SCIENCE & TECHNOLOGY

Psychologists and other researchers have long been interested in the ways that hallucinogens alter mental processes. This drawing, made by a professional artist after an LSD high, illustrates how powerfully such drugs can affect one's sense of space and proportion.

Hallucinations

"How Hallucinogenic Drugs Work" by Barry L. Jacobs, in *American Scientist* (July-Aug. 1987), 345 Whitney Ave., New Haven, Conn. 06511.

"Turn on, tune in, drop out." That was the motto of one-time Harvard lecturer (and former hippie) Timothy Leary, who advocated the use of hallucinogenic drugs (e.g., LSD) during the 1960s to "expand" the mind.

Twenty years ago, use of such drugs was an indication of counterculture involvement; Washington still classifies most hallucinogens as Schedule I substances—that is, the most hazardous ones. Yet, as Jacobs, a Princeton neuroscientist, observes, research into the biochemical and behavioral effects of hallucinogens on animals and humans has produced a wealth of information about the most subtle operations of the human brain.

Jacobs reports, among other things, that scientists have located the specific "site of action" in the brain for hallucinogens: a particular group of brain cell "receptors" that respond to the neurotransmitter serotonin, one of many chemicals involved in the transmission of brain cell signals. Most of these "serotonergic" neurons originate in the brain stem—a "primitive" area known to control basic bodily functions, such as breathing—but then spread throughout the brain. When a hallucinogen, such as LSD, DOM, DMT, psilocin, or mescaline, permeates the brain stem, it stimulates the serotonin receptors and triggers a cascade of nerve impulses that produce intense, dreamlike sensations.

What continues to elude researchers, Jacobs adds, is the exact *mecha-*

nism by which a drug user experiences a hallucination. In some brain areas, the hallucinogen appears to inhibit nerve signals; in others, it unleashes a flood of them. The brain itself is an extraordinary tangle of neurons and chemical signals, and a reaction in one locality can set off multiple reactions throughout the brain mass—which is exactly why small amounts of most hallucinogens (often a few micrograms) can induce such powerful experiences. Also puzzling: The serotonin receptor sites seem to play a role in producing anxiety and migraine headaches.

A "critical" experiment remains to be done, says Jacobs, one that will help clarify how hallucinogens act on the brain. That experiment would involve giving human subjects drugs that block serotonin's actions at the special receptor sites, and then noting whether the subjects are still able to hallucinate when hallucinogens are administered.

But owing to federal restrictions on drug experiments, the author observes, such a test is a long way off.

America's Rhinos

"The Rise and Fall of the American Rhino" by Donald R. Prothero, in *Natural History* (Aug. 1987), Central Park West at 79th St., New York, N.Y. 10024.

Lumbering along on African or Asian plains, rhinoceroses are an impressive sight. With one grand horn (in some cases, two) planted firmly on their snouts, the thick-skinned, hairless mammals stand up to six feet tall and 14 feet long, and weigh as much as five tons.

They are loners, tending toward grasslands, savannas, or marshes. They have bad eyesight, a good sense of smell, and a mean temper. Most noticeably, they have the distinct look of a tropical animal.

But Prothero, a geologist at Occidental College, notes that until five million years ago, the grunting "odd-toed" beasts (which are surprisingly agile; they can run as fast as 30 miles per hour) were not exclusively a tropical oddity. They roamed North America in great numbers and in great generic variety, ranging from "sheep-sized runners to hippo-like grazers." In fact, the author observes, *Rhinoceros occidentalis* (Western rhinoceros) was "the commonest large herbivore on this continent for most of the last 50 million years."

"Nearly every continental ecosystem has a large mammalian herbivore that can eat the highest-growing, toughest vegetation and is relatively protected from predation by its size," says Prothero. Early rhino thrived in Eurasia and North America during the middle Eocene era, some 50 million years ago. The world was warmer then. There were no polar ice caps; the climate of North America was so temperate that alligators and semitropical plants flourished in Alaska. At that time, *hyrachyus*, a primitive, horse-like rhino dominated the landscape. It gave rise to three major generic lines: the amynodont (a stocky river dweller), the hyracodont (the long-limbed "running" rhino), and the primitive rhinocerotid (the ancestor of the modern rhino).

However, a worldwide cooling during the Oligocene era, some 30 million years ago, altered North America's vegetation. The amynodonts and