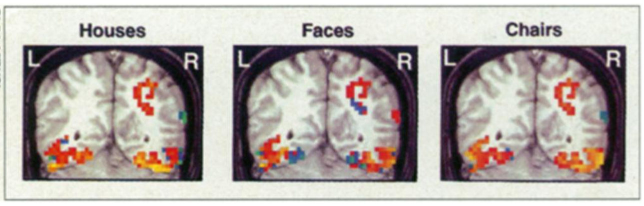
A new look at recognizing what people see

Scientists have long struggled to determine how the brain sorts out its jumble of visual information to recognize objects. Many studies have indicated that the brain dedicates separate regions, or modules, to the identification of different objects that meet the eye. For example, studies of stroke patients have linked damage in particular brain regions to specific deficits in visual abilities, such as recognizing faces.

A new study, however, suggests that broad regions of the brain sometimes work together to make sense of what people see. Alumit Ishai and her coworkers at the National Institute of Mental Health in Bethesda, Md., used magnetic resonance imaging (MRI) to track brain activity as volunteers viewed photos or line drawings of three types of objects: human faces, houses, and chairs.



Ishai/PNAS

MRI images indicate that recognition of different visual objects is distributed across multiple regions in the brain's ventral temporal cortex. Yellow and orange areas show the most activation, blue and green the least.

The researchers had predicted that houses and chairs would activate the same areas in the temporal cortex, whereas faces would activate another module. "The motivation for the study was the dual-system hypothesis, that faces have a special neural machinery that is different from the general mechanism that processes all other objects," says Ishai. "When we analyzed the data, we had a big surprise."

The MRI images revealed that each object activated different hot spots in the ventral temporal cortex, the part of the brain widely believed to be involved in recognizing objects sensed by the eye. Houses most strongly activated an area called the medial fusiform gyrus, whereas the hot spot for chairs was the inferior temporal gyrus. A third area, the lateral fusiform gyrus, lit up brightest in response to faces, the researchers report in the Aug. 3 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

The researchers also found a significant amount of activity shared between these regions. Although the medial fusiform gyrus responded most strongly to images of houses, chairs also prompted appreciable activity in this region. Likewise, the areas that lit up brightest in response to chairs or faces were also stimulated by houses. This finding, the researchers say, suggests that recognizing images triggers activity across multiple areas of the brain rather than in discrete, specialized modules.

Nonetheless, Ishai's group did find indications that face recognition is more localized than is recognition of other objects. They observed less shared activity between the region most strongly activated by faces and each of the others than they observed between the regions best activated by houses and by chairs.

The amount of attention volunteers paid to objects made less difference in the results for faces than it did for houses and chairs. This suggests that faces may spark recognition more automatically than other objects do.

"I think, in general, the motivation for the [research] is exactly right and very important," comments Nancy Kanwisher of the Massachusetts Institute of Technology. "Given all the evidence that there is some degree of specialization in the visual pathways, it's important to ask whether you find specialization for any old category."

However, Kanwisher suggests, Ishai's group may be "slightly downplaying the degree of specialization" in the temporal cortex. "Even a module that is specialized for processing just one kind of object would still be expected to engage partially on other kinds of objects, so the distributed responses reported by Ishai do not strongly argue against a modular view," she contends.

"This is an important paper because it tackles a very simple but very fundamental question about how the brain represents knowledge," remarks Martha Farah of the University of Pennsylvania in Philadelphia. "There is no more fundamental question in cognitive neuroscience than how a bunch of neurons can implement knowledge." —*S. Carpenter*

The secret to a solar cell's stability?

If solar cells are going to power more than hand-held calculators, new photovoltaic materials will have to be efficient and robust as well as cheap. A semiconductor just entering the market, called copper indium gallium diselenide (CIGS), might fit this bill. It converts sunlight into electricity almost as efficiently as the best solar devices. What's more, it seems to maintain that efficiency indefinitely and doesn't break down even after prolonged exposure to sunlight.

Now, David Cahen of the Weizmann Institute of Science in Rehovot, Israel, and his colleagues propose a new explanation for CIGS' amazing stability. Ordinarily, atoms in a stable compound don't move around. The researchers, however, suggest that copper atoms can diffuse through CIGS to repair any sites damaged by exposure to radiation. In this way, the material essentially heals itself.

Radiation hitting a CIGS solar cell loosens the chemical bonds holding the copper atoms in the compound's crystal lattice. Cahen's team calculates that these liberated atoms wander freely through the material ready to immediately fill in for any newly liberated atoms.

In this equilibrium, the copper atoms act "as an electrical analogue of a mechanical shock absorber," the researchers report in the August ADVANCED MATERIALS. They argue that in CIGS, the mobile copper atoms "allow the material a degree of flexibility that is essential for accommodating externally imposed changes."

Rommel Noufi of the National Renewable Energy Laboratory (NREL) in Golden, Colo., agrees that the mechanism proposed by Cahen's team is plausible but cautions that the new study provides "no experimental proof." He adds, "It's another perspective on why these materials are stable, but not the only one."

Solar cells generally consist of a stack of several layers of materials. The CIGS cells have a glass foundation topped with molybdenum, CIGS, cadmium sulfide, and then zinc oxide.

Noufi and his colleagues have proposed that a type of CIGS with a modified crystal structure forms at the semiconductor's interface with cadmium sulfide. This 10- to 50-nanometer-thick interfacial layer, they argue, is largely responsible for the material's high efficiency and possibly its stability. Cahen, however, doesn't accept the idea of an extra layer.

In an upcoming PROGRESS IN PHOTOVOLTAICS, the NREL team will report on CIGS devices that can convert into electric current 18.8 percent of the sunlight energy falling on them. Previous versions had an efficiency of about 16 percent (SN: 12/4/93, p. 374). The researchers achieved the latest improvements by modifying each of the layers.

Regardless of the continuing uncertainty over how they work, the performance of CIGS in solar cells is nearly as good as that of crystalline silicon, "the workhorse of the photovoltaics industry," Noufi says. Crystalline silicon solar cells, however, need thick layers of high-quality material, making them expensive for large-scale applications, such as solar panels for generating electricity. Using a thin film of CIGS in such devices could cost less per watt of energy, Noufi predicts. —*C. Wu*