

Delgado

With electrical stimulation at various brain sites, Delgado first provokes a monkey's attack, then tames it.

PSYCHOBIOLOGY

The emotional brain

Neurosurgeons believe they can help some violent patients but the effort would break new medical-ethical grounds

by Patrica McBroom

Beneath the thick, ballooning cortex of the human brain lie nerve structures collectively termed the limbic lobe. This is the emotional brain, where arise the basic feelings of anger, fear, pleasure, sadness, joy, sociability and sexuality on which preservation and propagation of the species depends.

Man inherits the limbic lobe from early mammals. According to Dr. Paul MacLean of the National Institutes of Health, this was nature's attempt to free higher animals from the repetitive, reflexive and programmed behavior of reptiles. With subjective feelings, early mammals were given flexibility in a world suddenly able to inspire emotion.

Without emotional input from the limbic lobe, the cortex above would be little more than a sophisticated piece of computing machinery. On the other hand, the limbic lobe, lying in the shape of a ring deep under the cortex, thinks only on the most primitive level, if at all.

In man, limbic emotions are mediated through a vast, cortical superstructure of memories, associations and, above all, language, which act to filter, control and redirect primordial emotions.

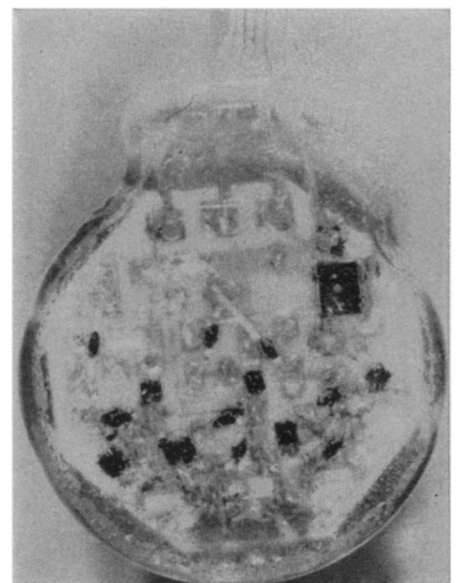
Nevertheless, evolution may have left

open some primitive channels of emotional expression in man. There could for instance be a fairly simple link between seizures in limbic cells and murderous assaults.

It is known that some people suffer from impulsive, sporadic attacks of uncontrollable rage—episodes that can be both distressing to the individual and homicidal. The chance these attacks might arise directly from limbic activity without the mediating influence of the cortex has led groups of neurosurgeons in Boston and elsewhere to exploration of the medical-ethical choice arising from prospects of helping and controlling such patients with limbic surgery.

The limbic brain has been extensively explored in animals, but very little in man. Electrical pulses from electrodes implanted in its various nerve cells will prompt monkeys to enraged attack or to docile affectionate behavior. Limbic stimulation can stop a bull in mid-charge or cause a cat to park on a button delivering constant, gratifying shocks to limbic regions.

The neurosurgeons have the means to investigate the human emotional brain with electrical probes. Such



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probes are commonplace in the surgical treatment of epilepsy, cerebral palsy and parkinsonism. The electrodes locate troublesome neural tissue which is then carefully removed.

Some cases of homicidal rage may

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also represent localized brain damage, but without the electrode investigation there is no way of finding out. And electrode investigation has so far been limited to those patients with seizures or other symptoms requiring surgery.

Four cases of epilepsy have crystallized the dilemma for neurosurgeons at Massachusetts General Hospital, one of several centers accumulating relevant experience.

The four epileptic patients were given to episodic rages. All had histories of violent assaults on other people. A medical team at Massachusetts General, headed by neurosurgeon William H. Sweet and including psychiatrist Frank R. Ervin and neurosurgeon Vernon H. Mark, implanted electrodes in the seizure area—amygdala cells in the lower half of the limbic ring. The electrodes allowed the team to monitor cell discharges and also stimulate the area.

What they discovered confirmed their suspicions: There was in these patients a one-to-one correlation between seizures in the limbic lobe and violent attack behavior. Episodic rage was, in fact, related to localized brain damage.

But what of patients given to periodic violence without signs such as those of motor epilepsy? They could be victims of focal brain seizures, but they might as easily be suffering from bruising years of emotional damage whose traces are not localized in any one spot of the brain or connected with what is thought of as brain damage.

Massachusetts General now has about 20 such violent patients who cannot be helped with either psychotherapy or drugs. The other medical centers, including the University of Indiana in this country, and hospitals in Tokyo and Copenhagen, have similar patients and are undertaking similar reviews of the ethical problems they pose: Pushing ahead would mean a forward step into new and dangerous territory. It raises the possibility of brain surgery as an approach to criminal behavior as well as physical exploration of emotional states.

At Massachusetts General, the problem has been referred to a standing committee on ethics whose job it is to establish new decision-making procedures for such cases. "We're neither wringing our hands nor ploughing ahead," says Dr. Ervin.

The questions that remain open are not all ethical.

Even if doctors should discover focal brain seizures in these violent patients, removal of the damaged limbic cells could have ramifications on unsuspected aspects of emotion and behavior. The amygdala area alone handles a wide

range of feelings and motivations. Although it is often implicated in violent animal behavior, some parts of the amygdala produce passivity, not rage. Stimulation in these parts induces long-lasting mood changes, a tranquility and relaxed detachment that seems to resemble the effects of marijuana, says Dr. Ervin.

Patients with epilepsy involving the lower limbic ring have experienced feelings ranging from terror, sadness, foreboding, familiarity, strangeness, wanting to be alone and persecution. Rare epileptic discharges in the upper half, the septum cells controlling positive emotions and sexuality, have on occasion produced ecstasy. Removal of some limbic cells could give unbridled release to others.

The four patients at Massachusetts General had surgery on the amygdala without any obvious disabling effects on behavior. But their state was so impaired by epileptic fits that almost anything would have seemed an improvement.

The main question is whether assaultive behavior can be turned off with surgery, whether the machinery of attack is a simple enough funnel to get at, as Dr. Ervin puts it.

If it is, but the patient must make an emotional tradeoff, then the question becomes: What price is he willing to pay for release from homicidal impulses? One man who came to Boston asking for help had been driven to the brink of murder more than 30 times. He would not drive a car for fear that some small provocation would send him into a killing rage. In some cases, such as this one, drugs help. But in other cases, where they don't, the dilemma is fearful.

As an alternative to surgery, physicians could implant electrodes permanently in the limbic brain allowing patients to forestall their attacks with an electrical pulse.

This is the course advocated by Dr. José Delgado, Yale physiologist who developed a radio-signalling electrode in use at Massachusetts General. Because of the radio telemetry, patients were able to move about freely, giving doctors far more information on their brain activity than if they had been hooked up to a machine.

Dr. Delgado cautions against extrapolating from successful surgery on epileptic patients. The mechanisms underlying poor impulse control are still a mystery. "You cannot generalize that because psychomotor epileptics are improved by surgery, others with aggression will also be helped," says Dr. Delgado, but he believes that electrode

implantation can be used effectively in controlling some types of compulsive aggressive behavior, once the critical areas are found.

More recently Dr. Delgado has completed tests on a new device, a kind of cerebral pacemaker, which he says is ready for human use. Implanted under the skin with wires leading into the brain, the new transdermal stimulator avoids possible infection from skin openings and so can be left permanently in the brain.

It opens the door to long-term control of emotional conditions, says Dr. Delgado. If necessary the device can be programmed to deliver electrical pulses every few seconds indefinitely. These electrical pulses are no different, says Dr. Delgado, from other input to the nervous system from drugs or normal sensory perception.

More important than behavior control, in Dr. Delgado's view, is the knowledge of brain physiology that could be derived from electrodes. "The most pressing need in the world is to investigate the cerebral mechanisms of peace and violence. A revolution in education could come from new understanding of how emotional links are established in the brain," he suggests.

The child who doesn't learn to use both eyes before the age of five never will learn, says Dr. Delgado. There may be similar critical times when the brain learns social behavior, he says. If there are, "we need to know at what age the brain sets to be socially integrated or violent."

Once the neural mechanisms are understood, education could be tailored to knowledge of physiology.

Dr. Delgado's point of view, however, is very much in the minority. Most scientists take a dim view of electrode implantation for purposes other than surgery or relief from intractable pain. Among their objections are the possibility of bleeding and infection, the difficulty of knowing just where the electrodes are, the potentiality of creating scars in brain tissue that later might trigger epileptic seizures and a general revulsion against making pincushions out of the human brain.

Such objections slow but do not stop exploration. Whether they use an electrode, brain surgery or drug therapy, scientists have begun unraveling the mysteries of the limbic lobe, offering future generations all the dangers implicit in brain control.

"The implicit goal of any investigation is potential control of the phenomenon," says Dr. Ervin. "Over the next half century, we've got to begin worrying about this."