



**A USER'S
GUIDE
TO THE
BRAIN**

**NO. 2 STRESS ALTERS
YOUR BLOOD CHEMISTRY**

FOR YEARS PSYCHOLOGISTS HAVE CONCENTRATED on the behavioral symptoms of burnout: lost energy, lost enthusiasm and lost confidence. Now, thanks to new brain scans and more sophisticated blood tests, scientists

can directly measure some of the effects of stress on mind and body—often with surprising results.

You are probably familiar with the signs of an adrenaline surge (racing pulse, hairs on the neck standing on end), which evolved to help us fight or flee predators and other immediate dangers. And you may have heard of cortisol, another stress hormone, which is produced more slowly than adrenaline and lingers in the bloodstream longer. But did you know that too little cortisol in your bloodstream can be just as bad as too much? Or that tucking into comfort foods, while soothing in the short term, can sabotage your long-term stress response by increasing the number of inflammatory proteins in your body?

What's emerging is a complex picture of the body's response to stress that involves several interrelated pathways. Scientists know the most about cortisol because until now that has been the easiest part to measure. "But when one thing changes, all the others change to some degree," says Bruce McEwen, a neuroendocrinologist at Rockefeller University who has spent decades studying the biology of stress, primarily in animals. So just because you see an imbalance in one area doesn't mean you understand why it is happening. "We're learning that post-traumatic stress disorder (PTSD), burnout, chronic fatigue syndrome and fibromyalgia are all related in some ways," McEwen says. The next step is to figure out if there are any genetic predispositions that tip the response to stress toward one set of symptoms or another.

NO. 3 YOU CAN'T AVOID STRESS

EVEN GETTING OUT OF BED CAN BE TOUGH ON THE BODY. SEVERAL hours before you wake each morning, a tiny region at the base of your cerebrum called the hypothalamus sends a signal that ultimately alerts your adrenal glands, which sit on top of your kidneys, to start pumping out cortisol, which acts as a wake-up signal. Cortisol levels continue to rise after you become conscious in what is sometimes referred to as the "Oh, s___! It's another day" response. This may help explain why so many heart attacks and strokes occur between 6 a.m. and 8 a.m.

Because cortisol is a long-acting hormone, you can dally under the covers a bit without losing any steam. But your brain is already taking steps to protect you from the shock of starting a new day. Rising cortisol levels signal the hypothalamus to stop sounding the alarm. Other parts of the brain chime in, and eventually the adre-

nal glands ratchet down their cortisol production. In other words, the brain's stress response contains its own off switch.

Most people's cortisol, as measured by a saliva test, peaks a few hours after waking. Levels then gradually decline during the course of the day—with a few blips scattered here and there. That pattern typically changes, however, in people who are severely depressed. Their cortisol level still rises early in the morning, but it stays high all day long. It's almost as if their hypothalamus has forgotten how to turn off the stress response. (Intriguingly, people who are sleep deprived also exhibit a high, flat cortisol level.)

Researchers figured something similar had to be happening in burnout victims. But rather than finding a prominent cortisol peak, investigators discovered a shallow bump in the morning followed by a low, flattened level throughout the day. Intriguingly, such blunted cortisol responses are also common among Holocaust survivors, rape victims and soldiers suffering from PTSD. The difference seems to be that people with PTSD are much more sensitive to cortisol at even these low levels than those with burnout. "We used to blame everything on high cortisol," says Rachel Yehuda, a neurochemist and PTSD expert at the Mount Sinai School of Medicine in New York City. "Now we can blame things on low cortisol as well."

“We’re learning that PTSD, burnout and chronic fatigue are all related.”

BRUCE MCEWEN, Neuroendocrinologist at Rockefeller University

NO. 4 STRESS CAN AGE YOU BEFORE YOUR TIME

SCIENTISTS HAVE LONG SUSPECTED THAT unremitting stress does damage to the immune system, but they weren't sure how. Then two years ago, researchers at the University of California, San Francisco, looked at white blood cells from a group of mothers whose children suffered from chronic disorders like autism or cerebral palsy. The investigators found clear signs

of accelerated aging in those study subjects who had cared the longest for children with disabilities or who reported the least control over their lives.

The changes took place in microscopic structures called telomeres, which are often compared to the plastic wrappers on the ends of shoelaces and which keep chromosomes from shredding. As a general rule, the youngest cells boast the longest telomeres. But telomeres in the more stressed-out moms were significantly shorter than those of their counterparts, making them, from a genetic point of view, anywhere from nine to 17 years older than their chronological age.

NO. 5 STRESS IS NOT AN EQUAL-OPPORTUNITY EMPLOYER

IN 1995, IN A NOW CLASSIC EXPERIMENT, SCIENTISTS AT THE University of Trier in Germany subjected 20 male volunteers to a situation guaranteed to raise their stress levels: participating in a mock job interview and solving arithmetic problems in front of strangers who corrected them if they made mistakes. As expected, each subject's cortisol level rose at first. But by the second day of

20 Age, in years, at which the human brain reaches its maximum weight. Such a gross measurement tells you nothing, however, about intellectual capacity, which depends more on the number and strength of connections among neurons in the brain

2% Weight of brain proportional to that of the adult body