The New York Times
nytimes.com

April 1, 2008

BASICS

Blind to Change, Even as It Stares Us in the Face

By NATALIE ANGIER

Leave it to a vision researcher to make you feel like Mr. Magoo.

When Jeremy Wolfe of Harvard Medical School, speaking last week at a symposium devoted to the crossover theme of Art and Neuroscience, wanted to illustrate how the brain sees the world and how often it fumbles the job, he naturally turned to a great work of art. He flashed a slide of Ellsworth Kelly's "Study for Colors for a Large Wall" on the screen, and the audience couldn't help but perk to attention. The checkerboard painting of 64 black, white and colored squares was so whimsically subtle, so poised and propulsive. We drank it in greedily, we scanned every part of it, we loved it, we owned it, and, whoops, time for a test.

Dr. Wolfe flashed another slide of the image, this time with one of the squares highlighted. Was the highlighted square the same color as the original, he asked the audience, or had he altered it? Um, different. No, wait, the same, definitely the same. That square could not now be nor ever have been anything but swimming-pool blue ... could it? The slides flashed by. How about this mustard square here, or that denim one there, or this pink, or that black? We in the audience were at sea and flailed for a strategy. By the end of the series only one thing was clear: We had gazed on Ellsworth Kelly's masterpiece, but we hadn't really seen it at all.

The phenomenon that Dr. Wolfe's Pop Art quiz exemplified is known as change blindness: the frequent inability of our visual system to detect alterations to something staring us straight in the face. The changes needn't be as modest as a switching of paint chips. At the same meeting, held at the Italian Academy for Advanced Studies in America at Columbia University, the audience failed to notice entire stories disappearing from buildings, or the fact that one poor chicken in a field of dancing cartoon hens had suddenly exploded. In an interview, Dr. Wolfe also recalled a series of experiments in which pedestrians giving directions to a Cornell researcher posing as a lost tourist didn't notice when, midway through the exchange, the sham tourist was replaced by another person altogether.

Beyond its entertainment value, symposium participants made clear, change blindness is a salient piece in the larger puzzle of visual attentiveness. What is the difference between seeing a scene casually and automatically, as in, you're at the window and you glance outside at the same old streetscape and nothing registers, versus the focused seeing you'd do if you glanced outside and noticed a sign in the window of your favorite restaurant, and oh no, it's going out of business because, let's face it, you always have that Typhoid Mary effect on things. In both cases the same sensory information, the same photonic stream from the external world, is falling on the retinal tissue of your eyes, but the information is processed very differently from one eyeful to the next. What is that difference? At what stage in the complex circuitry of sight do attentiveness and awareness arise, and what happens to other objects in the visual field once a particular object has been designated worthy of a further despairing stare?

Visual attentiveness is born of limited resources. “The basic problem is that far more information lands on your eyes than you can possibly analyze and still end up with a reasonable sized brain,” Dr. Wolfe said. Hence, the brain has evolved mechanisms for combating data overload, allowing large rivers of data to pass along optical and cortical corridors almost entirely unassimilated, and peeling off selected data for a close, careful view. In deciding what to focus on, the brain essentially shines a spotlight from place to place, a rapid, sweeping search that takes in maybe 30 or 40 objects per second, the survey accompanied by a multitude of body movements of which we are barely aware: the darting of the eyes, the constant tiny twists of the torso and neck. We scan and sweep and perfunctorily police, until something sticks out and brings our bouncing cones to a halt.

The mechanisms that succeed in seizing our sightline fall into two basic classes: bottom up and top down. Bottom-up attentiveness originates with the stimulus, with something in our visual field that is the optical equivalent of a shout: a wildly waving hand, a bright red object against a green field. Bottom-up stimuli seem to head straight for the brainstem and are almost impossible to ignore, said Nancy Kanwisher, a vision researcher at M.I.T., and thus they are popular in Internet ads.

Top-down attentiveness, by comparison, is a volitional act, the decision by the viewer that an item, even in the absence of flapping parts or strobe lights, is nonetheless a sight to behold. When you are looking for a specific object — say, your black suitcase on a moving baggage carousel occupied largely by black suitcases — you apply a top-down approach, the bouncing searchlights configured to specific parameters, like a smallish, scuffed black suitcase with one broken wheel. Volitional attentiveness is much trickier to study than is a simple response to a stimulus, yet scientists have made progress through improved brain-scanning technology and the ability to measure the firing patterns of specific neurons or the synchronized firing of clusters of brain cells.

Recent studies with both macaques and humans indicate that attentiveness crackles through the brain along vast, multifocal, transcortical loops, leaping to life in regions at the back of the brain, in the primary visual cortex that engages with the world, proceeding forward into frontal lobes where higher cognitive analysis occurs, and then doubling back to the primary visual centers. En route, the initial signal is amplified, italicized and annotated, and so persuasively that the boosted signal seems to emanate from the object itself. The enhancer effect explains why, if you’ve ever looked at a crowd photo and had somebody point out the face of, say, a young Franklin Roosevelt or George Clooney in the throng, the celebrity’s image will leap out at you thereafter as though lighted from behind.

Whether lured into attentiveness by a bottom-up or top-down mechanism, scientists said, the results of change blindness studies and other experiments strongly suggest that the visual system can focus on only one or very few objects at a time, and that anything lying outside a given moment’s cone of interest gets short shrift. The brain, it seems, is a master at filling gaps and making do, of compiling a cohesive portrait of reality based on a flickering view.

“Our spotlight of attention is grabbing objects at such a fast rate that introspectively it feels like you’re recognizing many things at once," Dr. Wolfe said. "But the reality is that you are only accurately representing the state of one or a few objects at any given moment." As for the rest of our visual experience, he said, it has been aptly called "a grand illusion." Sit back, relax and enjoy the movie called You.