemes drawn from the lexicon, combining them in particular ways to construct phrases and sentences. The computational system corresponds roughly to what one might think of as ‘syntax.’

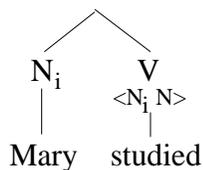
The particular computational system that I propose is indistinguishable in its structure and functioning from a processor. It operates in a linear manner, it combines elements, and it checks to make sure that lexical requirements are being satisfied. However, unlike classic processors, it is entirely unconstrained by grammatical principles, obeying a single efficiency-related imperative that is independent of language—it must minimize the burden on working memory, the pool of resources that supports operations on representation (e.g., Carpenter, Miyake, and Just, 1994; Robinson, 2002). This entails compliance with the following mandate.

- (3) *The Efficiency Requirement*
 Resolve dependencies at the first opportunity.

The intuition here is simply that the burden on working memory is lessened by resolving dependencies at the first opportunity rather than storing them for later resolution.

The formation of a sentence such as *Mary studied Russian* takes place in two steps. Working from left to right, the computational system first combines *Mary* and *study*, creating an opportunity for the verb to resolve its first argument dependency. (I indicate that the dependency has been resolved by copying the index of the nominal onto the appropriate symbol in the verb's argument grid.)

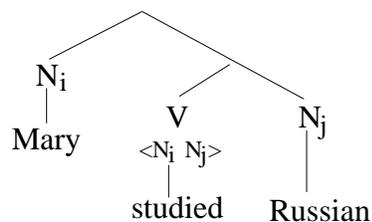
(4) Step 1: combination of the verb with its first argument



In abbreviated form: [**Mary_i studied**]
 <N_i N>

In the next step, the computational system combines *study* and *Russian*, creating an opportunity to resolve the verb's second argument dependency. Once again, this opportunity is immediately exploited, in accordance with the Efficiency Requirement.

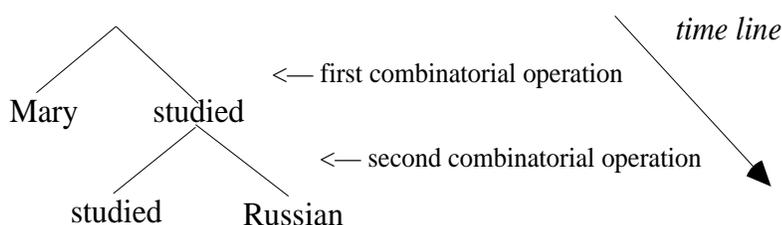
(5) Step 2: combination of the verb with its second argument



In abbreviated form: [**Mary_i [studied Russian_j]**]
 <N_i N_j>

As I see them, 'syntactic structures' are nothing but a fleeting residual record of how the computational system goes about combining words—one at time, from left to right, and at the first opportunity. The structure in (4) exists only as a reflex of the fact that the verb first combines with the nominal to its left. And the structure in (5) exists only to represent the fact that the verb then combines with the nominal to its right. A more transparent way to represent these facts might be as follows, with the time line running diagonally from the top down.

(6) An alternative way to depict formation of *Mary studied Russian*:



As both notations illustrate, English sentences formed by the proposed computational system have properties very similar to those that traditional approaches attribute to them. In particular, their internal organization manifests a binary-branching design, with a subject-object asymmetry (that is, the subject is structurally higher than the direct object). Crucially, however, these properties are not stipulated by grammatical mechanisms—there are no phrase structure rules or X-bar schema. Rather, the design features of sentences emerge from the interaction of the lexical properties of individual words with an efficiency-driven processor, operating from left to right in real time.

A metaphor may help clarify this point. Traditional UG-based approaches to language focus on the ARCHITECTURE of sentences, positing principles that lay down an intricate innate grammatical blueprint for language. As I see it though, there are no architects. There are just carpenters, who design as they build, limited only by the material available to them (words with particular properties) and by the need to complete their work as quickly and as efficiently as possible.

On this view then, there is no grammar per se. There is a lexicon that includes an inventory of words and information about the particular arguments that they require. And there is a computational system, which is just a processor that combines words one at a time in a linear fashion. The processor is driven by efficiency considerations that are designed to ease the burden on working memory, but it has no special properties beyond this.

This idea runs against long-standing views within linguistics, calling into question one of the few points on which there is a (near) consensus—the existence of grammar. This cannot be taken lightly. After all, grammar—and especially Universal Grammar—offers powerful explanations for a wide and varied range of problems that arise in the study of syntax, typology, acquisition, and other areas central to the field. The remainder of this paper is devoted to a consideration of these matters.

3. The problem of syntactic description—some agreement puzzles

The first and classic function of a grammar is to deal with the demands of syntactic description—identifying and making sense of the properties of sentences in particular human languages. As is well known, even ‘simple’ phenomena

manifest intricacies that challenge the resources of the most sophisticated theories. Verbal agreement in English is a case in point.

3.1 Computing agreement

As a first approximation, English seems to require a match between a verb's person and number features and those of its subject. (For the sake of exposition, I use Roman numerals and upper case for nominal features, and arabic numerals and lower case for verbal features.)

(7) Third person singular subject, third person singular verb form:

One remains.

IIISG 3sg

(8) Third person plural subject, third person plural verb form:

Two remain.

IIIPL 3pl

In fact, of course, things are not so straightforward. As the next examples show, there are cases in which the verb agrees with a nominal other than its subject.

(9)a. There is **paper** on the desk.

3sg IIISG

b. There are **pencils** on the desk.

3pl IIIPL

In fact, in some cases, the nominal triggering agreement is not even an argument of the inflected verb.

(10) There seems [to be **paper** on the desk].

3sg IIISG

Moreover, there are patterns in which the verb agrees with just part of an NP—the first conjunct of the coordinate NP (Sobin, 1997, p. 324).

(11) There is [**paper** and ink] on the desk.

3sg IIISG

As explained in much more detail in O'Grady (2005, p. 90ff), agreement reflects the interaction of lexical and computational factors. On the lexical side, inflected lexical items can introduce an 'agreement dependency'—they carry person and number features that must be matched at some point with features

elsewhere in the sentence. The agreement dependencies associated with the inflected form of English verbs are included in the lexical entries that follow.

- (12)a. *remains*: V, <N>
 3sg ←
- b. *studies*: V, <N N>
 3sg ← →

But how are such dependencies resolved? The lexicon is silent on this matter, and there is of course no agreement ‘rule’ or comparable grammatical device. Rather the problem is left to the computational system to deal with.

Matters are straightforward in a simple sentence such as *One remains*. There, combination of *one* and *remains* creates an opportunity to resolve both the verb’s argument dependency (as an intransitive verb, it is looking for a nominal argument) and its agreement dependency. Given the Efficiency Requirement, there is no choice but to resolve both dependencies at once, thereby yielding agreement with the subject NP in this case. (I use a check mark to indicate resolution of an agreement dependency. For simplicity of exposition, I do not represent argument dependencies in what follows.)

- (13) Combination of *one* and *remains*; resolution of the agreement dependency
 [**One remains**]
 IIISG 3sg^v

A different result comes about in a pattern such as *There is paper on the desk*, where *be* takes the expletive *there* as its first argument and *paper* as its second argument. Working from left to right, the processor first brings together *there* and *is*, creating an opportunity to resolve the verb’s first argument dependency.

- (14) [**There is**]
 3sg

However, because *there* lacks number features, no opportunity arises at this point to resolve the verb’s agreement dependency, which is therefore held, presumably at some cost to working memory.

In the next step, the computational system combines *is* with the nominal to its right, creating an opportunity not only to resolve the verb’s second argument dependency but also to take care of the agreement dependency as well.

- (15) [There [**is paper**]]
 3sg^v IIISG

Consistent with the Efficiency Requirement, both opportunities are immediately exploited, thereby creating a pattern in which the verb agrees with a non-subject nominal.

It takes even longer to come across an opportunity to resolve the agreement dependency in a sentence such as *There seems to be paper on the desk*.

(16)a. Combination of *there* and *seems*:

[**There seems**]

3sg

b. Combination of *seems* and *to*:

[There [**seems to**]]

3sg

c. Combination of *to* and *be*:

[There [seems [**to be**]]]

3sg

d. Combination of *be* and *paper*; resolution of the agreement dependency:

[There [seems [to [**be paper**]]]]

3sg^v

IIISG

Here again, the computational system does exactly what one would expect an efficiency-driven linear processor to do—it resolves the agreement dependency at the first opportunity, even though this opportunity does not arise with an argument of the inflected verb.

Yet a different result occurs in the case of patterns such as *There is paper and ink on the desk*. Given the linear, efficiency-driven character of the computational system, sentence formation proceeds in the manner summarized below.

(17)a. Combination of *there* and *is*:

[**There is**]

3sg

b. Combination of *is* and *paper*; resolution of the agreement dependency:

[There [**is paper**]]

3sg^v IIISG

c. Combination of *paper* and *and*:

[There [is [**paper and**]]]

3sg^v IIISG

d. Combination of *and* and *ink*:

[There [is [paper [and ink]]]]
 3sg^v IIISG

The key step here is the second one, in which the verb combines with just the first conjunct of the coordinate phrase, the nominal *paper*, creating an opportunity to resolve the agreement dependency. The end result is the phenomenon known as ‘partial agreement’—the verb agrees with a subpart of one of its arguments. As expected, this phenomenon is only possible when the coordinate NP follows the verb. Where it appears to the left, and is therefore fully formed before the verb is encountered, partial agreement is impossible.

(18) [Paper and ink] are/*is on the desk.

In sum, there is no subject-verb agreement per se in English. There are just dependencies involving person and number features, which—like other dependencies—are resolved at the first opportunity. If the verb’s first argument (its ‘subject’) happens to carry features, then the agreement dependencies are resolved right away—giving the appearance of subject-verb agreement. But when the first argument carries no features, the verb must look elsewhere for a way to resolve its agreement dependencies.

As a result, English ends up with a seemingly exotic system of agreement in which the verb variously agrees with its first argument (the ‘subject’), its second argument, the argument of an embedded verb, and the first conjunct of its second argument.

(19) • agreement with the first argument (the subject)

Paper is on the desk.

• agreement with the second argument

There is **paper** on the desk.

• agreement with the argument of an embedded verb

There seems [to be **paper** on the desk].

• agreement with the first conjunct of a coordinate NP

There is [**paper** and ink] on the desk.

Seen from the perspective of ‘grammar,’ this range of facts appears to be quite exotic. (Lasnik 1999, p. 126 calls it ‘superficially bizarre,’ while Sobin 1997 attributes it to infection by a ‘grammatical virus.’) In reality, things make perfect sense if there is no grammar per se and if sentences are formed by a linear

computational system (a processor) driven by the need to minimize the burden on working memory by resolving agreement dependencies at the first opportunity.

3.2 Some further observations

Although agreement dependencies are always resolved *at the first opportunity*, they are not always resolved *immediately*. In a sentence such as *There is paper on the desk*, for instance, the computational system has to wait until it encounters the verb's second argument before having an opportunity to resolve the agreement dependency.

(20)a. Combination of *there* and *is*:

[**There is**]
3sg

b. Combination of *is* and *paper*; resolution of the agreement dependency:

[There [**is paper**]]
3sg^v IIIsg

This can't be helped. The computational system has to play the hand that it is dealt, and the lexicon is the dealer. If the verb provided by the lexicon has a featureless first argument, there is no opportunity for immediate resolution of the verb's agreement dependency and no choice but to hold the dependency in working memory and to move on.

Interestingly, there is some evidence of attempts at a 'repair strategy' designed to permit immediate resolution of agreement dependencies by endowing *there* with person and number features (third person and singular). This is perhaps most obvious in the widespread use in colloquial speech of contracted *is* in patterns that would normally call for the plural form of the verb (e.g., Sparks, 1984).

(21) There's two men at the door.
(cf. *There is two men at the door)

There may be more radical signs of rebellion in the speech of children. Until my daughter was almost twelve, for example, she insisted on using only the third singular form of *be*, even in its uncontracted form, when the subject was expletive *there*.

(22) There **is** two men outside.

I've also noted similar examples in the speech of second language learners. The following two sentences were produced by Arnold Schwarzenegger (cited in *The New Yorker*, June 26, 2004, pp. 80 & 85.)

- (23)a. The next thing we know, **there is** injured or there is dead people.
 b. **There is** a certain amount of people meant to be leaders ...

Patterns such as those in (22) and (23) are not widely accepted by adult native speakers, but it seems to my ear that the acceptability of ‘singular *there*’ improves with the distance between the verb and the postverbal nominal whose features would otherwise resolve the agreement dependency. Thus the following sentences strike me as far more acceptable than (22).

- (24)a. ?There seems [to be two of them].
 b. ?There is likely [to be two of them].

Contrasts along these lines have in fact been documented for the English of New Zealand and the Falkland Islands (Britain & Sudbury 2002, p. 228-29) as well as for the English of York (Tagliamonte 1998, p. 173): the likelihood of ‘singular *there*’ in these speech varieties increases with the number of lexical items intervening between the verb and the noun carrying number features.

A possibly more extreme situation is found in Appalachian English, for which Wolfram and Christian (1976, pp. 78 & 82) report the use of singular *there* even in monoclausal sentences such as (15) at rates exceeding 90%. Also of potential relevance is their observation (pp. 125-26) that speakers of Appalachian English often replace expletive *there* by the inherently singular *it*.

- (25)a. ... the deadliest snake *it* is. [... the deadliest snake *there* is.]
 b. *It*'s rapids down there. [=There's rapids down there.]
 c. *It* was a fly in it. [=There was a fly in it.]

A second point where the English system of verbal agreement is less than robust occurs in *there* patterns where the second argument is a conjoined NP. As observed earlier, such patterns routinely manifest ‘partial agreement,’ with the verb’s agreement dependency being resolved by the first conjunct of the coordinate NP.

- (26) There is [**paper** and ink] on desk.

As already noted, there are good computational reasons for resolving the verb’s agreement dependency in this way. Nonetheless, the end result is a somewhat uncomfortable paradox—a verb carrying *singular* inflection takes a *plural* argument (the coordinate phrase *paper and ink*), which can itself serve as antecedent for a plural pronoun.

(27) There is [paper and ink]_i on desk. I put **them**_i there.

It is presumably not a coincidence that this state of affairs triggers a variety of reactions, as many commentators have observed (e.g., Schmidt and McCreary, 1977 and the references cited in Morgan and Green, 2005). Based on a survey of 18 native speakers of English, Morgan and Greene (p. 468) report that ‘among speakers who otherwise appear to speak the same variety of the language, there is [a lot of] variation in number marking’ in sentences in which the agreement trigger is a postverbal coordinate NP. Some speakers have the verb agree with the nearer conjunct, whereas others insist on the plural if either conjunct is plural. There is also variation depending on the choice of conjunction (*and* versus *or*) and on whether the coordinate NP is definite or indefinite.

It is often suggested that language is a ‘dynamic system’ that is in a constant state of flux (e.g., Ellis & Larsen-Freeman, 2006, p. NN). Indeed, Hopper (1998, p. 157) goes so far as to suggest that language is ‘always provisional, always negotiable.’ This is surely somewhat of an exaggeration if we consider language as a whole, but it is perhaps applicable to certain sub-phenomena within language—including, as we have seen, aspects of verbal agreement in English.

An advantage of a processing-based approach to agreement is that it provides independent computational grounds for identifying places where the resolution of agreement dependencies is more likely to be in flux. As we have just seen, one such case involves patterns such as *There seems to be two of them*, in which no nearby opportunity to resolve the agreement dependency presents itself. Another is exemplified by patterns like *There is paper and ink on the desk*, where resolution of the agreement dependency at the first opportunity yields a paradoxical result (singular agreement for an argument that turns out to be plural once the second conjunct is in place). The fact that these are the very points where variation and instability are observed fits well with the general approach to agreement that I have been outlining.

4. The problem of markedness—relative clauses

One of the most important and enduring discoveries in syntactic analysis is the observation that particular patterns are ‘marked’ in the sense of being somehow less expected and more difficult than certain alternatives. This asymmetry has a remarkably broad range of consequences extending from typology, to language acquisition and loss, to processing.

A classic example of markedness involves the contrast between subject and direct object relative clauses.

- (28)a. Subject relative clause:
the student [who saw the woman]
- b. Direct object relative clause:
the woman [who the student saw]

A wide range of phenomena suggests that subject relative clauses are less marked than their direct object counterparts. As shown in the ground-breaking work of Keenan and Comrie (1977), for instance, languages that permit direct object relatives also have subject relatives, but the converse is not true: there are languages like Malagasy which allows only subject relatives.

- (29)a. Relativization of the subject:
ny mpianatra [izay nahita ny vehivavy]
the student that saw the woman
'the student who saw the woman'
- b. Relativization of the direct object:
*ny vehivavy [izay nahita ny mpianatra]
the woman that saw the student
'the woman who the student saw'

There is also ample evidence that subject relatives are easier to acquire, in the case of both first language acquisition (e.g., O'Grady, 1997, p. 175ff) and second language learning (e.g., Hamilton, 1994). In addition, it is well known that patients suffering from agrammatic aphasia find it far easier to understand subject relative clauses than direct object relatives (e.g., Grodzinsky, 1989). Finally, there is a great deal of evidence that subject relatives are easier to process than their direct object counterparts (e.g., Wanner and Maratsos, 1978; Gibson, 1998; Caplan and Waters 2002).

Why should things work this way? The answer, I believe, lies in a difference in the demands made on working memory in the course of forming the two types of structure. As illustrated below, a typical relative clause begins with a relative pronoun (e.g., *who*) that must be associated with a position in the verb's argument grid—the first position in the case of the subject relative and the second position in the case of the direct object relative.

- (30)a. Subject relative clause:
the student [**who**_i saw the woman_j]
 <N_i N>

Is [the boy who is watching Mickey] _ happy?

b. The non-structure-dependent response

*Is [the boy who _ watching Mickey] is happy?

The results were clear—no errors of the type in (39b) were found. Clark (2002) reports similar results for adult second language learners.

So how do children figure this out, the proponent of UG asks. The standard answer, as Pullum and Sholz (2002, p. 17) note, is that there are only two possibilities. Either the relevant principle is given in advance as part of a genetically endowed Universal Grammar, or it must be acquired through trial and error based on experience.

Chomsky dismisses the idea of learning from experience in this case by appeal to the ‘argument from poverty of stimulus.’ In order to *learn* that the inversion rule acts on the verb in the main clause—and not just the first verb in the sentence, children would need to encounter sentences such as (6a), in which the verb in the main clause is not also the first verb in the sentence. But, Chomsky (1980, p. 40) argues, sentences of this sort are vanishingly rare. In fact, he suggests, ‘a person could go through much or all of his life without ever having been exposed to [such sentences].’ Hence, the learner has to rely on UG to correctly formulate the inversion rule.

Sampson (1989) and Pullum (1996) adopt a different approach, suggesting that Chomsky is wrong about the poverty of the stimulus and that the input does in fact contain the types of sentences needed to induce structure dependence from experience. Among the examples from actual speech offered by Pullum are the following:

(40)a. Is [the boy who was hitting you] _ still here?

(cf. [The who was hitting you] **is** still here.

b. Is [what I am doing] _ in the shareholder’s best interest?

(cf. [What I am doing] **is** in the shareholder’s best interest.

In each of these sentences, the fronted verb is from the main clause, even though it is not the first verb in the sentence. Pullum suggests that such sentences may in fact be relatively frequent, constituting perhaps 1% of the interrogative patterns and more than 10% of the *yes-no* questions in at least certain types of discourse.

Crucially, however, MacWhinney (2004, p. 890) reports that sentences such as these actually appear very rarely in speech to *children* (perhaps once in three million utterances). He tries to save the input hypothesis by suggesting that a different type of pattern supports induction of the right generalization—namely

wh-questions such as (41), which he suggests are more common in speech to children.

- (41) Where's [the other dolly [that was in here]]?
(cf. [The other dolly [that was in here] **is** where])

As can be seen here, the fronted verb comes from the main clause, consistent with the structure-dependent inversion rule. Nonetheless, there is reason to doubt the general availability of sentences of this sort as well: Legate & Yang (2002) report just 14 instances in the 20,651 questions in the CHILDES data base for Nina and just 4 examples in the 8,889 questions in the data base for Adam.

Sentence counting aside, there is perhaps a more fundamental issue at stake here: does anyone on either side of the debate really believe that children who were not exposed to sentences such as (41) would be unable to figure out how inversion works? Would such children really be incapable of choosing between (42a) and (42b)?

- (42)a. The structure-dependent response
Is [the boy who is watching Mickey] _ happy?
- b. The non-structure-dependent response
*Is [the boy who _ watching Mickey] is happy?

I don't think so—my intuition is that children would still make the right choice. Which brings us to the question of how an emergentist approach to language might deal with the problems associated with inversion.

5.2 Inversion without grammar

On the lexical side, I assume that certain English verbs (in particular, copulas and auxiliaries) have the special property of being able to look to either the left or the right for their first argument. Thus whereas the verb *study* has the properties repeated in (43a), looking only leftward for its first argument, the verb *be* has the additional option of being able to look to either the left or the right. (For ease of exposition, I assume that the second argument of *be* is an adjective, as in *Grass is green*, even though various other types of categories can appear in this position as well.)

- (43)a. *study*: V, <N N>
← →
- b. *be*: V, <N A>
↔ →

Copulas look rightward for their first argument in *yes-no* questions as well as in certain other non-realis contexts. Take for example the sentence *Is grass green?*, which is formed as follows. (See O’Grady, 2005, pp. 189-90 for details.)

(44)a. First step: The copula combines to the right with its first argument.

[**Is** grass_i]
<N_i A >

b. Second step: The copula combines to the right with its second argument.

[**Is** [grass_i] green_j]
<N_i A_j >

On this view then, *yes-no* questions have a copula or auxiliary verb in initial position not because there is a grammatical rule that moves it there, but simply because verbs of this type look rightward for their first argument in question patterns.

Now let us turn to the problematic case represented by the contrast in (45).

(45)a. ‘Inversion’ affects the verb in the main clause:

Are [Americans who are rich] happy too?

b. ‘Inversion’ affects the first verb:

*Are [Americans who rich] are happy too?

The formation of (45a) is straightforward. To begin, *are* combines to the right with the nominal *Americans*, resolving its first argument dependency.

(46) [**Are** Americans_i]
<N_i A >

Next the relative clause is formed and integrated into the sentence.¹

(47) [**Are** [Americans **who are rich**]_i]
<N_i A >

¹ In fact, of course, this happens in the step-by-step manner illustrated below.

(i) Combination of *Americans* and *who*:

[Are [**Americans who**]]

(ii) Combination of *who* and *are*:

[Are [Americans [**who are**]]]

(iii) Combination of *are* and *rich*:

[Are [Americans [who [**are rich**]]]]

At this point sentence-initial *are* can finally combine with its second argument, the adjective *happy*—exactly parallel to what happens in simple question structures such as *Are Americans happy?* or *Is grass green?*

- (48) [**Are** [Americans who are rich]_i **happy**_j]
 <N_i A_j>

However, things do not go so smoothly in the case of (12b), in which the ‘wrong’ copula appears at the beginning of the sentence. The problem lies in the fact that the full NP to the right of the verb (its intended first argument) is ill-formed for independent reasons. (Predicative adjectives such as *rich* do not take direct arguments in English; a copula is required.)

- (49) [Are *[**Americans who rich**]_i]
 <N_i A>

This, presumably, is the reason why utterances of this type are not heard in the speech of children (or anyone else for that matter).

In sum, the syntax of *yes-no* questions is not directly learned from experience. Nor is it given by Universal Grammar. The facts simply follow from the interaction of an efficiency-driven computational system with the properties of the words on which it operates.

6. The problem of language acquisition—rethinking explanatory adequacy

‘Language acquisition’ is a cover term for a wide and varied range of developmental phenomena that includes everything from learning that English [t] is alveolar rather than dental to figuring out when it is appropriate to say “Excuse me.” Somewhere between these two extremes are the challenges associated with acquiring a 60,000-to-100,000 word lexicon, thousands of phrasal expressions and idioms, and hundreds of structural patterns, each with their own characteristics and idiosyncrasies. The search for a unified theory of language acquisition is therefore daunting, to say the least, and perhaps not even practical, at least for the time being.

A more realistic goal is to focus on particular narrowly circumscribed questions and puzzles that arise in the study of the acquisition of specific phenomena. For example, within the class of phenomena that make up ‘complex syntax’ (for lack of a better term), it makes sense to ask whether there are contrasts and constraints that cannot be learned from experience and must therefore follow from inborn mechanisms of some sort. In fact, this question has been at the heart of linguistic theory since the early 1960s, and has been the subject of extensive but inconclusive debate almost from the outset.

My take on the debate is substantially different from that of many opponents of UG in that I do not deny the existence of a learnability (poverty-of-

the-stimulus) problem. That is, in contrast to (say) MacWhinney (2004), I do not believe that experience, even on the most generous estimate of its richness, is sufficient to support induction of complex syntax. The properties of binding, quantifier scope, and island phenomena (to take three examples at random) are simply too complex, the relevant input too sparse, and mastery too rapid and error-free to be the product of induction.

Interestingly, I know of no actual dissent on this point. There is of course a good deal of opposition to the *idea* of inborn grammatical principles. And there are many accounts for the acquisition of phenomena that are either unrelated or only peripherally related to proposed UG principles—lexical properties, word order, the expression of inflection, the development of function words, and so on. There are even occasional attempts to offer alternatives to some of the simpler phenomena for which poverty-of-stimulus claims have been made (the debate over ‘structure dependence’ in the case of inversion, for instance; see section 5). But I know of no induction accounts for structural constraints on pronoun interpretation (the ‘binding principles’), for constraints on quantifier scope, or for subjacency effects that look at an even remotely representative set of facts associated with these phenomena.

How then is it possible to maintain, as I do, that very significant facts about language are underdetermined by experience and at the same time hold, as I also do, that UG does not exist? The answer is that something other than UG is responsible for bridging the gap between experience on the one hand and knowledge of the intricacies of natural language syntax on the other. The burden of explanation, I suggest, falls on the processor—the efficiency-driven linear computational system that I take to lie at the heart of the human language faculty.

6.1 The role of the processor in language acquisition

As I see it, the role of the processor in language acquisition is two-fold. First, it helps define an initial state for the language learner by seeking to minimize the burden on working memory—thereby ensuring resolution of dependencies at the first opportunity. As explained in detail in O’Grady (2005), a surprisingly wide range of intricate facts follow, including core properties of co-reference, control, agreement, contraction, extraction and other phenomena that have long been offered as *prima facie* evidence in support of UG. I suspect and believe that many additional phenomena work this way.

The second role for the processor involves the creation of ‘routines’ consisting of the operations and sequences of operations needed to form and interpret the many different types of utterances that are used in the course of communication.

Some simple routines in English

A verb looks to the left for its first argument.
 A verb looks to the right for its second argument.
 A preposition looks to the right for its nominal argument.
 A determiner looks to the right for a nominal.

As these examples help illustrate, the routines required for a particular language typically include details not covered by the processor's general mandate to minimize the burden on working memory. Even though the processor is compelled to resolve dependencies at the first opportunity, language-particular factors determine (for example) whether the opportunity to resolve a verb's first argument dependency will occur to the left (as in English *I ran*) or the right (as in Tagalog *Tumakbo ako* 'ran I'). They likewise determine whether the verb will introduce agreement dependencies (as happens in English, but not Mandarin) and, if so, how those dependencies will be expressed (as suffixes in English, but as prefixes in Swahili).

I assume that the learning of these details is 'usage-based' (e.g., Tomasello 2003). More specifically, I assume that as particular routines are executed over and over again, they are gradually strengthened. In the words of Anderson (1993, p. 181), routines 'gather strength as they prove useful.' Over time, they become established to the point where their use is automatic and seemingly effortless.

Because usage-based learning is input-dependent, its developmental course is sensitive to external factors such as frequency, recency, contextual contingencies, perceptual salience, attention, and the like, as well as to internal factors such as working memory (e.g., Ellis 2006a,b). Of these various considerations, the one that stands out in my mind as particularly crucial is the efficiency-driven character of the processor, particularly its propensity to reduce the burden on working memory.

The development of pronouns is a case in point. As is well known, reflexive pronouns are mastered first in the course of language acquisition (see O'Grady 1997, p. 226ff for a review of the literature). Interestingly, however, the frequency facts strongly favor plain pronouns: a search in the CHILDES data base of maternal speech to Adam, Eve and Sarah turned up 17 instances of *himself*, compared to 487 instances of *him*; there was one instance of *themselves* and 717 of *them*. There is also no reason to think that salience seriously diminishes children's access to plain pronouns in object position, which unlike their counterparts in subject position, are rarely dropped inappropriately in child language (Ingham 1993/1994, Theakston, Lieven, Pine & Rowland 2001).

Crucially, however, there is good reason to think that the referential dependencies introduced by reflexive pronouns are easier to resolve in the course of processing. As explained in detail in O'Grady (2005, p. 28ff), reflexive

pronouns differ from plain pronouns in being immediately interpretable. In a sentence such as (50), for instance, the reflexive pronoun can be interpreted the instant it is added to the sentence, since its referential dependency can be resolved by the index of *John* in the grid of the verb with which the pronoun combines..

- (50) [John_i [overestimates himself_x]].

$$\begin{array}{c} \langle N_i \ N_x \rangle \\ \downarrow \langle \text{resolution of the referential dependency} \rangle \\ i \end{array}$$

In contrast, a plain pronoun in the same position must be linked to a referent mentioned previously in the discourse or somehow evident from the context.

- (51) [John_i [overestimates him_x]].

$$\begin{array}{c} \langle N_i \ N_x \rangle \\ | \\ ? \langle \text{-----} \rangle \end{array}$$

Independent experimental work by Piñango et al. (2001) and Sekerina et al. (2004) confirms the increased processing difficulty associated with plain pronouns (see also O’Grady, 2005, p. 166ff).

Or take relative clauses. As observed in O’Grady (1997:175), children do better on subject relatives in experiment after experiment. Yet, direct object relatives occur far more frequently in the input: 57.9% off all relative clauses produced by the mothers of four English-speaking children studied by Diessel (2004) were direct object relatives, while an average of 34.3% were subject relatives (pp. 145-46).

Diessel & Tomasello (2005, p. 899) speculate that children’s success on subject relatives stems from the fact that these constructions are ‘similar to non-embedded simple sentences.’ But this ignores psycholinguistic evidence that points in a quite different direction: as the classic work by Wanner & Maratsos, cited in section 4 shows, the processing of direct object relatives taxes working memory because of the need to link the relativized element to a non-adjacent verb.

The explanation for these and countless other facts about language lies (I claim) not in the input, but in the nature of the processor that analyzes the input. That processor is surprisingly simple, but it does more than just track frequency, create associations, and record distributional contingences. If I’m right, an equally important property is the mandate to minimize the burden on working memory. This has far-reaching consequences both for the structure of language and for the manner in which it is acquired, as the extensive discussion in O’Grady (2005) attempts to demonstrate.

6.2 A note on second language acquisition

Second language learning presents an even more complicated situation than does first language acquisition, thanks to the relevance of additional factors—prior knowledge of another language, type of instruction, possible critical period effects, and individual differences in motivation, among others. Once again though, it makes sense to address specific questions involving particular phenomena. One such question, which has long been central to research in this area, has to do with ‘transfer’—the influence of learners’ first language on their interlanguage.

The best known UG-based theory of transfer, dubbed ‘Full Transfer/Full Access’, holds that the parameter settings of the native language are initially carried over to the second language, but that continued access to UG eventually permits them to be reset in response to the appropriate triggers (e.g., Schwartz & Sprouse 1996). What might an emergentist approach claim?

In recent work (O’Grady 2006), I have suggested that the idea behind the Full Transfer/Full Access theory is in some sense right, but only if we rethink what is transferred and what is accessed. In particular, what is transferred in the case of syntax is not a set of parametric values, and what is accessed is not Universal Grammar. Rather, transfer applies to the native language processing routines, and the cognitive system that is accessed is simply the processor, which determines the cost and calculates the strength of those routines.

Space does not permit a detailed discussion of this idea here, but it is nonetheless worth noting the type of phenomena that might be used to test it against the claims of the UG-based theory. As in the case of parallel work on first language acquisition, the UG thesis can be properly confronted only through the analysis of phenomena that are governed by abstract constraints for which there is a paucity of relevant data in the input (the poverty of stimulus problem). And, of course, in order to investigate transfer effects, it is crucial that the phenomenon in question have somewhat different properties in the L1 and L2.

I believe the quantifier scope is one such phenomenon. Of particular interest is the fact that languages such as English and Japanese differ with respect to the interpretation of sentences such as (52) and (53).

(52) Someone stroked every cat.

(53) Dareka-ga dono neko-mo nadeta.
 someone-Nom every cat stroked
 ‘Someone stroked every cat.’

Whereas English permits the two readings paraphrased below, Japanese allows only the first of these interpretations.

(54)a. There is a particular person who stroked every cat.

- b. For every cat, there is a (possibly different) person who stroked it.

Moreover, the principles governing this phenomenon are apparently both highly abstract and sensitive to extremely limited forms of experience. For instance, in their survey of maternal input to 42 children (age 18 mos. to 5 yrs.), Gennari & MacDonald (2005/2006, p. 146) found only 14 instances of *every* + noun in a total of 27,804 adult utterances (and about half of these were time phrases such as *every time* and *every day*).

Important work by Marsden (2004) outlines a UG-based account of this phenomenon and of its acquisition in Japanese as a second language by English-, Korean-, and Chinese-speaking learners. O'Grady (2006) proposes an emergentist alternative, focusing on the role of the processor in explaining the character of the scope phenomenon, the nature of cross-linguistic differences in its properties, and the manner in which L1 transfer effects are manifested—and ultimately suppressed.

6.3 Rethinking explanatory adequacy

If these ideas are on the right track, then the key to understanding the nature of the human language faculty lies in the workings of a simple efficiency-driven processor. As explained in detail in O'Grady (2005), the processor contributes to two crucial explanatory endeavors.

On the one hand, the processor has a crucial role to play in understanding why language has the particular properties that it does—why reflexive pronouns appear to seek a local, c-commanding antecedent, why verbs agree with subjects rather than direct objects, why direct object relative clauses are more marked than their subject counterparts, and so forth.

On the other hand, the processor also has a vital role to play in understanding how language is acquired. In particular, it is responsible both for bridging the gap between experience and ultimate proficiency in a language and for forming the particular routines that underlie the formation and interpretation of the actual sentences of a language—with their particular word order, agreement patterns, and so forth.

It is widely believed, both by proponents and opponents of UG, that 'explanatory adequacy'—the gold standard against which the success of linguistic analysis is to be assessed—should be defined with respect to language acquisition, following an early suggestion by Chomsky (1965:25-26). In a more recent formulation, Chomsky (2002:129) puts it this way: 'Explanatory adequacy [is] achieved when a descriptively adequate analysis is completed by a plausible hypothesis about its acquisition.'

While such an approach brings language acquisition to the forefront of contemporary linguistics, this may not be the right place for it—regardless of its great practical and emotional importance. On the view I have put forward, language acquisition is simply something that happens when a processor of a

certain type interacts with experience of a particular type—certain preferences are implemented and particular routines emerge. If this is right, then processing, not language acquisition, is THE central linguistic phenomenon and the one whose understanding should define the achievement of explanatory adequacy.

7. Conclusion

There is no disagreement in linguistics over the explanatory potential of processing considerations, even among proponents of grammar-based approaches to language (e.g., Newmeyer, 1998). Indeed, as Chomsky (2005, p. 10) acknowledges, explanations of the properties of language that refer to ‘general considerations of computational efficiency and the like’ are highly desirable. Ideas along these lines have in fact been pursued for many years, and there is a sizable literature devoted to processing explanations for specific syntactic phenomena (see O’Grady, 2005, p. 12 for a brief review).

The real question is whether theories of sentence formation need to refer to a grammar in addition to a processor. In particular, if one posits the right type of processor, is there anything left for a grammar to do?

As we have seen, an efficiency-driven linear processor designed to minimize the burden on working memory can account both for the sorts of facts that fall under UG and for the sorts of facts that must be attributed to language-particular grammars. It explains why the subject is structurally higher than the direct object in a transitive clause. It explains intricate facts about verbal agreement in English. It explains why only a verb in the main clause undergoes inversion in *yes-no* questions. And it explains why direct object relatives are more marked and therefore harder to acquire and use than subject relatives. Many additional examples are discussed in O’Grady (2005), all pointing toward the need to shift the burden of explanation in linguistic analysis from an autonomous grammatical system to a processor whose properties seem to follow from the effects of working memory.

The empirical challenges associated with this shift are daunting, it must be admitted. The phenomena that constitute the primary concern of syntactic description (binding, control, agreement, quantification, and so forth) do not simply disappear. The fundamental questions raised by language acquisition, language loss, and language change remain as vital as ever. And data from psycholinguistics, much of it quite puzzling to begin with, becomes even more important than before.

In other words, the problems don’t get easier. The hope is simply that new insights can be uncovered, eventually allowing a deeper understanding of how language works.

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