I f you “can’t see the forest for the trees,” you’ve focused too much on the details to take in the larger situation; your priorities may be confused, but usually this won’t threaten your survival. If you can’t see the tiger for the trees, you have a problem of a rather different sort.

Recent research by Tarr professor of molecular and cellular biology Markus Meister suggests that the eye’s retina—in animals as diverse as rabbits and salamanders—focuses on “difference” as we scan the landscape. The retina de-emphasizes recurring features, like the relatively static and non-threatening trees, while keying in on the mobile and potentially lethal tiger. In a recent issue of *Nature*, Meister and coauthors Toshihiko Hosoya of the RIKEN Brain Science Institute in Japan and Stephen A. Bacchus of Stanford University report that, rather than simply relaying an exact representation of visual reality to the brain, the retina may engage in “predictive coding,” accenting important features in the field of vision.

The researchers used pieces of retina taken from New Zealand white rabbits and larval tiger salamanders. (According to Meister, the retina remains neurologically functional for anywhere from eight to 24 hours after removal from the eye.) The tissue samples were placed, with their ganglion-cell sides down, on an array of 61 electrodes. “Visual stimuli,” the authors write, “were generated on a computer monitor and projected through an objective lens onto a 3.25-mm. diameter aperture of the retina.”

“Reading” the reaction of the nerve cells via the electrodes, the researchers observed attention “spikes” when they varied the visual stimuli. In effect, the retinal cells themselves became inured to exposure to a consistent pattern and “perked up” when exposed to something new and different. In an environment such as a forest, where vertical lines predominate, the retina tends to respond more strongly to horizontal elements than vertical ones—paying attention to novelty.

If you were to stare at a checkerboard floor-tile pattern for a few minutes, until your vision blurred a little and you lost focus, you might think “you” were getting bored with the pattern. Meister’s research suggests that the process is both more local and more specific—not even, really, a matter of your brain or the larger nervous system. The loss of focus amounts to a kind of preprocessing on the part of the retina.
Meister has been working on vision-related research for more than 15 years. Vision shows remarkable parallels not only across taxonomic classes, such as mammals and amphibians, he says; there are even features that seem to be common to all vertebrates. “Each visual system [the eye, the optic nerve, the connections to the brain],” he explains, “has evolved to solve the particular tasks required by its owner. But as regards the retina, it is actually remarkably similar in all these animals. The same basic types of neurons, the same three-layer structure, the same kinds of connections, and generally the same principles of processing.

“Here is why I think that’s the case,” he continues. “The retina is essentially the interface between the animal and images from the natural world. It must convert an optical image into neural signals, adjust the gain [increase in signal power expressed as a ratio of output to input] to deal with different conditions of illumination, and then somehow compress the information so it can be transmitted to the brain. All these tasks are pretty much driven by visual images from the natural world, and those are the same whether you’re a monkey or a rabbit.” Though the researchers have not done experiments on a human retina, “You can see effects in human vision that look like this,” Meister says. “They go under the rubric of ‘pattern adaptation.’”

Markus Meister’s research may someday help restore vision after retinal degeneration. One form, macular degeneration (the macula is the center of the retina, at the back of the eye), is a leading cause of blindness. It affects more than an estimated 25 million people worldwide, including nearly a third of those older than 75. As the U.S. elderly population swells during the next two decades, the number of Americans affected is expected to double.

Although macular degeneration is not a central focus of Meister’s work, he says that, “down the line, understanding how the retina encodes visual information will be essential to building a ‘retinal prosthesis’ that could emulate the retina’s function.”

Currently, he’s participating in two projects to develop such a treatment, one at Massachusetts Eye and Ear Infirmary, the other at MIT and Massachusetts General Hospital. “One scheme,” he explains, “is to make a chip that will stimulate the optic nerve fibers with electrical pulses that would otherwise have been produced by the retina. The more we understand how the real retina processes images, the better we will know how to control such an artificial retina. The other scheme is built on a form of gene therapy—less technical wizardry involved, but it may work sooner.”

Vladimir A. Lukhtanov saw Agrodiaetus butterflies of several species flying together, and even though they all looked much the same in most respects—all an inch to an inch and a half wide, with the same sort of spots, and, upon examination, same-shaped genitalia—the males of different species had wings of different color. Why?

Lukhtanov is an entomologist at St. Petersburg State University in Russia, where one of his students was Nikolai P. Kandul. Kandul came to Harvard and completed a doctorate in organismic and evolutionary biology this year, working in the laboratory of Hess professor of biology Naomi E. Pierce. With Kandul as link, collaborating teams—consisting of Lukhtanov and one other from St. Petersburg, and Kandul, Pierce, and two others from Harvard—analyzed the Agrodiaetus butterflies that Lukhtanov had seen.

The researchers built a phylogeny, or family tree, of 15 species. They were relatively young species and genetically very closely related. Kandul and his colleagues believe that the species formed in a process called “reinforcement.” Reinforcement occurs when natural selection strengthens behavioral discrimination to avoid costly interspecies matings that tend to produce weedy, sterile hybrids. The evolutionary process of reinforcement can eventuate in speciation, providing a direct link between Darwin’s theory of natural selection and the origin of new species.

“The phenomenon of reinforcement,” says Kandul, “is one of the very few mechanisms that has natural selection playing a role in speciation. It might be...