copies of genes following, for example, duplication events (C. Chothia, Medical Research Council, Cambridge). Similarly, proteins can alter their function through step-by-step changes so as to maintain structural stability. A good example is the evolution of the crystallins, structural proteins found in eye lenses, from enzymes (see an earlier discussion in *News and Views*¹). An alternative pathway by which new proteins can evolve is by the stitching together of 'modules', leading to proteins with novel functions.

Although natural selection has for the most part been responsible for the evolution of protein function, most changes at the DNA level are now accepted to be neutral in that they are neither detrimental nor advantageous to the organisms that bear them. Using population genetics theory, neutralists (such as M. Kimura, National Institute of Genetics, Japan) argue that the rate of molecular evolution is limited by the mutation rate. By contrast, neodarwinists contend that the evolution of primary interest is that which gives rise to adaptation, and that the arising of new mutations can be seen as the blank block of stone which is reduced by selection to create adaptation (R. Dawkins, University of Oxford).

Recently there have been enormous methodological and statistical advances in the analysis of adaptation and biological diversity, whether it be at the level of morphology or behaviour. The comparative method in particular has been invaluable in identifying the evolutionary forces responsible for moulding adaptation (P. Harvey, University of Oxford). A key step forward has been the formulation of statistical methods for analysing correlation between different traits such as brain and body size, and ecological factors, while controlling for the effects of phylogeny. In linguistics, the comparison has been used to reconstruct the relationships between extant languages to build language family trees; but there is a need for formal models to tackle such questions as the rate of divergence between languages with common roots, and allow researchers to investigate the mechanisms by which such divergence takes place (M. Pagel, University of Oxford).

Borrowing

Because information can be transferred between individuals by learning, there is plenty of scope for borrowing in cultural evolution. This 'cultural transmission' of information is not unique to humans, and one striking example in animal behaviour comes from studies of the songs of birds, such as the European starling, introduced into New Zealand in the last century (P. Jenkins, University of Auckland). Introductions to isolated islands provide an unparalleled opportunity to unravel the effects of genetic and cultural pro-

cesses taking place during song ontogeny.

Birds produce song using a bipartite organ known as the syrinx, the two parts of which can generate sounds independently². Jenkins found that starlings are able to mimic the songs of two other birds simultaneously using their 'two voices', but that the actual phrases borrowed are apparently chosen to match an underlying species-specific song template which presumably has a genetic basis.

But how far can one push the analogy between genetic and cultural evolution to derive insights about the way languages and cultures evolve? For languages, the fact that, at the coarse level at least, boundaries between them often correspond with discontinuities in the genetic constitution of human populations (L. Cavalli-Sforza, Stanford University) implies that genes and languages to some extent share a common evolutionary history (see also the findings described in *News and Views* two months ago³).

Protolanguages

Optimists take the view that it may even be possible to reconstruct protolanguages ancestral to extant language families (S.A. Starostin, USSR Academy of Sciences) — in the case of Nostratic languages, for example, by the application of statistical methods to assess phonetic correspondences between language subgroups, based on objective linguistic genealogical trees. Nevertheless there are great difficulties to be overcome; some, such as loss of information because of the rapid change of divergent languages, may be insurmountable.

Indeed, whereas common ancestry may account for many 'global' aspects of human culture such as speech, C. Renfrew (University of Cambridge) argues that the types of methodologies generally applied by evolutionary biologists are unlikely to be able to cope with the realities of cultural evolution which include the widespread occurrence of independent invention and borrowing. Renfrew even questions the extent to which it is possible to recognize and define similarities in human culture, let alone quantify them.

So did the meeting result in a meeting of minds? Sad to say, my impression is that bringing together researchers from such disparate disciplines as molecular biology and linguistics is rather like trying to mix two immiscible liquids. When shaken together, the liquids may for a moment seem to dissolve into one. In time, however, they separate out again. □

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2. Stewart, C.B., Schilling, J.W. & Wilson, A.C. *Nature*, **330**, 401–404 (1987).
3. Doolittle, R.F. *Nature* **336**, 18 (1988).
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Deep acupuncture

SMALL foreign objects can be quite mobile in the body. Embedded shrapnel splinters or porcupine quill tips can slowly travel through the tissues, ratcheted along by the ceaseless movements of the body acting on their barbed or asymmetric structure. They may ultimately emerge far away from the original site of entry.

On a microscopic scale, a small foreign body must be very blunt. It does not pierce or damage the cells it encounters, but merely noses them aside: this is why a hypodermic needle does so little damage. So Daedalus is now inventing telemicrosurgery. A little barbed metal needle is inserted under the patient's skin, and is guided to its target in the body by vibromassage pads applied at strategic sites. The needle is steered by altering the direction of vibration and the relative phases of the massage pads, while its progress is monitored by X-ray. With a sufficiently high vibrational frequency, the micro-missile could reach its goal in days or hours rather than the years that a porcupine quill tip may take on its odyssey.

Most medical applications will use a hollow needle. It may be filled either with a potent drug too dangerous to release into the body at large, or pure vacuum: sealed in either case by some low melting biocompatible wax. When it reaches its target, an alternating magnetic field will be applied over the site to warm the metal needle by induction. The wax will melt, either releasing the drug exactly at its desired site, or sucking a biopsy sample of a few cells back into the needle. It can then be steered back to the surface, for recharging or examination of its catch.

Thus the surgeon will be able to reach any site in the body without making an incision. With stronger induction-field heating, the micro-needle may even be useful in minor surgery — perhaps warming a region of tissue to promote healing, burning open a drainage path for an internal site of infection, or killing encysted parasites. In particular, it will transform neurology. The little needle could safely enter the most crucial nerve trunk, nosing its way among the mass of nerve fibres without doing any harm. It could identify each fibre it reaches by firing it: perhaps by mere contact, or maybe by the alternating current induced by a weak low-frequency magnetic induction field. When a particularly troublesome nerve is encountered (such as those which cause persistent neuralgia, or the phantom-limb pain of amputees) it could be specifically killed. Just turn the induction field up to maximum, and the suddenly heated needle will cauterize the offending nerve fibre, without affecting even its close neighbours. No conventional surgery could be so precise!

David Jones