Press, 1999), adds: "It's an accident of birth, like having five fingers instead of seven."

More focused comparisons have yielded similarly provocative conclusions. In another talk, MIT linguist David Pesetsky, a former student of Chomsky's, examined the Question Rule, or the arrangement of parts of speech in a question. At first glance, questions appear strikingly different in many languages. In English, for example, we ask, "Whose book did Mary buy?" In Russian, the same question, "Chju Marija kupila knigu?" (translated word for word), comes out as "Whose Mary bought book?" Comparing these sentences and equivalents in Bulgarian and Okinawan, a Japanese dialect, Pesetsky and students Paul Hagstrom and Norvin Richards have discovered a recurring syntax theme: No matter what their native tongue, people consistently place variations on the word "whose" and accompanying words at one end of a sentence.

Both sets of findings are compelling, says Victoria Fromkin, a linguist at the University of California, Los Angeles (UCLA). "The universal properties they've found—combined with the fact that children show an amazing ability to pick up language—make a very strong case that our species is biologically endowed with a set of rules for communication," she says. But some researchers contend that Cinque, Pesetsky, and their colleagues are overreaching. "We all agree that humans have a language faculty," says UCLA's Edward Keenan. "What's at issue is how specific it is." But regarding precise rules for a universal grammar, he says, "the evidence just isn't in." Pesetsky demurs: "I think we're tapping something basic here." –**KATHRYN S. BROWN**

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AAAS MEETING
▶NEUROBIOLOGY

Magnetic Cells: Stuff of Legend?

Many animals are attuned to a world hidden from our perception: Bats bounce sound waves off prey, snakes slither through grasslands awash in infrared light, and sharks hunt in the electrical trails of their next meal. Now scientists have taken a step closer to confirming the existence of another sense: the ability to use Earth's magnetic fields to navigate on starless nights or in turbid waters. Migratory and homing animals such as birds, bees, and fish seem to possess a built-in compass, and at the meeting Carol Diebel of the University of Auckland in New Zealand presented new findings on the iron-laden cells that may provide these creatures with a legend to Earth's magnetic road map.

Two years ago, a team led by Diebel's colleague Michael Walker showed that captive trout could be conditioned to nudge a bar and receive food when the fish detect a magnetic field. In a 1997 report in *Nature*, the group traced this magnetic sense to nerves rooted in tissue, rich in iron crystals, located in the trout's nose. Now Diebel and Walker have found that these crystals—presumably composed of magnetite, a mineral used in the first humanmade compasses—are polarized like a bar magnet, and that they appear to be strung together in chains inside so-called magnetoreceptor cells. Scientists who have been engaged in a decades-long hunt for these cells—and have endured derision for working in a field tarnished by dubious research—say they feel vindicated. "This is the last nail in the argument for these things being the magnetoreceptor cells," says Joseph Kirschvink, a geobiologist at the California Institute of Technology in Pasadena who first proposed the magnetite-based magnetoreception theory 20 years ago.

Over the past 3 decades, magnetite has been found in life-forms as diverse as bacteria, birds, whales, and humans. Although the 50-nanometer particles are just the right size to act as bar magnets in the body (crystals too large would set up interfering fields, while those too small would create unstable fields), locating the magnetite-bearing cells in higher organisms has been like trying to autopsy a living person: The tissue-dissolving methods used to identify magnetite turn the sample to mush.

Diebel knew her team was looking for a needle in a haystack. Organisms contain very little magnetite and the cells that harbor it could be anywhere, as magnetic fields pass through the body relatively unimpeded. "You could spend forever trying to find nanometers of crystal in millimeters of tissue," she says. "We had to invent new methods every step of the way." Her group turned to a magnetic force microscope, running it less than a hair's width above thin slices of trout nose tissue. Positive charges in a magnetic field attract the magnetized probe, and negative charges repel it. The trout snout lit up the computer screen. "We were jumping around the room when we saw this blip" representing a magnetic dipole, Diebel says.

The group next used a confocal microscope to map structures within the putative magnetoreceptor cells, arrayed in the shape of a three-leaf clover. They discerned what appeared to be chains of magnetite that resemble those in bacteria which respond to a magnetic field. How the chains may function in multicellular organisms is anybody's guess, but Kirschvink speculates that changes in Earth's magnetic field twist the chains, perhaps forcing open ion channels that send signals to the brain.

Not everyone is convinced the scientists have uncovered the whole picture. "These cells appear to be involved in magnetoreception, but their role in behavior is still unclear," says John Phillips, a neuroethologist at Indiana University, Bloomington, who studies how light helps newts orient themselves in their surroundings. To tie the mechanism to behavior, researchers still must try to disrupt the cells and show an effect on navigation. The work could open the door to exploring an enduring biological mystery: whether, unwittingly, we use the traces of magnetite in our own bodies to make more sense of this bewildering world.

–**MELISSA MERTL**

AAAS MEETING
▶BIOENGINEERING

Fishing for Toxic Chemicals

Many toxicologists can remember being dogged at some point by people opposed to chemical tests on animals. But when Richard Winn, a toxicologist at the University of Georgia, Athens, asked one protester how she would feel if lab mice and rats were retired in favor of fish, she answered, he recalls, "that because fish don't have faces, she would be much more comfortable." If other animal activists feel the same way, then Winn has moved a step closer to

Guinea pigs with gills? Medaka fish could supplant rodents as the animal of choice for tox labs.

CREDIT: R. WINN

easing the disapproval that he and his colleagues often feel. At the meeting, he described a promising new line of fish for screening toxic chemicals.

To enhance their ability to detect the mutations that chemicals might cause, in the mid-1980s toxicologists began equipping lab mice with bacterial genes that can be pulled out and screened for damage. This is much easier than, say, screening the entire mouse genome or waiting for tumors to develop. Now, Winn and his colleagues have introduced the same bacterial genes into fish, and they found in early tests that the transgenic fish are just as sensitive at picking up mutations as the modified rodents are.

Experts caution that more work will be needed before the fish find widespread use as guinea pigs. But if the research does pan out, the fish should help make toxicology testing cheaper as well as less politically sensitive than it is in rats or mice. A standard 2-year testing regimen on rats, for example, can cost $1 million or more; nobody's done such an estimate for fish, but keeping a fish costs "pennies a year," compared to about 20 cents a day per rodent, Winn says.

Hoping to find an alternative, Winn turned to medaka, the small, Japanese, freshwater fish already used for toxicology tests. These fish had previously been modified so that they carry a foreign gene to detect mutagens, but this target is so small that it can pick up only certain small-scale chemical effects—those that alter a single A-T base pair.

In the first phase of its experiment, Winn's group took two bacterial genes, called *LacI* and *cII*, which are used in mice to detect mutations caused by chemicals, and spliced them into a bacterial virus. The researchers then injected this bacteriophage into medaka eggs, where it carried the new genes into the nucleus. The fish that developed, Winn found, carried the genes in all their cells and had a low rate of spontaneous mutations in those genes.

Winn's group next dumped a standard mutagen, *N*-ethyl-*N*-nitrosourea (ENU), into the fish tanks and, after waiting 1 to 16 hours, ground up the fish and retrieved the bacterial DNA for analysis. The researchers found that they could detect even slight genetic changes, charting a two- to threefold increase in mutations at low exposures to ENU.

Winn also described a transgenic medaka with a third gene called *LacZ*, which he says works well for detecting radiation-induced damage. Radiation tends to knock out or rearrange big chunks of DNA, and this gene is big enough—and its carrier, a circular piece of DNA called a plasmid, is sturdy enough—that there is sufficient DNA left for analysis after a radiation hit. In collaboration with University of Georgia colleagues who work at the site of the Chernobyl reactor accident and at nuclear waste dumps, Winn has begun exposing these fish to radiation-tainted sediments and looking for effects on the gene.

"I was really thrilled" to hear about Winn's progress, says toxicologist Barbara Shane of Louisiana State University in Baton Rouge, who studies cancer in mice. She and others are eager to begin tests on transgenic medaka. Winn cautions, however, that more work is needed to prove that the fish give predictable results with many more chemicals. "We're still at an early stage, but it's time to talk about it," he says.

–JOCELYN KAISER

AAAS MEETING

ANTHROPOLOGY

More Questions About The Provider's Role

Of all sexual arrangements, monogamy is the rarest of the rare—only a small percentage of animals do it. Why did our ancestors adopt such an unusual arrangement? One theory has been that early human fathers provided food for their mates in exchange for fidelity. But according to reports presented at the meeting, multiple partners and blurred lineages have developed in some modern cultures. The existence of such societies, one anthropologist suggests, raises questions about whether the nuclear family, with a faithful couple at its heart, arose as a result of the food-for-fidelity bargain. Other evolutionary models, such as mitigating males' fierce competition for access to females, may better explain monogamy's origin, argues anthropologist Kristen Hawkes of the University of Utah, Salt Lake City.

Daddies' kids? The Barí belief that a child can have several fathers raises questions about monogamy's origins.

CREDIT: STEPHEN BECKERMAN/PENN STATE

For a long time, many anthropologists thought monogamy arose in our early ancestors as part of an unspoken bargain, in which males bought fidelity by filling the family cooking pot, seeking to avoid investing resources in another man's child. In this view, the gender bargain was a key adaptation that set off the evolution of our genus, *Homo*. But when Hawkes heard about isolated primitive societies in which paternity is often fuzzy, she started wondering whether other models could better account for such diverse family arrangements.

While living among the Aché tribe of Eastern Paraguay and later the Hadza tribe in northern Tanzania off and on for several years, Hawkes and her team found signs of a remarkably egalitarian society. After the men returned from a hunt, each family received equal portions of meat. This doesn't fit the bargain hypothesis, Hawkes says. What's more, the few Hadza men who scored a kill—not an easy task when hunting big game with a daily failure rate of 97%—had younger (and therefore presumably more fertile) wives and other sexual partners, and they fathered more children than other men did. The hunters' offspring also had a higher survival rate, perhaps because the fathers tended to mate with skilled, hard-working women who gathered most of the food by foraging for plants.

Other research presented at the meeting also undermines the bargain hypothesis. Among the Aché as well as the Barí of Columbia and Venezuela, the belief that a child can have several fathers (a phenomenon called partible paternity) is quite common, says anthropologist Stephen Beckerman of Pennsylvania State University in University Park. About 24% of the Barí children and 63% of the Aché children had more than one cultural "father," and all of the fathers offered the children food gifts and protection. Such children had a survival advantage, Beckerman reports, noting that "80% of the children with secondary fathers survived to age 15, compared to only 64% of the children with a single father." Thus, "partible paternity is a poke in the eye for the bargain hypothesis." Beckerman says this shows that being certain of paternity is not necessary in some human cultures—and therefore may not have been "a crucial element in the evolution of modern humans."

If not male provisioning, then what did spur monogamous arrangements? Hawkes has her own theory: Monogamy arose as "negotiations between males" about access to females, to cut the high risks of direct fighting.

Other anthropologists like Hawkes's critique. "It was way too simple an idea that monogamy is exclusively based on male provisioning," says Frank Marlowe, a biological anthropologist at Harvard. Still, not everyone is convinced. "Some anthropologists bitterly disagree with [Hawkes]," says Nicholas Blurton-Jones, a biological anthropologist and professor emeritus at the University of California, Los Angeles. "But she's gaining ground."

–MICHAEL HAGMANN