Instincts for the past tense

Does the structure of the English language reflect the structure of the mind?

Words and Rules: The Ingredients of Language
by Steven Pinker
Weidenfeld & Nicolson/Perseus: 1999.
348 pp. £14.99, $26

David Poeppel

Have you ever wondered why the past tense of sing is sang but the past of fling is flung while that of bring is brought? And, more importantly, why a reviewer can ding your grant, and why you can complain that a reviewer dinged it — but not that a reviewer dang, dung or dought it? If you are curious about these sorts of language phenomena (and many others), get Steven Pinker's *Words and Rules*. Finding a reader-friendly balance between humour, irreverence and anally retentive scholarship, Pinker unpacks a remarkable variety of facts associated with the distinction between regular and irregular English words and their structure. If you like (English) words and want to know why they are put together in the way they are, this book is definitely for you.

If you have not been too worried about the English past tense, is the book still worth reading? It is, if you are willing to entertain the argument that the detailed theoretical–linguistic, psycholinguistic and neuro–linguistic dissection of the English past-tense system sheds light on a much larger issue: the structure of the human mind. The position developed in *Words and Rules* is that the small and circumscribed linguistic system under consideration should be viewed as a model system for the scientific study of language. Biologists focus on model organisms such as *Drosophila*, zebrafish or *C. elegans*, and physicists develop theories based on carefully restricted model systems such as inclined planes or coupled oscillators. Pinker suggests that the English past tense can serve as the "drosophila of psycholinguistics" — as a model system for investigating the structure of language and mind from every possible perspective.

The intellectual foundation providing the backdrop for the research is the very old but still vibrant debate between rationalists and empiricists, a debate based on ideas developed by René Descartes, Thomas Hobbes and Gottfried Leibniz and their counterparts John Locke and David Hume. Is the mind a system of 'reckoning' using abstract representations (symbolic computation, in contemporary terms), or is it an associative memory in which computation builds on the frequency and similarity among remembered items (a connectionist architecture, in contemporary terms)? Are cognitive systems such as language largely innately specified and richly structured, or are they acquired on the basis of general learning principles?

In the domain of language, these issues have been explored in many contexts, including the formation of the past tense in English. The past-tense theory that forms the basis for much current research was proposed by Noam Chomsky and Morris Halle in 1968. Working in the framework of rule-based generative linguistics, they showed that the entire repertoire of English irregular verbs (there are approximately 165, compared with thousands of regular verbs) could be accounted for by merely three phonological rules. In 1986, an influential paper by David Rumelhart and James McClelland showed that a relatively simple connectionist network could also capture a surprisingly large set of facts about past-tense formation without appealing to a modularized architecture and rules.

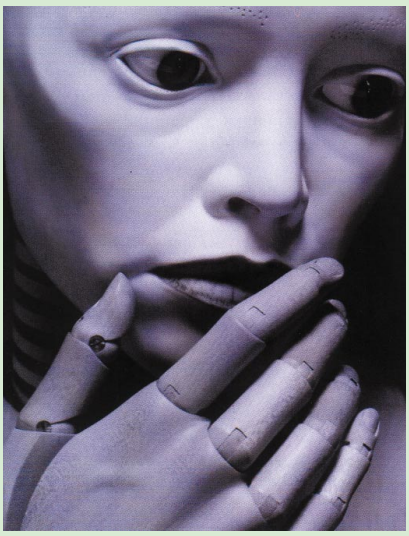
Pinker explains both proposals, and their strengths and weaknesses, in some detail. The discussion of the Rumelhart–McClelland model is particularly clear, and enables the reader to reason through each step relevant to the function of this connectionist network.

Pinker attempts to unify the two views. The approach is based on the past dozen years or so of work in his lab, with crucial contributions made by the cognitive scientists John Kim, Gary Marcus, Sandeep Prasada, Alan Prince, Michael Ullman, Fei Xu, and others. The essence of the proposal is, unsurprisingly, that you can have your cake and eat it too.

Pinker argues that the Cartesian–Hobbesian 'reckoning' approach worked out by Chomsky and Halle is the right way to think about regular inflection, but the Humean–Lockean associationism approach developed by Rumelhart and McClelland is right for irregular inflection.

Specifically, the mind is made up of a "frequency- and similarity-loving associative memory and a promiscuous combinatorial grammar". This hybrid model is argued to be preferable because it captures the sensitivity of speakers to family resemblances among irregulars (for example bind–bound, find–found) as well as the algebra-like computation of regular word forms. Importantly, both mechanisms are active all the time. Whenever a speaker or listener encounters an irregular item, the responsible mechanism is associative memory, which immediately supplies the relevant (memorized) past-tense form. In contrast, for regular verbs no memorized past-tense forms exist and the correct form is thus computed online, by adding -ed.

Pursuant to the "past-tense-as-psycholinguistic-zebrafish" approach, Pinker goes on to discuss the model in action. Chapters on language processing, language acquisition, and the German regular–irregular distinction cover the range of effects with which the model deals effectively. These chapters are fun to read, and reflect the fact that the group has worked on these problems for many years. The two chapters with the broadest implications discuss the possible neurological basis of the regular–irregular distinction and the connection of regulars and irregulars to the nature of categories in cognition. The neurological work makes connections between memory systems (and other cognitive systems) and regularity in language. In particular, neuropsychological and neuroimaging data suggest that irregulars are associated with a temporal-lobe network implicated in memory. The computation of regulars, on the other hand, is associated with a frontal network



A world of silent communication

Pupil: Pose 1, **by Katherine Wetzel and Elizabeth King, is one of many images to be found in *Ghost in the Shell: Photography and the Human Soul, 1850–2000* (Los Angeles County Museum of Art/MIT Press, $59.95, £37.50) by Robert A. Sobieszek. The book traces the history of photographic portraiture, and analyses the premise that the human face expresses the essence of the human character.**

implicated in the execution of rule-like behaviour.

In a final chapter, Pinker argues that the regular–irregular distinction exemplifies a more general feature of the human mind. Cognition, he argues, is supported by two types of categories — classical categories (for example, odd number) and fuzzy, family-resemblance categories (for example, chair). The nature of the categories supporting cognition is an old chestnut in cognitive science, and Pinker wants to connect the psycholinguistic research to more general properties of cognitive systems. Regular words are examples of classical categories, whereas irregular words are examples of family-resemblance categories. Symbol combination is crucial for the computation of regulars, as well as classical categories more generally; and associative memory is the core mechanism subserving the representation of family-resemblance categories in general, and irregulars in particular. Insofar as both classical, definitional information and family-resemblance information constitute crucial aspects of what the mind must deal with, both mental mechanisms are integral requirements for a functioning cognitive system.

For a broad audience, *The Language Instinct* (Penguin, 1995) was Pinker's more amusing book, and *How the Mind Works* (Penguin, 1998) was more speculative. *Words and Rules* is an academic work. I very much like the thoroughness and clarity of this book, notwithstanding at least one important sin of omission. Pinker thoughtfully argues for abstract representation and symbolic computation. In fact, a central concern throughout is to show that one cannot get away without a highly structured linguistic computational system. Surprisingly, Pinker does not raise what many linguists and psycholinguists consider the most interesting argument for a richly structured computational system (language faculty) that makes use of symbolic rules. It is called the poverty-of-the-stimulus argument, and it asserts that every speaker comes to know abstract properties of his or her language in the absence of any input that could provide the necessary evidence. In a work of such broad scope, the most powerful argument for structure deserves mention.

This complaint, however, is somewhat cosmetic. More importantly, the book provides a scholarly, persuasive, enjoyable and eminently readable account of important language phenomena. ■

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More on language

How the Brain Evolved Language
by Donald Loritz
Oxford University Press, £35, $45

Why not knot right?

The 85 Ways to Tie a Tie: The Science and Aesthetics of Tie Knots
by Thomas Fink and Yong Mao
Fourth Estate: 1999. 144 pp. £10

Gregory Buck

There is a little irony in the fact that I am reviewing this book. I am a modern American mathematician, well-schooled in the sartorial traditions of my field, and so would perhaps be a natural reviewer for a book entitled *The Well-Wrinkled Tee Shirt* or, perhaps, *Wearing Sandals in the Snow*. However, I teach at a liberal arts college, and so can wear a tie while teaching when I want to without risking my mathematical reputation — of course, for conferences I pull my clothes out of the bottom of the dirty-laundry pile like everyone else. (My colleagues in the economics department scoff at my tie-wearing, considering it too infrequent to be taken seriously, but they are extremists — I am pretty sure they wear ties with their pyjamas.) I have always liked tying ties, but, despite the fact that I study knot theory, like most people my tie-knot knowledge was cultural and accidental. I knew a couple of tie knots but not their names, nor could I recall where or when I learned them.

This wonderful little book by Thomas Fink and Yong Mao has changed my life. Now, when I tie a tie, I know what I am doing, and why. Fink and Mao have performed a great service for civilization, doing for tie-knot tying what Isaac Newton did for the motion of the heavens: lifting it from the darkness of secrecy, ritual and superstition to the light of rational, scientific good taste.

To accomplish this remarkable feat, Fink and Mao have employed the analytical tools of topological (and geometric) knot theory and statistical mechanics with cleverness and dexterity — introducing just enough of each to get the job done. That may sound ambitious, but this is a book aimed at the general reader. A beautifully concise, four-page appendix contains the only mathematics that could be considered challenging. The illustrations are superb — I tried nearly all the knots illustrated and got them right first time. The notation for the knots is elegant and easy to master.

The scientific force of the work is that Fink and Mao have created a formal model that captures the salient characteristics of tie-knot tying in the real world, and have then analysed the formal model, guided by the scientific lights of simplicity and symmetry, and have solved the problem completely, identifying the 85 ways to tie a tie (given natural constraints). Their model predicts the knots most commonly used, and provides several new possibilities.

Knotty problem: imagine how many tie knots are tied in a day.

Fink and Mao have obeyed the imperative of the scientific entrepreneur: create a niche, and then fill it completely. This book is now the definitive work on tie knots, and as such is the definitive work on one of the most common applications of knot theory (and therefore of topology). The applications of knot theory are legion: a test tube of DNA may contain billions of knots, but sometimes they are hard to see. Polymers in general may gain many of their characteristics from tangling, knotting and linking, but this may not be apparent when you are holding the material in your hand. Magnetic field lines are often knotted, linked or otherwise entangled, but one doesn't often observe this on the way to the market. But now imagine the morning dressing routines around the world — imagine how many tie knots are tied in a day.

Finally, we must consider the stylistic force of the work. Fink and Mao provide an informative history of tie-knot evolution. They also provide much more — a guide to taste in knot tying. An attentive reader will learn which knot works best with a given tie and collar, and will learn tie knots that can be enjoyed as things of beauty in and of themselves (for me it was the Plattsburgh). Fink and Mao have shown that it is possible to be both smart and smart — in brains and style. And so here is a prediction: anyone who wears a tie, who is at all of a scientific bent, will enjoy this book very much. ■

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Also available

Ideal Knots
edited by A. Stasiak, V. Katritch & L. H. Kauffman
World Scientific, $55, £34