The barest essentials

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Grammar

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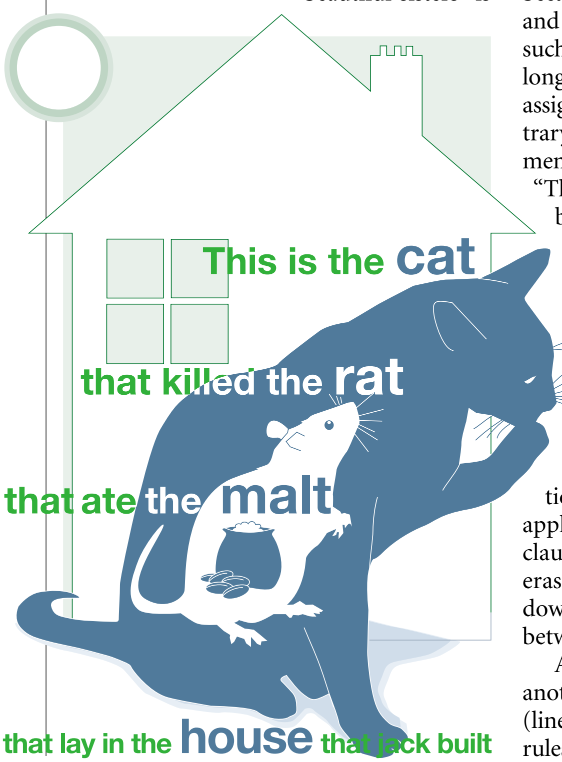
Two styles of explaining the science of mind and behaviour have been competing for as long as anyone cares to remember: empiricist, centring on habit formation, statistical learning, imitation and association; and rationalist, focusing on the projection of internally represented rules. Despite relentless effort, the former has delivered rather meagre results, whereas the latter, with its pivotal concept of an internally represented grammar, has produced the solid ‘conceptual cognitive revolution’.

For a rationalist cognitive scientist, a grammar is a finite mental object, systematically assigning abstract structures to all the well formed expressions of a language — that is, to each member of a set that, for natural languages (such as Chinese or Italian), is infinite and discrete. Infinite, because every speaker of a language can produce and understand an unlimited number of new grammatical sentences. Discrete, because continuous modification of a sentence to change it into another is impossible. No sentence could be halfway between “It’s a good car, but they don’t sell it” and “It’s a good car, but they don’t tell it.”

A grammar capable of generating complex structures for all well formed sentences of a natural language must have recursive rules, because phrasal constituents can contain other phrasal constituents of the same or higher kinds (“The young doctor’s three beautiful sisters” is a noun phrase containing another noun phrase; “The spy who came in from the cold” is a noun phrase containing a sentence.) Moreover, structural rules of sentence formation can be applied recursively to embed relative clauses embedding other relative clauses, without limit (as in “This is the cat that killed the rat that ate the malt that lay in the house that Jack built”). Because such grammars are finite, whereas the languages they generate are infinite and contingently shaped by use, it is advantageous, and methodologically cogent, to consider the concept of grammar as primary, and that of language as derived.



Since the mid-1950s, powerful formal criteria, derived from analysis of the artificial languages of mathematics and computer programming, have been applied to the study of natural languages to determine principles by which a given class of grammars can generate a given target language. A universal (‘Chomsky’) hierarchy of grammars (automata) was established: the most powerful class contains as a subclass the immediately less powerful one, and so on. In tune with the dominant empiricist–inductivist tradition of the 1950s, the first grammars to be explored at the lowest level in the hierarchy were probabilistic and finite-state. From a very large corpus of ascertained utterances of the language, one can compute the conditional probability that a word (or string of words) will follow another.

As well as being utterly unrealistic as cognitive models for a human brain–mind because of the burden on archival memory and the relentless updating of probabilities, such a grammar would be inadequate because long-range syntactic dependencies would be assigned a vanishingly small probability, contrary to fact. A simple example is the agreement between subject and verb in the sentence “The children are laughing”, and how it can be interrupted by another agreement relation, as in “The children whom the teacher is scolding are laughing.”

To account for natural languages we must therefore move up at least one level, to context-free grammars (push-down automata). The powerful new properties available are: recursiveness (a rule can accept as input the output of its previous application); abstract dependencies (a rule may apply to a whole noun phrase, or a whole clause, not just to single words); and an erasable finite-memory device (the push-down store), allowing local comparisons between one sequence and a previous one.

As it turned out, we had to move up yet another level, to context-sensitive grammars (linear bounded automata) because we need rules sensitive to the syntactic environment (context) in which a certain string appears in a sentence. We need to modify that string, according to the rule, if and only if it is flanked in the sentence by some identifiable syntactic configuration. We have to find a class of grammars that provides a reasonable model of human linguistic ability, admitting highly constrained displacements of whole sentential constituents from one position in the sentence to another, as in “Which guest of your mother did you inadvertently insult?”, with rules that systematically also apply to unexpressed linguistic components — implicit pronouns, for instance, as in “Go home!” (‘you’ being left implicit.) Such grammars must display the subtle difference, obvious to any English speaker, between “John is easy to please” and “John is eager to please”.

These grammars are all-important to humans, but are not precisely matched by mathematical theory because they dwell at the level of a formally ill-defined, special class of context-sensitive grammars — possibly because natural languages have been shaped by the haphazard biological evolution of the human brain. Nonetheless, a new approach — the theory of generative grammars (the ‘minimalist program’) — is focusing on identifying the principles conceptually necessary to account for grammatical phenomena in the languages of the world, and on what excludes those phenomena that do not arise. A very narrow grammatical apparatus appears to be sufficient to account for all human grammars: concatenation (merging lexical elements one with the other) and movement (the result of copying a phrasal constituent elsewhere in the sentence, concatenating it to the extant structure, then deleting one of the copies). All linguistic variation is restricted to a free combinatorial choice between two possible values assigned to each of a few parameters. Human natural grammars are trimmed to the barest essentials, with boundaries along the lines of strict conceptual necessity, rather than along the whimsical contours of evolution. ■

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FURTHER READING

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