of Cellular Microbiology at the Max Planck Institute for Infection Biology in Berlin, Arturo Zychlinsky, and a microscopy team headed by Volker Brinkmann discovered that neutrophils can also grasp onto and destroy bacteria extracellularly: using different microscopes, the researchers were able to demonstrate that neutrophils form fine fibers outside of the cells.
The scientists in Berlin have termed these structures "neutrophil extracellular traps," or NETs, which are exceedingly sophisticated and not only entangle, but also disarm and kill bacteria. The mesh of these nets is composed of chromatin, a composite of deoxyribonucleic acid and proteins, which is normally found only in the nuclei of eukaryotic cells. The majority of the proteins in chromatin are histones, which are poisonous to bacteria. In addition, the NETs contain immune agents from the neutrophilic granules. Both methods of attack can explain the recent findings made in cooperation with Yvette Weinrauch from New York University, which show that NETs can kill bacteria with great efficiency, including various forms of Shigella (the pathogen that causes bacterial dysentery), Salmonella (typhoid fever) and Staphylococcus, the etiological agent of many diseases from ear infections to toxic shock syndrome.

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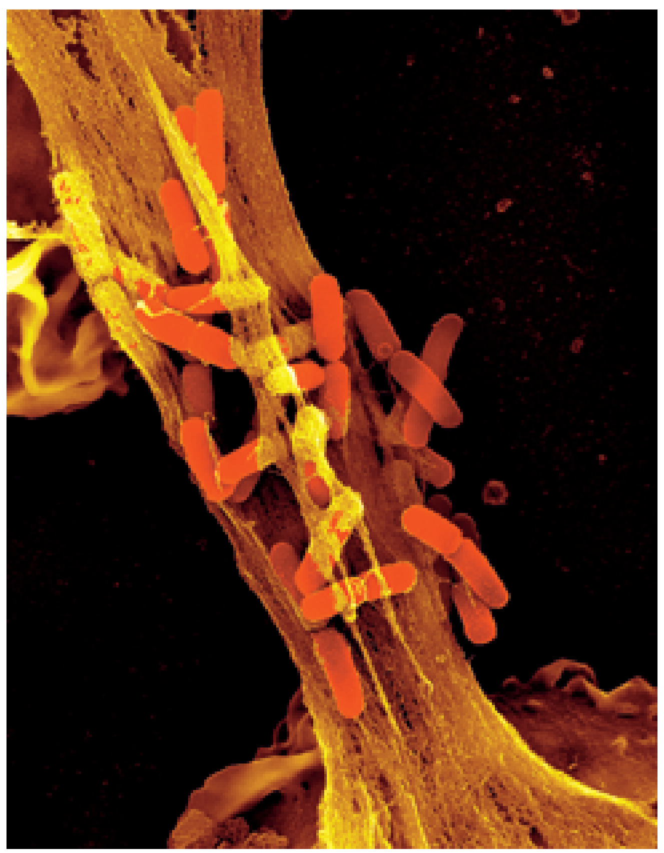
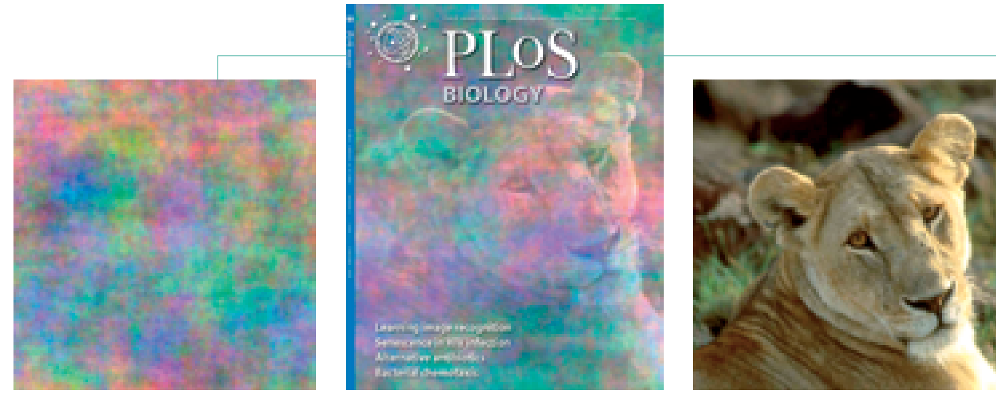


Fiber net bundle with Shigella (orange).

BIOLOGICAL CYBERNETICS

Seeing by Learning

Cross-linkage of nerve cells in the higher cognitive regions of the brain enables people to remember other people, objects and events. Thanks to the plasticity of such networks, we can continuously store new content. Researchers at the Max Planck Institute for Biological Cybernetics in Tübingen have now discovered that learning also has a feedback effect on the neurons of the brain's visual centers themselves. And that this optimizes interaction and feedback between sensory and associative brain areas, in addition to the "upward" information flow from visual areas (PLOS BIOLOGY, February 17, 2004).



The natural image of a lion (right) was mixed with "visual white noise" (left) to create a version of the natural image that is blurred and difficult to recognize (center).

FIG.: ROBERT SHALLENBERGER/US FISH AND WILDLIFE SERVICE

Primates' brains recognize familiar objects and persons with great accuracy, even when embedded in complex and dynamic settings. This ability is largely based on the fact that learning and neuronal plasticity enable the brain, also during adulthood, to constantly adapt itself and continually optimize the perception process – this is why, as experience shows, repeated observation improves our ability to recognize objects. It has long been unclear, however, how the brain coordinates such improvements.
Visual signals initially travel from the eyes to the primary visual cortex and from there further into nearby "lower" processing areas in which visual features are analyzed. Together, these regions form the brain's so-called visual centers. Injury to these centers results in blindness. From here, visual signals are sent to "higher" cognitive brain areas in the temporal and frontal lobes, which are involved in representing objects and persons. Injuries to these regions mean that objects and persons can still be seen, but no longer recognized.
Scientists have established that learning alters the activity and cross-linkage of neurons in higher brain centers in adulthood. It is assumed that such modifications constitute the internal representation of learned contents. On the other hand, the properties of the visual centers, according to standard opinion, are no longer capable of change. Recently, however, scientists came across the first evidence that learning also modifies visual centers; however, the extent and behavioral relevance of the learning effects remained unclear.
Gregor Rainer, Han Lee and Nikos Logothetis from the Max Planck Institute for Biological Cybernetics have now been able to show that learning does indeed strongly influence the activity of sensory brain centers. The cognitive scientists were able to empirically investigate such effects by training monkeys to identify computer images of specific objects from their "natural" environment, which, with the aid of interpolation techniques, could then be made less recognizable to varying degrees.
The scientists presented the monkeys with individual images of "natural" objects – including, for example, birds and humans – each blurred to a greater or lesser extent. Shortly afterwards, a second image was shown to the monkeys, whose task it was to signal whether the second image corresponded with the first. The neuronal activity in the lower visual processing regions was simultaneously recorded. The result: In new and non-blurred images, the activity of the neurons showed little change, whereas in blurred images, the activity increased dramatically. In addition, the greater the activity and informational content of the neurons, the more the monkeys' ability to detect partially recognizable images improved.
But just how do individual neurons in the lower visual centers manage to improve recognition of blurred images? After identifying a group of neurons that responded and fired more strongly to blurred stimuli, the scientists investigated the monkeys' eye movements to find out how the animals were able to recognize already familiar objects. The results showed that, subsequent to learning, eye movements scanning the original images overlapped considerably with those scanning their blurred counterparts. The monkeys had obviously learned to concentrate their attention on particularly striking properties of the images, allowing them to recognize the blurred versions of the original images.
The experiments show that the recognition of ill-defined images is greatly improved by learning, and that such improved performance is dependent on the neurons in the lower visual processing regions. These neurons compensate for indistinct visual contents by coordinating different regions of the brain and constructing a learning-dependent increase in information on visual stimuli. Lower visual processing areas are therefore fundamental in resolving ambiguities in the contents of perception, and achieve this by interacting with higher brain regions – this is how even unclear images are interpreted correctly in the end.
These discoveries prove that learning also leads to changes in the informational content and the activity of neurons in lower visual centers. Seeing and recognition, according to Rainer and his colleagues, are dynamic processes that are fundamentally contributed to by the interactions between lower sensory brain regions and higher cognitive regions. In the course of such interactions, the continuous signals from the retina are processed against the brain's expectations and experiences. This integration between input and expectations already occurs in the lower visual centers. As a result, we see that which we have learned to recognize.

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