Taking the fuzziness out of quasicrystals

By striving for perfection, scientists have gained a clearer picture of how certain types of quasicrystalline materials are put together. X-ray scattering experiments demonstrate that these unusual materials appear to have a fivefold icosahedral symmetry, a pattern that fails to fit conventional crystallographic rules. In the past, however, the fuzziness of the X-ray results left room for a number of different theories as to how such crystals are organized internally. Now several teams of researchers have prepared quasicrystalline samples perfect enough to give extremely sharp X-ray images that settle the question.

A normal crystal consists of groups of atoms that appear, like building blocks, in a regularly repeating pattern. In contrast, according to the original quasicrystal model, quasicrystals have at least two different basic building blocks, or unit cells, fitted together so as to create a structure that is neither regular nor random. Yet despite the lack of a perfectly repeating pattern, the orientation of one unit cell still determines the orientation of cells far away. The whole structure has a kind of long-range order (SN: 7/16/88, p.42).

But X-ray scattering experiments on the earliest known quasicrystalline materials produced images that were fuzzy, indicating the presence of more disorder than the quasicrystal model allows. Scientists favoring the quasicrystal model attributed the fuzziness to the presence of defects known as phasons, which correspond to misalignments of the material's unit cells.

However, Peter W. Stephens, presently at Tohoku University in Sendai, Japan, and Alan I. Goldman of Iowa State University in Ames suggested another possibility, which they called the icosahedral glass model. They proposed that the materials are more like glasses than defect-strewn crystals. In their model, groups of atoms form into a single type of unit cell in the shape of an icosahedron (a regular geometric figure having 20 triangular faces). Such units then fit together as best they can to create a rather sloppy but still partially ordered structure.

The discovery of a new class of quasicrystalline materials in Japan in 1987 set the stage for a test of the two competing models. Researchers found that combining aluminum and copper with either iron or ruthenium leads to crystals many times more perfect than any previously known quasicrystalline materials. Samples of these new materials, produced during the last two months at the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., Tohoku University, AT&T Bell Laboratories in Murray Hill, N.J., and Harvard University, have none of the characteristic disorder seen in other quasicrystals.

"The materials are too perfect to be described sensibly in terms of an icosahedral glass model," says Paul J. Steinhardt of the University of Pennsylvania in Philadelphia. Steinhardt and Dov Levine proposed the original quasicrystal model.

"With these new materials, you can nail down the widths and positions of [X-ray] peaks to such a high accuracy that there's no need to discuss defects in the material," says IBM's Peter A. Bancel. "It really blows any competing picture out of the water."

"I'm tremendously excited," says Goldman, who is studying samples of the ruthenium alloy. "Of course, I'm a little disappointed that our model doesn't hold up here, but models are meant to be looked at critically and put aside if they don't explain the phenomena."

But many questions remain. Although researchers now know that true quasicrystals can be produced, no one knows why the new materials work so well and why the previously discovered materials form into such poor crystals. Researchers are now busy working on that puzzle. *— I. Peterson*

Baby faces show the right side of emotion

The crease of a smile and the angle of a frown are providing surprising clues to how the brain generates spontaneous emotional expressions in the first year of life.

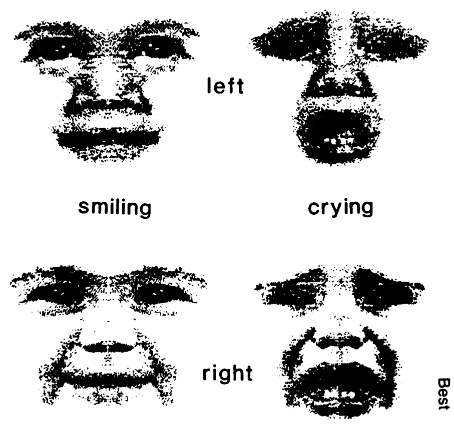
In two independent studies, researchers document greater emotional intensity on the right side of the face among infants, although previous investigations indicate emotional expressions are more intense on the left side of the face among right-handed adults.

Researchers assume the adult pattern reflects the influence of the brain's right hemisphere, which controls many muscles on the left side of the face and is crucial in generating emotional displays. In addition, the left hemisphere — which controls much of the right side of the face — may be more important in inhibiting emotional displays, thus contributing to more intense expressions on the left side.

The new evidence suggests the right hemisphere matures more quickly during infancy, says psychologist Catherine T. Best of Wesleyan University in Middletown, Conn. Its initial specialization for emotion apparently involves dampening the expression of spontaneous emotions produced deep within the brain. As the left hemisphere matures and emotions come under more voluntary control during preschool years, its inhibiting effect on emotions eventually may surpass that of the right hemisphere.

Best and colleague Heidi F. Queen made computer copies of photographs of six smiling and four crying babies between 7 and 13 months of age. Each half of a face was then combined with its mirror image. For example, the right side of a smiling face was flopped over to create a complete face. In a series of experiments reported in the March Developmental Psychology, right-handed university students used a seven-point scale to rate the intensity of emotional expression in each composite image. They also determined whether the right- or left-side composite for each infant was more expressive.

Right-sided expressions were rated as more intense, the researchers note, especially when the mouth was rated separately. Crying expressions were rated as more intense than smiling expressions.



Left and right mirror-image composites of a smiling and a crying infant.

Another study, conducted by Mary K. Rothbart and her co-workers at the University of Oregon in Eugene, had undergraduates rate the intensity of distressed and happy expressions made by 59 infants videotaped several times between 3 and 13½ months of age. Using stills from the videotapes, raters covered each half of a baby's face before making a judgment.

Again, expressions were significantly more intense on the right side of the face, say the psychologists, who will describe their findings in an upcoming Neuropsychologia.

Best says these results support evidence of an earlier right-hemisphere inhibition of spontaneous left-sided movements in general. For instance, most infants prefer to turn their heads and bodies to the right (SN: 1/7/89, p.10).

"While we can only speculate now on the brain development that mediates the change from infant to adult facial [patterns]," Rothbart says, "a better understanding of this process may not only explain facial expressions — it may also clarify basic mechanisms of emotional development." *— B. Bower*