properties and connectivity patterns of its component neurons. Such models could in principle account for extraction of robust signals from noisy input (R. Douglas, MRC, Oxford), and even suggest a mechanism for working memory in which a pattern of activation is maintained in the absence of the input that triggered it (C. Koch, Caltech).

Is there any such thing as a canonical cortical circuit, and can lessons from the visual system be extrapolated to other cortical areas and functions? Those in search of a general theory of cortical function will be encouraged by the work of M. Sur (MIT), who has found a surprising degree of functional similarity between visual and auditory cortex. If visual inputs are surgically redirected to the auditory cortex of young ferrets, they form a topographical map in which individual cortical cells show orientation selectivity, a property that has no known counterpart in normal auditory cortex. Remarkably, the animals still interpret signals from the operated eye as light rather than sound, even though they are being processed by auditory instead of visual cortex.

Another striking example of functional plasticity is seen in the case of language, often regarded as the most specialized of human cognitive skills. Although certain brain areas are specialized for language production, children who suffer strokes to these areas often recover normal language abilities, indicating that their function can be taken over by other areas (E. Bates, Univ. of California, San Diego). And H. Neville (also UCSD) found that people who have been deaf since early childhood, and who communicate in sign language, show different patterns of cortical activation from those of hearing people during both visual and linguistic tasks.

Although such wholesale rewiring may be peculiar to early development, cortical plasticity can also be demonstrated in adulthood. S. Florence (Vanderbilt Univ., Tennessee) showed that limb amputation leads to extensive changes in subcortical somatosensory connections, but that these are largely corrected by compensatory changes in the cortex. M. Merzenich (Univ. of California, San Francisco) found that even in normal animals, connections can be greatly modified by experience; thus, if a monkey's hand is repetitively stimulated over a period of several weeks, the map of the hand on the somatosensory cortex is altered. The changes are consistent with a hebbian model in which parts of the hand that are stimulated in synchrony form connections to the same cortical site, while segregating away from others that are stimulated out of synchrony.

Again, however, it is in the visual system that plasticity has been studied in greatest detail, and altering the pattern of thalamic inputs to the primary visual cortex produces profound changes in the representation of the visual field within the cortex (M. Stryker, Univ. of California, San Francisco; C. Gilbert, Rockefeller Univ.; R. Freeman, Univ. of California, Berkeley; Y. Chino, Univ. of Houston). Some of these changes are long-term and depend on anatomical reorganization, but others are very rapid; if for example a small patch of cortex is temporarily deprived of visual input (by introducing a dark spot in the visual field), cells in the deprived cortical region begin within seconds to respond to inputs from adjacent parts of the visual field. The underlying cellular mechanism has not been established, however, and it remains unclear whether the observed effects are due to change in the shapes of the cortical receptive fields (Gilbert) or to a more general increase in the excitability of the deprived cortical cells (Freeman).

Clearly, the cerebral cortex is no longer the uncharted territory that it was a few decades ago, but will current techniques and concepts be sufficient to sustain the present rate of exploration? It is clear that some major obstacles lie ahead: for example, W. Singer (Max Planck Inst., Frankfurt) presented evidence that perceptual binding, the process by which multiple elements are combined into a single perceptual entity, may involve synchronous firing of large populations of cells. Such patterns cannot be revealed by metabolic imaging or single cell recordings, and can only be studied using multiple electrodes, a challenging technique that is still confined to a few laboratories. Moreover, some basic issues are still obscure; for instance, as H. Barlow (Univ. of Cambridge) pointed out, timing is an essential component of both perception and behaviour, yet we still have little idea of how time is represented in the brain. Finally, conspicuous by its absence at this meeting was any discussion of the frontal lobes or their role in 'higher' cognitive functions. Human behaviour is of course determined not only by sensory inputs, but also by emotions, knowledge and reason, and understanding how all these factors interact to control behavioural decisions remains a very distant goal.

The brain is of course a product of development and ultimately of evolution, and to understand how intelligence evolved, we will need to understand not only how the brain works, but also how its development is controlled by the genome. As was clear from many other talks at the meeting, our knowledge of brain development is advancing rapidly, but the underlying genetic mechanisms are still largely mysterious. It will be interesting to see if the great synthesis looks any closer by the millennium. □

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DAEDALUS

Carbon in chains

A FEW years ago Daedalus proposed to make the long-sought linear polymer of carbon, carbyne, by rapid quenching of hot carbon vapour (*Nature* 360, 22; 1992). A recent synthesis using just this method has been dignified by editorial mention in these columns (J. Maddox, *Nature* 375, 11; 1995). Other syntheses have been reported, and the topic is developing rapidly. Carbyne is unstable, and probably explosive in bulk. Daedalus hopes to tame it by alloying it with metal.

He points out how easily graphite forms compounds with metals. Metal atoms readily get into the electron-rich spaces between its sheets of atoms, where they form collective metal–carbon bonds. Conversely, graphite is quite at home in many metals. Cast iron owes its easy machinability and its high internal damping to its graphite content. Daedalus reckons that carbyne could be stabilized the same way. Its chains of multiple-bonded carbon atoms should happily share some of their energetic π-electron density with a surrounding metal.

DREADCO's chemists are now working to this brief. One group is quenching carbon vapour in the solutions used to deposit metal mirrors; the idea is that the metal atoms will cluster around the carbyne chains as they form. Another is starting from heavy metal acetylides, which are highly explosive when dry. In the wet, however, there seems a good chance of getting them to rearrange quietly, with their C_2^{2-} ions linking into carbyne chains stabilized by their metal atoms. One way or another, the chemists hope to make a sort of metal–carbyne alloy, with parallel carbyne chains glued together by a matrix of metal.

This, of course, would be the ultimate carbon-fibre reinforced metal. Its uniquely short and stiff carbyne bonds should make it immensely strong. Like wood it will have a grain direction; but more isotropic forms, the equivalents of chipboard and plywood, could easily be fabricated. Metal–carbyne wire and laminate will make amazingly light and rigid prestressed structures, suspension bridges of unprecedented span and wonderfully light aircraft. Sadly, the alloys will retain much of the high energy of the carbyne: once ignited, they will probably burn fiercely. So Daedalus is thinking of other uses.

One will almost certainly be electronic. A set of carbyne chains in parallel with metal, and bonded to it by collective π-bonds, should have intriguing anisotropic, nonlinear or semiconducting properties. It might even be the long-awaited room-temperature superconductor!

David Jones