Such connections would reduce the need for an orderly map, adds Schieber, because neurons could be called into action in a way analogous to how computers store files on a disk. "The computer can write different bits and pieces of one file at different spatial locations on the disk," he says, "then it goes from place to place on the disk, picking up pieces of information it wants."

Such a dispersed system would be well suited to providing plasticity—the constant reforming of neural liaisons associated with learning, which is known to go on in the motor cortex as a person or monkey learns new motor skills. "The horizontal connections ... would allow new representations to emerge and to come back to their original forms in a very dynamic way," Sanes says.

The new findings also provide clues to a special function that primary motor cortex may play in movement control. The cortex is not absolutely necessary for movement; other brain areas also make connections with the motor neurons of the spinal cord. Cats can walk even when their cerebral cortex has been removed, and monkeys without a primary motor cortex can be trained to make many types of movements. Such findings raise the question of what essential tasks the primary motor cortex performs.

SUNY's Strick proposes that the multi-muscle connections of cortical neurons make the primary motor cortex particularly suited to guide complex actions that require the coordination of several muscles. In support of this hypothesis, Strick and co-worker Donna Hoffman have shown that monkeys with lesions in their primary motor cortex, while severely handicapped at first, can be rehabilitated to do many simple movements that depend largely on single muscles, such as flexing and extending their wrists. As Strick and Hoffman found earlier this year, however, the animals never regain their ability to make smooth diagonal movements that use two muscles simultaneously, such as wrist flexion with deviation to the side. To make that diagonal movement, Strick says, the monkey is reduced to using first one muscle, then the other, producing "zig-zag movements, as if tacking like a sailboat." That, he adds, suggests that "moving on the diagonal is something that would require the unique branching patterns of the cortical neurons."

So out of the remapping of the primary motor cortex comes not only a new understanding of how this brain area is arranged, but also new insights into its crucial role in complex movements. And that means that whether you are pumping iron or doing something as routine as tying your shoes, you can thank your primary motor cortex that you can glide smoothly through the movements without any zigs or zags.

**–Marcia Barinaga**


Additional Reading

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CHEMISTRY

# Sentencing Molecules to Prison

Chemists undoubtedly rank as the world's most proficient jailers. They are now adept, for example, at placing single atoms in solitary confinement, using as jail cells hollow molecular cages such as the 60-carbon molecules known as buckyballs. Researchers have long wanted to build a different kind of prison, however—one with cells large enough to house large groups of molecular prisoners. In those close quarters, chemists hope, the molecules might react in new ways. But such large cages have proved to be hard to build.

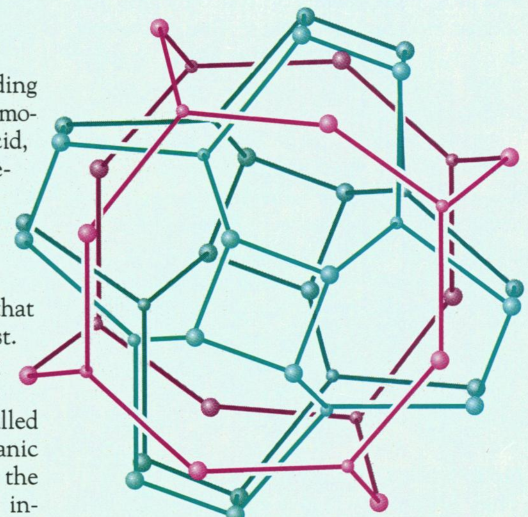
Now serendipity has intervened, and a group of Australian researchers has succeeded not only in creating larger cages but in trapping molecules inside them. The researchers, led by Richard Robson of the University of Melbourne, reported in the 17 May *Journal of the American Chemical Society* that an experiment meant to produce one kind of structure yielded something quite different: a crystalline lattice with a regular array of spherical cells 23 angstroms across. X-ray crystallography showed that these chambers were big enough to trap as many as 20 large organic molecules from the solvent in which the structure takes shape.

"It is pretty exciting," says Jeffrey Moore, an organic chemist at the University of Illinois, Urbana-Champaign, because the small confines of the cages may allow researchers "to steer chemical reactions down a different chemical path" from the one the molecules would take on their own, perhaps yielding new and useful products. And because the molecular cages can easily be dissolved by acid, researchers should easily be able to recover any reaction products they create.

Initially, Robson says, he and his colleagues Stuart Batten and Bernard Hoskins set out to make a new type of zeolite—a porous crystalline structure that can act as a molecular filter or a catalyst. To do so, they blended four building blocks—ions of zinc, cyanide, and nitrate, and large organic molecules called tri(pyridyl)1,3,5,-triazine—in an organic solvent. Intermolecular forces caused the building blocks to self-assemble—but instead of forming porous crystals, the blocks arrayed themselves in planes made up of cagelike compartments interspersed with rings.

The planes then stacked, interpenetrating so that the rings in one plane encircled the cages in the other. "It was purely accidental," says Robson. "We had no idea this sort of thing was possible." The result was a high-security molecular prison for the solvent molecules: Because the rings reinforce the cages with additional molecular bars, "there isn't any room for anything to get in or out," Robson says.

Next, the researchers hope to trap reactive molecules, such as alkenes, to see whether the confined geometry encourages them to form novel structures. Ordinarily, alkene molecules prefer to link up with hundreds and thousands of their kind to make long polymer chains. But the jail cell limits the number of molecular building blocks, preventing such chains from forming. Under those circumstances, Robson believes, the molecular building blocks may instead produce ring-shaped structures with novel chemical properties.



SOURCE: ROBSON *ET AL.*

**Cagey chemistry.** Two structures interlock to create a secure molecular jail cell.

Whether such products will ultimately prove useful, Robson says, "we won't know until we try." Either way, the researchers hope to learn whether their tiny prisons are as good at transforming molecules as they are at trapping them.

**–Robert F. Service**