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March 2011 ScientificAmerican.com

**THE NEUROSCIENCE  
OF RESILIENCE**

## How Minds Bounce Back

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PSYCHOLOGY

# THE NEUROSCIENCE OF TRUE GRIT

When tragedy strikes, most of us ultimately rebound surprisingly well. Where does such resilience come from?

*By Gary Stix*

**I**N FALL 2009 JEANNINE BROWN MILLER WAS DRIVING HOME WITH HER husband after a visit with her mother in Niagara Falls, N.Y. She came upon a police roadblock near the entrance to the Niagara University campus. Ambulance lights flashed up ahead. Miller knew her 17-year-old son, Jonathan, had been out in his car. Even though she couldn't make out what was happening clearly, something told her she should stop. She asked one of the emergency workers on the scene to check whether the car had the license plate "J Mill." A few minutes

later a policeman and a chaplain approached, and she knew, even before they reached her, what they would say.

The loss of her son—the result of an undiagnosed medical problem that caused his sudden death even before his car rammed a tree—proved devastating. Time slowed to a crawl in the days immediately after Jonathan's death. "The first week was like an eternity," she says. "I lived minute by minute, not even hour by hour. I would just wake up and not think beyond what was in front of me."

## IN BRIEF

**Convention held** that psychological resilience to life's stresses remained a fairly rare event, a product of lucky genes or good parenting.

**Research into bereavement** and nat-

ural disasters has found in recent years that the quality of resilience is, in fact, relatively commonplace.

**People respond** to the worst life has to offer with varied behaviors, some of

which might be classified as narcissistic or dysfunctional in some other way.

**But these behaviors**—coping ugly, as one researcher calls it—ultimately help with adaptation in a crisis.

**The question arises** whether interventions to teach resilience—programs already instituted in schools and in the military—will really help if people cope naturally on their own.





**Jeannine Brown Miller**, who weathered her son's death in 2009, touches the tree into which Jonathan's car crashed.

Support came from multiple places, including her own personal decisions. Five hundred of Jonathan's classmates from Lewiston-Porter High School attended the wake and funeral, a demonstration of sentiment that helped to assuage the pain. She also found solace in her devout Catholic faith. After two weeks she returned to work as a human resources consultant. A couple of months after the accident she could visit the restaurant where she and her son had breakfasted the day he died. Support from the community never wavered. A ceremony honored Jonathan at the high school graduation, a Jonathan "J Mill" Miller Facebook page receives regular updates, and a local coffee shop serves "76" coffee in memory of his now retired football number. A year on she still cries every day, but she has found many ways to cope.

When the worst happens—a death in the family, a terrorist attack, an epidemic of virulent disease, paralyzing fear in the midst of battle—we experience a sense of profound shock and disorientation. Yet neuroscientists and psychologists who look back at the consequences of these horrific events have learned something surprising: most victims of tragedy soon begin to recover and ultimately emerge largely emotionally intact. Most of us demonstrate astonishing natural resilience to the worst that life throws our way.

The study of resilience is starting to uncover a series of underlying mechanisms through brain imaging and gene databases in addition to psychologists' traditional tools of social science questionnaires. After disaster strikes, biochemical, genetic and behavioral factors act together to restore our emotional equilibrium. Research seeks insights into the foundations of emotional strength—an understanding that may someday teach us what to do when the natural healing processes fail.

In the meantime, schools, the military and the corporate world are not waiting for a complete picture of genes, neurotransmitters and the rest before embarking on programs to inoculate against life's biggest stresses. In the absence of a definitive handbook on hardiness, a vigorous debate has emerged over whether any at-

tempt to toy with what may be an innate quality may leave us worse off. The debate has special urgency now, as the U.S. Army begins a gargantuan training program to inculcate resilience in more than a million soldiers and their families, perhaps one of the largest psychological interventions ever undertaken by a single institution.

## THE MECHANISMS OF RESILIENCE

SIGMUND FREUD had written in 1917 of the necessity of "grief work" in which we take back the emotional energy, or libido, as he called it, that had been invested in the now "non-existent object"—in other words, the deceased. This century-old view of the psyche as a plumbing system for channeling subliminal life forces prevailed, in the absence of evidence to the contrary, until recent decades. That is when psychologists and neurobiologists began to probe for alternative explanations.

One of the things they began to look at is the nature of resilience. The term "resilience" (from the Latin *re* for "back" and *salire* for "to leap") joined the psychological lexicon from the physical sciences. In a psychological sense, says University of California, Los Angeles, resilience researcher Christopher M. Layne, "it basically means that you spring back to functioning in a short period," like a steel beam, which bends under stress and returns afterward to where it started. Of course, no little metal strip in our heads acts as a thermostat that bends when our emotions run hot, triggering a neurochemical cascade that returns us to a set point of emotional equilibrium. Scientists have found that our biology is more complicated than the analogy from metallurgy.

Resilience begins at a primal level. If someone takes a swing at you, the hypothalamus—a relay station in the brain that links the nervous and endocrine systems—churns out a stress signal in the form of corticotropin-releasing hormone, which begins a chemical deluge telling you to put up your dukes or head for the hills. Your brain pulsates like a flashing light: fight or flight, fight or flight. Afterward, the biological typhoon subsides. If you are constantly called on to defend your turf, a set of stress hormones gush constantly. One of them, cortisol, produced by the adrenal glands near the kidneys, can actually damage brain cells in the hippocampus and amygdala, regions involved with memory and emotion. So you end up an emotional and physical wreck. Luckily, the vast majority of us have resilience on our side.

Stress hormones, aided by certain protective biochemicals, seem to switch off more readily in people who are resilient. In recent years scientists have discovered a number of biological signposts that indicate that a person might be capable of toughing it out. The list is long and involves chemicals such as DHEA (dehydroepiandrosterone), which lessens the effects of cortisol, and neuropeptide Y, which appears to, among other things, reduce anxiety by counteracting the effects of corticotropin-releasing hormone, released by the hypothalamus. In 2000 Dennis S. Charney and other researchers at the Yale University-affiliated VA Hospital in West Haven, Conn., found that under the intense stress of mock interrogations, U.S. soldiers with higher blood levels of neuropeptide Y performed better during the exercise. Later, in 2006, Rachel Yehuda and others at the Bronx Veterans Affairs Medical Center discovered that elevated levels of the chemical in combat veterans meant a lower risk of post-traumatic stress disorder.

Many biological pathways—chains of interacting proteins—contribute to something as multifaceted as resilience. So far, though, scientists have put together little more than a tantalizing collection of hints of the biological profile of the hardy soul. In May 2010 Eric J.



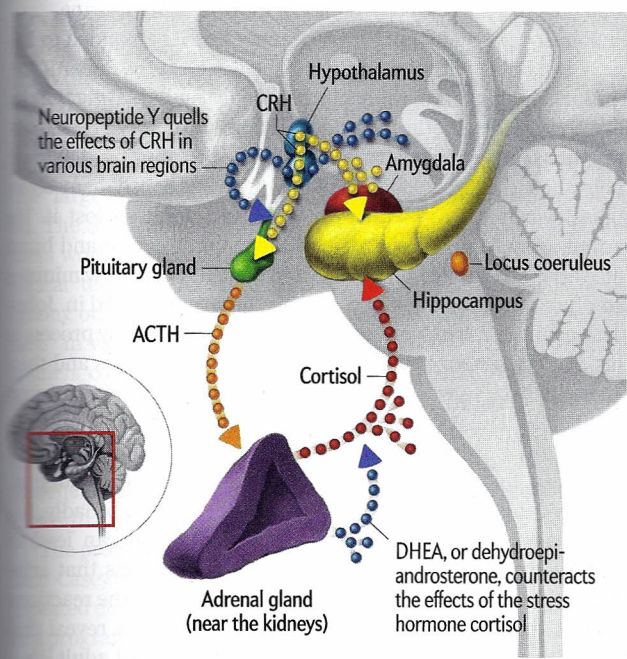
Nestler of Mount Sinai Medical Center and his colleagues reported, for instance, on a protein, called DeltaFosB, that appears to protect mice and possibly humans against stress induced from being alone and isolated or threatened by more aggressive mice. DeltaFosB acts as a molecular switch that turns on a whole set of genes (inducing production of the proteins they encode). It registered high levels in resilient rodents and was deficient in postmortem brain tissue of depressed patients. A drug that boosts DeltaFosB might protect against depression and bolster resilience more generally.

Still, it will be a while before an energy drink gets stoked with resilience powder. A pill that ups the brain's production of DeltaFosB might one day become a reality. For the time being, the work remains confined to rodents, as investigators explore the subtleties of a chemical that not only enables mice to nobly withstand the best efforts of laboratory researchers to scare them to death but may also, more ominously, play a role in the rewarding sensations of drug addiction.

## RESILIENCE BOOSTERS

# Toning Down the Brain's Alarm System

When faced with danger, the brain initiates a chemical cascade that primes you to put 'em up or run away. In turn, a series of chemicals in the brain can dampen this response, thereby promoting resilience to stress. One key chemical cycle begins when the hypothalamus releases corticotropin-releasing hormone (CRH), causing the pituitary gland to secrete adrenocorticotropin hormone (ACTH) into the bloodstream, which triggers the adrenal glands (near the kidneys) to release the hormone cortisol. Cortisol heightens the body's ability to respond to challenging situations, but too much can over time cause lasting damage. To help keep things in check, a series of chemicals (two shown below) dampens the stress response. Drugs or psychotherapy might stimulate production of these stress busters.



An array of other genes and proteins may contribute, but as with DeltaFosB, researchers must tread cautiously. The *5-HTT* gene, once thought to be a key "resilience gene," provides a cautionary tale of the pitfalls of a purely genetic approach. Nearly a decade ago a number of studies showed that people with the lengthier version of this gene seemed to resist depression more ably than those who had the shorter form—in other words, they were more resilient.

The gene made it big in 2006, when a *New York Times Magazine* article pointed to the imminent arrival of a commercial *5-HTT* test to assess resilience. This early optimism quickly faded into confusion (a common pattern in studies purporting to tie a complex behavior to a single gene). Two recent so-called meta-analyses of studies found that the evidence did not confirm a link between a variant of the *5-HTT* gene and depression induced by stressful life events. Another one did find a connection. If the gene is linked to resilience, the tie is likely a weak one. Ultimately, the psychobiology of resilience may lead to new drugs and more precise methods of assessing our adaptation to life stresses. For now, immediate insights into understanding the resilient self will come not from studying a gene or cell receptor but rather from performing old-fashioned face-to-face interviews with those immersed in personal crisis.

## COPING UGLY

BEHAVIORAL SCIENTISTS have accumulated decades of data on both adults and children exposed to trauma. George A. Bonanno of Teachers College at Columbia University has devoted his career as a psychologist to documenting the varieties of resilient experience, focusing on our reactions to the death of a loved one and to what happens in the face of war, terror and disease. In every instance, he has found, most people adapt surprisingly well to whatever the world presents; life returns to a measure of normalcy in a matter of months. The theme of his research pervades the corner office in an aging building at Columbia. On the inner door, he has pasted a clipping from a German newspaper that profiled him with a headline: "S\*\*t Happens, Bonanno Says."

Bonanno started researching how we respond emotionally to bereavement and other traumatic events in the early 1990s while at the University of California, San Francisco. In those days, the prevailing wisdom held that the loss of a close friend or relative left indelible emotional scars—and Freudian grief work or a similar tonic was needed to return the mourner to a normal routine. Bonanno and his colleagues approached the task with open minds. Yet, again and again during the experiments, they found no trace of psychic wounds, raising the prospect that psychological resilience prevails, that it was not just a rare occurrence in individuals blessed with propitious genes or gifted parents. This insight also raised the unsettling prospect that latter-day versions of grief work might end up producing more harm than good.

In one example of his work, Bonanno and his colleague Dacher Keltner analyzed facial expressions of people who had lost loved ones recently. The videos bore no hint of any permanent sorrow that needed extirpation. As expected, the videos revealed sadness but also anger and happiness. Time and again, a grief-stricken person's expression would change from dejection to laughter and back.

Were the guffaws genuine, the researchers wondered? They slowed down the video and looked for contraction of the orbicularis oculi muscles around the eyes—movements known as Du-





**Hurricane Katrina** tested the resilience of New Orleans residents.

chene expressions that confirm that laughs are what they seem, not just an artifact of a polite but insincere titter. The mourners, it turns out, exhibited the real thing. The same oscillation between sadness and mirth repeated itself in study after study.

What does it mean? Bonanno surmises that melancholy helps us with healing after a loss, but unrelenting grief, like clinical depression, is just too much to bear, overwhelming the mourner. So the wiring inside our heads prevents most of us from getting stuck in an insoluble psychological state. If our emotions get either too hot or cold, a kind of internal sensor—call it a “resilience-stat”—returns us to equilibrium.

Bonanno expanded his studies beyond bereavement. At Catholic University and later Columbia, he interviewed survivors of sexual abuse, New Yorkers who had gone through the 9/11 attacks and Hong Kong residents who had lived through the SARS epidemic. Wherever he went, the story was the same: “Most of the people looked like they were coping just fine.”

A familiar pattern emerged. In the immediate aftermath of death, disease or disaster, a third to two thirds of those surveyed experienced few, if any, symptoms that would merit classification as trauma: sleeping difficulties, hypervigilance or flashbacks, among other symptoms. Within six months the number that remained with these symptoms often fell to less than 10 percent.

Yet if most of these people did not confront lasting harm, what were they feeling? Had they escaped unscathed? It was difficult to know. The introduction of post-traumatic stress disorder into the *Diagnostic and Statistical Manual of Mental Disorders* in 1980 had tended to narrow psychologists’ perspective. The framework established by the diagnostic manual tended to push researchers toward study of only groups who met the rote classification of post-traumatic stress disorder. The new trauma designation meant that patients who displayed symptoms of stress would get shoved into this diagnostic basket, even if they were ultimately capable of muddling through.

Bonanno began to inspect the feelings of those who had not sought psychological help. Subjects in social science research have notoriously distorted recollections of past events when they

fill out questionnaires: when their worlds cave in, they may exaggerate how bad things are or remember them as overly catastrophic. To compensate, Bonanno began to do so-called prospective studies in which he would follow groups of varied ages before some of the individuals in those groups would die, a technique that helped to eliminate what psychologists label recall bias. He also began to use a sophisticated statistical technique—latent growth mixture modeling—that enabled him to delineate more precisely the specific type of reactions people experienced following trauma.

Similar to the earlier laughter studies, these more incisive looks at the bereavement process captured a wide range of responses that did not fit neatly into categorizations used to designate healthy adaptation. The messiness of it all prompted Bonanno to label the less classic responses “coping ugly.” Some people engaged in

“self-enhancing bias”—inflated perceptions of who they were and how they acted, behavior that, in other circumstances, may have bordered on narcissism. For the mourner, these slight distortions may have served to avoid rumination: Could I have done something different to prevent this from happening?

Ego boosting was not the only strategy. Others repressed negative thoughts and emotions—and some just convinced themselves that they could handle whatever came their way. Still others laughed and smiled their way through, even though many psychologists would consider this an unhealthy form of denial. Bonanno found that coping ugly served not only the bereaved but also Bosnian civilians in Sarajevo in the aftermath of the Balkan conflict and witnesses of the 9/11 attack on the World Trade Center Towers. The people were similar to Fred Johnson, who coped his way through the aftermath of Hurricane Katrina.

Johnson, 57, a lifelong New Orleans resident responded to Katrina by helping with the posthurricane rescue at the Superdome. The lines snaking from the stadium to board buses leaving the city furnished a disquieting spectacle. Some parents were so distraught as they emerged from the stadium that they tried to hand their young children to the rescuers. Others had soiled themselves. Aghast when he first witnessed the scene, Johnson lost it. He moved away from the entrance of the giant structure and burst into tears. The whole thing was just too much. Then a few minutes later he stopped, and what he calls his “governor” kicked in. Johnson explains: “When I become overwhelmed, I think my process is this. I’m going to cry about it, I’m going to dry my eyes and then I’m going back to work, but I’m not going to keep crying, crying, crying. I think that’s my governor. That’s how I keep my sanity.”

Bonanno’s work has won acclaim, but not everyone remains convinced that resilience is as innate as his studies suggest. Some colleagues claim that he defines the term too broadly. Bonanno acknowledges that adversity in childhood can lead to more lasting consequences than transient emotions that arise after a death in the family or a natural disaster. Yet the reactions of most adults, whether to a job loss or a tidal wave, reveal that the ability to rebound remains the norm throughout adult life.



## BE ALL THAT YOU CAN BE

IF RESILIENCE PREVAILS as the status quo for virtually all of us, what about the 10 percent or so who, in the face of emotional trauma, will fail to bounce back and instead become mired in anxiety and depression? Is it possible to train them to bear up better? The jury is still out, but the evidence at hand suggests caution. Psychologists and aid workers who descend on a disaster scene have often intervened with a technique called critical incident stress debriefing. It requires individuals or a group to talk about their experiences to rid themselves cathartically of nascent trauma symptoms. Victims of the Columbine High School shootings and the Oklahoma City bombing went through debriefings.

Several studies over more than 15 years have shown the technique is not effective and might cause harm. Sometimes one frazzled person in a group session can infect panic in others, making things worse for most of the participants. After the 2004 Indian Ocean tsunami, the World Health Organization warned against debriefings because they might prompt some victims to feel more unsettled. The experience with debriefings raises questions about newer attempts to inculcate resilience by mustering techniques from the armamentarium of positive psychology.

The positive psychology movement had its formal coming-out ceremony in 1998, when Martin E. P. Seligman, a professor at the University of Pennsylvania, advocated at the annual meeting of the American Psychological Association that mental illness should not be the sole preoccupation of his discipline. Seligman came to positive psychology from his discovery that dogs went into a state of abject submission—what he called “learned helplessness”—after exposure to electrical shocks. Seligman took inspiration from that research to explore the prospect of clinical interventions that accomplish the polar opposite: encouraging optimism, well-being and, yes, resilience in patients.

Seligman became instrumental in launching the Penn Resiliency Program two decades ago, which has proved its worth, particularly among school-age children. Drawing from theories of depression, the training involves techniques such as the mental reframing used by cognitive-behavioral psychologists to get patients to revise thoughts in a more positive light. Evaluations of the program through at least 21 controlled studies in 2,400 children ages eight to 15 showed success in preventing depression and anxiety.

Now the U.S. Army is scaling similar methods to more than one million soldiers and their families, in what it labels as likely the “largest deliberate psychological intervention” ever attempted. The \$125-million, five-year program already has 800,000 soldiers working with an online “global assessment tool,” a psychological test that measures emotional and spiritual well-being, among other factors, and taking training courses to enhance “fitness” in various aspects of emotional resilience. Each month 150 soldiers come to the University of Pennsylvania to learn how to teach resiliency to others in the military. Ultimately, Seligman foresees the data gathered from these programs going into a huge database of psychological and health statistics, which civilian researchers will mine for resilience studies. “This is science taken to a level that psychology’s never had before,” Seligman says.

The program got off to a rushed start: Army Chief of Staff William Casey was anxious to help rank-and-file soldiers who faced repeated deployments. No pilot studies attempted to probe whether a program that had worked for teenagers would carry over to a soldier facing a third tour in Iraq. As the program progresses, re-

searchers will measure whether soldiers better withstand the stresses of military life. “Even though we’re building this in mid-air, it’s still being rigorously evaluated,” Seligman observes.

Bonanno, for one, has pointed to the lack of evidence for the effectiveness of the program—and in light of the checkered history of previous interventions, he wonders whether more harm than good might result. He has collaborated on an unpublished study that tracked over 11 years some 160,000 soldiers throughout the military, half of whom had at least one deployment to Iraq or Afghanistan. Nearly 85 percent who went were deemed resilient, judged by an absence of trauma symptoms, and only 4 to 6 percent had diagnoses of post-traumatic stress disorder. “If most people are resilient, as they seem to be in all the studies we’ve done, what happens to those people if you give them stress-inoculation training?” Bonanno asks. “Can you make them less resilient? That’s a question that I think is imperative to answer.”

The entire military has not embraced universal resilience training. William P. Nash, a physician formerly charged with overseeing stress-monitoring programs for the U.S. Marines, says there is little evidence for prophylactic resilience training. He compares the situation in the military to professional football. No matter how much players train during the week, they still get bruised and battered on Sundays. “You can never prevent bad things from happening,” Nash says. “In the same way, you can’t prevent people from getting damaged by stress.”

Can anything be done to promote a person’s ability to cope in the face of adversity? Arming people beforehand may or may not work. Sophisticated drug therapies are years away. After a disaster, the most experienced investigators—psychologists and other health professionals from the National Center for PTSD—have developed an approach designed to encourage a person’s own coping abilities rather than introspective delving into psychopathological reactions. “If someone is okay, you’re acknowledging that they’re okay,” says Patricia Watson, who helped to originate this technique. Psychological First Aid, its formal name, recognizes that many handle things well on their own: it focuses first on the practical. Food and shelter take precedence, but victims also learn about help available and how to monitor their own progress. After 9/11, some of those who had been near the World Trade Center thought anxiety and depression were to be expected three months after the calamity, and so they ignored the kind of help available for those with more than just passing symptoms. “People ended up suffering longer than they had to because they thought this was just normal,” Watson says. For victims of full-fledged post-traumatic stress disorder, various psychiatric drugs as well as cognitive-behavioral therapy that exposes a patient to the source of stress have shown some success.

The new science of resilience shows that one size does not fit all in coming to terms with what befalls us. Sometimes the worst does happen, but our innate capacity to bounce back means that most of the time things turn out all right. ■

Gary Stix is senior writer at Scientific American.

### MORE TO EXPLORE

The Other Side of Sadness: What the New Science of Bereavement Tells Us about Life after Loss. George A. Bonanno. Basic Books, 2009.

Flourish: A Visionary New Understanding of Happiness and Well-being. Martin E. P. Seligman. Free Press, 2011.