COGNITION RESEARCH

Monkeys Read Faces too

Photo: Cory T. Miller

Rhesus monkeys possess a large repertoire of vocal and facial expressions.

Investigating the link between facial and vocal expressions is a prerequisite for understanding human speech perception. Scientists at the Max Planck Institute for Biological Cybernetics in Tübingen have now shown that not only humans, but also rhesus monkeys are able to understand the connection between their own species' facial and vocal expressions (NATURE, July 26, 2003). The researchers see this ability in monkeys as an evolutionary precursor to human speech perception.

Species-specific vocal expressions of monkeys are essential for their social interactions, reproductive success and survival. The animals often produce their sounds in connection with quite specific body postures and facial expressions. With most primate species – as with humans too – these various kinds of signals are very complex, as is most clearly illustrated in human language. Here, the combination of auditory and visual signals plays an important role in our perception: It makes a big difference if a person smiles or looks angry when they speak. However, it was previously not known whether animals also perceive sounds and facial expressions as a whole. Rather, the prevailing view was that only humans possess this ability.

Dr. Asif Ghazanfar and Prof. Nikos Logothetis from the Max Planck Institute for Biological Cybernetics, Tübingen, have now investigated whether rhesus monkeys (*Macaca mulatta*) – a species with a complex repertoire of facial and vocal expressions – are able to recognize the connection between auditory and visual signals within their communication system. They showed eleven monkeys two synchronized videos played side by side, each video featuring the same monkey but producing quite different facial expressions: in one case associated with "threat" calls and in the other with friendly "coo" calls. Simultaneously the monkeys heard a vocal expression over loud speakers that only matched one of the two videos. Without any training at all, the majority of monkeys (65 percent) immediately realized which facial gesture fitted the sounds and instantly looked at the screen with the matching facial expressions.

These experiments substantiate the idea that rhesus monkeys can match particular sounds with the "same meaning" facial expressions of their species.

Asif Ghazanfar interprets this ability as representing an evolutionary precursor of humans' complex speech perception. Earlier, behavioral studies with highly-trained monkeys had exclusively concentrated on the connection between visual and tactile stimuli, but the results of these studies proved inconclusive. The new results closely correspond to those from similar tests with small children: babies can already link voices and facial expressions at the age of two months – long before they learn to speak. It could indeed be that humans inherited this trick from their primate ancestors.

It is known from studies with humans that the temporal cortex plays an important role in the integration of various communication modes in the brain. Ghazanfar and Logothetis now want to clarify which neurons and brain areas in primate brains contribute to linking of different sensory modalities. The question is also: Are there corresponding areas in human and non-human primate brains that integrate the auditory and visual modalities? The answer could provide clues to the animal origins of human speech. ●

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RESEARCH *in Brief*

SENSORY PHYSIOLOGY

A Switch in the Ear

We perceive our surroundings using our senses: Specialized receptors in the eye, skin or tongue allow us to register light, touch, pain or cold. Now, one of the last, still uncharted sensory receptor molecules has been identified as an ion channel responsible for converting mechanical energy into electrical impulses in inner ear hair cells (SCIENCE, June 12, 2003).

Through these cells, with their surface covered in minute protuberances of hairs, we detect mechanical stimuli such as noise or movement. When the tiny hairs are deflected by noise or movement, ions stream into the cell and mechanical energy is converted into electrical impulses. But at the molecular level it was not known exactly how the sensory hair cells manage this energy transformation; it was merely assumed that certain ion channels mediated this conversion.

Now researchers at the Max Planck Institute for Developmental Biology (Tübingen) and for Medical Research (Heidelberg) have reported the identification of the receptor molecule responsible for this signal transformation in zebra fish in the international journal SCIENCE.

All sensory perception is based on the conversion of stimuli into electrical signals that are passed on to the brain. For the conversion, or transduction, of these signals many sensory receptors use the same type of ion channel, the transient receptor potential channels or TRP-channels. Ion channels are proteins that form small pores in the cell membrane and selectively permit small molecules to flow into the cell.

Genetic analyses in organisms such as the worm and the fruit fly have proved useful for identifying the molecules involved in sensory perception. R. Walker and his fellow researchers [R. Walker, A. Willingham, C. Zucker, SCIENCE 287, 2229 (2000)] achieved a breakthrough in the molecular understanding of mechanosensation – the conversion of mechanical stimuli into electrical signals – when they identified a new kind of TRP-channel required for touch sensation in fruit flies. For higher organisms, however, no homologous gene could be found in the genome databanks; an indication that this special channel, called NompC, is perhaps only present in invertebrates.

The hope that Nomp C might also be involved in sensory hair cell transduction was almost given up. Now the scientists in Tübingen and Heidelberg have made a significant breakthrough with the identification of a NompC receptor related ion channel in zebra fish.

Elimination of this channel and consequently its activity in zebra fish larvae (3-4 days old) results in deafness. Electrical current measurements carried out with the sensory hair cells in zebra fish showed that NompC is in fact necessary to transduce mechanical stimuli.

This evidence indicates that mechanical stimuli perception in lower, as well as higher organisms is controlled by an evolutionary conserved ion channel, NompC, that arose in a common arthropod and vertebrate ancestor, and subsequently formed this specific sensory system.

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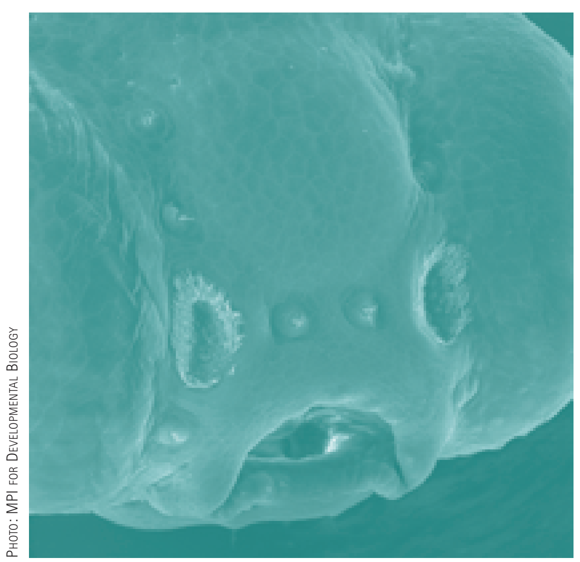

Photo: MPI for Developmental Biology

Electron microscope image of a 5-day-old zebra fish larvae. Two clusters with sensory hair cells of the lateral-line system are visible above the mouth along with clusters near the eye. Fish and amphibians use the lateral-line organ to register movement in water.