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MINIMALISM AND THE JOURNEY TOWARDS BIOLINGUISTICS

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I

Chomskyan generative grammar differentiated itself from traditional grammar – and from other contemporary rival theories of linguistics (like the British theories of Firth and Halliday and American structuralist theories) – by starting from mentalist claims. One of the claims was that the grammar of a language is represented in the mind of a speaker-hearer of that language, and it is by virtue of this representation – this "grammar-in-the-mind" – that the speaker-hearer produces and understands the language. This claim (in itself) may sound somewhat obvious and therefore not very interesting to a contemporary ear. But it must be remembered that the claim was made at a time when the reigning paradigm in the social sciences was behaviourism; any mention of a thing called 'mind' was taken to be unscientific, since (for a behaviourist) only things that could be observed could be the subject of an empirical science. Chomsky was flying in the face of contemporary science when he said that the object of study in the linguistic sciences was a postulated mental entity. Chomsky called this grammar-in-the-mind 'competence' rather than 'knowledge', presumably to emphasize that it was more akin to a skill or ability: the speaker-hearer could do things with it rather than describe or understand it.

One may contrast Chomsky's notion of 'competence' with Saussure's notion of 'langue'. For Saussure, 'langue' is the system underlying a language that exists in a speech community, possibly as a system of mutually accepted conventions; if it exists in a speaker-hearer's mind, it does so only as a result of the speaker-hearer learning the conventions. For Chomsky, the competence in a speaker-hearer's mind is not something that is learnt, at least not learnt in the usual sense in which one speaks of learning any system of knowledge. Rather it is the expression, or maturation, of an innate

instinct of 'language-making' that is a biological endowment of the human species.

This is the "innateness hypothesis" of Chomsky regarding the acquisition of language. The idea is that a human child is born with the knowledge of the formal properties that characterize the grammars of all languages; we can speak of these formal properties, taken together, as constituting a Universal Grammar (UG). UG is, of course, not present in the child as a set of rules. What the child is endowed with (at the time of birth) is a mechanism for constructing UG-compliant grammars; the rules of UG are (as it were) inherent in the workings of this mechanism. The task of a linguist (then) is analogous to that of a biologist trying to reconstruct a bird's instinctive knowledge of how to build a nest by looking at how the bird goes about its nest-building task.

II

Now an important thing to keep in mind is that the above-mentioned 'mentalist' claims translated into 'physical' claims. Chomsky talked about 'mind/brain', not 'mind' alone. It was claimed that the language faculty is localized in a part of the brain, and is therefore physically realized. Should we then expect UG to be physically represented in the brain?

Brain research has found nothing corresponding to UG in the brain. But this should not be surprising. Imagine a Martian observing two humans playing chess. What he will see are the actual movements; he cannot see the rules according to which the movements are made. When brain research examines the brain during a language-related activity, what it sees are the movements, and not what determines the movements. If language-making is an instinct of the human species, we should look for UG in the part of the brain where instincts are encoded; and that – we are told – is the old part of the brain, the brain stem, which is the least understood part of it. And we still have no idea how instincts are physically represented in the brain stem.

But even apart from this handicap, there are other reasons why brain research and language research have not been able to converge in a better way. We can say that the fault lies on both sides. Admittedly, brain research is still in an early stage. The first tentative attempts to investigate the brain-language relation depended on medical cases like accidents where the patient suffered a brain injury; the investigator tried to determine which language functions were impaired and tried to correlate this to the location of the injury. As Chomsky remarked in the course of an interaction with biologists at

CCMB (Hyderabad) in 1997, this type of research was like someone driving a crowbar into a computer and then seeing which functions of the computer were damaged!

But one thing that happened as a result of the early investigations of the brain (in the 1950's) was that our picture of the mind underwent a change. We now know that the mind is not a unitary thing; it has a modular structure. (In this respect, it is like the body, which consists of organs.) The different things that we do with the mind, like memory, logical reasoning and processing of sensory data, are localized in different parts of the brain. The language faculty also has a location in the brain. Salutary as these developments are, however, they still give us only a broad picture of the brain-language relation.

On the side of linguistics, our understanding of language also needed to evolve. Our early conception of the principles of UG was as things which were specific to the language faculty; we thought of them as 'isolated' in the brain. UG existed in the mind/brain in a kind of 'modular isolation'. We had no prior conception of what sort of thing would qualify to be a UG principle. If some constraint could be shown to hold across a number of languages, it would be immediately taken to be a UG principle.

In the 1980s, the paradigm of research in the Chomskyan school was known as the Government-and-Binding Theory. All the principles that made up the subcomponents of this theory — such as Case Theory, Binding Theory, Bounding Theory — were unthinkingly taken to be UG principles. The distance of such principles from any conceivable realization in the brain was unbridgeable.

Let us illustrate one such 'UG principle' which was invoked to explain the so-called island constraints. Syntactic islands are configurations from which subextraction is not possible. For example, in the following sentences, we can see that extraction is allowed from the main clause, but disallowed from the embedded adverbial clause. (The star sign '*' prefixed to (1b) indicates that the sentence is ungrammatical.)

(1) a. **Who** did you hit _____ [before you hit Bill] ?

b. * **Who** did you hit Bill [before you hit _____] ?

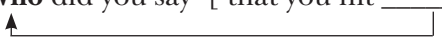
One could imagine that these sentences could be uttered as questions in a context where an interlocutor has just said either (2a) or (2b):

(2) a. I hit *someone* [before I hit Bill]; but I don't know who.

b. I hit Bill [before I hit *someone*]; but I don't know who.

Both these sentences are fine, because there is no extraction from the position of 'someone' in either. Let us lay to rest a possible conjecture that (1b) is bad because the extraction is from an embedded clause and so the movement is 'too long'. In (3) below, the movement is equally long, but the sentence is fine; the difference here is that the embedded clause is a complement and not an adverbial adjunct.

(3) **Who** did you say [that you hit _____] ?



It is not only adverbial clauses that disallow subextraction from within them. Relative clauses also behave in the same way. In fact there is a host of syntactic configurations that are opaque to subextraction. Explaining their behaviour was the task of a subcomponent of GB called Bounding Theory. The central proposal here was that apparent long extraction was actually done in short steps, each step being to the left boundary of the immediately containing clause; and complement clauses offered a landing site for the step – an "escape hatch" – in their left periphery, but adverbial and relative clauses did not.

It is difficult to see how this explanation would translate into observable brain behaviour. In more recent linguistic work (however), an alternative analysis has been proposed for certain of the syntactic islands. In Nunes & Uriagereka (2000), it is claimed that adverbial adjuncts are built-up separately from the main clause in a parallel derivation; and that they are already 'spelt out' when they are merged with the main derivation. ('Spell-Out' is an operation by which a syntactic structure is interpreted both phonetically and semantically, i.e. is assigned a phonological form and a meaning. After a structure has undergone Spell-Out, no further change can apply to it; in particular, no phrase can be extracted from it.) In fact, there had been an earlier suggestion, in Lebeaux (1988), that relative clauses are merged in the derivation 'late'. Although this suggestion was made in order to explain certain anaphoric relations, we can readily see that it falls in line naturally with the Nunes-Uriagereka analysis that adjuncts are derived separately. Putting the two ideas together, we can say that adjuncts – whether adverbial adjuncts or

relative clauses – are not only built up separately, but built up late. This would explain their island behaviour. We can now dispense with the Bounding Theory of GB. Although we, perhaps, do not yet have fine enough tools to observe the brain to determine whether there is a 'timing' difference between the building up of the main derivation and that of adjuncts, this is a potentially verifiable hypothesis by brain research – unlike the Bounding Theory.

III

Actually the one big thing that made early Chomskyan linguistics psychologically unreal was the way a sentence (or a clause) was generated. In the *Aspects* model – i.e., the theoretical model set out in Chomsky's *Aspects of the Theory of Syntax* (1965) – this task was conceived as follows: first one selected the symbol S (which stood for 'sentence'), then applied a phrase structure rule that rewrote it as follows:

(4) S → NP Aux VP

Other phrase structure rules rewrote NP, Aux and VP (in various ways, to reflect the variety of types of Noun Phrases, auxiliaries and Verb Phrases that English can have). One could eventually have (among other options) the following pre-terminal string. (A pre-terminal string is a string of category labels that can only be replaced by lexical items, not by other category labels.)

(5) Det N Tense V Det N

Now an operation of "lexical insertion" took place, replacing each of the category symbols with a lexical item (word or morpheme) of the appropriate category. The result could be the following:

(6) the princess -ed kiss the frog

This would be (with bracketing, which we have not indicated) the 'deep structure' of the sentence *The princess kissed the frog*.

Note that sentence generation proceeds from top to bottom, beginning with S and ending with words and morphemes. This was an algorithm that Transformational Grammar inherited from the IC-analysis ('immediate constituent analysis') of structuralist grammar. The main focus in these early days was to get the constituent structure

right in terms of an algorithm that had the mathematical property of recursion. (Recursion enabled the grammar to generate an infinite set of sentences.)

But this top-to-bottom procedure could make no pretence to psychological reality. Obviously, a speaker does not plan an utterance by first choosing the category symbol S! He or she does not first prepare a syntactic frame by going through a sequence of rewrite rules, and *then* choose words to fit the frame. Instead, a speaker starts with ideas, which correlate with words. The words then determine the syntactic frame. For example, in (6), it is the choosing of the verb 'kiss', a transitive verb, that determines that there should be a direct object. Similarly it is the choice of the nouns 'princess' and 'frog' that determines that there should be a determiner in the phrases containing these nouns.

The first indication of a reversal of the direction of structure-building was the proposal in GB theory (Chomsky 1981) of a new principle called the Projection Principle. This said that all syntactic structure is projected by lexical items; or, to put it more strongly, there can be no syntactic structure except what is projected by lexical items. As we know, each lexical item brings with it a small structure around it, which is necessitated by its meaning. This is the structure of the phrase that the lexical item is the head of. For example, 'kiss' requires a 'kissee,' which must be a 'thing'; and things are signified by nouns. This means that 'kiss' brings with it the structure of a transitive verb phrase; or in other words, 'kiss' projects such a phrase and is the head of that phrase. Similarly, the Tense morpheme '-ed' projects a clausal structure. The Projection Principle says that all the structure in a sentence is put together from the structures projected by its lexical items.

A corollary of the Projection Principle was that the old phrase structure rules were dispensed with, as being redundant. But in the 'GB days' – i.e., throughout the 1980s – we continued to build sentence structure from top-to-bottom, which was an anomaly.

This anomaly was addressed in the next big development in Chomskyan linguistics. In an extended essay titled "A Minimalist Program for Linguistic Theory" (1992), Chomsky proposed an overhaul of theory; the new theory came to be known as Minimalism. Perhaps, the most striking innovation of the new theory was the proposal that syntactic structures should be built from bottom to top. Chomsky didn't need to be extremely innovative to come up with this proposal, because the bottom-to-top algorithm was already the sentence-building procedure of two rival, contemporary

approaches to Grammar, namely Tree Adjoining Grammar (TAG) (which was being developed by a group of computational linguists) and Montague Grammar (which was being pursued by some semanticists).

But a thing to note is that with the new algorithm, a certain syntactic operation came to prominence, namely Merge. Merge became the driving force of syntax; given a Lexicon, i.e., a dictionary of words and morphemes, it could build every possible structure — the infinite number of structures — of a language. In Minimalism it was further suggested that Merge be restricted to being binary; that is only two syntactic elements could be put together in a single application of Merge. But the syntactic elements that are so put together can themselves be simple or complex. All the permutations and combinations are possible: both terms can be simple, cf. (7a), one term can be simple and the other complex, cf. (7b), or both terms can be complex (cf. 7c).

(7) a. [the] + [cheese] → [the cheese]

b. [eat] + [the cheese] → [eat the cheese]

c. [the mouse] + [eat the cheese] → [the mouse eat the cheese]

Now since the Lexicon contains only simple elements, the question arises: where do the complex elements come from? Obviously, if the Merge operation could source its terms only from the Lexicon, it would be unable to handle cases like (7b) or (7c). The answer has to be that Merge can take (as a term) the output of other Merge operations. This forces us to the conclusion that there are parallel Merge operations taking place, perhaps simultaneously, in different sites of the mind/brain. That is, there is parallel processing of language in the mind/brain. Now this is a computational idea, and not a purely syntactic idea.

Many imaginative extensions suggest themselves at this juncture. For example, when we are speaking about Merge, are we speaking only about Language, or also about thinking? A property of Language that has often been emphasized by theorists of Language is that Language is infinite, in the following sense: while one can say how many words and morphemes a language has, that is, the Lexicon of a language is numerable, one cannot say how many sentences a language has, i.e., its sentences are innumerable. It achieves this infinity because of

recursion: one can have a sentence inside another sentence, a noun phrase inside another noun phrase, etc. (This fact is captured by the dictum 'Language makes infinite use of finite means.') Now one can say the same thing about thoughts: they are innumerable. Another property of Language is its creativity: every sentence one speaks is a 'new' sentence, in the sense that it is made up for that occasion. Now one can say the same thing about thoughts: each thought arises as is appropriate for an occasion. So then, can we extend the driving mechanisms of Language to thought? To put it more narrowly, is binary merge also the operation by which the mind/brain puts together thoughts? We shall not pursue these ideas here because we still know very little about these questions. At the same time, we can keep in mind Chomsky's observation that Language is the best understood part of human cognition.

To come back to our original question: how has linguistics changed in order to make itself more amenable to investigations of the brain? As we saw, Minimalism was a kind of watershed: it proposed a derivational algorithm that went from bottom to top, starting with words and ending with structured sequences of words, which seems to mimic the way in which a speaker goes about putting together an utterance. Besides, this algorithm had a central driving mechanism, Merge, which (as we pointed out) seems to have resonances in other parts of brain research such as our investigation of Cognition. Apart from all this, an important step of Minimalism was the insistence that all the principles of language must be explained either (i) as economy conditions, or (ii) as legibility conditions imposed on derivations by the two outside systems that interface with language. On the sound side, the interface is with the articulatory system, which is a physical system and which is not particular to language in any sense: the lips, and the tongue, and the larynx have other functions. And the articulatory system tells language: "If you generate a sound that requires the tongue to be both high and low in the mouth at the same time, I cannot do it!" Similarly the meaning-making component of the brain — which again is not particular to language: its primary job is to make meaning of the world (of things and events) — tells language: "If you have an unbound variable, i.e., an expression whose reference cannot be determined, I cannot interpret it." By forcing linguistic research to take cognizance of outside systems, Minimalism brought UG out of its modular isolation.

Similarly, Chomsky (2000) ("Minimalist inquiries") proposed the theory of phases. This says that a derivation is spelt out in small chunks called 'phases'. Once a chunk is spelt out, the derivation

no longer has to remember its internal structure. Therefore, at any point of the derivation, the derivation has to remember only what is currently being built up, because the earlier part of the structure — the earlier phase — is reduced (as it were) to a 'word'. This lightens the burden of the derivational memory. The larger point is that linguistics is now taking into account another module of the mind/brain, namely memory. (In early stages of Chomskyan linguistic theory, memory figured only in a minor role, e.g., in explaining some performance errors.)

In "Beyond Explanatory Adequacy" (2004), Chomsky insisted that the principles of UG should be completely explained in terms of (i) the legibility conditions imposed on a derivation by the outside systems that interface with language, and (ii) considerations of computational efficiency. We should do this in such a way that, after what can be explained by these two factors, the residue of UG should be nil.

Now these factors are language-independent. Interface conditions are things that language responds to. Computational efficiency could be even organism-independent: the need to limit the "length of wiring" in an operation is something that applies to all biological systems.

What we see then is that since the beginning of Minimalism, Chomsky has been moving towards biolinguistics, i.e., a linguistics that is based in biology. This should make its approximation to brain research easier.

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