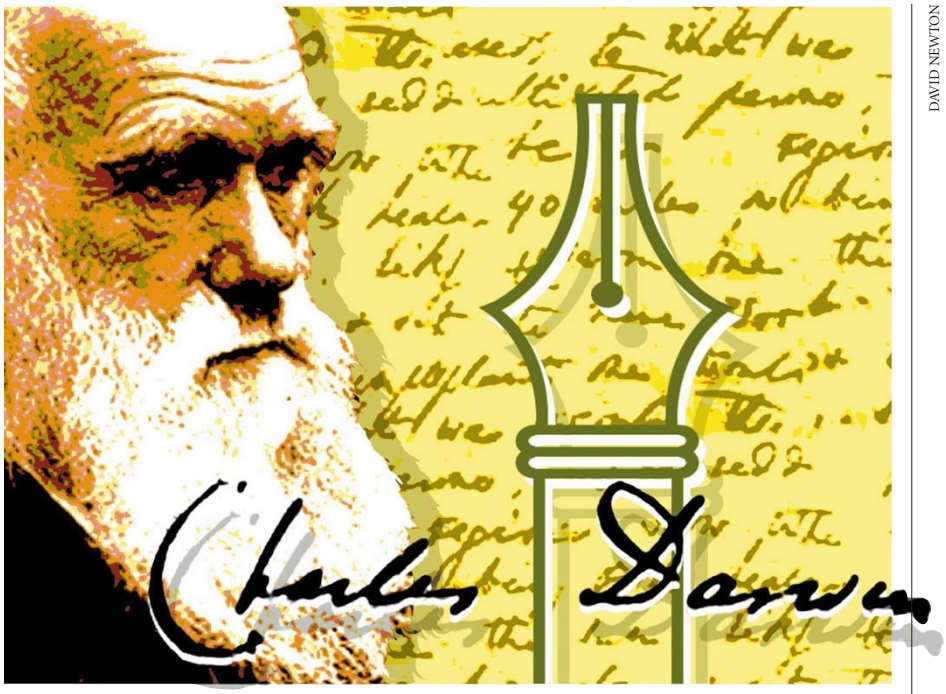
of parrots and humans. On the credit side, Pepperberg gives an excellent justification for her training procedures, the descriptions of the results are detailed and lucid, and, best of all, the interpretations are calm and considered. Pepperberg is well aware of Occam's razor and is careful not to indulge in ridiculous overinterpretations. One might nonetheless wonder what exactly was the point of this labour of love. To misquote Ludwig Wittgenstein, what would a parrot tell us if it could talk? Not a lot, seems to be the answer. Is a research programme to teach human speech to parrots likely to lead to deeper insights than one devoted to teaching us the calls and songs of the parrot?

Pepperberg's justification is that her data might help to improve the lives of captive parrots, "prevent habitat destruction and capture of birds in the wild, or enable researchers to develop better animal models for various human dysfunctions". I hope she's right. ■

John C. Marshall is in the Neuropsychology Unit, University Department of Clinical Neurology, Radcliffe Infirmary, Woodstock Road, Oxford OX2 6HE, UK.



DAVID NEWTON

Communications from the dead

Dear Mr Darwin: Letters on the Evolution of Life and Human Nature
by Gabriel Dover
Weidenfeld & Nicolson: 2000. 268 pp. £20

A. J. Berry

In 1876 Charles Darwin contributed £10 — a substantial amount at that time — to the costs of the criminal prosecution of Henry Slade, a renowned spiritualist medium. Slade, his accusers charged, was a fraud, and his séances were merely elaborate exercises in legerdemain. Remarkably, the case pitted the two discoverers of natural selection against each other: Alfred Russel Wallace, author of an approving book on spiritualism, was the defence's star witness. Despite Wallace's characterization of the defendant as an "earnest inquirer after truth in the department of Natural Science", Slade was convicted. Darwin was delighted; he had no time for the "clever rogues" who preyed upon grieving relatives anxious to contact a loved one.

Darwin, who died in 1882, may now have cause to reconsider his attitude towards posthumous communication as he himself has recently taken to holding forth from beneath the flagstones of Westminster Abbey. The medium in this case is geneticist Gabriel Dover, whose book, *Dear Mr Darwin*, comprises a series of letters between Dover and Darwin. Dover brings Darwin up to date on evolutionary biology since 1882, and Darwin, for his part, supplies appreciative yet inquisitive responses.

Things start rather formally — it's "My Dear Dover … Ever your most truly, Charles Darwin" to begin with — but become increasingly chummy as the correspondence develops — it's "Dear Gabby…. Your most sincere friend, Chas. Darwin" by the end. The gimmick is almost painfully cute, but Dover handles it deftly: he is not unduly deferential, and his Darwin not overly impressed by what Dover has to say. The result is a quirky but readable account of the Dover perspective on modern evolutionary biology.

Darwin's education, however, is in idiosyncratic hands. At the outset, Darwin must predictably swallow doses of Mendel and Hardy-Weinberg, but the textbooks are then quickly forsaken when, on the second page of Dover's second letter, we run into his pet theory, 'molecular drive'. This, Darwin learns, is, along with natural selection and genetic drift, one of "the three forces of evolution". Much of the book is dedicated to explicating molecular drive and to justifying its exalted place in Dover's pantheon of evolutionary forces.

Dover introduced the term in the early 1980s after DNA-sequencing studies of multi-gene families — groups of related genes that often sit side by side along chromosomes — had revealed a striking and unexpected evolutionary pattern now known as 'concerted evolution'. Within a species, all members of a gene family may be identical, or at least very similar, whereas between even closely related species we see plenty of sequence divergence between homologous gene families. The homogenization of gene-family members within species is caused by a number of simple and well-understood genetic processes, primarily unequal crossing over and gene conversion. Molecular drive is, in Dover's words, an "umbrella term" covering these and other "non-Mendelian mechanisms of inheritance".

Does molecular drive really rank beside selection and drift as one of the primary determinants of evolutionary change? Hardly. Darwin distinguished between two fundamental aspects of the evolutionary process: the genesis of variation, and the subsequent fate of that variation. In creating new configurations of existing genetic variation, molecular drive definitely contributes to step one. But does it contribute to step two? In principle, a variant can indeed spread through a gene family by molecular drive, especially when there are asymmetries in the drive process. For example, gene conversion is sometimes 'biased' such that an *a* allele is more likely to be converted to an *A* than an *A* to an *a*; such a situation may result in a molecularly driven increase of the *A* allele.

But crucially, the ultimate fate of any variant, whether subject to molecular drive or not, is determined by its impact on fitness: natural selection will intervene if it either enhances or diminishes its bearer's chance of reproduction. If the variant has no such impact — it is selectively neutral — then genetic drift is usually the major player, although molecular drive may sometimes also play a role. Molecular drive's contribution to the second phase of the evolutionary process is thus subordinate to the 'traditional' forces determining the fate of genetic variation in natural populations. Molecular drive is an interesting evolutionary phenomenon, but it is false advertising to bill it as a third major force of evolution.

Dover's Darwin, whose critical facilities

may have been dulled by a century or so underground, is more readily convinced of molecular drive's significance than I am. Having scripted Darwin's endorsement of his theory, Dover then settles down to enjoy his new role as Darwin's speech-writer. Responding to a lengthy Dover diatribe against Richard Dawkins, whose "selfish genery is genetically misconceived, operationally incoherent and seductively dangerous", Darwin reports that he will conscientiously hunt up Dawkins's books in a library: "I hope they are not filed under 'Science'!".

Dear Mr Darwin, however, is not confined to molecular drive and having Darwin say nasty things about Richard Dawkins. Dover writes at length on recent advances in developmental genetics, and adds his voice to those objecting to evolutionary psychology's insistence on attributing every quirk of human behaviour to the action of natural selection. Given that evolutionary psychology is an implicitly genetic theory (a trait must have a genetic basis to be subject to natural selection), it is interesting to note that many of its most persistent critics are geneticists.

Dear Mr Darwin is an engaging tour of Dover's passions, even if some are announced with more fanfare than they merit. Let us hope, however, that Dover's communications with Darwin do not create a literary fad based on the harassment of dead scientists. The thought of Linnaeus being badgered by manic modern cladists is alarming. On receiving one of Wallace's spiritualist publications, T. H. Huxley replied, "I never cared for gossip in my life, and disembodied gossip, such as these worthy ghosts supply their friends with, is not more interesting to me than any other." ■

A. J. Berry is at the Museum of Comparative Zoology Labs, 26 Oxford Street, Cambridge, Massachusetts 02138, USA.

On being human

The Cultural Origins of Human Cognition
by Michael Tomasello
Harvard University Press: 1999. 248 pp. $29.95, £18.50

Andrew Whiten

Human language and thought elevate us mentally to a grade far removed from anything known in other animals. Yet it has happened in just a twinkling of evolutionary time. Less than six million years separate us from the non-human, non-verbal ancestor we share with chimpanzees. So, suggests Michael Tomasello, we are faced with a puzzle: how could human minds vault this high so quickly? The question becomes more acute if one acknowledges little sign of any accomplishment beyond basic ape mentality until two million years ago or even less. Tomasello's solution — given how far he wants to push the idea — is a radical one. Depending on the reader, I suspect it will elicit excitement, irritation or incredulity. These different reactions may be more or less appropriate according to the evolutionary timescale Tomasello truly aspires to address.

The key proposition is that there was just one critical step in biological evolution which transformed our ancestors' capacity to sustain culture. A new 'ratchet' effect arose, in which cultural advances were built upon progressively in a way not seen in the social traditions of other animals. Human cognition would thenceforth become increasingly complex and differentiated, eventually achieving modern levels of sophistication without need of further biological change.

To see how radical a proposition this is, consider the case of language. Tomasello is arguing that the structures of our highly elaborated language capacities today have nothing to do with the evolution of a dedicated and, in some views, highly structured language instinct (he gives short shrift to the idea of innate mental modules, of any kind). Instead, he proposes that syntax and all the other complex aspects of human language have simply been built up over the generations, by cumulative, ratcheted, cultural evolution. The biological substrate did not need to change. What makes such a scenario plausible, according to Tomasello, is evidence that, quite early on, the human child demonstrates a capacity to translate between the perspectives of self and other that goes beyond anything seen in apes. Perceiving others as intentional agents, in particular, permits the child to become the kind of 'imitation machine' needed to participate in the powerful ratchet effect.

Tomasello's ambitious thesis requires accounts of changes on three very different timescales; evolutionary, historical and ontogenetic. To this task he brings almost unrivalled authority, based on an influential suite of both comparative and developmental studies; he cites more than 40 observational and experimental studies conducted by his group on monkeys, apes and children. These studies, mostly conducted in the 1990s, cover an impressive array of socio-cognitive capacities, including imitation, joint attention, theory of mind and language acquisition.

This substantial empirical base is coupled with a sophisticated grasp of the theoretical issues at stake, particularly when it comes to Tomasello's prime area of expertise, the development of language. Written with refreshing simplicity and directness, the product is a slim volume that nevertheless packs in a richly articulated and challenging model of mind, backed by a wealth of pithily summarized comparative and developmental studies.

At least two-thirds of the book is devoted to tracing the origins and development of components of cultural learning in children, with a particular emphasis on language. This is a masterly survey, covering pre-linguistic scaffolding for language, the acquisition of symbol and syntax use, discourse and the implications of internalization for other aspects of cognition.

Certain features of Tomasello's thesis are less compelling. He considers the possibility that the vital change may have happened two or even six million years ago. But his argument appears to neglect enormous changes in the brain, which has tripled in size since six million years ago and roughly doubled in the past two million. It seems more likely that whatever elaboration of social and cultural practices occurred in this period, it was underwritten by equally massive and rapidly driven neural changes.

A predominant role for cultural change becomes more likely in the context of the past quarter of a million years of *Homo sapiens*' existence. If the greater part of existing language structure arose over this period, the idea that this happened through cultural learning and ratcheting processes still constitutes a major challenge to those who argue for innate language systems. Tomasello notes that the main diversification of the Romance languages occurred in a few hundred years; so why could not cultural processes of syntacticization turn an embryonic language into a vastly more complex one over hundreds of thousands of years?

A further doubt is whether Tomasello has correctly identified the critical cognitive step that elevated our ancestors' social sophistication over existing anthropoid psychology. His conclusion is largely founded on experimental findings in captive apes far removed from the rich inputs of their natural environments. Field researchers tend to perceive more advanced cultural processes at work, although these perceptions are difficult to substantiate without experimental controls. Accordingly, we are at something of an impasse on this question. Tomasello's thesis probably depends less than he implies on the exact difference between chimpanzee and human cultural propensity, especially if the thesis gets its main application in the recent rise of *Homo sapiens*.

Nevertheless, students of primate behaviour are one of several groups who should read this important book. It spells out forcefully what appears to make human development so distinctive, and does so from the perspective of an expert in language acquisition who has also devoted much time to comparative work with apes. It is strong medicine for