

the acquisition of complex information about an organism's environment implies selection to better store and use the information. The evolution of extra-large brains and corresponding intelligence in dolphins and primates illustrates that convergence. Conway Morris stops short of saying that another species has yet evolved the sophisticated language of humans, but suggests that "waiting in the wings of the theatre of consciousness are other minds stirring, poised on the threshold of articulation". These are provocative words and, whether or not one agrees with his conclusions, the examples are fascinating and indicate a prodigious knowledge of the scattered literature on convergent evolution.

Given this rampant convergence here on Earth, Conway Morris believes that "extra-terrestrials with nervous systems will hear, see, and smell in very much the same way as we do, and if that is so will also possibly have similar mental processes". So where are these ETs? Alas, he doubts that they exist. Conway Morris and Gould both think that we humans might be alone, but for different reasons. For Gould, "the awesome improbability of human evolution" derives from contingency in adaptive evolution. Conway Morris argues that if our planet were even slightly different from the way it actually is, then life might not have emerged. His argument is based on the difficulties of getting life started, on the failure of scientists to synthesize life from scratch, and on some unusual features of Earth and our Solar System. He even suggests that intelligence might never have evolved here had not a cataclysmic impact jettisoned the Moon into its orbit. This sounds rather like Gould's historical contingency, except that Conway Morris emphasizes physical events creating opportunities for life to emerge and adapt, whereas Gould emphasized the idiosyncratic nature of adaptation itself.

The tension between inevitability and loneliness leads Conway Morris towards a higher objective, which is to re-establish "notions of awe and wonder" in evolution and thus "allow a conversation with religious sensibilities". He dismisses Fred Hoyle's "strange ideas about the origins of biological complexity" but admits a grudging respect for Hoyle's remark that the Universe is a "set-up job". Conway Morris's metaphysical vision occasionally becomes overwrought, as when he says: "Not only is the Universe strangely fit to purpose, but so, too, as I have argued throughout this book, is life's ability to navigate its solutions." Whatever Conway Morris may think about the Universe and its predispositions, *Life's Solution* invokes the standard darwinian explanation of adaptation by natural selection for life's ability to navigate.

I recommend this book to anyone grappling with the meaning of evolution and

our place in the Universe, and to biologists interested in adaptation and constraints. I am obliged, however, to caution readers about the deprecating way in which Conway Morris sometimes refers to evolutionists whose views he opposes. He is especially dismissive of Gould, who died a year ago: readers interested in their conflict can read an exchange elsewhere (*Natural History* 107, 48–55; 1998). Conway Morris's antagonism to Gould becomes more puzzling when one reads — in a chapter titled "Towards a theology of evolution?" — of his disdain for "ultra-Darwinists" and "genetic fundamentalism", as these were also frequent targets of Gould's pen. But while Gould argued for the separation of science and religion, Conway Morris is searching for common ground.

Conway Morris derides the "almost gleeful abasement of humans" by ultra-Darwinists, and claims that Darwin himself "retreated into a gloomy agnosticism". But the closing passage of *The Origin of Species* is far from gloomy: "There is grandeur in this view of life, with its several powers having been originally breathed into a few forms or into one; and that ... from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved." In the second edition Darwin inserted three words (italicized here): "... breathed *by the Creator*". In *Life's Solution*, Conway Morris has perhaps explained why, in his view of life, the second edition might be preferable to the first. ■

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Listen, learn and construct

Constructing a Language: A Usage-Based Theory of Language Acquisition

by Michael Tomasello
Harvard University Press: 2003. 388 pp.
\$45, £29.95

Eve V. Clark

In 1965, Noam Chomsky posited that linguistic theory should be able to account for how children acquire a first language. In so doing, he triggered debates that have lasted ever since. What is innate? What and how much language do children hear? Are children's errors corrected? Do children use two different mechanisms for learning grammar: one for regularities in syntax and morphology that can be described with rules, another for irregular forms?

But few linguists have spent much time looking at language acquisition itself, pre-

fering to debate the logic of the enterprise within linguistic theory. They have tended to ignore findings from studies of acquisition that are inconsistent with their favourite theories. In short, they have not recognized that describing a language is not the same as describing the process by which people acquire it.

By contrast, in the past few decades, psycholinguists have documented many of the facts of acquisition. They have examined what speech children hear, studied the processes for learning complex systems, and identified factors that influence development. But they have also generally ignored changes in syntactic theories — descriptions of the rules that govern language — and the associated issue of just what is innate about language in humans.

Tomasello has added a new perspective to these debates from the psycholinguistic side, based on his work with primates as well as children. He has brought together a number of the topics that psycholinguists have worked on: language studied as a system for communication, the relationships between language, memory and attention, how inferences about meaning are made in context, choices of conceptual perspective — the decision to call a dog a "dog" rather than an "animal" — how common ground is built up in communication, and how a speaker's intentions are interpreted. He emphasizes that language is essentially social and that it relies not only on vocabulary and linguistic constructions, but also on non-linguistic elements such as gesture and gaze.

He starts from the premise that children acquire language by attending closely to the language they hear. To do that, they must analyse speakers' intentions and find any patterns in the language that speakers use. Tomasello argues that children acquire constructions in the same way as they do words: they have to learn both, and just as they slowly build up their vocabulary, they also slowly build up a repertoire of constructions. Words, in fact, are stepping-stones to constructions. For instance, children first use a verb like "want" only with "that" ("want that"), then with a following verb ("wanna go"), and only later still with a direct object and following verb ("want him [to] go out"). They build up larger constructions by combining smaller ones. Because Tomasello looks at speaker intentions as well as patterns of use, he integrates the cognitive and the social in language development from the start.

Researchers have always assumed that children acquire vocabulary by learning, but many have argued that learning alone can't explain children's acquisition of the regularities of language that can be described in rules for syntax and morphology. Acquisition of these, propose Steven Pinker and others, depends on innate language-specific



capacities. These capacities, argue researchers, are shared by all languages and include innately given word classes.

But in Tomasello's view, acquiring a first language entails mastering more than its grammar. It means learning to use the language to communicate, using the same resources that adult speakers do. The child's abstraction of grammatical rules, as sketched out in Chomsky's proposal, remains an important part of this task but, as Tomasello points out, it is unclear how quickly children identify such rules.

Tomasello presents a wealth of observation and argument in support of his approach. He appeals to recent linguistics research on constructions in syntax, and to psychological research on children's understanding of intentions and beliefs in others, on joint attention in communication, and on function-based distributional analyses and analogy in learning. He makes a compelling case for his view of acquisition as an alternative both to those linguistic accounts that have focused on grammar and on how much is innate, and to current 'connectionist' accounts by Jeffrey Elman and his colleagues that focus on the forms learnt but not on their meanings. He argues against the idea that there are different mechanisms for learning rule-based and irregular forms of language, and in favour of a single mechanism for

learning both words and constructions. And, like many biologists, he cautions against assuming innateness without examining the alternatives.

Tomasello should make us think more, and more carefully, about language in social as well as cognitive terms, and to consider the roles of attention, memory and learning in the process of acquisition. But he also leaves many questions unanswered. For example, what are the units of language being learnt? How should one define them — the notion of clause, for example? When do children learn to rely on conventions — that "dog" designates the category of dogs in English, but "chien" does so in French? Did languages evolve in the kinds of settings where adults and infants first establish joint attention? How do children learn the meanings of words and constructions? How is the choice of a conceptual perspective by the speaker — "that dog" or "that animal" — related to the build-up of common ground in conversation? How do children get rid of errors such as "comed" (for "came") or "me throw" (for "I want to throw it") in their speech? Are they attentive to corrections from adults, and if so, how? Are they, in fact, exposed to enough information about constructions to allow for learning?

These are all empirical questions that must be taken seriously. How children

acquire language can no longer be presented as a thought-experiment about the language that is the product of acquisition: it demands concrete data and theory about the process of acquisition. ■

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Changing the world

Niche Construction: The Neglected Process in Evolution

by F. John Odling-Smee, Kevin N. Laland & Marcus W. Feldman

Princeton University Press: 2003. 486 pp. \$75, £49.95 (hbk); \$39.50, £26.95 (pbk)

Laurent Keller

"Niche construction changes our conception of the evolutionary process ... and should be regarded, after natural selection, as a second major participant in evolution." So argue the authors of this book as early as page 2. But what exactly is niche construction? And if it's really so important, how could evolutionary biologists have neglected it for so long?

The concept of niche construction is relatively simple. All living creatures, through both their metabolism and their behaviour, actively change and control the world in which they live. Organisms choose habitats and resources; they construct nests, holes, burrows, webs or pupal cases; and they modify the chemical environment in which they live. These alterations, which occur at scales ranging from the extremely local to the global, inevitably modify some of the selection pressures acting on the organisms. And it is precisely this — the effects of an organism on its own environment — that the authors believe to be the important component that has been neglected by the conventional theory of evolution.

The concept that organisms bring about important changes in their environment that may in turn affect their fitness is not completely new, however. Charles Darwin had already made several potent observations to this effect. For example, in *On the Origin of Species* he states: "When a species, owing to highly favourable circumstances, increases inordinately in numbers in a small tract, epidemics — at least this seems generally to occur with our game animals — often ensue: and here we have a limiting check independent of the struggle for life." This observation is strongly reminiscent of one in *Niche Construction* in which the authors discuss how large-scale human aggregation resulting from the construction of villages, towns and cities may create new health hazards such as the spread of epidemics.

In the 1980s, several scientists pointed