The bird gets a little r-e-s-p-e-c-t

By Sandra Blakeslee The New York Times Thursday, February 3, 2005

NEW YORK Birdbrain has long been a colloquial term of ridicule. The common notion is that birds' brains are simple, or so scientists thought and taught for many years. But that notion has increasingly been called into question as crows and parrots, among other birds, have shown what appears to be behavior as intelligent as that of chimpanzees.

The clash of simple brain and complex behavior has led some neuroscientists to create a new map of the avian brain. This week, in the journal Nature Neuroscience Reviews, an international group of avian experts is issuing what amounts to a manifesto. Nearly everything written in anatomy textbooks about the brains of birds is wrong, they say. The avian brain is as complex, flexible and inventive as any mammalian brain, they argue, and it is time to adopt a more accurate nomenclature that reflects a new understanding of the anatomies of bird and mammal brains.

"Names have a powerful influence on the experiments we do and the way we think," said Erich Jarvis, a neuroscientist at Duke University and a leader of the Avian Brain Nomenclature Consortium. "Old terminology has hindered scientific progress." The consortium, comprising 29 scientists from six countries, met for seven years to develop new, more accurate names for structures in both avian and mammalian brains. For example, the bird's seat of intelligence, or its higher brain, is now termed the pallium.

Scientists have come to agree that birds are indeed smart, but those who study avian intelligence differ on how birds got that way. Experts, including those in the consortium, are split into two warring camps. One holds that birds' brains make the same kinds of internal connections as mammalian brains do and that intelligence in both groups arises from these connections. The other holds that bird intelligence evolved through expanding an old part of the mammal brain and using it in new ways, and it questions how developed that intelligence is.

"There are still puzzles to be solved," said Peter Marler, an authority on bird behavior at the University of California, Davis, who is not part of the consortium. But the realization that one can study mammal brains by using bird brains, he said, "is a revolution."

"I think that birds are going to replace the white rat as the favored subject for studying functional neuroanatomy," he added.

The re-analysis of avian brains gives new credibility to many behaviors that seem odd coming from presumably dumb birds. Not only do crows make hooks and spears of small sticks to carry on foraging expeditions, some have also learned to put walnuts on roads for cars to crack. African gray parrots not only talk, they have a sense of humor and make up new words. Baby songbirds babble like human infants, using the left sides of their brains.

Avian brains got their bad reputation a century ago from the German neurobiologist Ludwig Edinger, known as the father of comparative anatomy. Edinger believed that evolution was linear, Jarvis said. Brains evolved like geologic strata. Layer upon layer, the brains evolved from old to new, from fish to amphibians to reptiles to birds to mammals. By Edinger's standards, fish were the least intelligent. Humans, created in God's image, were the most intelligent. Edinger cut up all kinds of vertebrate brains, noting similarities and differences, Jarvis said.
In mammals, the bottom third of the brain contained neurons organized in clusters. The top two-thirds of the brain, the neocortex, consisted of a flat sheet of cells with six layers. This new brain, the seat of higher intelligence, lay over the old brain, the seat of instinctual behaviors. In humans, the neocortex grew so immense that it was forced to assume folds and fissures, so as to fit inside the skull.

Birds' brains, in contrast, were composed entirely of clusters. Edinger concluded that without a six-layered cortex, birds could not possibly be intelligent. Rather, their brains were fully dedicated to instinctual behaviors.

This view persisted through the 20th century and is still found in most biology textbooks, said Harvey Karten, a neuroscientist at the University of California at San Diego and a member of the consortium, whose research has long challenged the classic view.

There is a bird way and a mammal way to create intelligence, he said. One uses clusters. One uses flat sheet cells in six layers. Each exploits the basic design of having a lower brain and a higher brain with mutual connections. In the 1960s, Karten carried out experiments to trace brain wiring and identify the paths taken by various brain chemicals. In humans, the chemical dopamine is found mostly in lower brain areas, called basal ganglia, which consist of clusters.

Using the same tracing techniques in birds, Karten found that dopamine also projected primarily to lower clusters and no higher. Later studies show numerous similarities between clusters in the mammalian brain and lower clusters in the avian brain. Experts now agree that the two regions are evolutionarily older structures that lie underneath a newer mantle.

Meanwhile, examples of brilliance in birds continue to flow from fields and laboratories worldwide.

Nathan Emery and Nicola Clayton at the University of Cambridge in England study comparisons between apes and corvids: crows, jays, ravens and jackdaws. Relative to its body size, the crow brain is the same size as the chimpanzee brain.

Everyone knows, Emery said, that apes use simple tools like twigs, selecting different ones for different purposes. But New Caledonian crows create more complex tools with their beaks and feet. They trim and sculpture twigs to fashion hooks for fetching food. They make spears out of barbed leaves, probing under leaf detritus for prey.

At a university in Japan, carrion crows line up patiently at the curb waiting for a traffic light to turn red. When cars stop, they hop into the crosswalk, place walnuts from nearby trees onto the road and hop back to the curb. After the light changes and cars run over the nuts, the crows wait until it is safe and hop back out for the food. And pigeons can memorize up to 725 different visual patterns.