Science, technology and computers

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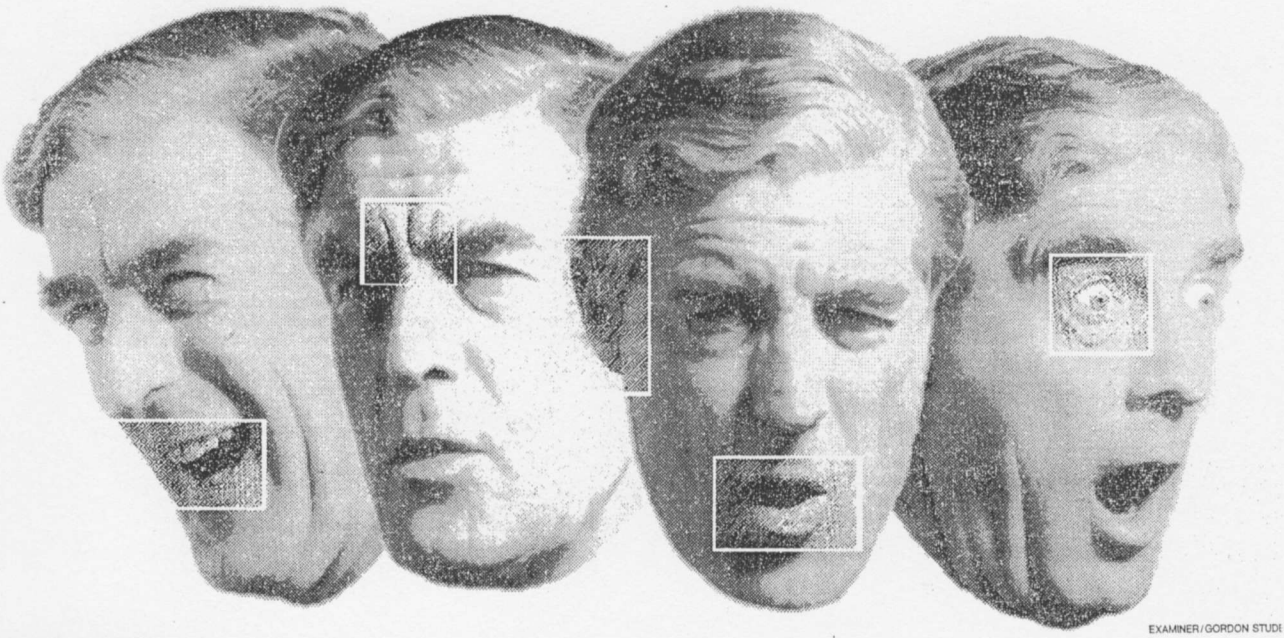


EXAMINER/GORDON STUDI

What is emotion for?

Ties between brain's cognitive and emotional centers show emotions may shape what we know, sift what we remember.

By Margie Patlak
SPECIAL TO THE EXAMINER

OUR EMOTIONS may hug the back burner in a society that places a high premium on thinking and perceiving — the so-called "cognitive abilities." But those quirky emotions may, in fact, turn out to be major players in the world of "higher" brain functions.

In several new studies, researchers mapping the anatomical ties between the cognitive and emotional centers in the brain suggest that emotions not only shape what we perceive but sift out what we remember.

New findings in animal research are generating intriguing data that may explain why certain phobias can't be erased, why some individuals tend to be more emotional than others, and why emotionally charged events that occur before your third birthday can strongly influence the rest of your life.

"It's a very exciting time for emotions research," says neuroscientist Mortimer Mishkin of the National Institute of Mental Health (NIMH). "We're finding that emotions at some level enter into most of what happens to us during the day."

Much of the recent research focuses on the amygdala, a small, almond-shaped brain structure lodged behind the cheekbone. Neuroanatomy studies reveal that the amygdala acts as both a gateway to emotions and a filter for memory by attaching significance to the plethora of information that is continually sent to the brain by the senses.

That information is routed to both the amygdala and the outer layer of the brain. This region, known as the cortex, generates a more complete picture of what's being perceived. The cortex also puts things in context — it determines, for example, that a growl that you heard comes from a bear, and that the bear is in the woods and not in a zoo.

The amygdala, in contrast, scrutinizes information perceived for its emotional weight. (It notes that the growl may spell danger.) If an emotional response is warranted, the amygdala sends signals along the numerous nerve cell pathways that connect it to other brain structures, which can then generate the gamut of emotional reactions such as fear, anxiety or joy.

The importance of the amygdala becomes apparent when the structure is damaged or missing. Monkeys whose amygdalas have been surgically removed are strikingly unresponsive to their environment and socially withdrawn. When they are pinched by investigators, for example, they flinch but don't try to escape or mount an angry counterattack. Studies of people whose amygdalas have been damaged reveal that they, too, deadpan in situations that normally evoke an emotional response.

Before 'the big picture'

Overly emotional reactions, in contrast, may stem from the amygdala responding too strongly to crude information sent to it by the senses before receiving "the big picture" from the cortex. Some people may react so strongly to a growl, for example, that by the time they realize the growl comes from a bear in the zoo, the alarm signals set off by their amygdala can't be controlled.

Evidence to suggest this speculation comes from studies on rats by neuroscientist Joseph LeDoux of New York University. He discovered an anatomical pathway that allows information gathered from the senses to travel directly to the amygdala before the same information reaches the cortex. This raw data can prompt the amygdala to trigger an emotional response before it receives a more accurate

[See EMOTIONS, D-15

Brain flaw may be key to depression

A brain disorder, not a character trait

By Margie Patlak
SPECIAL TO THE EXAMINER

USING A colorful imaging tool, researchers are sketching an underlying flaw in the brain that may be the key to severe depression.

Although previous research has uncovered a difference in the level of some brain compounds in depressed people compared to those in normal ones, the latest findings suggest the source of those chemical differences.

"We now know where to look in the brain for the error that produces depression," says neuroscientist Michael Phelps of the UCLA School of Medicine.

The latest findings also suggest that severe depression is not a controllable personality trait, but rather a brain disorder. "I hope our findings will destigmatize psychiatric illness," says psychiatrist Wayne Drevets of Washington University School of Medicine. "If you've got one of these severe types of depressions that we have studied, you can't just pull yourself up

[See DEPRESSION, D-15]

◆ *EMOTIONS from D-16*

What is emotion for?

picture from the cortex.

Similar anatomical pathways probably exist in the human brain, LeDoux says. But in most individuals, if a first emotional response proves unnecessary, it is quickly overridden by signals the cortex sends to the amygdala. Some people may be too emotional, however, because their amygdala's response is stronger than their cortex's ability to control it with more rational and accurate information, LeDoux speculates.

The parts of the cortex that can counter an emotional reaction are not fully developed in a human baby until sometime between 18 and 36 months — several months after the amygdala and other emotional centers in the brain become active. This scenario might explain why babies are subject to such frequent and uncontrollable emotional outbursts, LeDoux days.

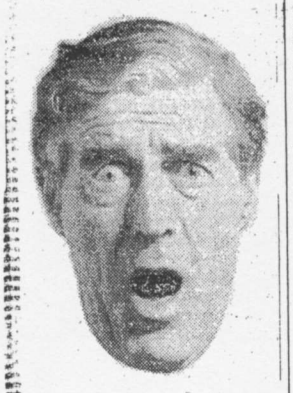
Phobias may remain

But the later maturation of the cortex may have more profound and longer-lasting implications on the personality, because the amygdala seems to permanently "record" every emotional event. Without the cortex's more rational and conscious editing of such records, phobias acquired early in life apparently can't be erased, LeDoux's studies on rats suggest.

When he surgically prevented the cortex from influencing the amygdala's response, the rats never lost their conditioned fear of a flashing light that had previously been twinned with an electric shock to the foot. In contrast, normal animals stopped fearing the light a short time after it began to flash without the simultaneous shocks.

According to LeDoux, the fear of the flashing light in the surgically altered animals was apparently being maintained by the amygdala as a permanent emotional memory. "The amygdala doesn't seem to have an eraser," LeDoux says.

Assuming similar wiring exists in the human, a phobia acquired early in life before the cortex matures — a fear of dogs, for example, because of a dog bite incurred at the age of one year — would be



permanently maintained by the amygdala as an unconscious memory. Therapy that instills rational thoughts to keep the fear in check could control the phobia. But because the phobia couldn't be erased from the amygdala's records, it could never be cured and might spring to life during a stressful event.

"A person may have a fear of heights," says LeDoux, "which therapy has dealt with effectively until the patient's mother dies. Then, all of the sudden, the phobia is back. That suggests emotional memories are never eliminated but merely held in check."

The amygdala not only maintains unconscious memories but also strongly influences what we consciously remember. Events with strong emotional overtones are recalled with much greater clarity and detail than more mundane circumstances. Most people born before 1960, for example, can recall with surprising detail what happened to them the day that President Kennedy was shot in 1963. Because that event had such a strong emotional impact on them or the people close to them, the details of that day can be recalled more accurately than those of the day before the assassination.

Once again, the amygdala has a hand in this "flashbulb" memory phenomena. Studies on monkeys reveal that both the amygdala and another brain structure called the hippocampus are needed for memories to be laid down. When Mishkin and his colleagues at the NIMH removed these two structures, monkeys could no longer perform well on a simple memory task completed with ease by normal monkeys. In addition, when there is damage to the hippocampus and amygdala in humans, people are unable to remember new information; memories of events prior to the brain damage remain intact, studies show.

Other research by Mishkin reveals that the nerve cells connecting the amygdala to the cortex are rich producers of opiates. Some of these compounds can enhance learning and memory, studies show.

The converging findings have led researchers to speculate that the amygdala and hippocampus serve as a filter for memory, allowing only significant information to be permanently stored in the cortex. Mishkin proposes the following scenario: an individual senses something with emotional significance — his baby being born, for example. The sights and sounds of this birth travel simultaneously to the cortex and to the amygdala and hippocampus to release various compounds, including opiates, which travel down the numerous nerve cell pathways connecting them to the cortex.

Once they arrive in the cortex, these compounds prompt the anatomical changes necessary for long-term memories of the images and sounds to form. The stronger the emotional significance of what's being perceived, Mishkin speculates, the more compounds the amygdala and hippocampus release to strengthen memories.

'Filter out what we wish'

A similar process might enable the amygdala to influence perception, allowing us to "filter out what we wish to ignore and enhance perception of what we wish to attend to," Mishkin says. The many nerve cell pathways between the amygdala and the parts of the brain that interpret what we perceive with our senses suggest that such influence is possible. Common experience and several studies, in addition, reveal that mood can strongly influence what we perceive. An enthusiastic person will "hear" more during a lecture, for example, than a bored person listening to the same talk.

◆ *DEPRESSION from D-16*

Brain flaw may be key to depression

by your bootstraps and shape up without proper drug treatment."

Phelps' research team in Los Angeles, and Drevets and neurologist Marcus Raichle at Washington University in St. Louis used positron emission tomography (PET) scans to find the parts of the brain that are abnormal in depressed people. PET scans dynamically reveal the active parts of the brain by showing, in a color-coded map, how much special radioactive sugar or oxygen is absorbed from the bloodstream by various regions of the brain.

When the St. Louis group compared the PET scans of severely depressed patients to those of normal volunteers who were asked to think a sad thought, they discovered some striking differences. One area of the brain was equally active in both the depressed and normal subjects — presumably the part responsible for the sad thought. But another brain area, the head of a tadpole-shaped region called the caudate nucleus, was markedly underactive in the depressed patients.

Area remains underactive

This area, which is thought to play a role in regulating emotion, continued to be underactive in the patients even after they recovered from their depression, additional PET scans showed.

The preliminary findings were presented at a recent National Academy of Sciences symposium on brain research. According to Raichle, they suggest that although depressed and normal people use some of the same parts of their brains when feeling sad, depressed patients may be more susceptible to having frequent sad feelings because of an underlying brain defect — perhaps a malfunctioning caudate nucleus.

Some of Raichle's findings are confirmed by those of Phelps, who consistently finds the head of the caudate nucleus underactive in patients with depression, compared to normal individuals. The PET findings also complement studies on people who have experienced a stroke or another disorder that damages the head of the caudate nucleus. These people develop many symptoms of depression, according to Drevets.

> 'I hope our findings will destigmatize psychiatric illness.'
>
> — Wayne Drevets, M.D.

But in some of the patients Phelps studied, the activity in the caudate nucleus approached normal levels as they recovered from their depression. These findings, which are contrary to those of Raichle's, suggest lowered caudate nucleus activity may be one of depression's symptoms and not necessarily the underlying cause of the disorder, says Phelps' colleague, UCLA psychiatrist Lewis Baxter.

Because more than 75 percent of the total amount of dopamine (a chemical communicator between nerve cells) is found in the caudate nucleus and two other connecting brain structures, Phelps speculates it may be faulty regulation of this neurotransmitter that lies at the heart of depression.

Why the inconsistencies?

Evidence for this theory comes from the fact that many drugs that foster profound changes in mood, such as cocaine, amphetamines and some types of antidepressants, work by altering the amount of dopamine in the brain. But, still other studies have linked different neurotransmitters to depression, and a true picture of what exactly causes the disorder is not likely to emerge for several years.

Inconsistencies in the neurotransmitter findings stem from the fact that these compounds are measured in the blood and cerebral spinal fluid of patients rather than directly in their brains. "By the time these measurements are done there's been a lot of dilution and pollution of the neurotransmitters," Phelps says.

Drevets notes that standard PET technology may soon help psychiatrists distinguish patients with a depression stemming from a brain abnormality from people with a milder form of depression more responsive to psychotherapy. "A person can get depressed after losing their spouse or their job and recover after getting talk therapy," he says, "but that's a very different kind of depression than the severe biochemical kind that tends to be inherited and isn't amenable to talk therapy. Psychiatry has been awaiting something like PET to be able to distinguish between the two."